Green Transport Delta

Electrification

Work Packages 2
The journey of building a batterypack assemblyline

21 Nov 2024

VDL NEDCAR

BRAINPORT DEVELOPMENT
economische ontwikkelingsmaatschappij

rai AUTOMOTIVE INDUSTRY NL

Battery Competence Center

Making a Battery pack production line

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- Project demand
  - High mix low volume batterypack productionline
- Product data
  - Batterypack Product data from our Partners
  - Batterypack product data available online ect.
- Process data

cat	sele	Product requirements	MIN	MAX
pack	0	P_dimensions (lxbxh) in mm	566 x 449 x 106	2050 x 1600 x 776
pack	1	P_ Dimension L (mm)	566	2080
pack	1	P_Dimension B (mm)	449	1600
pack	1	P_Dimension H (mm)	106	776
pack	1	P_Volume	84,51	787,10
pack	1	P_Weight (kg)	85	863
pack	1	P_Voltage (Volts) nominal	52	666
pack	1	P_Power (Ah)	71,12	400
pack	1	P_Capacity (kWh)	5,824	135
pack	1	P_Cooling type	air	liquid
pack	1	P_heat dissipation from cell / module		
pack	1	P_Thermal interface to pack	various	various
pack	1	P_IP rating	IP54	IP69k
mod	0	Module dimensions (lxbxh) in mm	505 x 276 x 74	780 x 360 x 190
mod	1	M_dimension L (mm)	432	780
mod	1	M_dimension B (mm)	276	361
mod	1	M_dimension H (mm)	74	190
mod	1	Module strings in pack s/p array	2	6
mod	1	Module number in string (#)	2	8
mod	1	Mvoltage nominal (Volts)		
mod	1	M_Power (Ah)		
mod	1	M_Capacity (kWh)	4,14	35
mod	1	M_Weight (kg)	21,1	217
mod	1	M_Controling unit		
mod	1	M_#cell per module	30	104
mod	1	M_Static Voltage difference		
		M_Temperature sensor accuracy		
		M_cooling plate air leaktest		
cell	1	C_Cell lowest voltage (mV)		
cell	1	C_Cell highest voltage (mV)	3700	3700

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01 LOADING ENCLOSURE

- INSTALL COOLANT BULKHEAD
- INSTALL COOLANT MANIFOLD
- INSTALL VENT & FLUID DRAIN
- INSTALL CONNECTORS
- INSTALL HV PARTS

02 ELECTRICAL PREPARATION

- INSTALL BUSBARS
- INSTALL CABLE HARNESS
- INSTALL FUSEBOX
- INSTALL BMS

03 THERMAL PREPARATION

- INSTALL HOSE CLIPS
- INSTALL COOLANT MODULE CONNECTORS
- INSTALL COOLANT MAIN LINE

04 MODULE PLACEMENT

- PICK AND PLACE MODULES
- COOLANT MANIFOLD INSTALL
- HV CHAIN INSTALL

05 THERMAL INSTALL

- INSTALL HOSE
- INSTALL COOLING PLATE
- INSTALL COOLANT HOSE

06 THERMAL TESTING

- LEAKTEST COOLING SYSTEM

07 ELECTRICAL INSTALLATION

- INSTALL M2M BUSBARS
- INSTALL ASSY HARNESS
- INSTALL BMS CONNECTIONS

08 ELECTRICAL TESTING

- CHECK CONNECTIONS
- CHECK COMMUNICATION
- CHECK RESISTANCE
- HV TEST PACK
- LOAD TEST
- THERMAL CAMERA TEST

09 VISUAL PRECOVER CHECK

- CHECK PRECENCY PARTS
- CHECK
- INSTALL BMS CONNECTIONS

10 SEALANT APPLICATION

- APPY SEALANT ON FRAME
- APPLY SEALER ON COVER
- APPLY GASKET ON LID

11 COVER INSTALL

- INSTALL LID ON FRAME
- SCREW LID ONTO ENCLOSURE
- INSTALL PANEL ON PACK

12 ENCLOSURE LEAKTEST

- LEAKTEST BATTERY PACK
- LEAKTEST BURST DISK
- LEAKTEST CONNECTIONS

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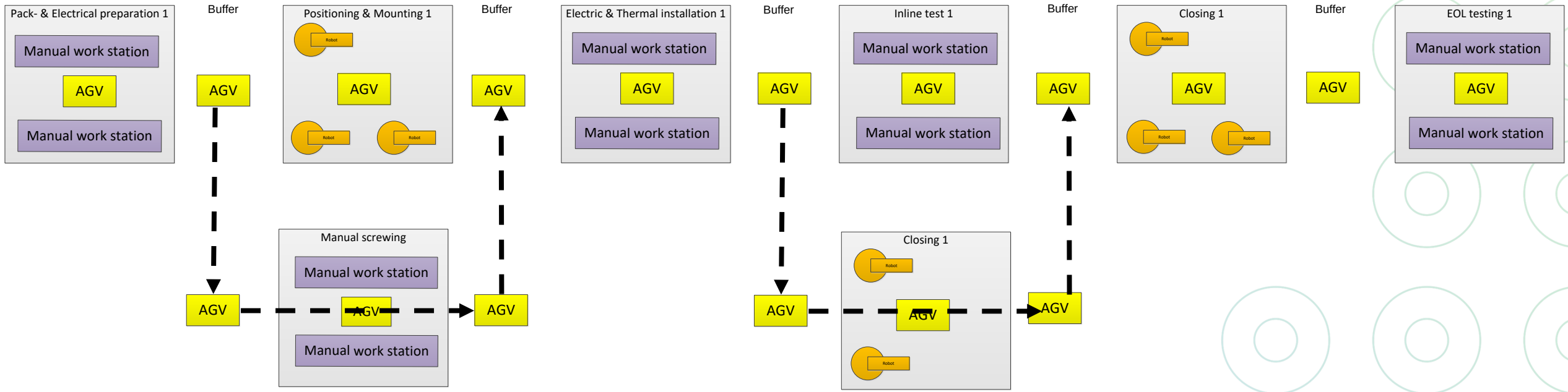

