

Vehicle Manufacturing

Introduction to Process basics



Agenda

- The landscape
- Vehicle Processes in some pills: from Stamping to Assembly
- Vehicle Assembly basics
- Process definition and Logistic Integration
- Digital validation
- Investments vs. Costs
- Final Q&A

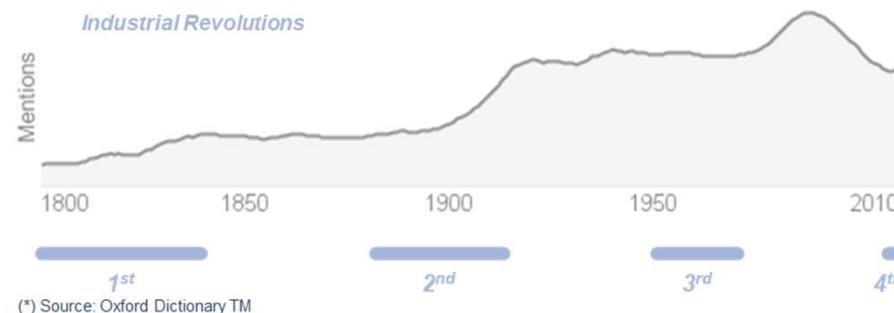
The Landscape

MANUFACTURING

/mən'ju: 'faktʃərɪŋ/

"The **process** of converting raw materials, components, or parts into finished goods that meet a customer's expectations or specifications. Manufacturing commonly employs a man-machine setup with division of labor in a large scale production" (*)

Use over time for: Manufacturing

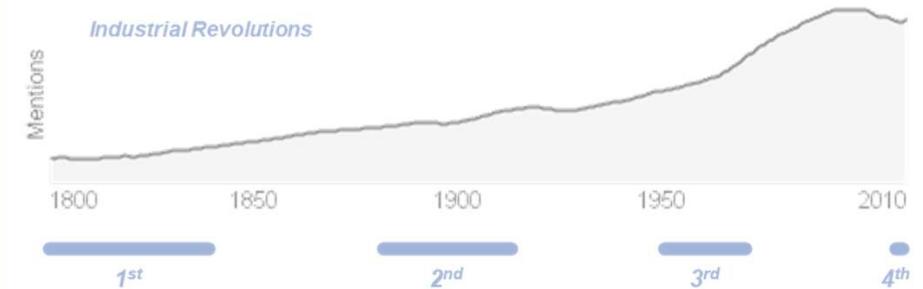


PROCESS

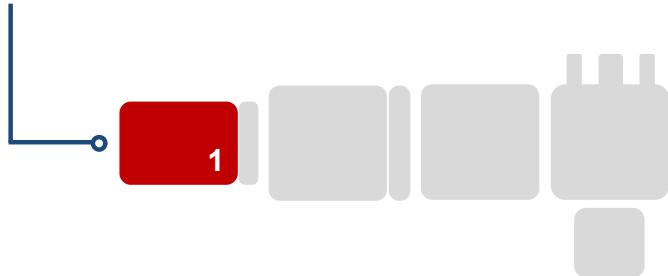
/'prəʊses/

"A systematic series of mechanized or chemical operations that are performed in order to produce something" (*)

Use over time for: process



Stamping



Stamping is the process that includes a variety of sheet-metal forming, such as punching using machine press, blanking, embossing, bending, flanging, etc.

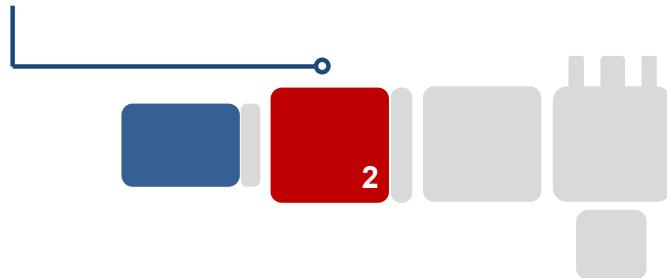
- ▶ Capital Intensive area
- ▶ High productivity rate: up to 18 strokes/minute
- ▶ High flexibility
- ▶ Changeover time < 180 seconds
- ▶ Hot Stamping technology



- Parts geometry
- Energy consumption
- Noise reduction



Welding (Body in White)



Body in White refers to the stage in which a car body's sheet metal components are welded together. BiW include also other joining process: i.e. gluing, riveting and tightening

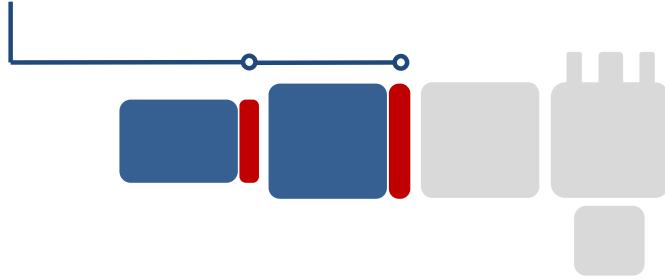
- ▶ Capital Intensive area
- ▶ Geometry Framing > 100 welding points
- ▶ Flexibility over Platforms and Models
- ▶ Mix Flexibility: 100%



- Parts geometry
- Easy and low-cost maintainability



Quality Centers



The heart of the plant is in the Quality Center to grant:

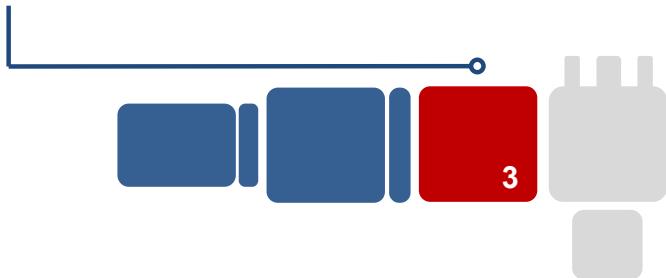
- ▶ Geometry consistency
- ▶ Zero Tolerance Room
- ▶ Measuring and Part Testing
- ▶ Product and Process Conformity



- Temperature and humidity control
- Resolution of measuring device



Paint

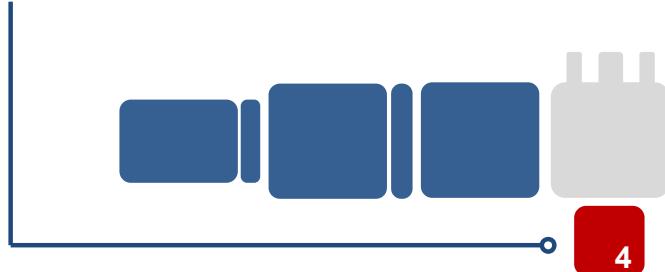


Paint process is the step in which body are cleaned and layers of chemicals and pigments are layed to protect surfaces and provide the final color and glossiness to the vehicle

