Digital Factory and Work Planning using Battery and Fuel Cell Manufacturing Examples

Michael Spitzhirn (imk Industrial Intelligence GmbH)
Sascha Ullmann (imk Industrial Intelligence GmbH)
Eva Tyleckova (Technical University of Ostrava)

imk Industrial
The Intelligence Consortium

imk Industrial Intelligence

Virtual Planning. Real Value.

ema Software Suite for visualization, simulation & evaluation in the digital factory

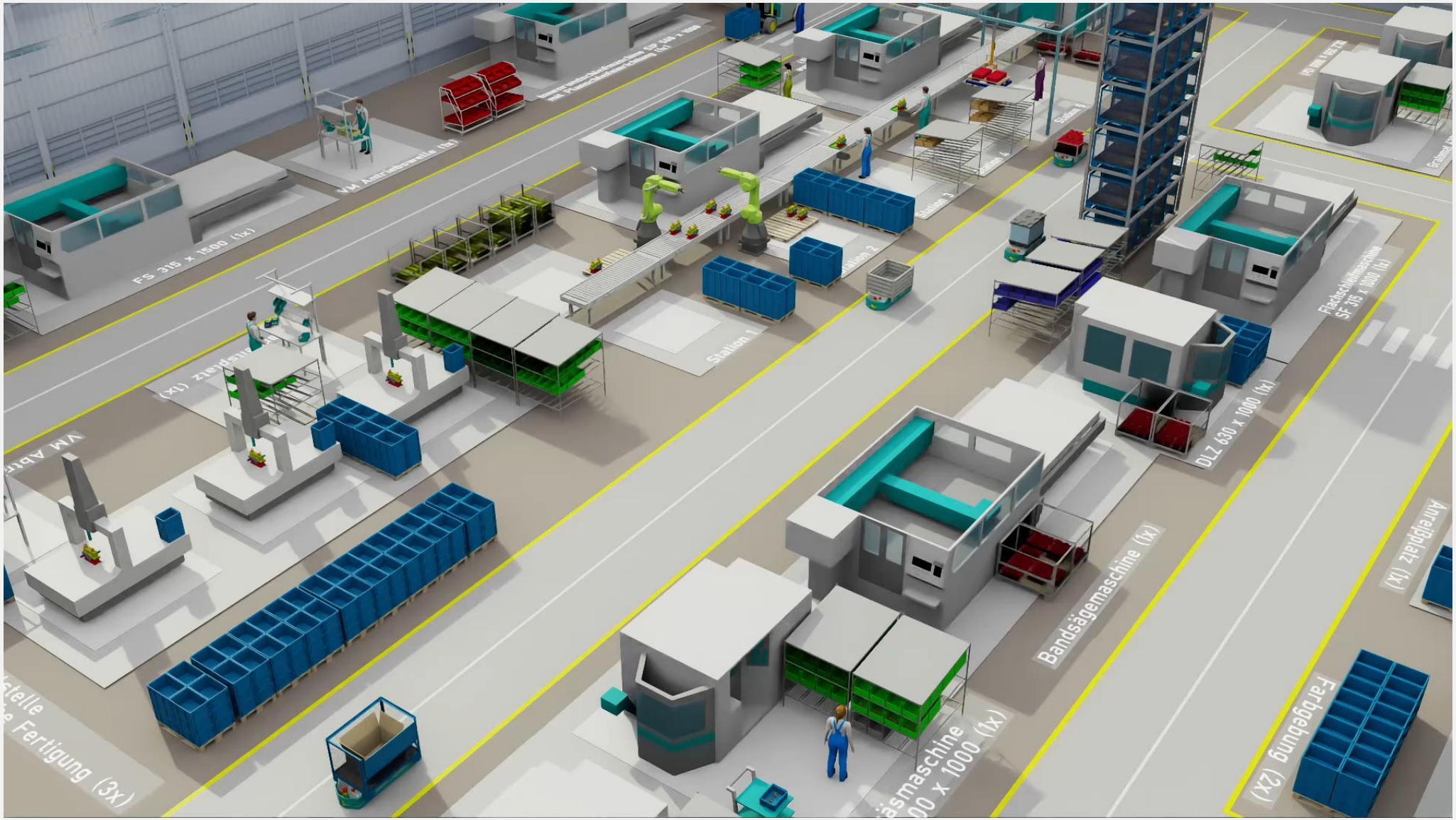
Training & Consulting for competent support in every step towards the Digital Factory

> 20 years experience for different industries, technologies & company sizes

+ 60 Universities & research instituts

imk

ema Software Suite - Digital Factory and Work Planning



Overview ema Software Suite

Plant Designer

- Material flow
- Resources
- Space requirement
- Production costs
- Value Stream

Work Designer

- Layout
- Simulation
- Production time
- Ergonomics
- Walk paths

Virtual Reality

- Viewer
- Layout
- Try-Out

Robotics

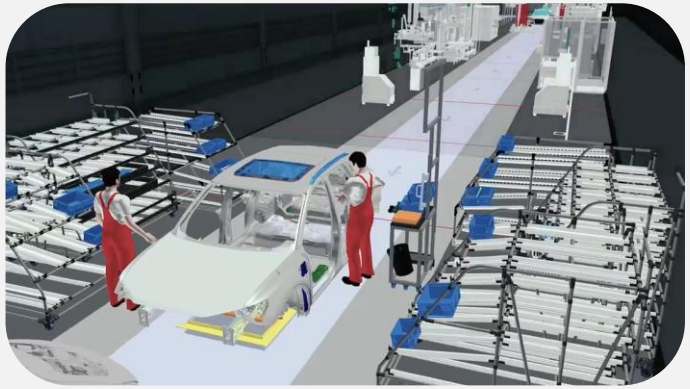
- Robotics
- Interaction
- Risk Assessment