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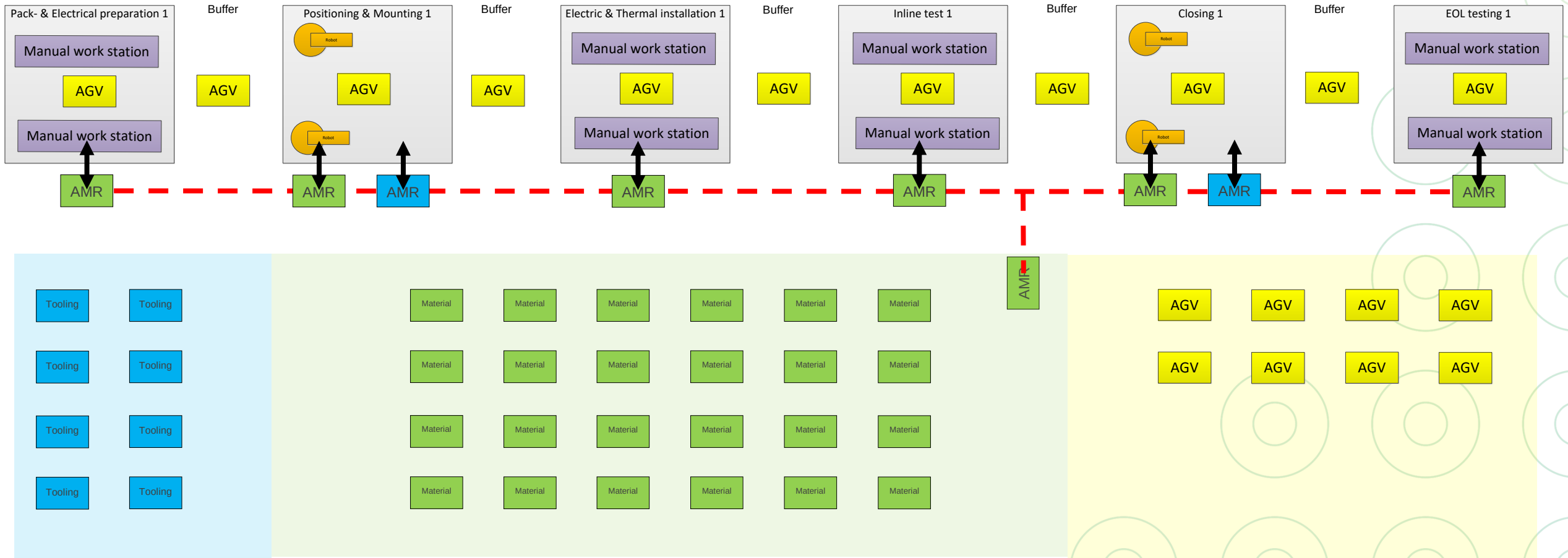