- ▶ Capital Intensive area
 - ▶ Water based
 - ▶ Full color Flexibility
- Energy Consumption
 - Temperature and humidity control
 - VOCs: reduced emissions
 - Clean rooms
 - Reduced Water Consumption and Sludge production



Plastic shop

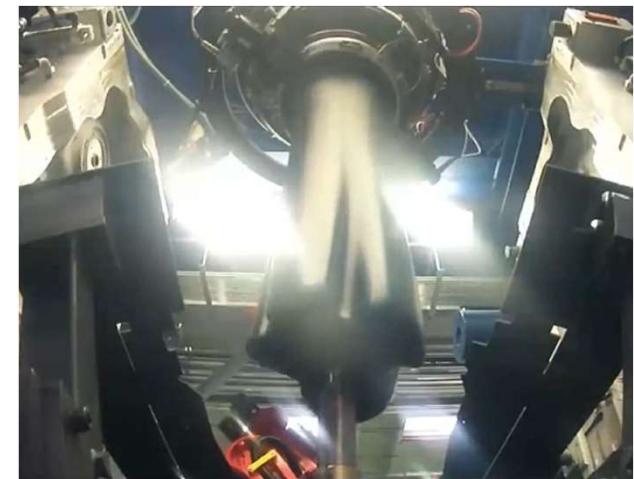


Plastic shop contains a variety of polymeric forming process such as:
stamping, warm forming, extrusion, blowing forming, etc.

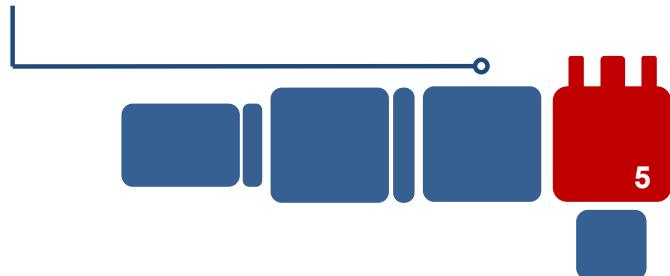
- ▶ Capital Intensive area
- ▶ Geometry
- ▶ Full parts Flexibility



- Parts geometry
- Energy consumption



General Assembly (GA)



Assembly is the process in which parts are added in sequence from workstation to workstation until the final assembly is completed. GA includes also testing and final certification

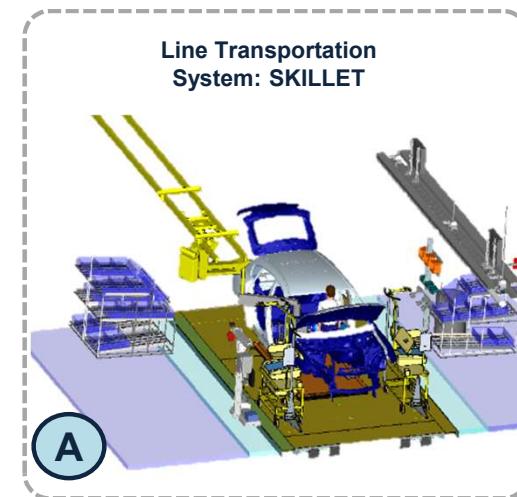
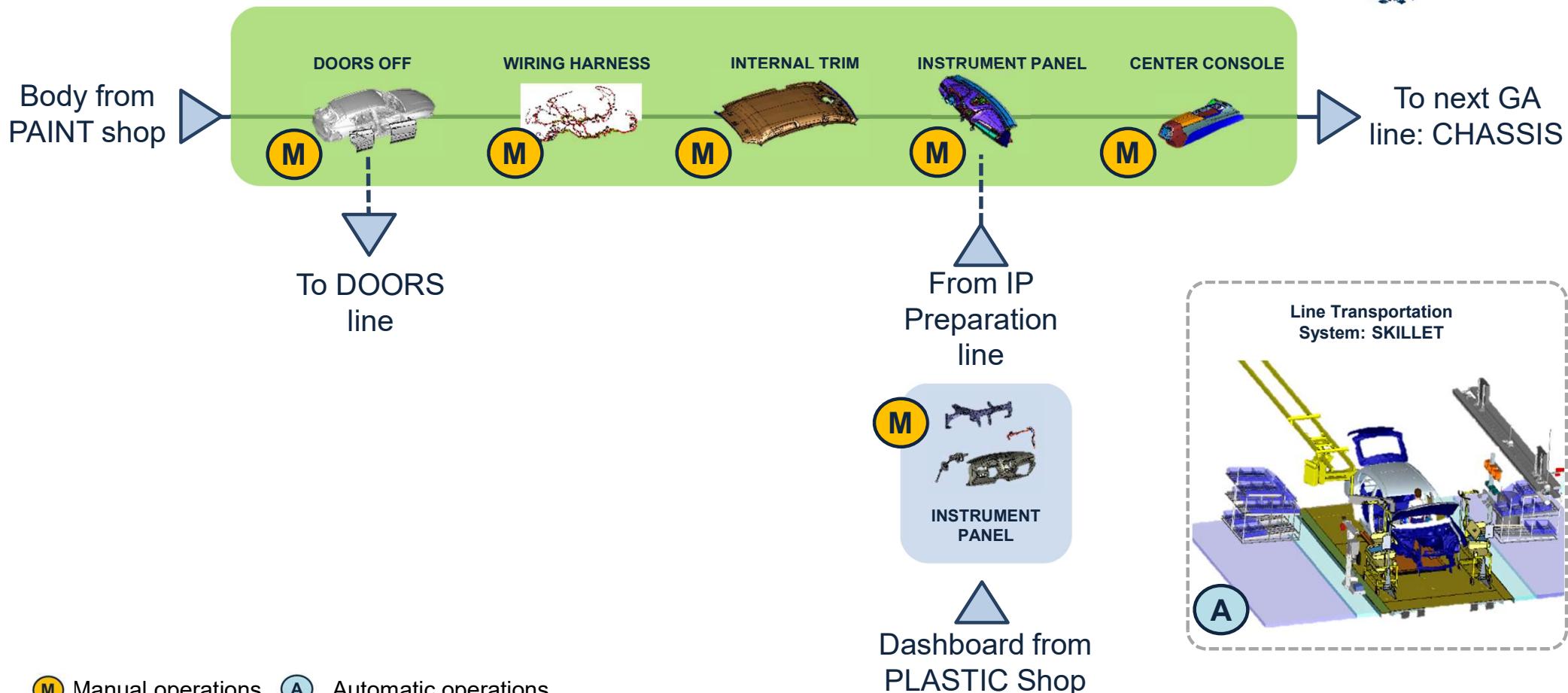
- ▶ Labor Intensive Area: added value activities
- ▶ Flexibility
- ▶ Short Assembly Line / High-Density Station



