



ergon nomos

innovations methods koncepts

Interactive Preproduction Planning and Ergonomic Assessment with ema⁵ – Introducing the “Editor for Manual Work Activities”



Agenda

1. imk automotive, Inc.
2. ema[®] Approach
3. ema[®] Application
4. imk Services



innovations

- ▶ **are our passion.**
Creative thinking is embedded in our company culture. Innovation enables us to generate long-term competitive advantages for our customers.

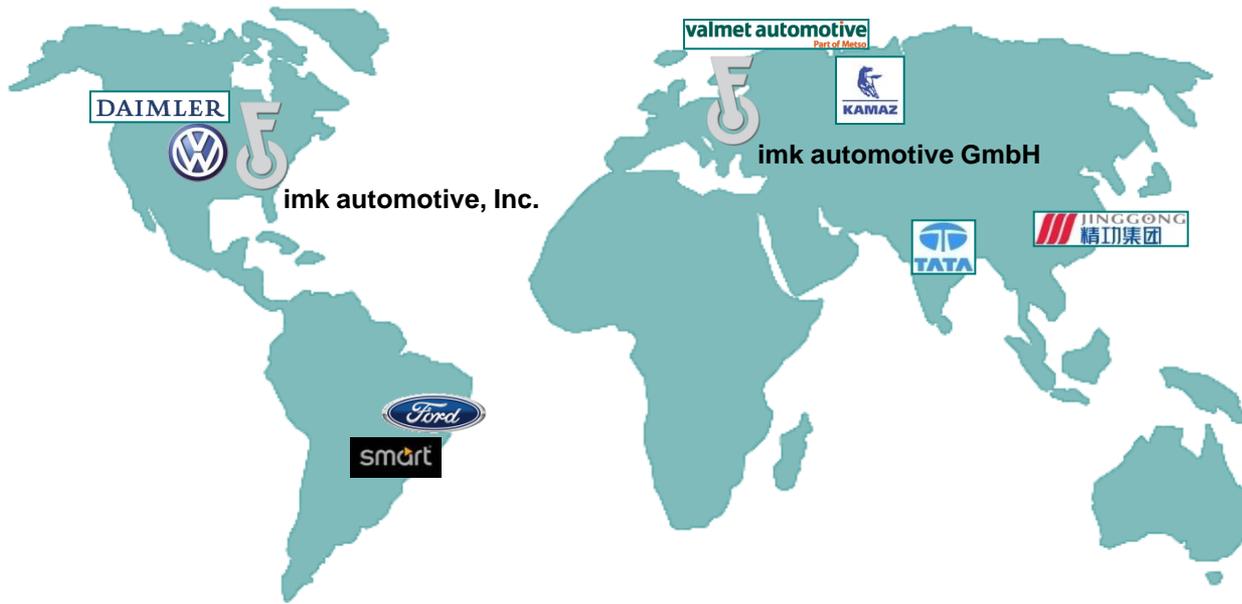
methods

- ▶ **are our foundation.**
They assure quality and ensure our project deadlines. We continuously improve our performance by developing and extending our range of methods.

koncepts

- ▶ **are our result.**
They are created by the interaction of innovation, methods, and professional experience. Our success is defined by measurable customer success.

Worldwide dedicated to the success of our customers.



European Customers



Automotive industry, mechanical engineering, industrial commodities, renewable energies, information systems, and aerospace industry.



Cross-industry consulting and engineering solutions.

Product Development
Dr. Jens Trepte

- Battery-electric Vehicles
- Mechatronic Systems
- Structural Components

Production Process Development
Carsten Otto

- Process Design
- Manual Production & Assembly
- Body In White

Information Technology
Gerson Heuwieser

- Software Development
- Training
- Support & Service

Consulting
Ingolf Grüßner

- Production Strategy
- Product & Production Optimization
- Ergonomics

Strategic Development
Dr. Wolfgang Leidholdt





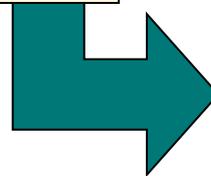
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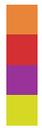
Human work planning on its way into the 3D Virtual Factory?