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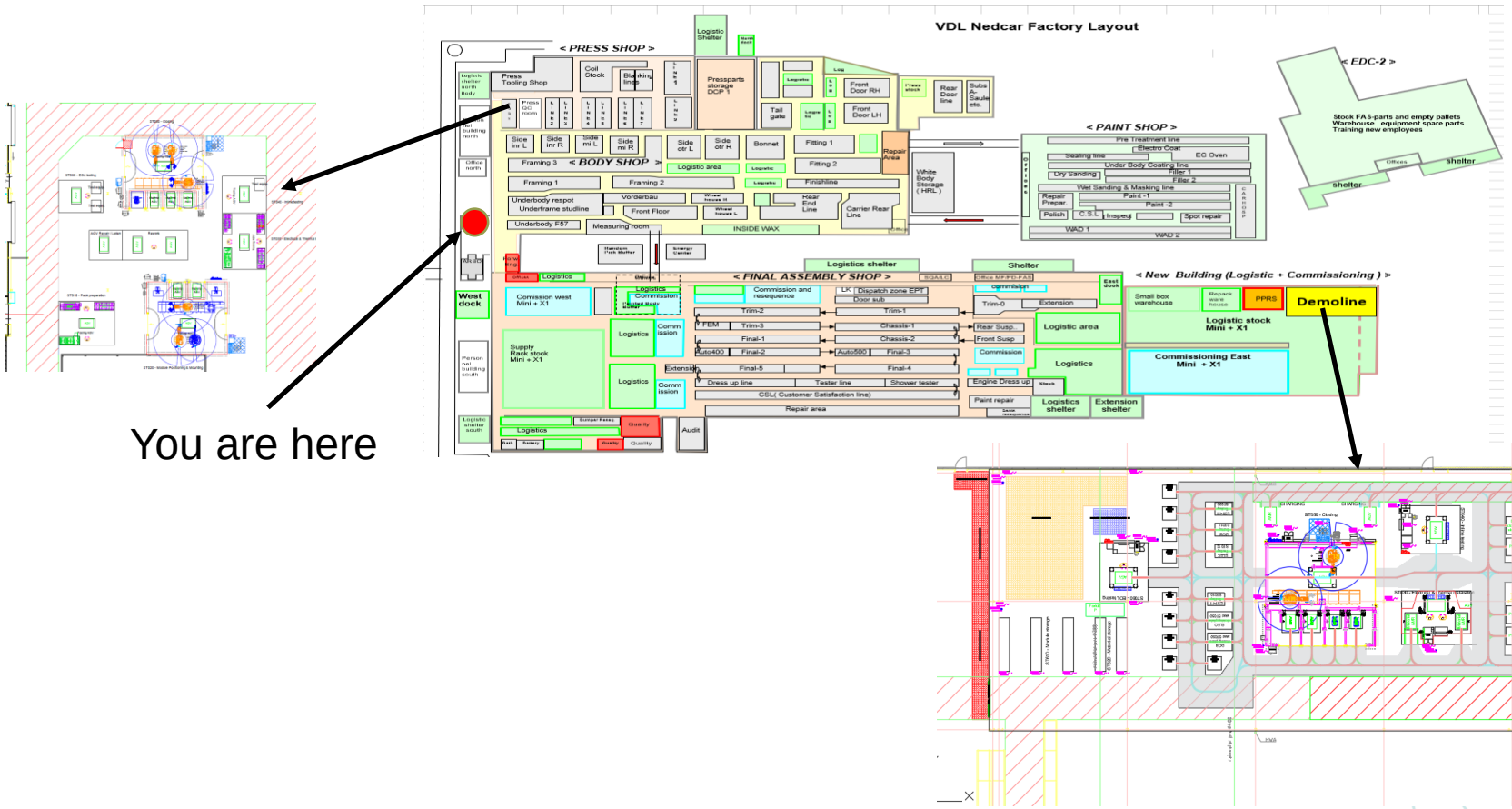

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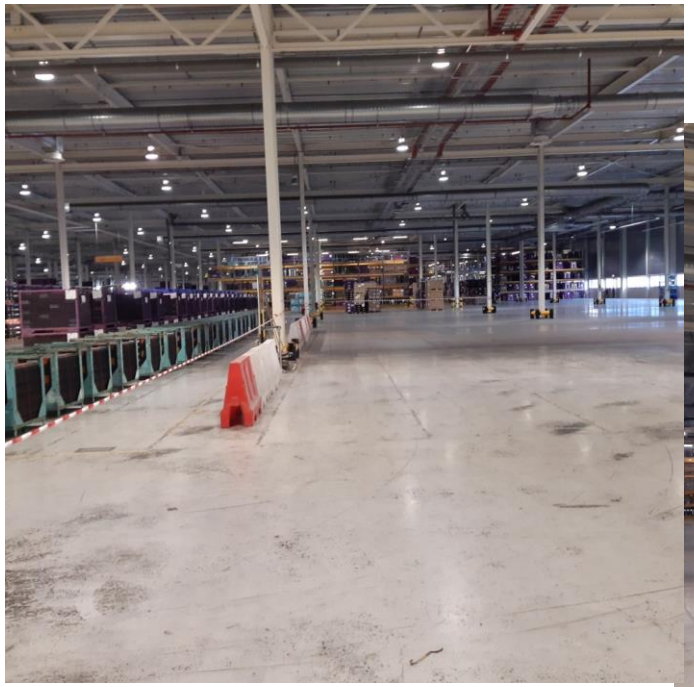