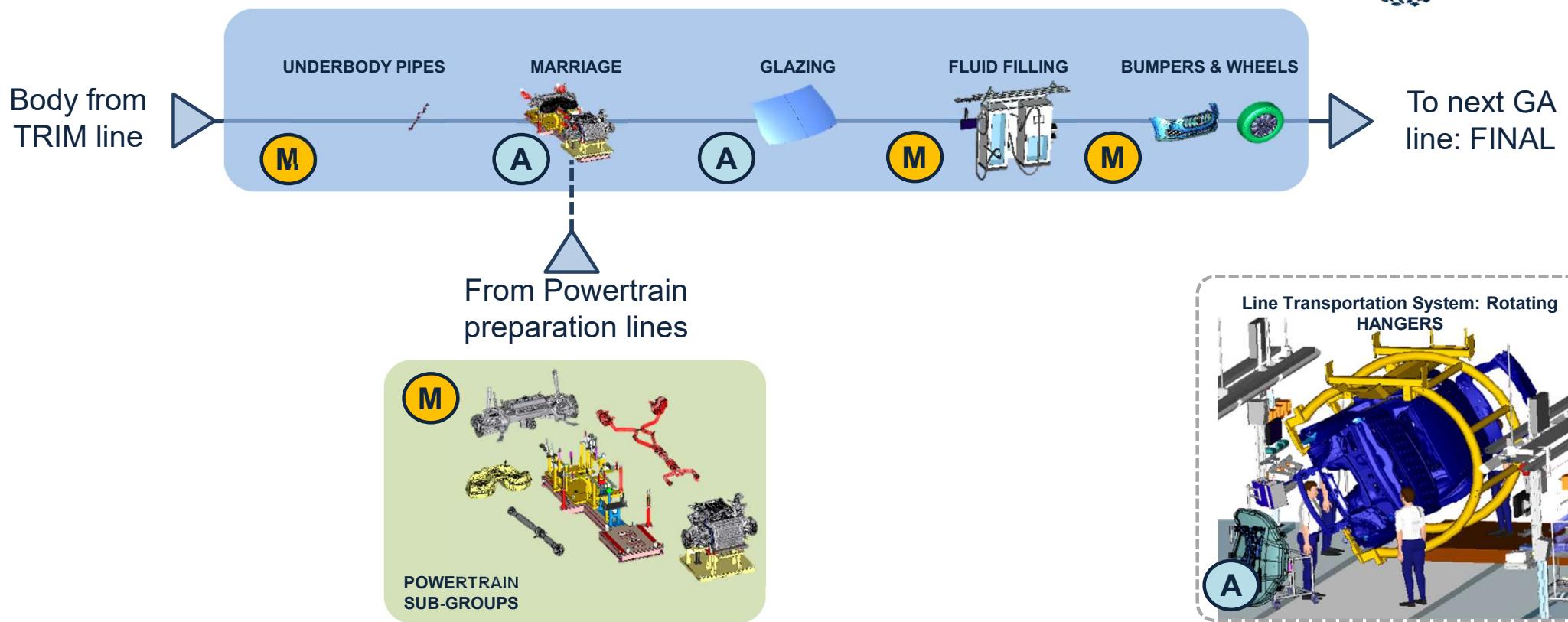
- Ergonomics
- Reduction of non-value added activities
- Balancing of manual operations
- Full and error-proof operations
- Logistic Integration