NVIDIA Omniverse™

- High-End-Rendering
- Data exchange
- Real time collaboration

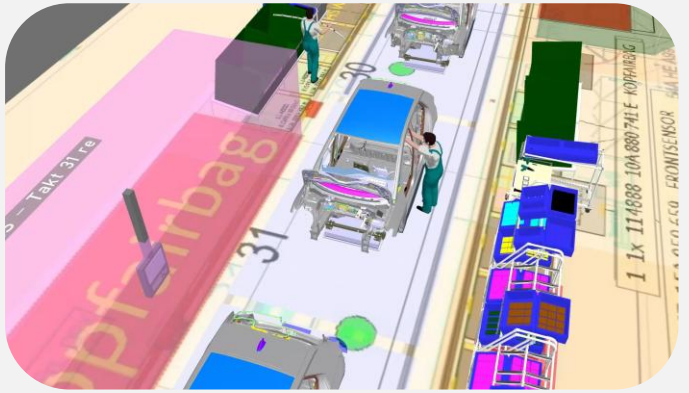
ema Work Designer - Use Cases

Workshops & Virtual Reality

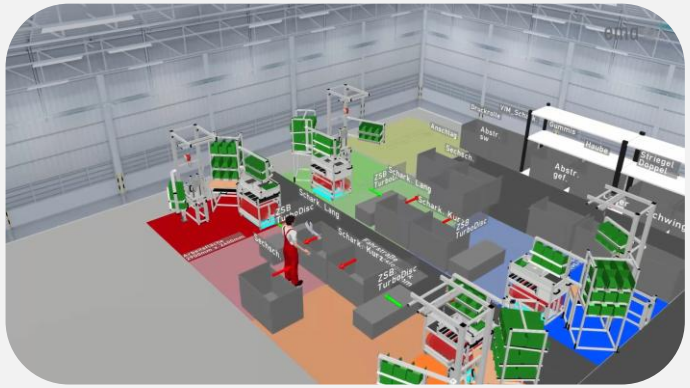


Planning & Virtual Factory

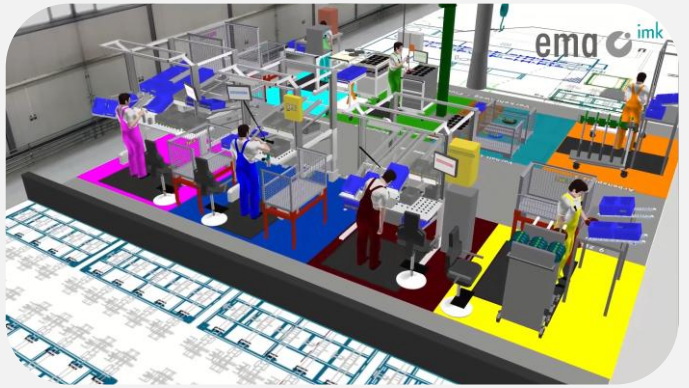
Layout & material provision



Machines & resources

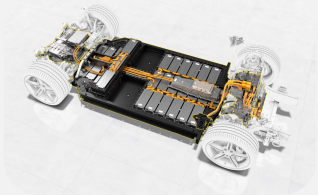


Ergonomics & Variants

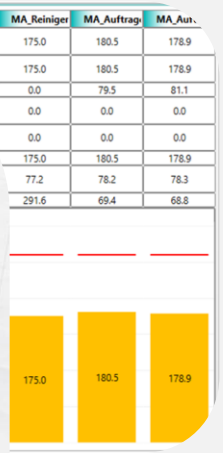


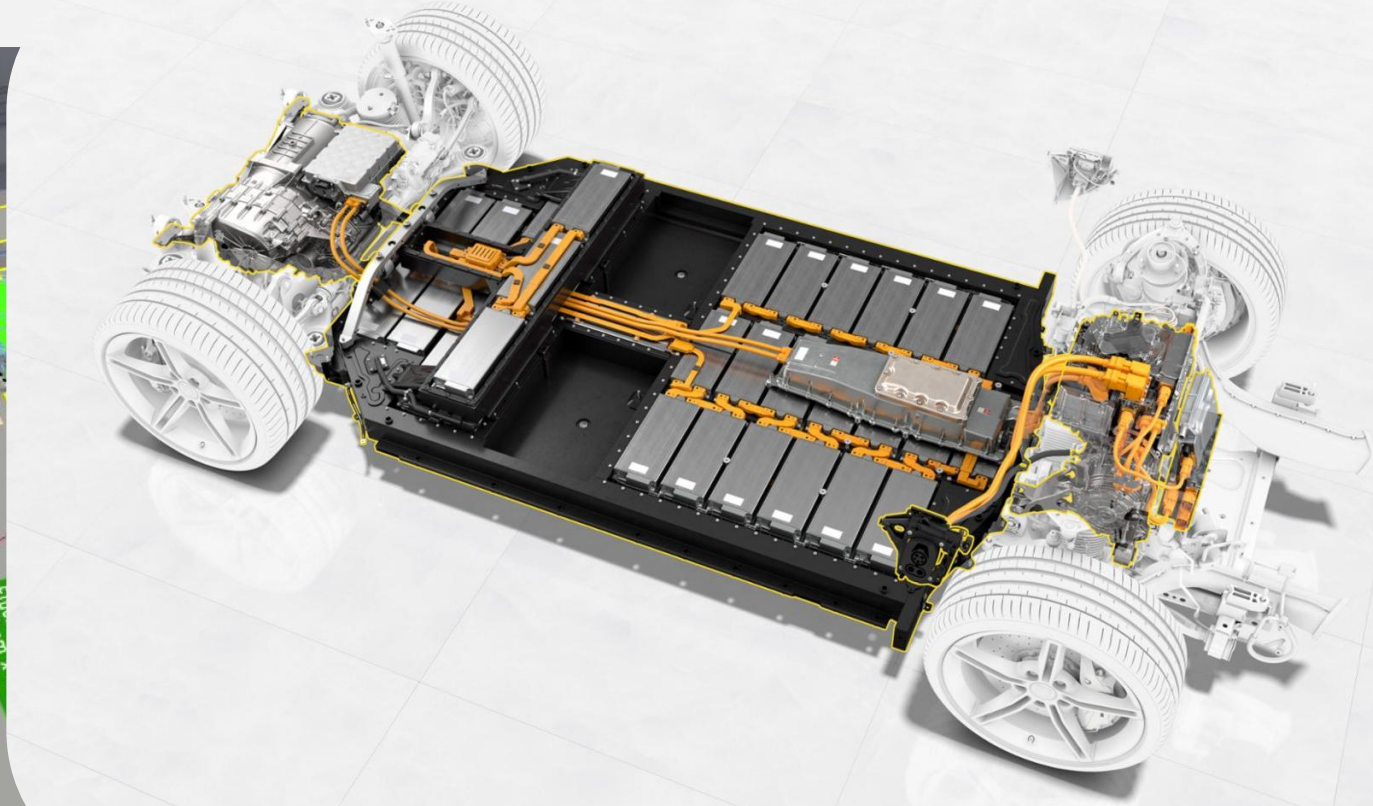
Optimization & Productivity

Designing efficient and ergonomic Battery Systems @ Dräxlmaier Group



Time Analysis





source: Porsche AG

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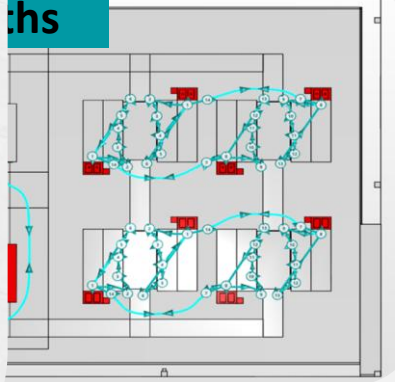
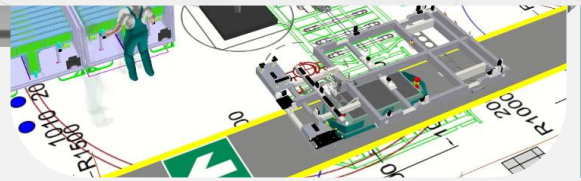




its

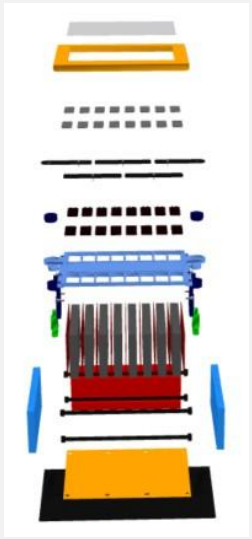
- streamlined & faster offer calcuation
- **Less iterative steps** throught increased results quality
- **Full transparency** between contract partners