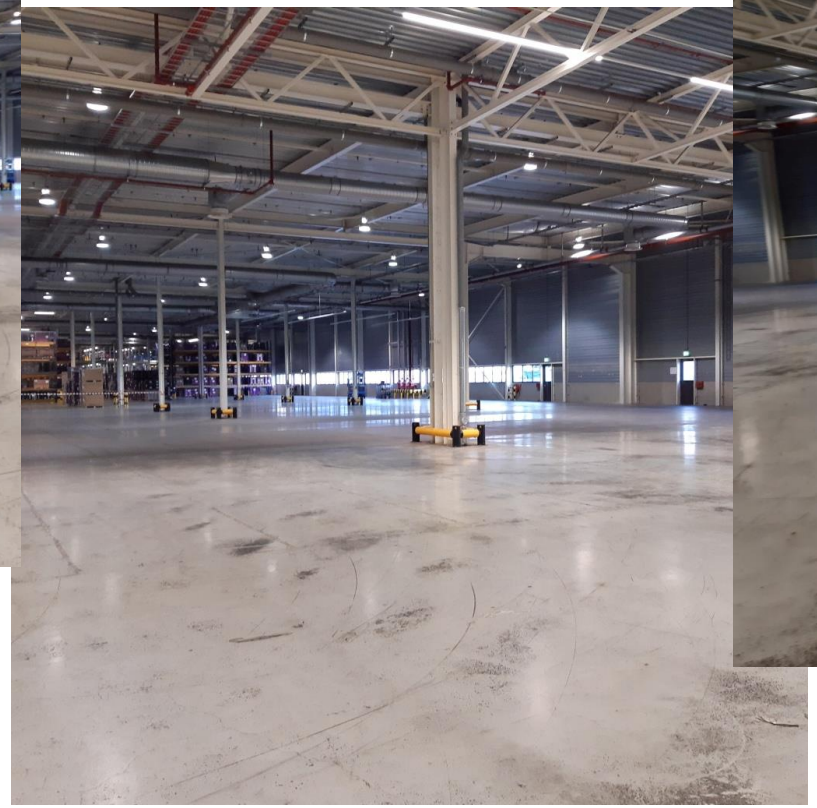

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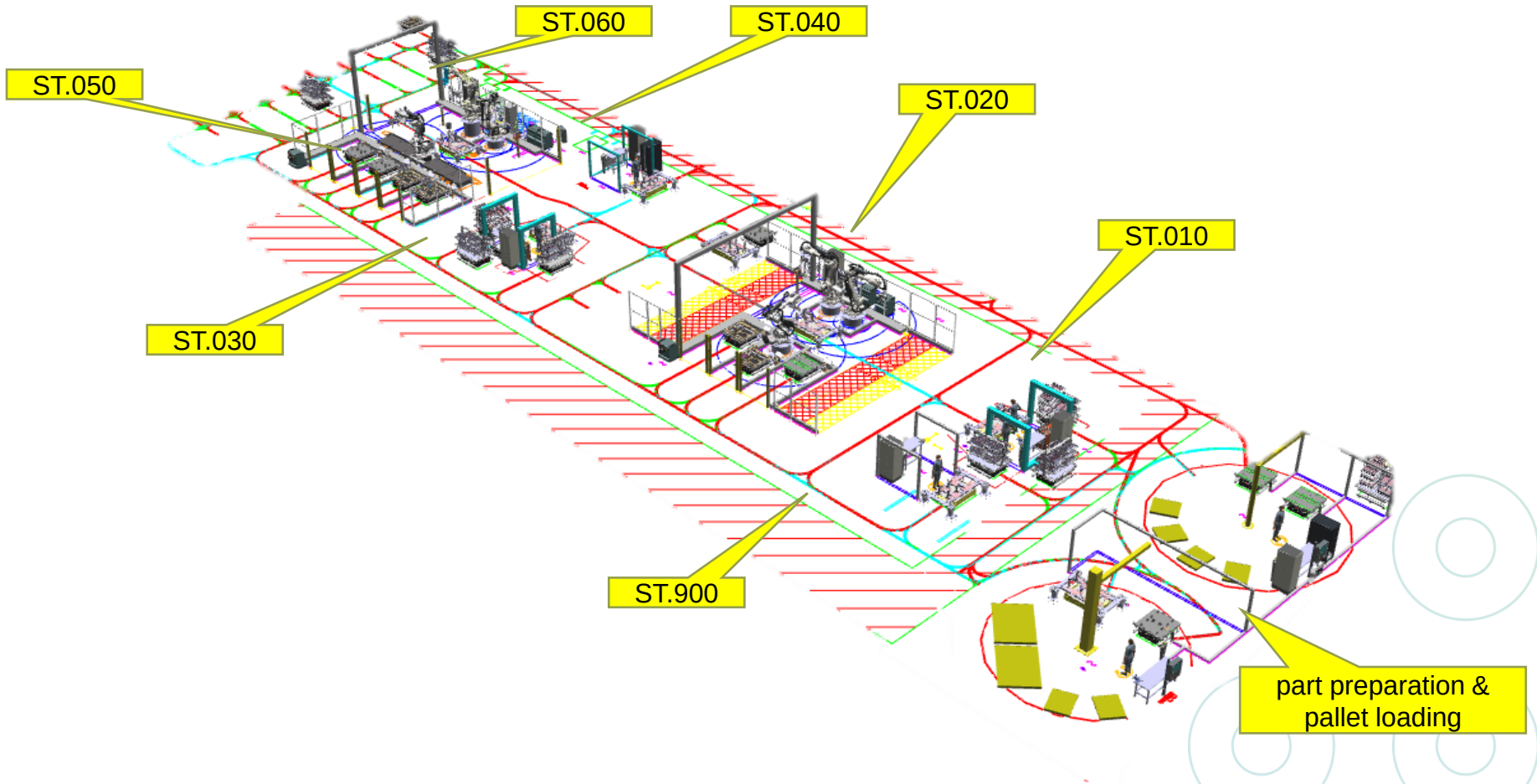

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Wereldwijde problemen door chiptekort: dit zijn de gevolgen vo je auto

Autoproducenten leggen massaal hun fabrieken stil. Niet vanwege corona, maar door het wereldwijde tekort aan halfgeleiders. Dat heef grote gevolgen wanneer je een auto hebt besteld.

Autoredactie/HLN 24-08-21, 20:00 Laatste update: 24-08-21, 20:46

These 19 Items Are in Short Supply Due to COVID-Related Supply Chain Issues

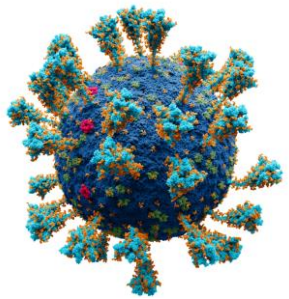
ARCHIVES Updated Oct 19, 2022, 6:00 PM GMT+2

The pandemic's lasting impact on the supply chain

by **Vox Staff**

NOS Nieuws • Maandag 15 februari 2021, 13:39

Grote vraag naar elektronica veroorzaakt chiptekort, raakt met name automarkt



How the World Ran Out of Everything

Global shortages of many goods reflect the disruption of the pandemic combined with decades of companies limiting their inventories.