General Assembly (GA) – TRIM – 1 of 4

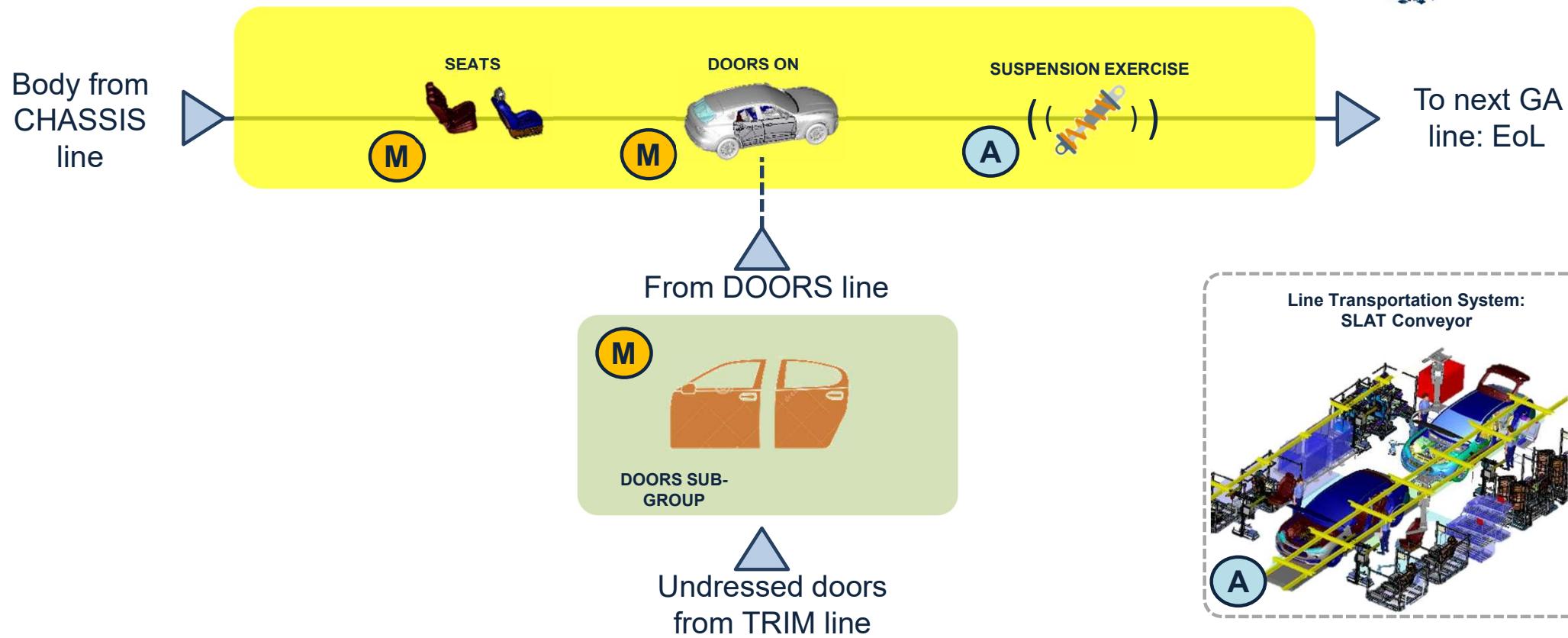


General Assembly (GA) – CHASSIS – 2 of 4



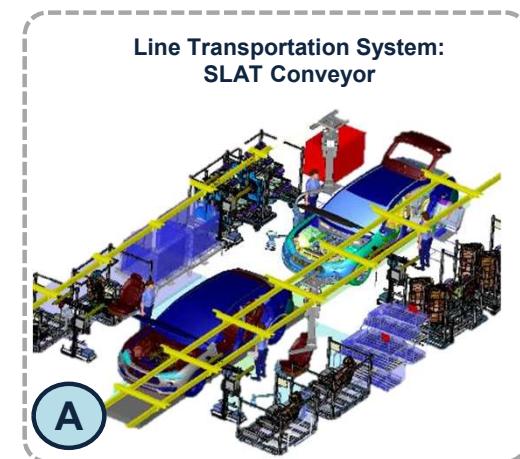
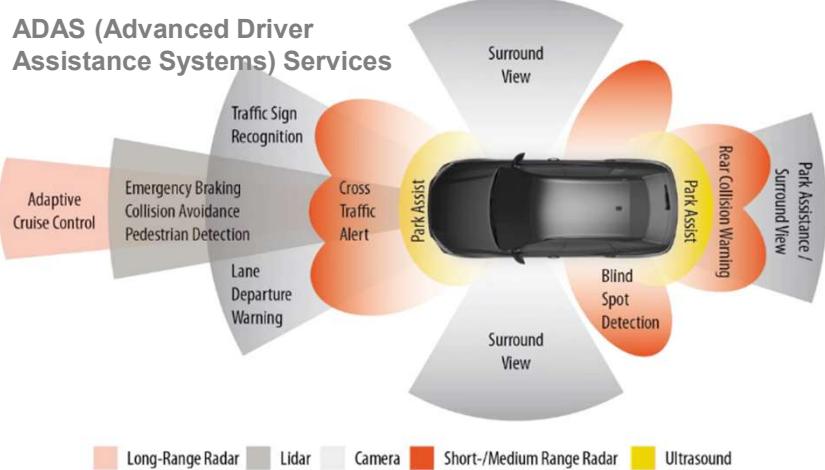
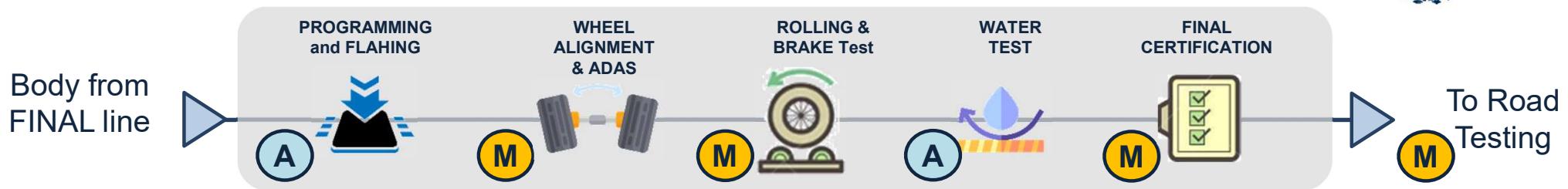
(M) Manual operations **(A)** Automatic operations

General Assembly (GA) – FINAL – 3 of 4



M Manual operations **A** Automatic operations

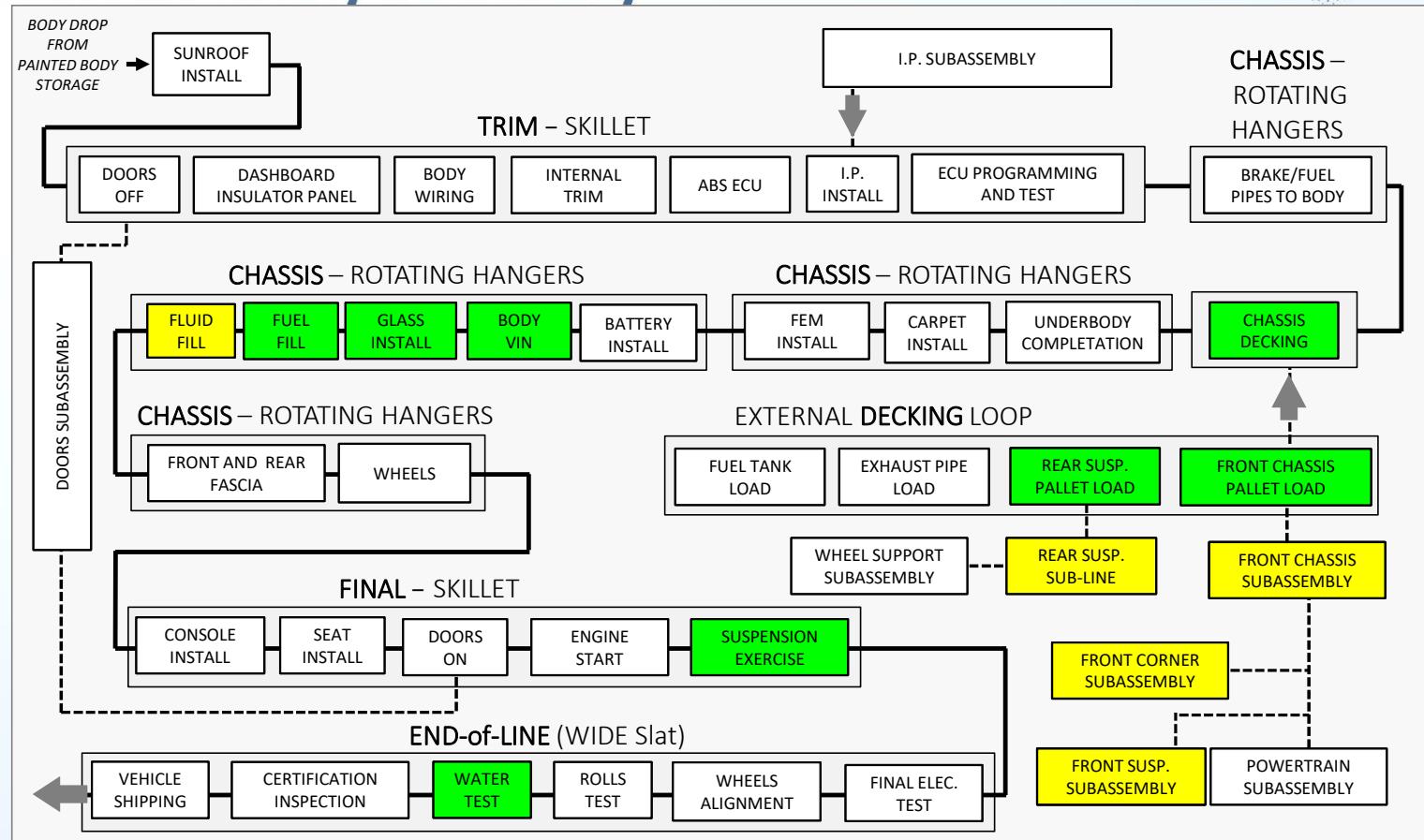
General Assembly (GA) – End of Line – 4 of 4