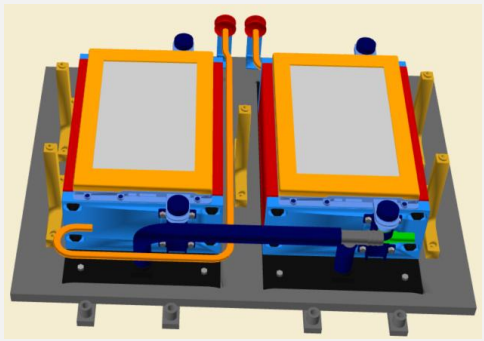
presented @ IIC 2024, Munich

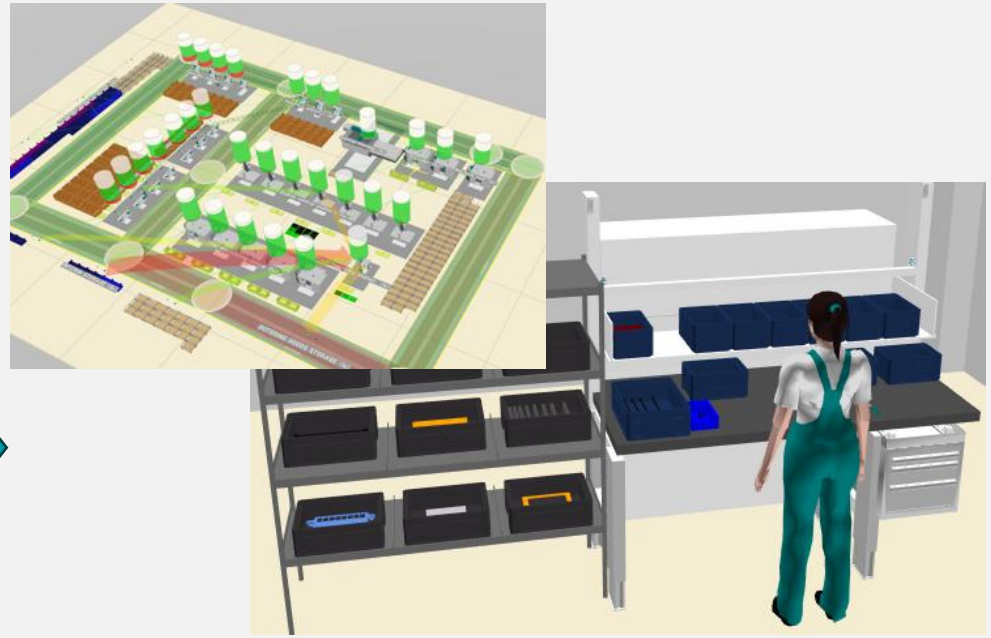
Planning battery production in teaching @ TU Chemnitz, aw&I & VSB

Use Case: Applying ema Software Suite in Education

- Course: Modern Trends in Contemporary Management
- Scenario: Battery Manufacturing
- Final product: Battery system







- Initial scenario: Battery components and Battery Assembly Workstation (non-optimized)
- Objective: Students identify inefficiencies and propose improvements using concepts and methods from theoretical courses.

Planning battery production in teaching @ TU Chemnitz, aw&I & VSB

ema Plant Designer - [edition Professional] - Project "Battery assembly"*

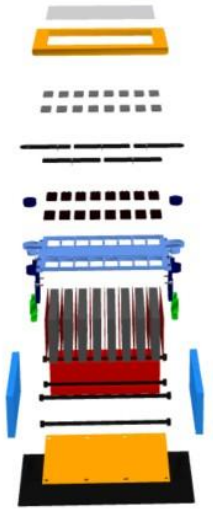
Project View Results Preferences Help emaWD

Library Import Wiz. Load Save Calculate Results Link Subtree MB Make/Buy

emaPD: no linked project
emaWD: no linked project

MBOM Resources

name	id
Workplaces	
Group of Workplaces	
Assembly station 1	659_6...
Assembly station 2	920_2...
Assembly station 3	683_7...
Assembly station 4	883_7...
CNC machinining centre	771_7...
Cutting machine	305_5...
Extruder	351_4...
Final assembly station	801_7...
Machine tool	470_7...
Quality control station 1	716_4...
Quality control station 2	561_2...
Transport Packages	
Containers	
EPAL 6	552_1...
Euro box pallet half he...	978_9...
Packages	
EPAL with KLT 4115	958_2...
EPAL with KLT 3215	163_5...
Pallets	



Features, Employees, Times | Cost

workplace					employee		workplace capacity			unplanned downtimes			planned	planned
name	id	planned...	planning	extern...	setup...	qualification	shift model	weeks [...	maxi...	availa...	MTBF [h]	MTTR [h]	downtimes [h/a]	occupancy ti...
Assembly station 1	659_604	0	☑	☐	☑	Asembly worker	15 shifts per week	50	95.00	95.00	0.00	0.50	2.00	0.00
Assembly station 2	920_281	0	☑	☐	☑	Asembly worker	15 shifts per week	50	95.00	95.00	0.00	0.50	3.00	0.00
Assembly station 3	683_753	0	☑	☐	☑	Asembly worker	15 shifts per week	50	95.00	95.00	0.00	0.50	2.00	0.00
Assembly station 4	883_707	0	☑	☐	☑	Asembly worker	15 shifts per week	50	95.00	95.00	0.00	0.50	3.00	0.00
CNC machinining centre	771_754	0	☑	☐	☑	CNC operator	15 shifts per week	50	95.00	95.00	0.00	0.50	2.00	0.00
Cutting machine	305_543	0	☑	☐	☑	Operator	15 shifts per week	50	95.00	95.00	0.00	0.50	2.00	0.00
Extruder	351_459	0	☑	☐	☑	Operator	15 shifts per week	50	95.00	95.00	0.00	0.50	2.00	0.00
Final assembly station	801_761	0	☑	☐	☑	Asembly worker	15 shifts per week	50	95.00	95.00	0.00	0.50	2.00	0.00
Machine tool	470_795	0	☑	☐	☑	Operator	15 shifts per week	50	95.00	95.00	0.00	0.50	2.00	0.00
Quality control station 1	716_482	0	☑	☐	☑	Quality technician	15 shifts per week	50	95.00	95.00	0.00	1.00	2.00	0.00
Quality control station 2	561_200	0	☑	☐	☑	Quality technician	15 shifts per week	50	95.00	95.00	0.00	1.00	2.00	0.00

Flow Production System | Transport Matrix

Flow Production System

name: Battery assembly

Linked Workplaces | Derive

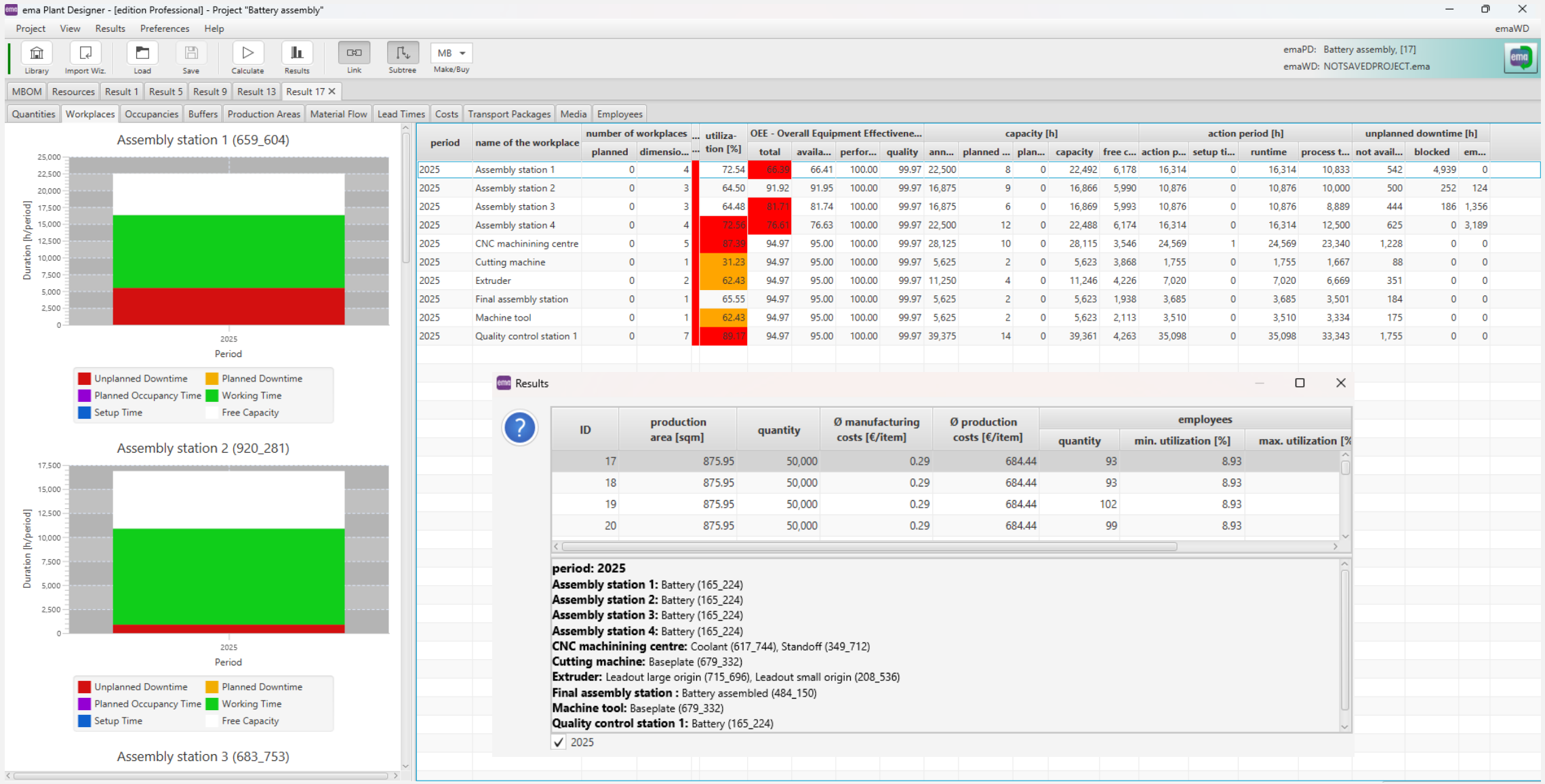
source	sink	buffers [amount]
Assembly station 1 (659_604)	Assembly station 2 (920_281)	0
Assembly station 2 (920_281)	Assembly station 3 (683_753)	0
Assembly station 3 (683_753)	Assembly station 4 (883_707)	0