MTM / UAS Basic activities						
Get and Place	Dist. Rang. cm	Code	<= 20	> 20 to <= 50	> 50 to <= 80	
			1	2	3	
<= 1 daN	Easy	approx.	AA	20	35	50
		loose	AB	30	45	60
		tight	AC	40	55	70
	Difficult	approx.	AD	20	45	60
		loose	AE	30	55	70
		tight	AF	40	65	80
Handful	approx.	AG	40	65	80	
> 1 to <= 8 daN	approx.	AH	25	45	55	
	loose	AJ	40	65	75	
	tight	AK	50	75	85	
> 8 to <= 22 daN	approx.	AL	80	105	115	
	loose	AM	95	120	130	
	tight	AN	120	145	160	
Place		Code	1	2	3	
approximate		PA	10	20	25	
loose		PB	20	30	35	
tight		PC	30	40	45	
Operate		Code	1	2	3	
one single operation		BA	10	25	40	
compound operation		BB	30	45	60	
Handle Tool Get, Place and Place aside		Code	1	2	3	
approximate		HA	25	45	65	
loose		HB	40	60	75	
tight		HC	50	70	85	
Motion Cycles		Code	1	2	3	
one motion		ZA	5	15	20	
motion sequence		ZB	10	30	40	
shift and one motion		ZC	30	45	55	
Fasten or Loosen		ZD	20			
Body Motions		Code				
walk / m		KA	25			
bend, stoop, kneel incl. arise		KB	60			
sit and stand		KC	110			
Visual Control		VA	15			
Process times		Code				
Process time restricted		PTU	1			
Process time unrestricted		PTB	1			
Process time		PT	1			



- Today's digital human models cannot understand standardized work instructions.
- Each particular movement has to be taught manually by highly qualified engineers.
- Compiling dynamic simulations of human work is complicated and costs a lot of time.
- Simulation models do not provide suitable tools for analyzing assembly time and ergonomics.

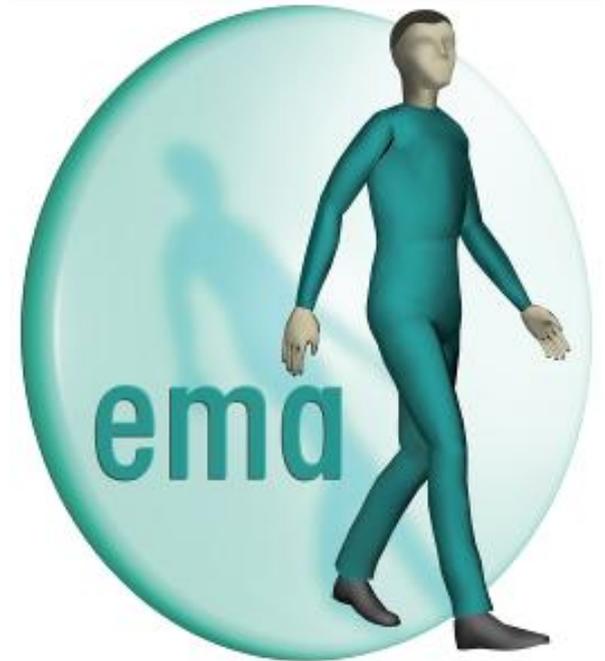


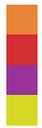


What is ema⁵?

- ema⁵ is the evolution from the unskilled digital human model to the virtual craftsman.
- ema⁵ is providing the human model the skills to understand and act according to standard work instructions.

How is that possible?





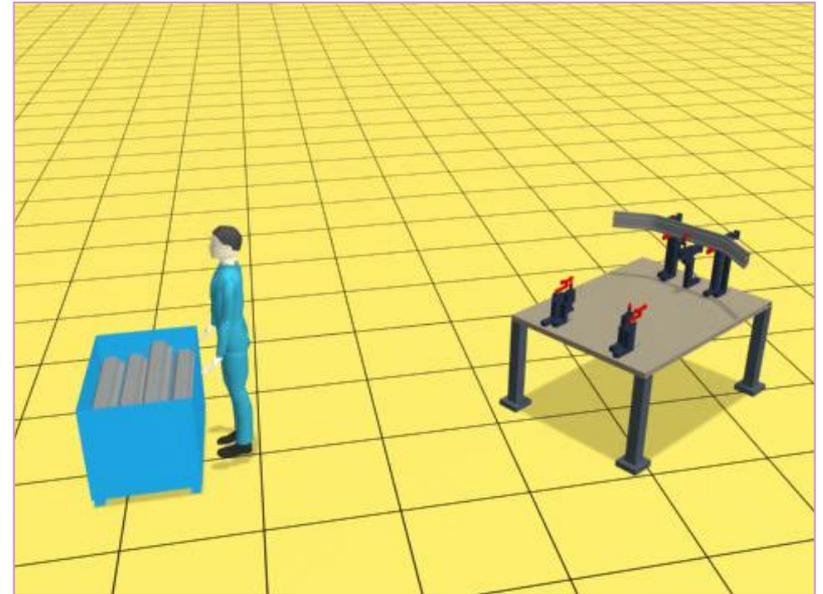
What is ema⁵?