M Manual operations **A** Automatic operations

General Assembly Summary

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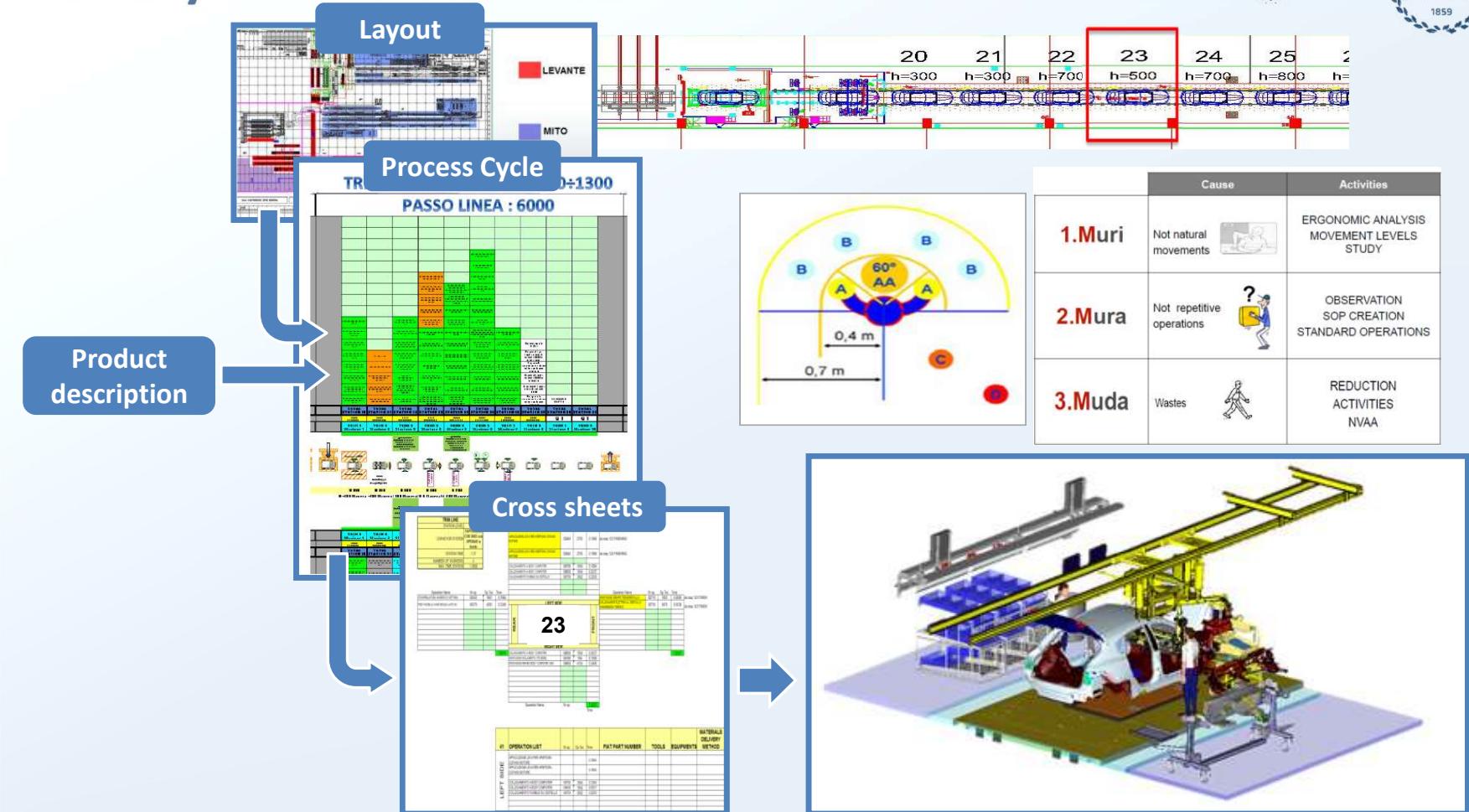
 Full automatic (8) Semi-automatic (5) Manual (30)

Assembly Process definition

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Workplace organization

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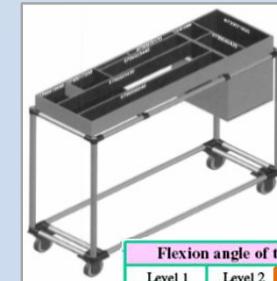
WRINGING REDUCTION



Working range

| Level 1 | Level 2 | Level 3 |
|---------------|---------|---------|
| more than 90° | 45°-90° | 0°-45° |
| | | |

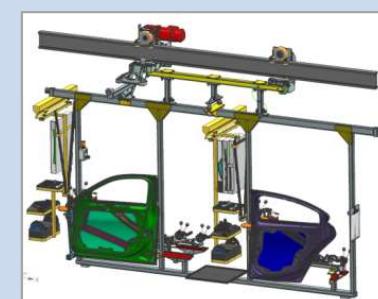
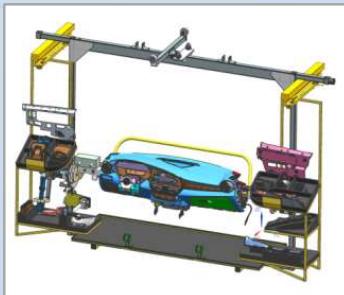
FLEXION ANGLE REDUCTION