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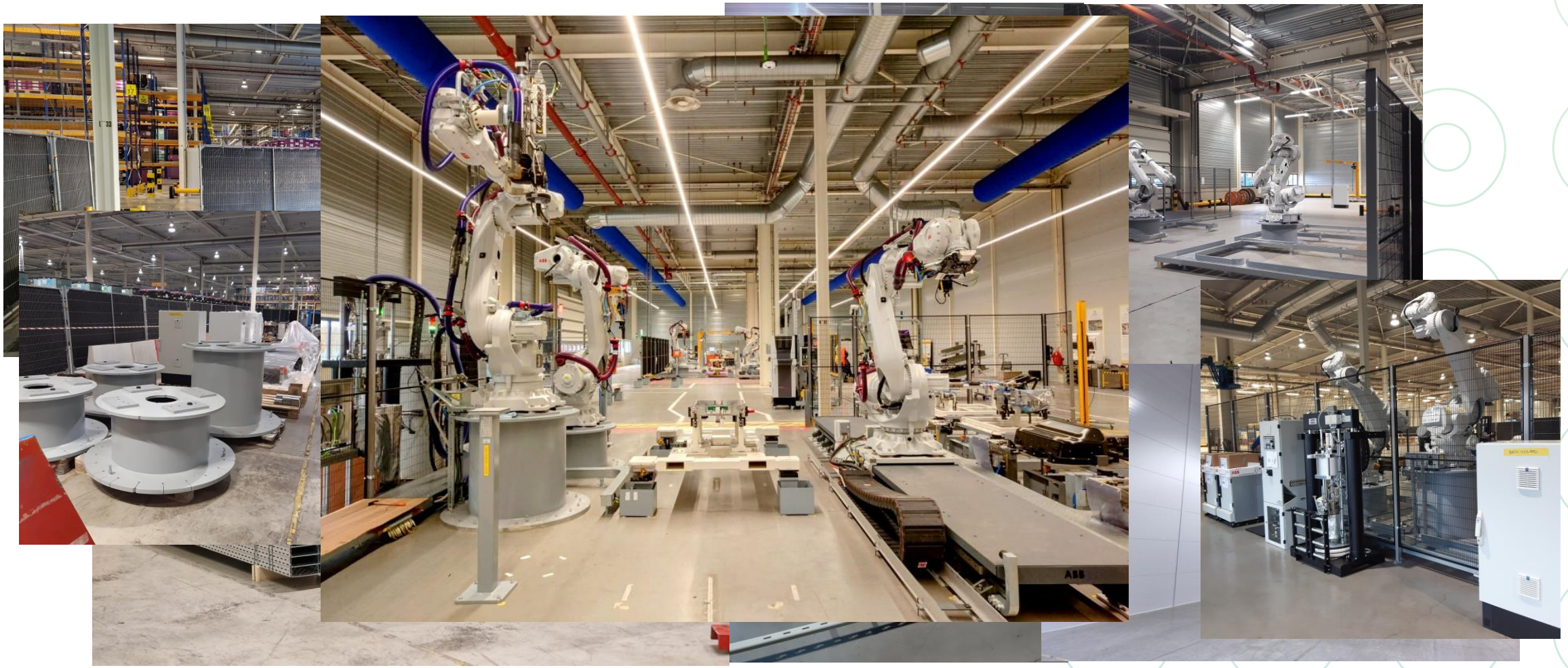

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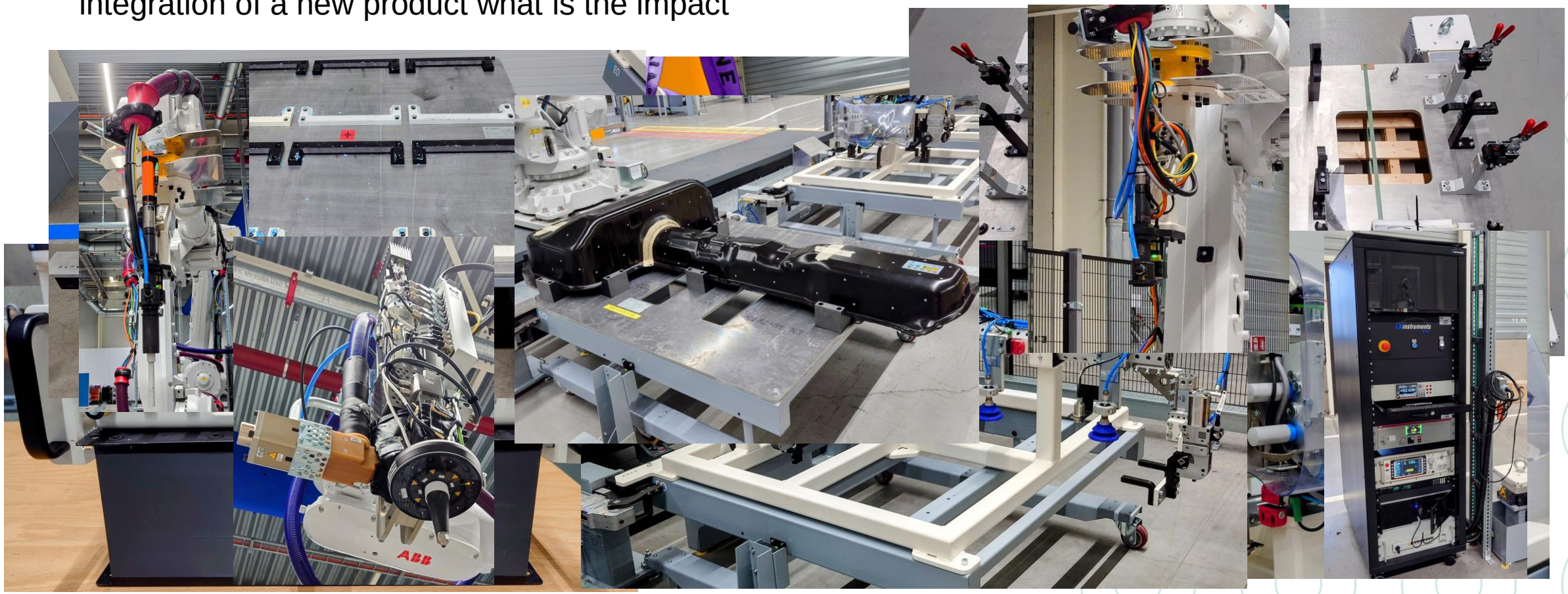
integration of a new product what is the impact