Setup Parts

name	setup time [...
Name	0.00

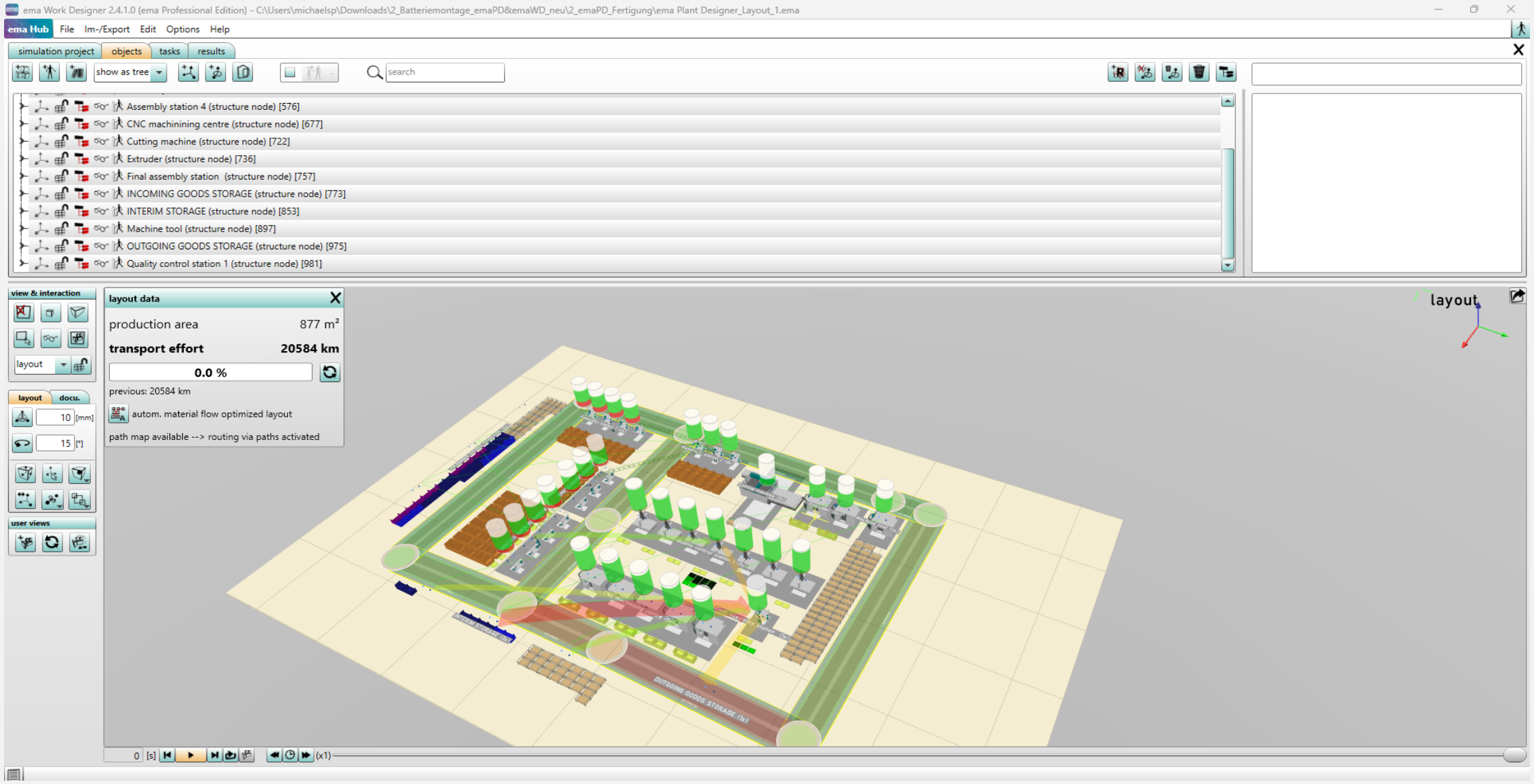
Products in Setup Parts -

Planning battery production in teaching @ TU Chemnitz, aw&I & VSB

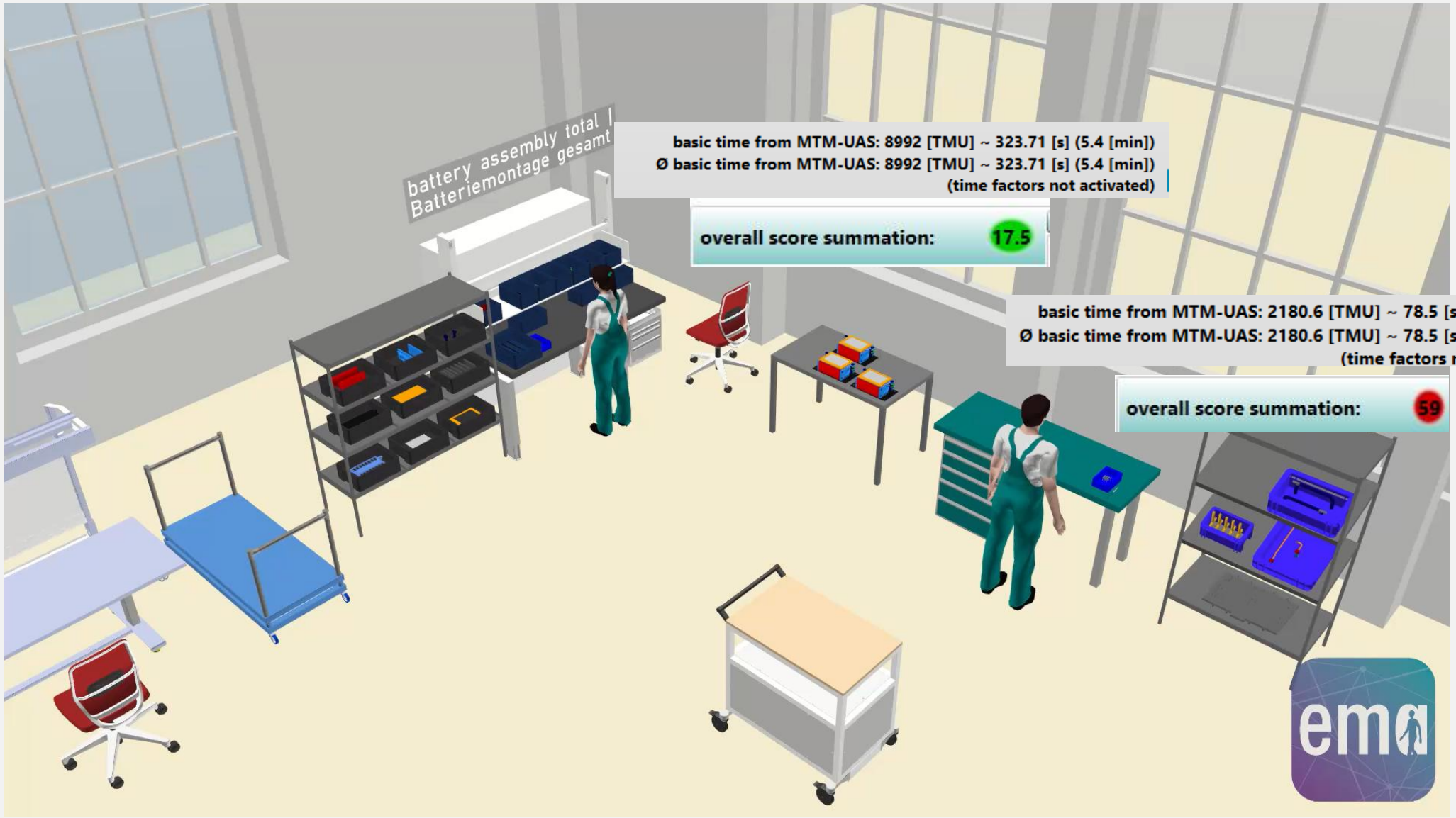


period	name of the workplace	number of workplaces planned	number of workplaces dimensio...	utiliza-tion [%]	OEE - Overall Equipment Effectivene... total	availa...	perfor...	quality	capacity [h] ann...	planned ...	plan...	capacity	free c...	action period [h] action p...	setup ti...	runtime	process t...	unplanned downtime [h] not avail...	blocked	em...
2025	Assembly station 1	0	4	72.54	66.39	66.41	100.00	99.97	22,500	8	0	22,492	6,178	16,314	0	16,314	10,833	542	4,939	0
2025	Assembly station 2	0	3	64.50	91.92	91.95	100.00	99.97	16,875	9	0	16,866	5,990	10,876	0	10,876	10,000	500	252	124
2025	Assembly station 3	0	3	64.48	81.71	81.74	100.00	99.97	16,875	6	0	16,869	5,993	10,876	0	10,876	8,889	444	186	1,356