The production planner is not a **Pixar™ animator!**

Instead of teaching each single posture ema⁵ uses **complex operation steps**, e.g.



- get and place object
- use hand tool / screw
- ingress / egress car
- etc. (~300 operations)



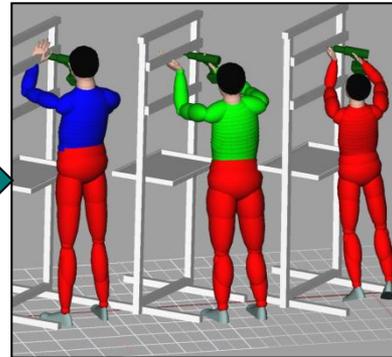
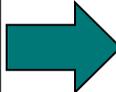
Not: Step(s) forward → stand upright → bend → hand to the object → pick → object to body → step(s) sideways → turn → step(s) forward → bend → object to target → let loose → hand back

But: take part out of box and place to corresponding appliance



What is ema⁵?

Complex operation steps are based on intensive research studies recording experienced workers with motion capturing technologies.



Verbundprojekt: „eMAN“
System zur Bewegungssynthese für digitale Menschmodelle

Professur Arbeitwissenschaft
 GOV
 Institut für Mechanik
 imk automotive

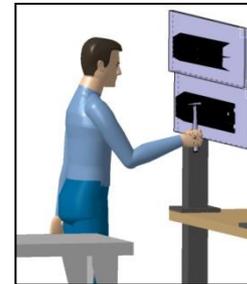
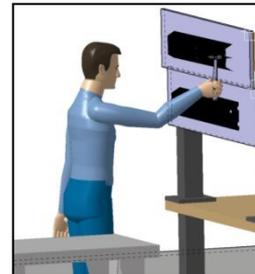
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 Europa fördert Sachsen.
 EFRE
 SACHSEN



ema⁵ brings human life into the virtual factory.

- ema⁵ understands work instructions.
- ema⁵ moves just like real humans do.
- ema⁵ is based on MTM standard times.
- ema⁵ allows reliable ergonomic evaluations.
- ema⁵ can be adapted to any PLM infrastructure.



ema⁵ enhances simulation quality, enables quick simulation updates, and saves up to 90% time.



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Library of complex operations

- task library
- synchronization activities
- head movement activities
- body movement activities
 - stand up
 - kneel down
 - sit down
 - single full step
 - single step
 - single step in direction
 - turn in direction
 - turn to object
 - walk on path
 - walk to target
- hand / arm movement activities
- object handling activities
 - encompass an object
 - hand object over
 - move object(s) on path

Drag & drop to define work process

Task Name	Duration 1	Duration 2	Duration 3	Duration 4	Duration 5	Duration 6
tKneelDown_39	25.625	26.25	26.875			
tMoveHatMovitMove	27.5	28.125	28.75	29.375	30	
tStandUp_40						

Automatic calculation of MTM-time

Parameter specification

tMoveHandToDefaultPos_10

- user defined name: tMoveHandToDefaultPos_10
- predefined target time [s]: 0.0
- use left hand:
- use right hand:
- body movement type: prevent stooping
- hand target type: over shoulder
- distance: close
- transversal position: neutral
- fix used hand(s) at target:

19:02:02:437 Job 'Framework initialization' has been done. Duration: 00:00:02.5312500

emaV5 - editor of manual activities

File Options Help

objects tasks ergonomics results

Worker calc. ergonomics

common

base cycle time [s] 60.0

influences by working on moving parts

derogation Rückwärts / seitwärts Laufen wenig

accessibility

accessibility Einsteigen in vorderen Innenraum

vibrations, momentum, forces

count 4-5

intensity apparent

joint postures

duration 0%

intensity ~1/2 max

other stresses and strains

other keine anderen körperlichen Belastung

Posture analysis (type, duration, percentage)

#	posture type	duration sum [s]	percentage [%]	posture score	twist score	bend score	reach score
3		0.000	0.00	0	0	0	0
4		0.000	0.00	0	0	0	0
5		1.238	2.06	1	0	0	0
6		1.624	2.71	3	0	0	0
7		0.000	0.00	0	0	0	0
8		0.000	0.00	0	0	0	0
9		0.000	0.00	0	0	0	0
10		0.000	0.00	0	0	0	0
11		0.000	0.00	0	0	0	0
12		4.409	7.35	5	0	0	0