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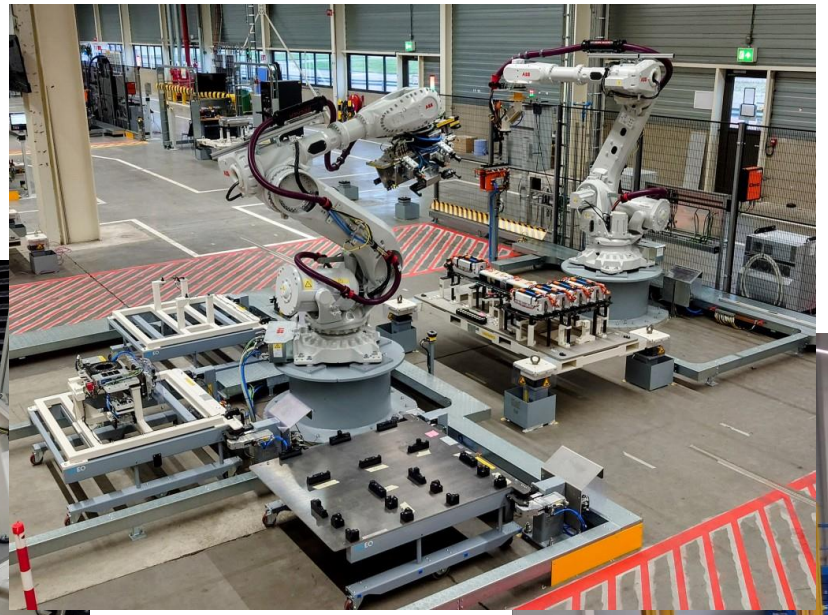

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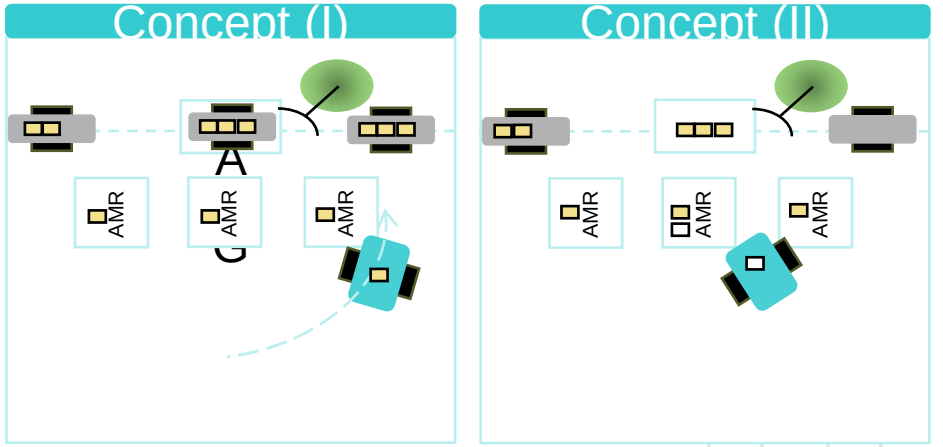
What is the best concept and what are the numbers of AGVs and AMRs in the Demo Line

- **Concept I:**
  The AGV stays at a workstation with the product during process time
- **Concept II:**
  The AGV drops off the loaded skid and promptly leaves the workstation after unloading

Conclusion

- Concept (II) achieves higher throughput rates, especially with fewer than 4 AGVs. Nevertheless, AGV utilization remains consistently higher in Concept (I)
- Buffers, either AGVs or physical spaces, are essential to manage revisits and flow changes



Deterministic Setup	Stochastic Setup
• Single Product type, single production flow • No buffers • Constant process times • **1 – 9 AGVs/AMRs** • 10 continuous shifts of 8 hrs	• Stochastically assigned **5** different product types and different production flows • Constant process times • **1- 6 AGVs, 1 – 5 AMRs** • 60 continuous shifts of 8 hrs