2025	Assembly station 4	0	4	72.56	76.61	76.63	100.00	99.97	22,500	12	0	22,488	6,174	16,314	0	16,314	12,500	625	0	3,189
2025	CNC machinining centre	0	5	87.39	94.97	95.00	100.00	99.97	28,125	10	0	28,115	3,546	24,569	1	24,569	23,340	1,228	0	0
2025	Cutting machine	0	1	31.23	94.97	95.00	100.00	99.97	5,625	2	0	5,623	3,868	1,755	0	1,755	1,667	88	0	0
2025	Extruder	0	2	62.43	94.97	95.00	100.00	99.97	11,250	4	0	11,246	4,226	7,020	0	7,020	6,669	351	0	0
2025	Final assembly station	0	1	65.55	94.97	95.00	100.00	99.97	5,625	2	0	5,623	1,938	3,685	0	3,685	3,501	184	0	0
2025	Machine tool	0	1	62.43	94.97	95.00	100.00	99.97	5,625	2	0	5,623	2,113	3,510	0	3,510	3,334	175	0	0
2025	Quality control station 1	0	7	89.17	94.97	95.00	100.00	99.97	39,375	14	0	39,361	4,263	35,098	0	35,098	33,343	1,755	0	0

Planning battery production in teaching @ TU Chemnitz, aw&I & VSB

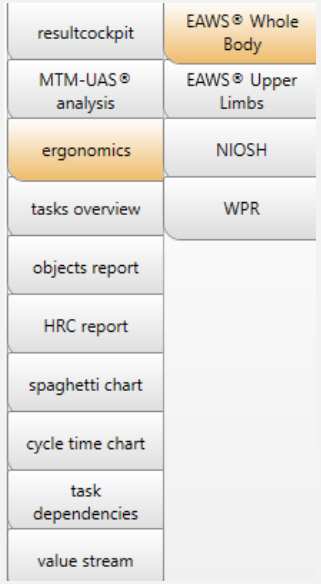


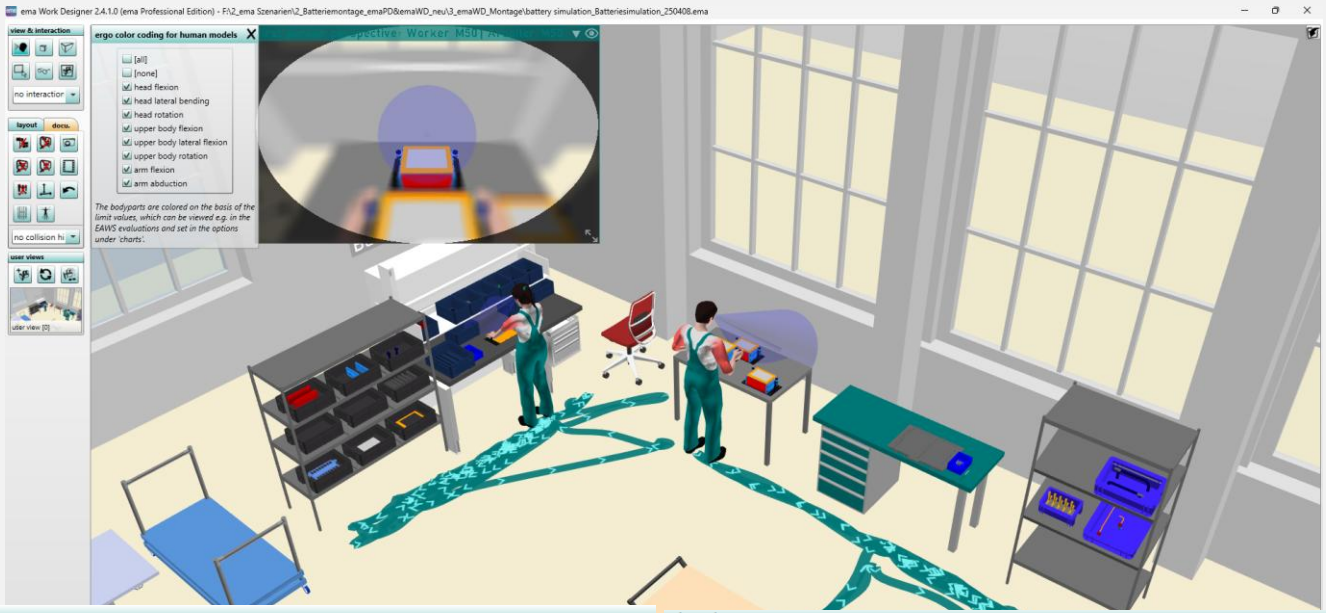
Planning battery production in teaching @ TU Chemnitz, aw&I & VSB