Flexion angle of the waist

| Level 1 | Level 2 | Level 3 |
|---------------|---------|---------|
| more than 30° | 15°-30° | 0°-15° |
| | | |

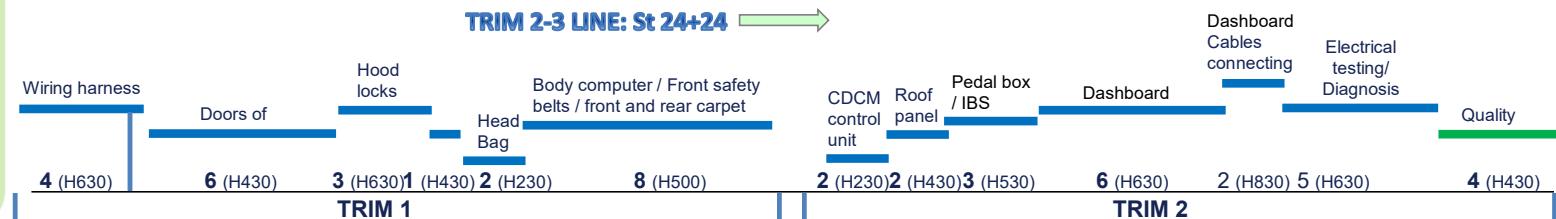
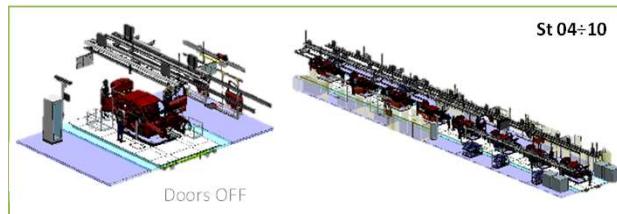
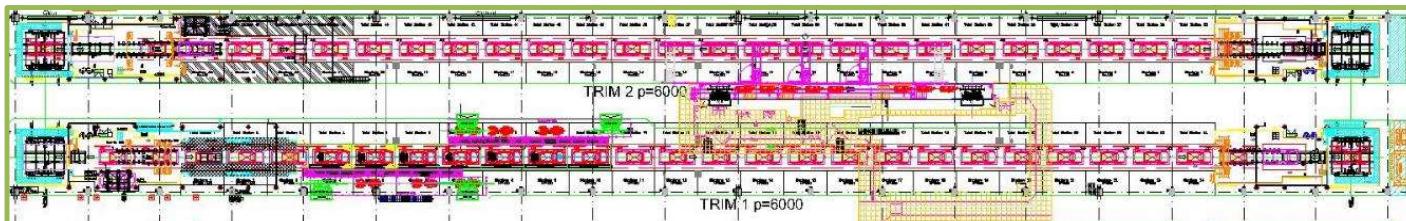
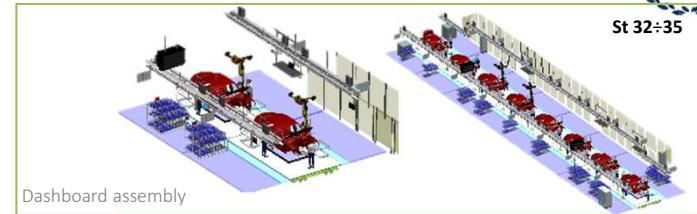
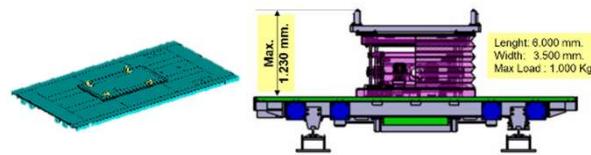
NVAA REDUCTION



Workplace organization – Ergonomics (Trim)

→ SKILLET conveyor with height variation

- ✓ flexible, according to type;
- ✓ Reconfigurable

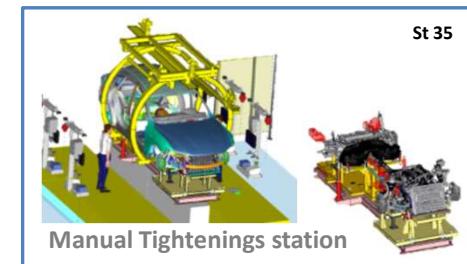
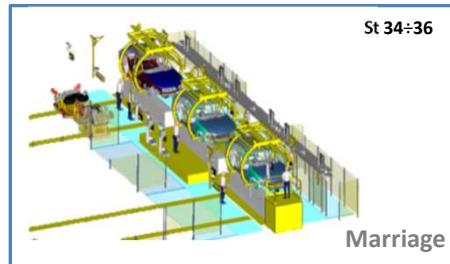


Workplace organization – Ergonomics (Chassis: marriage)

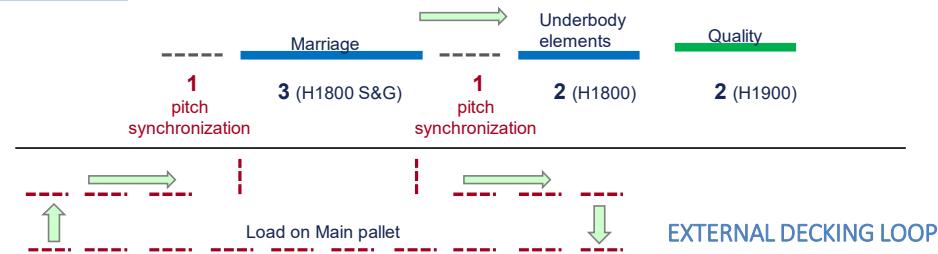
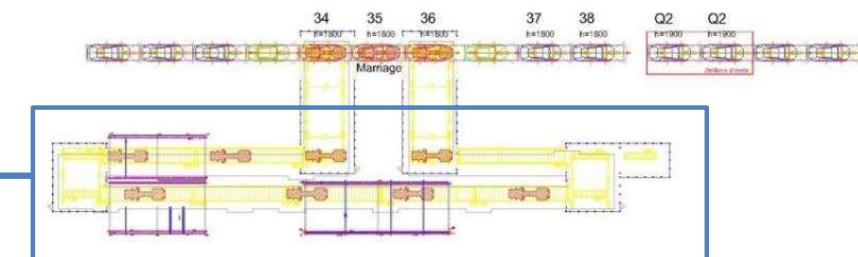
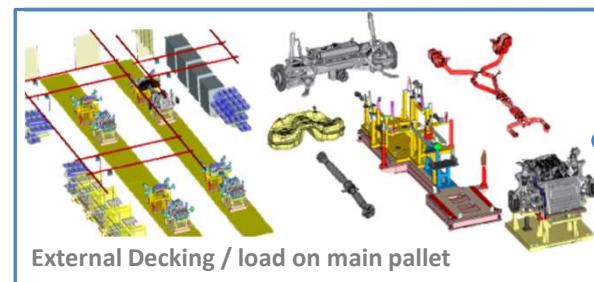
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→ ROTATING HANGERS
conveyor: height has to be configured by design and it's fixed