Total risk score

overall score summation: 31

posture score summation: 17

posture scores 17

twist score 0

bend score 0

reach score 0

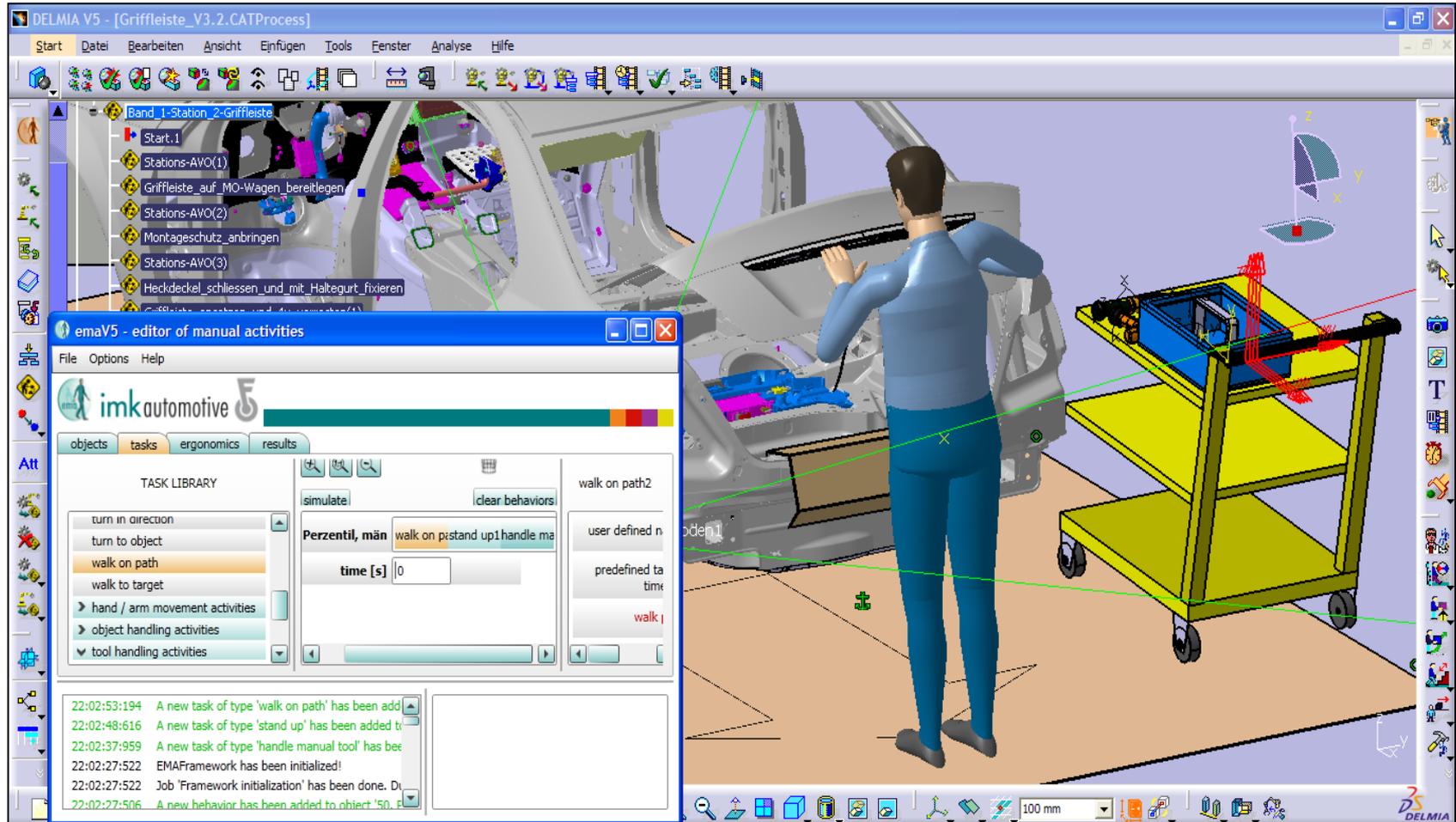
extra score summation: 14

influences by working on moving parts 3

Detailed timeline (e.g., spine flexion)

19:02:08:750 A grid with 4100/4100/4100 (l/w/h) and 68921 gridcells have been initialized.

19:02:08:203 113 nodes have been added to scenegraph, 0 errors have occurred.