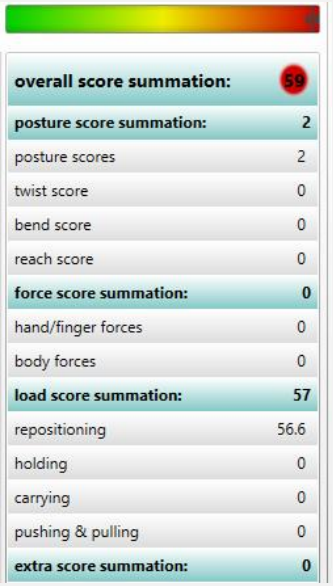


8x playback speed

Planning battery production in teaching @ TU Chemnitz, aw&I & VSB





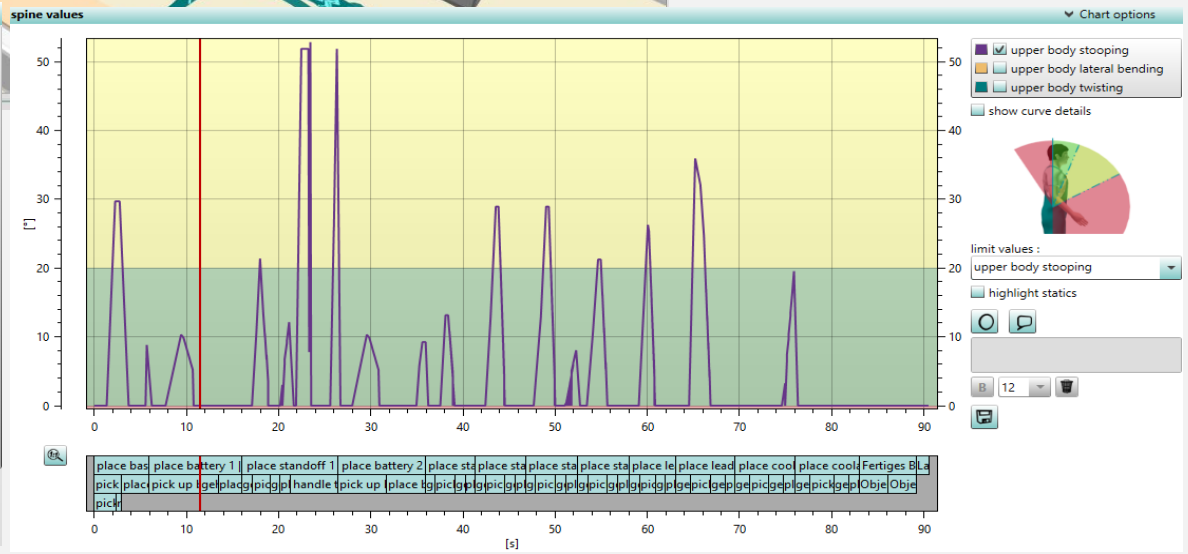


MTM-UAS® analysis

	#	type	code	hand	TMU	q x f	TMU infl.	TMU uninfl.	overall TMU	duratic [s]	Ø dura [s]	cycle [%]
−	1	**[226] place baseplate | Platzieren von Grundplatte**			**165**		**215.0**	**0.0**	**215.0**	**7.74**	**7.74**	**100.00**
−	2	**[342] pick up baseplate | Aufnehmen Grundplatte**			**130**		**155.0**	**0.0**	**155.0**	**5.58**	**5.58**	**100.00**
	3	[341] pick up baseplate | Aufnehmen Grundplatte	KA		25	2 * 1	50.0	0.0	50.0	1.80	1.80	100.00
	4	[341] pick up baseplate | Aufnehmen Grundplatte	KB		60	1 * 1	60.0	0.0	60.0	2.16	2.16	100.00
	5	[341] pick up baseplate | Aufnehmen Grundplatte [344] move object(s) to target	AH2	L + R	45	1 * 1	45.0	0.0	45.0	1.62	1.62	100.00
	6	[230] place baseplate | Platzieren von Grundplatte	KA		25	2 * 1	50.0	0.0	50.0	1.80	1.80	100.00
	7	[230] place baseplate | Platzieren von Grundplatte	PA1	L + R	10	1 * 1	10.0	0.0	10.0	0.36	0.36	100.00
−	8	**[227] place battery 1 | Platzieren von Batterie 1**			**145**		**245.0**	**0.0**	**245.0**	**8.82**	**8.82**	**100.00**
	9	[232] pick up battery 1 | Aufnehmen Batterie 1	KA		25	3 * 1	75.0	0.0	75.0	2.70	2.70	100.00
	10	[232] pick up battery 1 | Aufnehmen Batterie 1 [231] place battery 1 | Platzieren von Batterie 1	AM1	L + R	95	1 * 1	95.0	0.0	95.0	3.42	3.42	100.00
	11	[386] gehen zu Montagetisch | walk to assembly table	KA		25	3 * 1	75.0	0.0	75.0	2.70	2.70	100.00
−	12	**[233] place standoff 1 | Platzieren von Abstandshalter 1**			**151**		**200.0**	**55.6**	**255.6**	**9.20**	**9.20**	**100.00**
	13	[406] gehen zu regal links / walk to rack_left	KA		25	2 * 1	50.0	0.0	50.0	1.80	1.80	100.00

basic time from MTM-UAS: 2180.6 [TMU] ~ 78.5 [s] (1.31 [min])
Ø basic time from MTM-UAS: 2180.6 [TMU] ~ 78.5 [s] (1.31 [min])
(time factors not activated)

approved by MTM ASSOCIATION



RUBIN
Regionale unternehmerische Bündnisse für Innovation

DuSwaP

– DuSwap–

Development of a dual stacking concept and hydrogen-free test scenarios as a basis for the provision of future required quantities of fuel cell stacks

Project partner

SITEC

XENON

texulting

sciospec

3D LABS

WiE Werk für industrielle Elektronik

KIESELSTEIN

TISORA TECHNOLOGIE INNOVATION SERVICE

FIBER-TECH FACTORY PARTS

Fraunhofer IWU

BEAS TECHNOLOGY

AMC www.amc-systeme.de

autengine

The project is funded by the BMBF.

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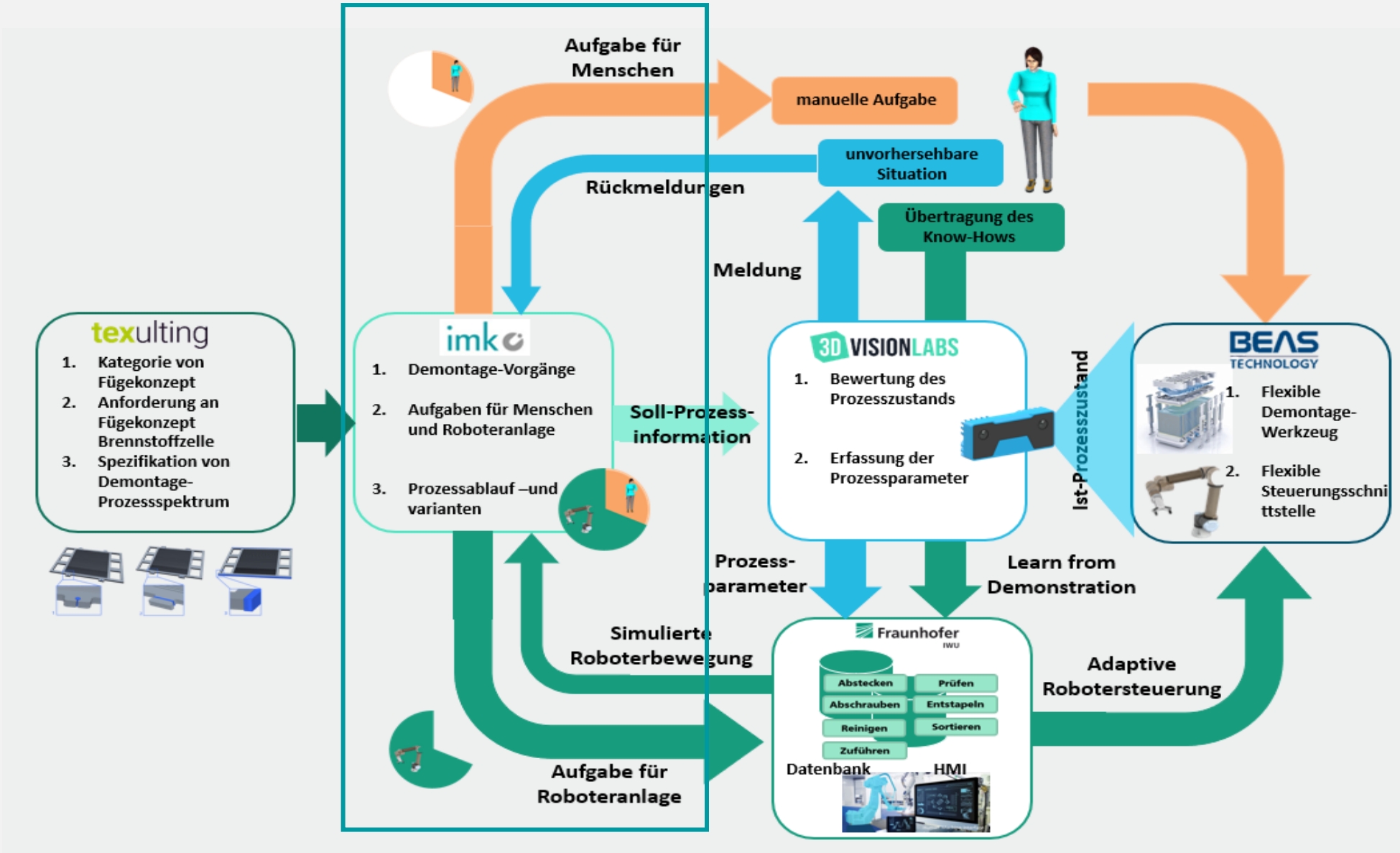
Bundesministerium für Bildung und Forschung