- ✗ Non flexible, according to type;
- ✗ Non reconfigurable



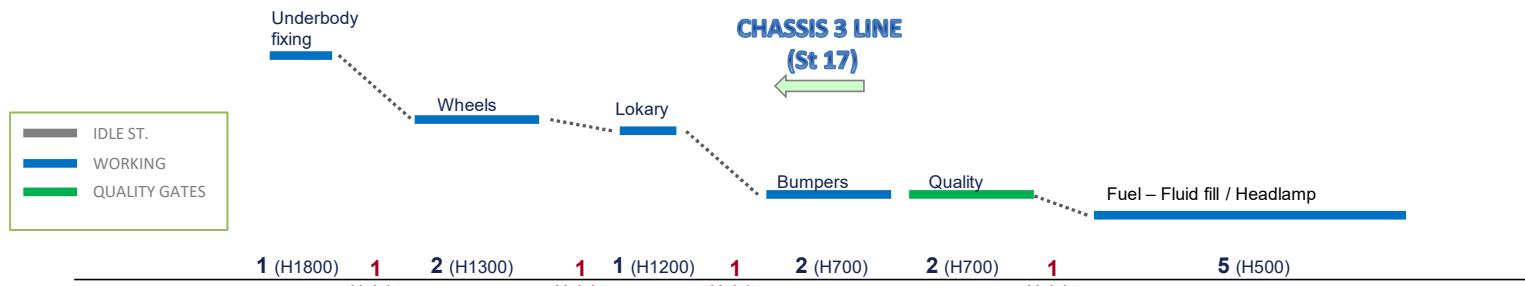
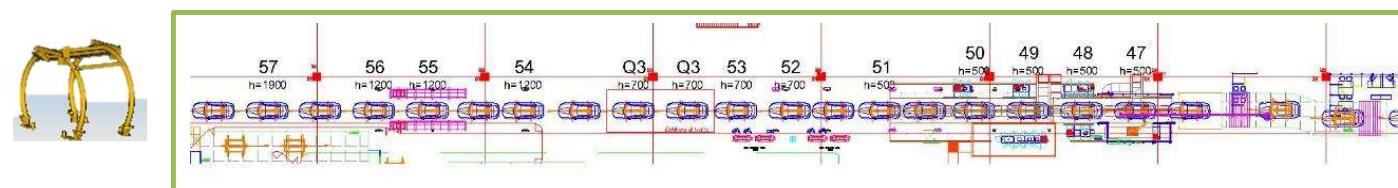
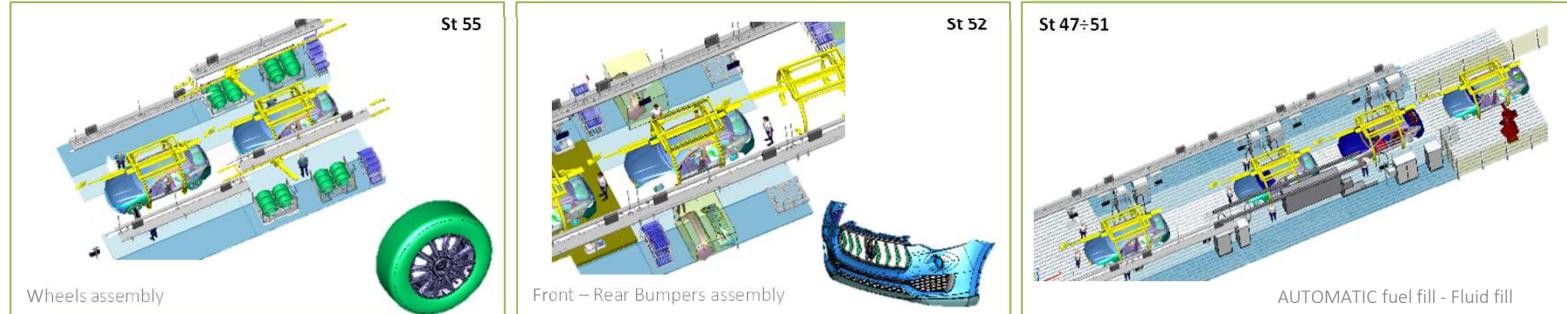
Workplace organization – Ergonomics (Chassis)

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→ ROTATING HANGERS
conveyor: height has to be configured by design and it's fixed