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Station 50 Robot Anomaly Detection

Problem

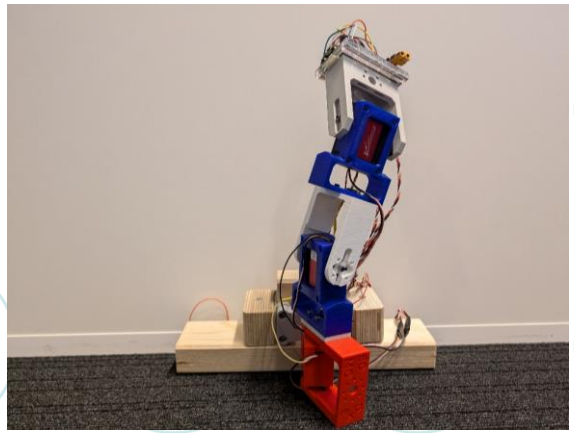
- We want to detect anomalies in the operations of the robot at Station 50 but **don't have labelled anomalies**.
- Can **synthetically added** anomalies be used to teach machine learning models?

Solution

- Simulate physical anomalies on a **proxy robot** and teach machine learning models to detect these anomalies.
- Verify that synthetically added anomalies exhibit the **same patterns** as physical anomalies.

Results

- Synthetic anomalies **can be used** to simulate real world physical anomalies for teaching machine learning models.



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Thermal Runaway Detection

Problem

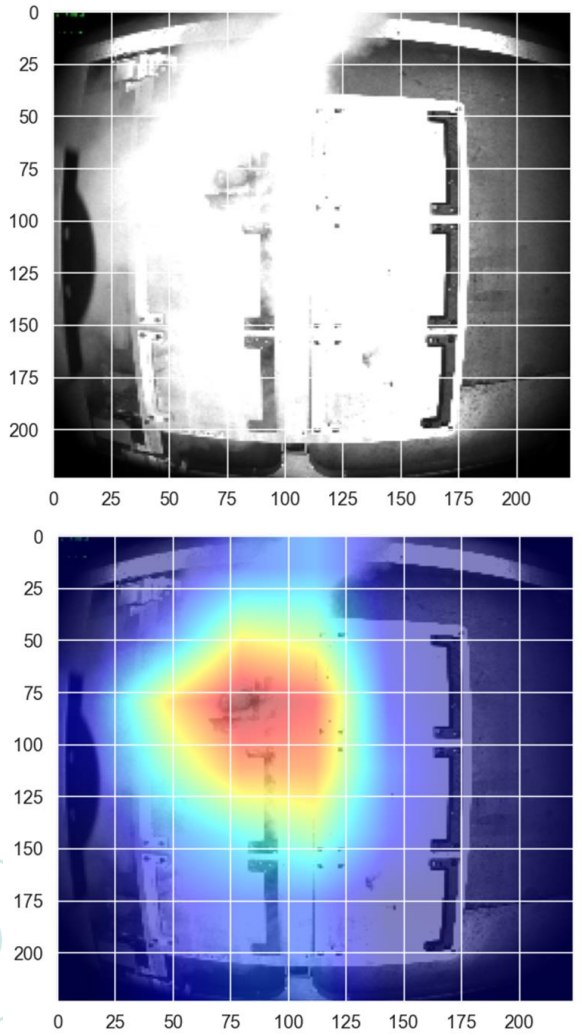
- **Thermal runaway** is an uncontrolled exothermic reaction that can lead to cell corruption, catastrophic failure, and potentially explosive consequences in the battery line.
- Can we **identify** this using optical and thermal **images** from the robots?

Solution

- Simulate thermal runaway conditions to **collect data** for training (teaching) deep learning model.
- Model **learns** if optical and thermal images show a thermal runaway event or not.

Results

- **Near perfect** classification accuracy of normal and thermal runaway cases.



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Station 20 Foreign Object Detection

Problem

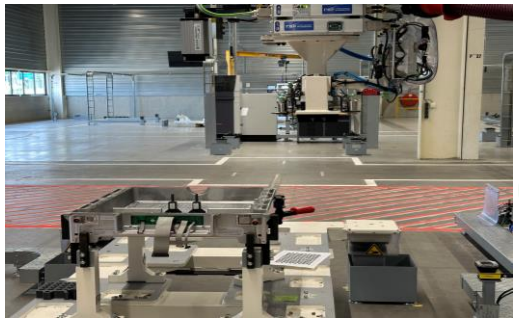
- **Battery cases** needs to be empty.
- Automatically check for presence of **foreign objects**

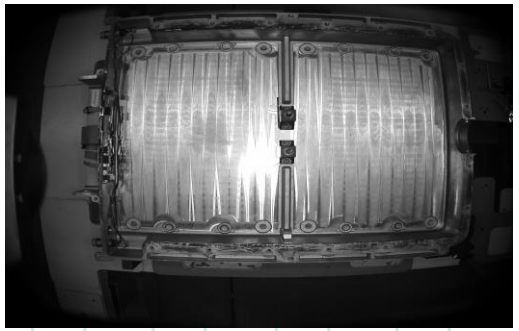
Solution

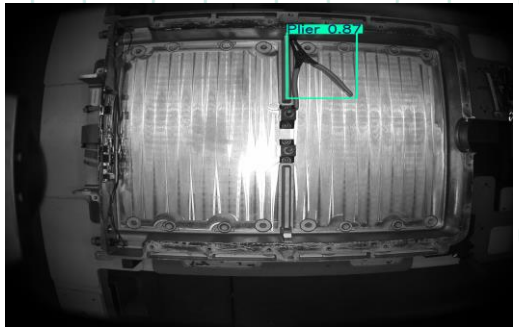
- Deep-Learning based detector
- Novel solution: Works with few labelled data.
  - Less manual labor
  - Less computation
  - Faster training
  - Rapid deployment possible