DuSwap: Flow chart for disassembling fuel cell stacks



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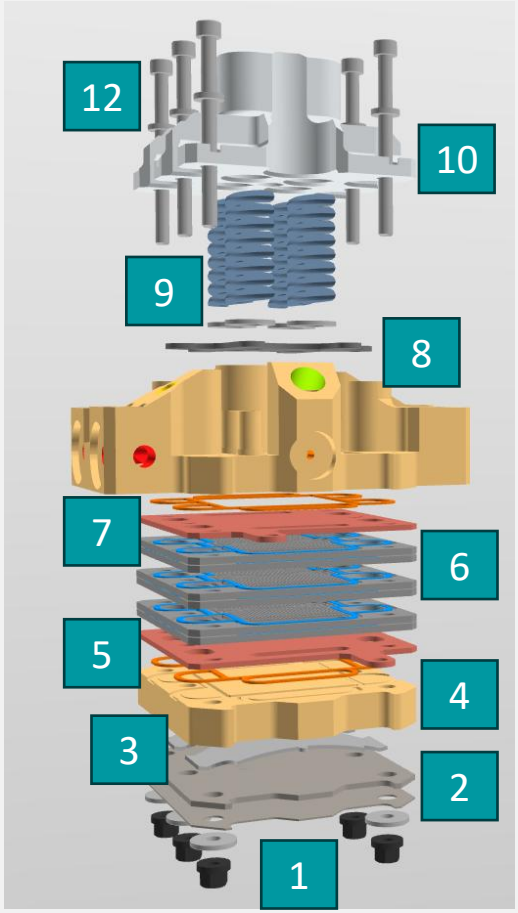
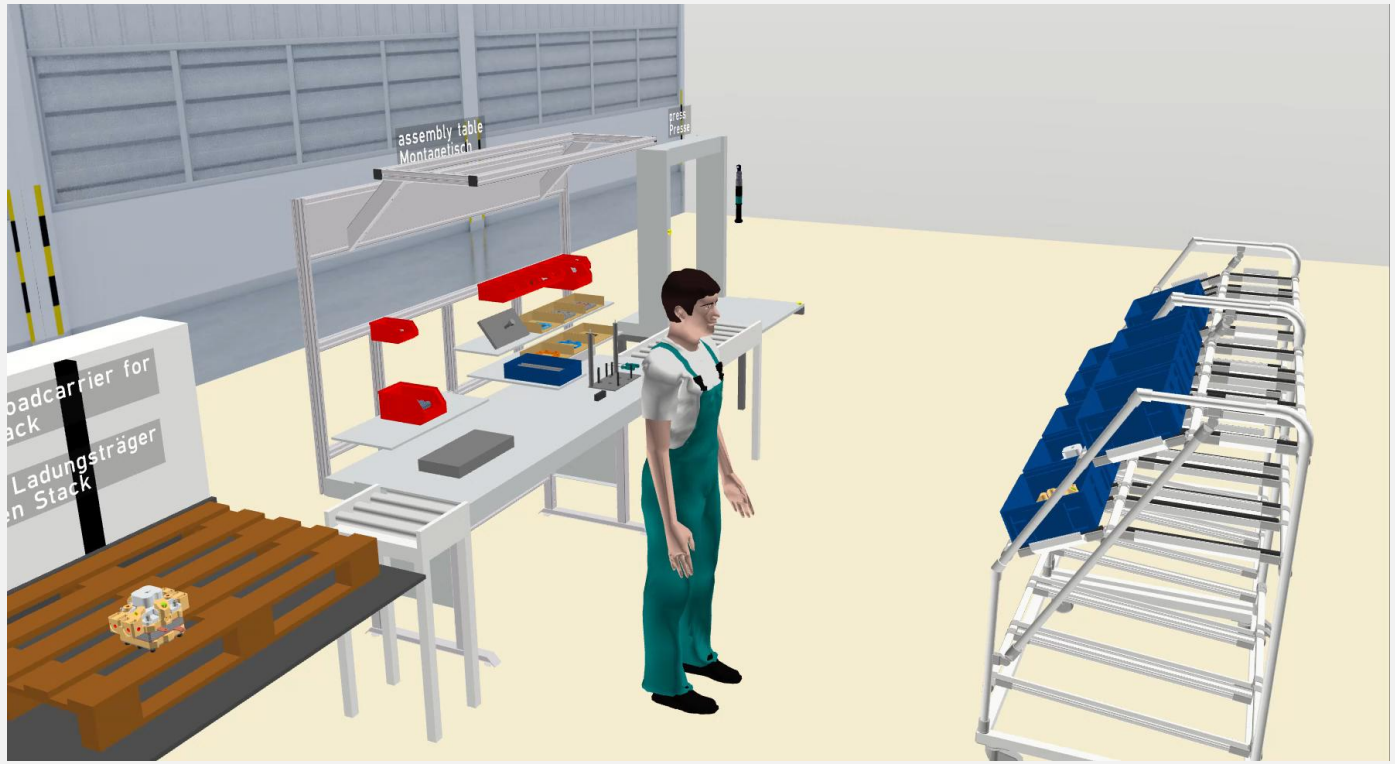
Open Source Stack OSS050: Components and Workflow Assembly



Nr.	Assembly work steps
1.	6 Insert cap nuts and washers into the workpiece carrier
2.	Place 2 compression plates (0.13 and 0.39 kg)
3.	Place compression spring plate (0.16 kg)
4.	Place the end plate at the bottom (0.33 kg) and insert the cell seal
5.	Place collector cathode (0.38 kg)
6.	Insert 3 single cells
7.	Place collector anode (0.38 kg) and cell seal
8.	Place compression plate (0.08 kg) on end plate (1.0 kg)
9.	Attach 4 spring elements (0.51 kg) with washers
10.	Place pressure hood (0.66 kg)
11.	Place ASM Upper end plate system (8. - 10.)
12.	Screw in 6 screws with washers
13.	Place finished stack in press

Assembly of OSS Stack



8x playback speed

	F05	M50	M95
EAWS whole body [Pt]	83.5	24.0	24.0
body posture [Pt]	2.0	2.0	2.0
action forces [Pt]	0.0	0.0	0.0
manual handling [Pt]	81.5	22.0	22.0
extra points [Pkt]	-	-	-
EAWS Upper extremities [Pt]	42.9	39.8	35.9
Base time (MTM-UAS) [min]	6.4	6.4	6.5
Walking distance [m]	44.4	44.4	44.4