Standard features of ema⁵ V1.0

- Library of elementary complex operation steps
- Full integration into PLM infrastructure of DELMIA V5
- Intuitive graphical user interface in German & English language

Analysis functions of ema⁵ V1.0

- Collision avoidance based on bounding volumes
- Plausibility check regarding the logical sequence of operations
- Automatic determination of walking paths and grip points on objects
- Calculation of standard times (MTM1) and automatically generated times
- Full ergonomic assessment based on standard “Automotive Assembly Worksheet”
- Synchronization points for the temporal coordination of activities for multiple workers

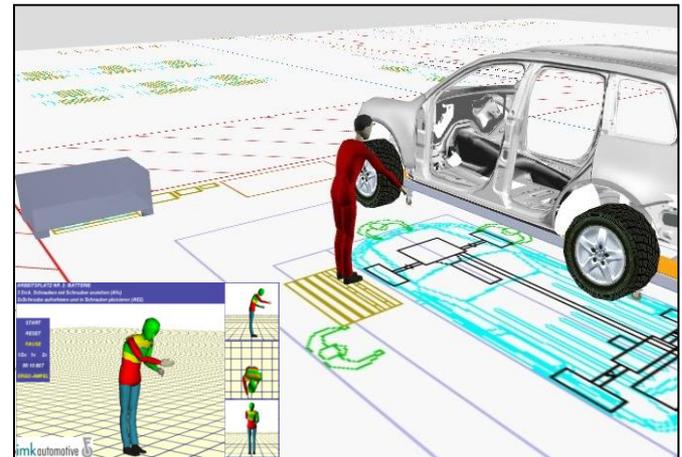


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Experts in integrating human Workforce into efficient production processes.

- Ergonomic analysis and consulting
 - Preventive production planning: identification of ergonomic weaknesses in the design of products, processes, and equipment
 - Optimization of series production: improvement of ergonomic conditions to keep workers' health and increase efficiency
- Customized trainings in Ergonomics
- Customized pilot applications of ema⁵
- Digital Production Planning / 3D validation
- Lean manufacturing & Industrial engineering





Ergonomic workplace design for ramp-up of entire VWGoA Chattanooga plant.

- Ergonomic evaluation of all manual work in Assembly, Body, Paint, and Logistics
- Status visualization on “Ergonomic Map”
- Development of counter measures for improving ergonomic conditions (e.g., work process optimization, tools & parts design)
- Follow-up workshops to test and facilitate implementation of counter measures
- Documentation and continuous status reporting to Plant Management

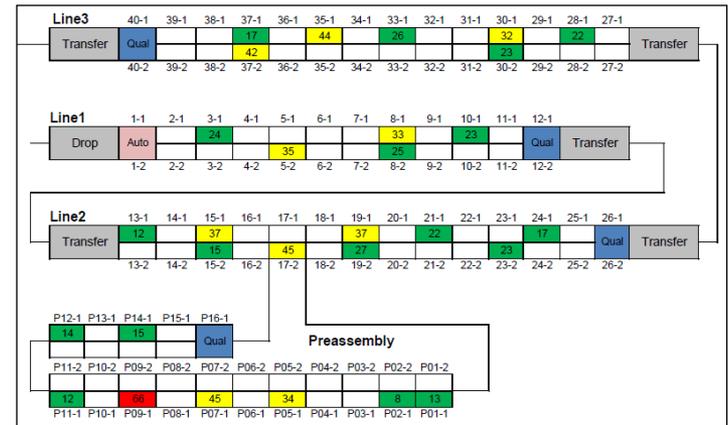


Figure 1: Status visualization on Ergonomic Map

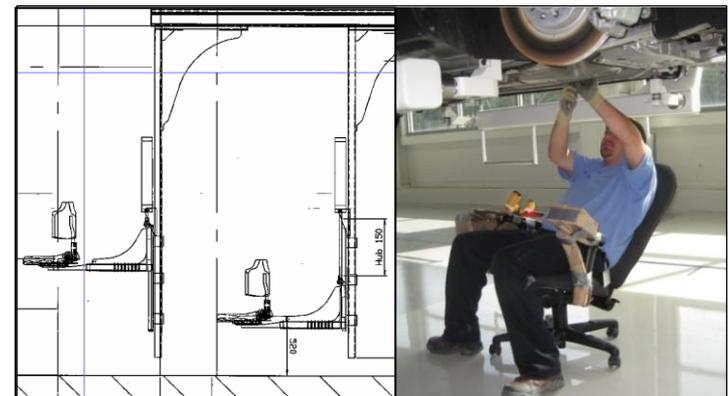


Figure 2: Development and testing of counter measures



We're here to help! For more information please contact:

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