Results

- Real time performance with high accuracy.
- **Accuracy with all available data: 96.8%**
- **Accuracy with few labelled data: 95.8%**







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Task Scheduling for Single AGV

Problem

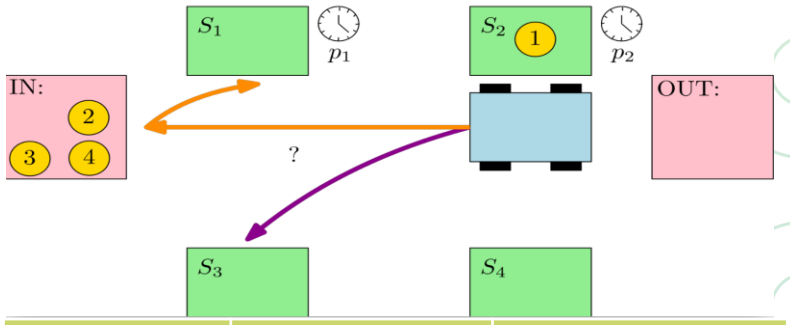
- Production of *n* batteries
- **Compute:** schedule for AGV
  (decide, after every transportation, what to do next)
- **Minimize:** total production time

Solution

- Mathematical formulation for exact algorithm
- Heuristic algorithms for quick computation
- AI algorithm inspired by Google DeepMind / AlphaGo

Results

- Exact algorithm cannot compute solution within HOURS!
- Heuristics are blazingly fast
- AI algorithm: quick enough, and better than heuristics



Algorithm	Algorithm Time	Computed Schedule
Exact	>24 hours	2000
Heuristic	0 sec	2800 (140 %)
AI-Based	360 seconds	2450 (122 %)

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Operator Guidance System (OGS)

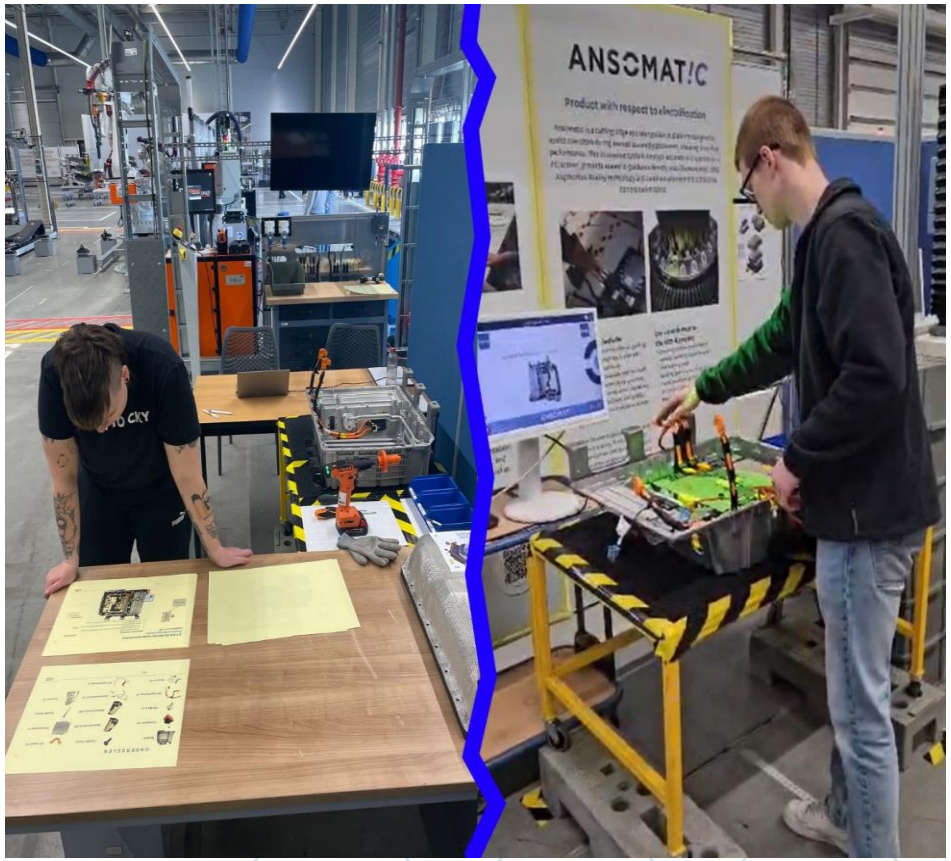
- Does the OGS have a significant influence on the employee's performance?

Experiment

- 2 setups: one with OGS and the other with instructions on paper
- 2 tester levels: MBO2 and MBO4*, 80 testers in total

Preliminary test results

- Experiment proves that OGS has a marked added value above paper instructions;
- In all OGS-conditions time to perform assembly task was shorter than with paper instructions, while at the same time leading to less mistakes as well as less requests for help during assembly.



*MBO = Secondary vocational education

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