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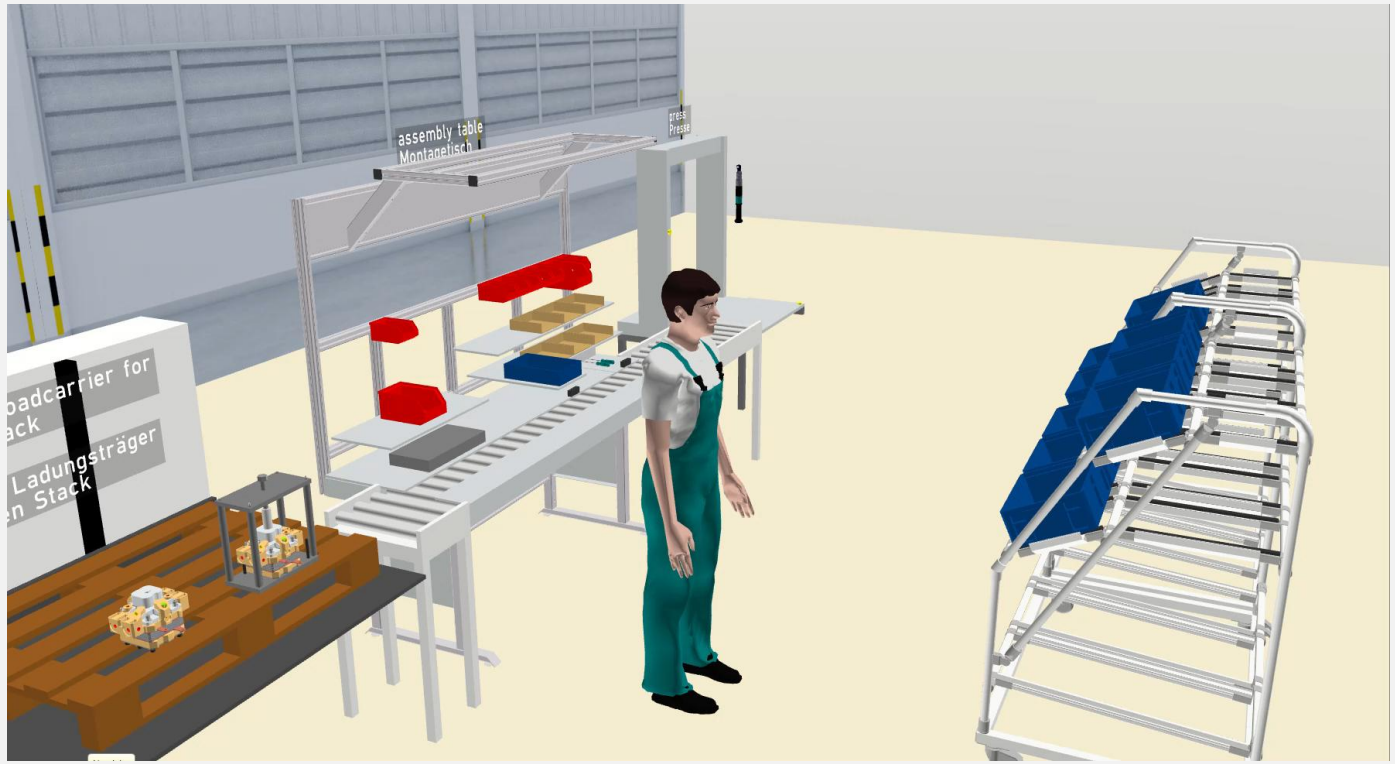
Disassembly of OSS Stack



8x playback speed

	F05	M50	M95
EAWS whole body [Pt]	98.5	15.5	28.0
body posture [Pt]	7.5	2.0	2.0
action forces [Pt]	0.0	0.0	0.0
manual handling [Pt]	91.0	13.5	26.0
extra points [Pkt]	-	-	-
EAWS Upper extremities [Pt]	40.6	40.7	40.6
Base time (MTM-UAS) [min]	4.7	4.7	4.8
Walking distance [m]	39.6	39.7	39.7

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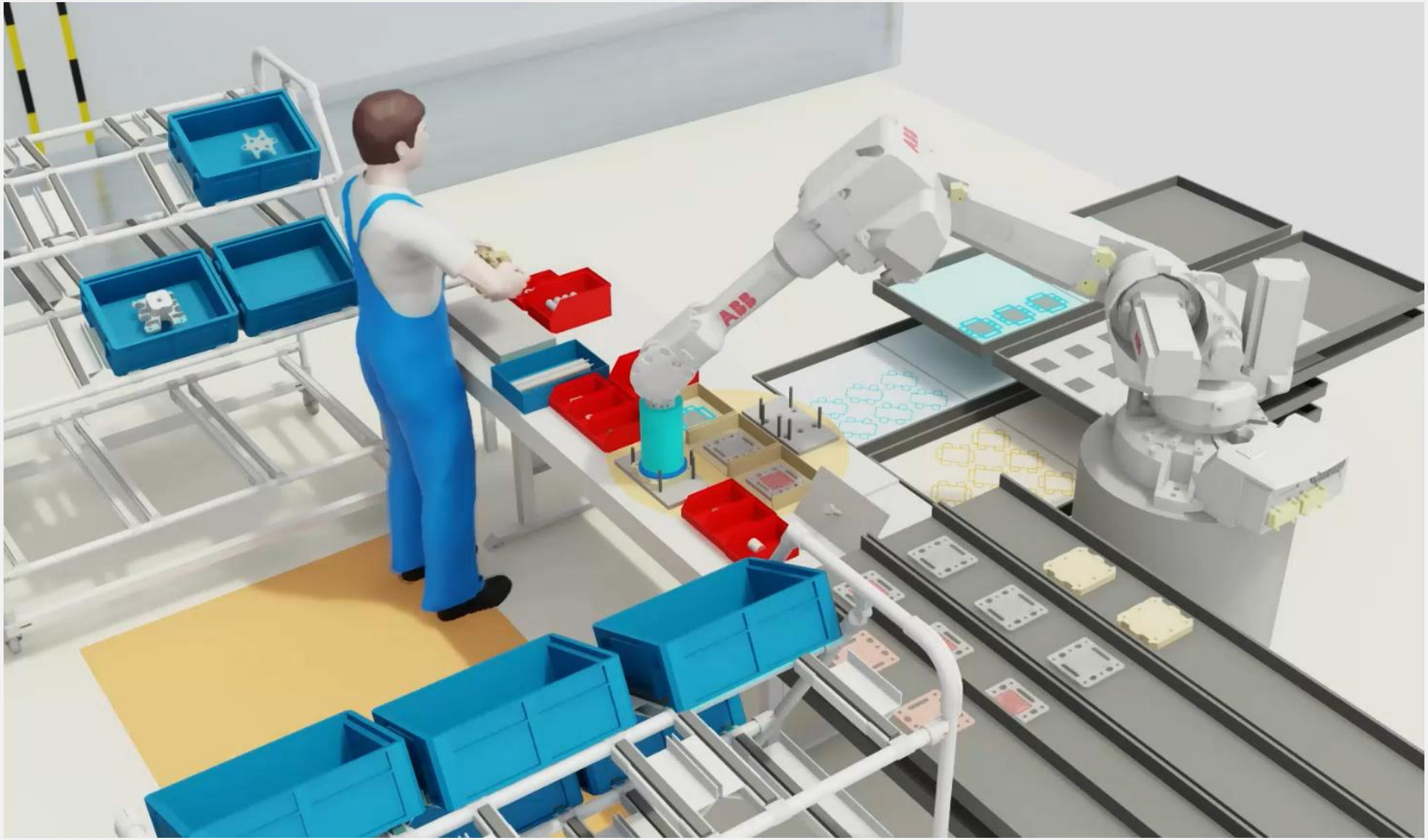
DuSwap: OSS Stack concept for collaborative work system



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für Bildung
und Forschung

Michael Spitzhirn

Specialist Digital Ergonomic Methods
Coordinator research projects and ema Education

+49 (0)151 289 00 775
michael.spitzhirn@imk-ic.com
www.imk-ic.com