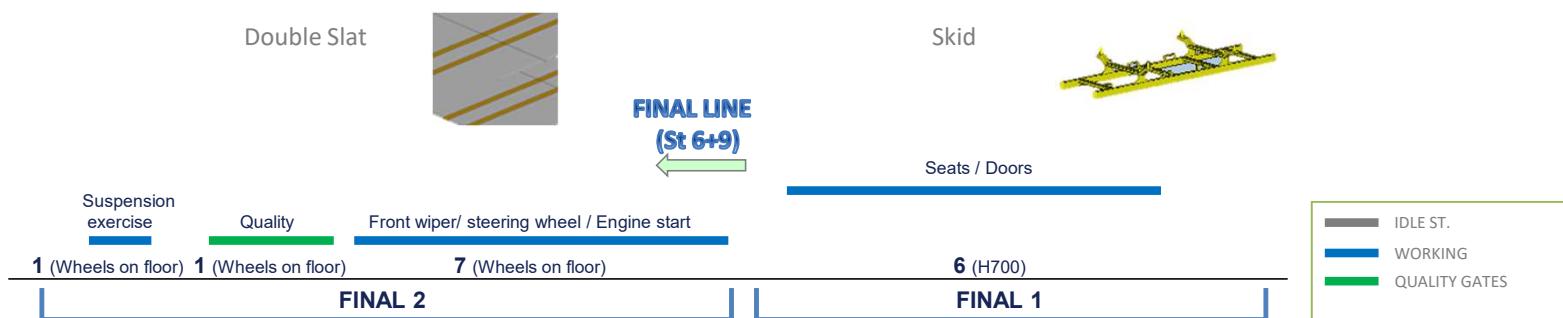
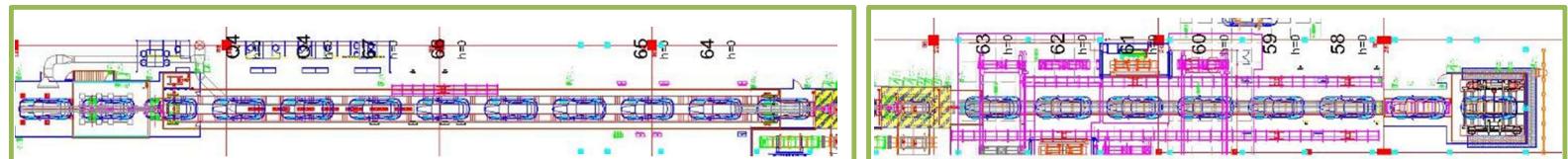
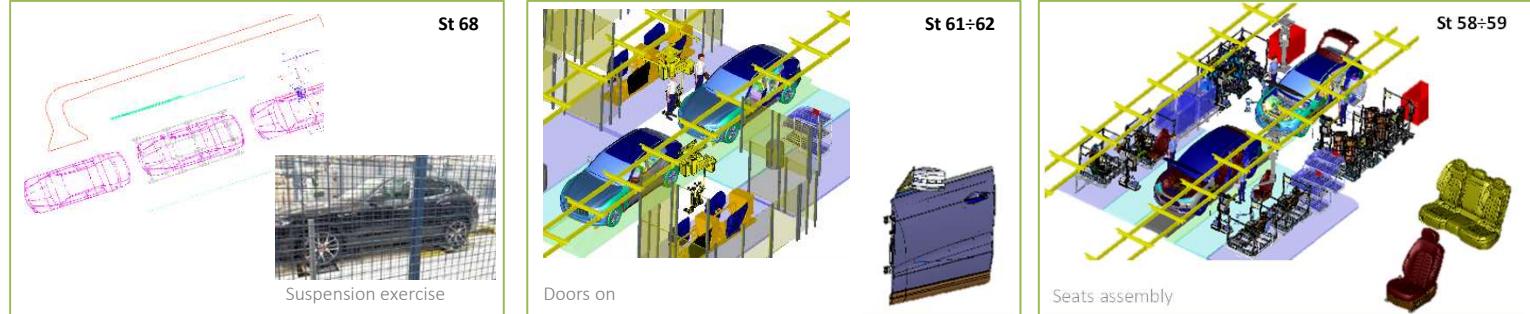
- ✗ Non flexible, according to type;
- ✗ Non reconfigurable



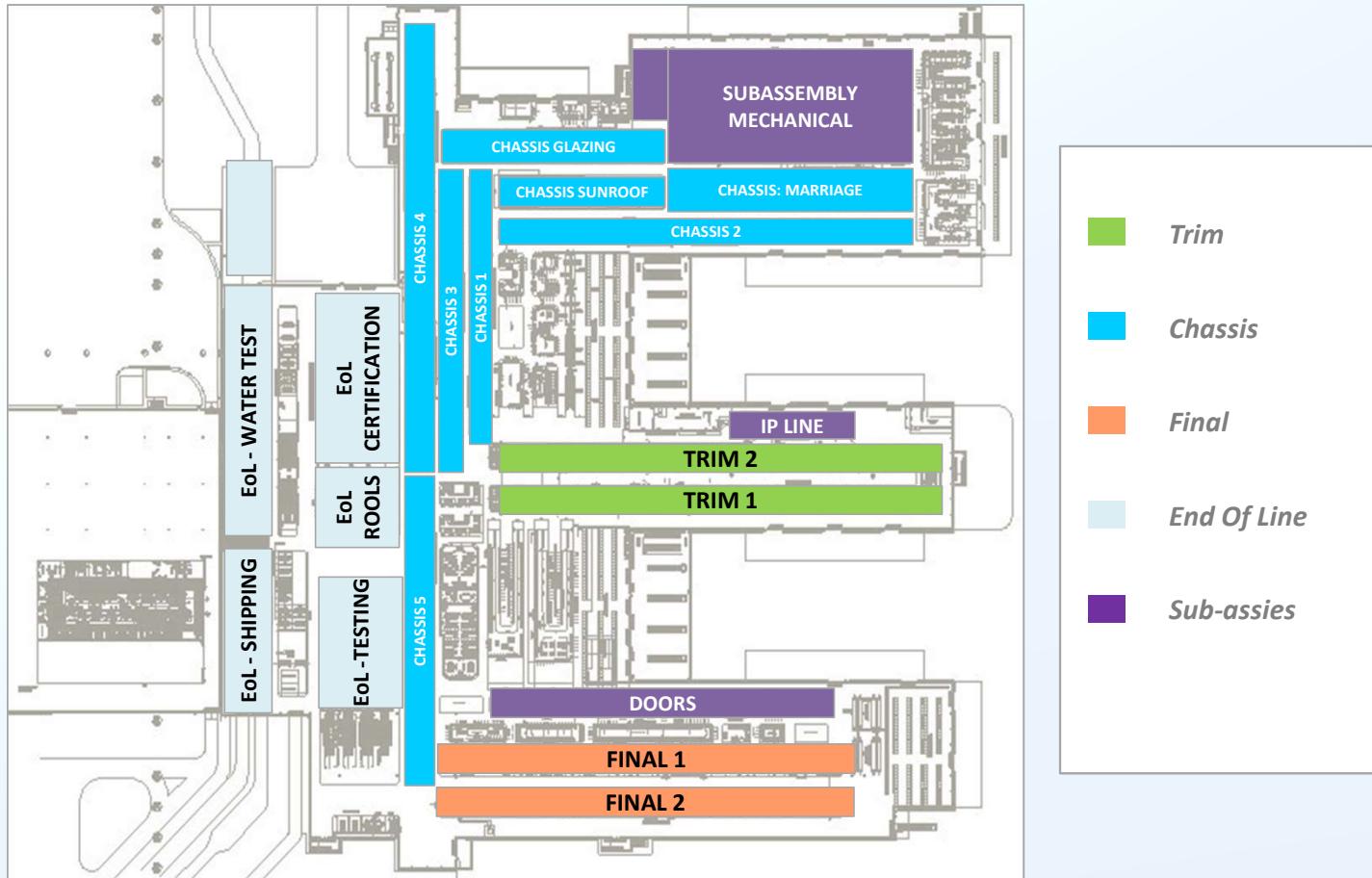
Workplace organization – Ergonomics (Final)

→ SLAT conveyor: height can't be configured: one level only

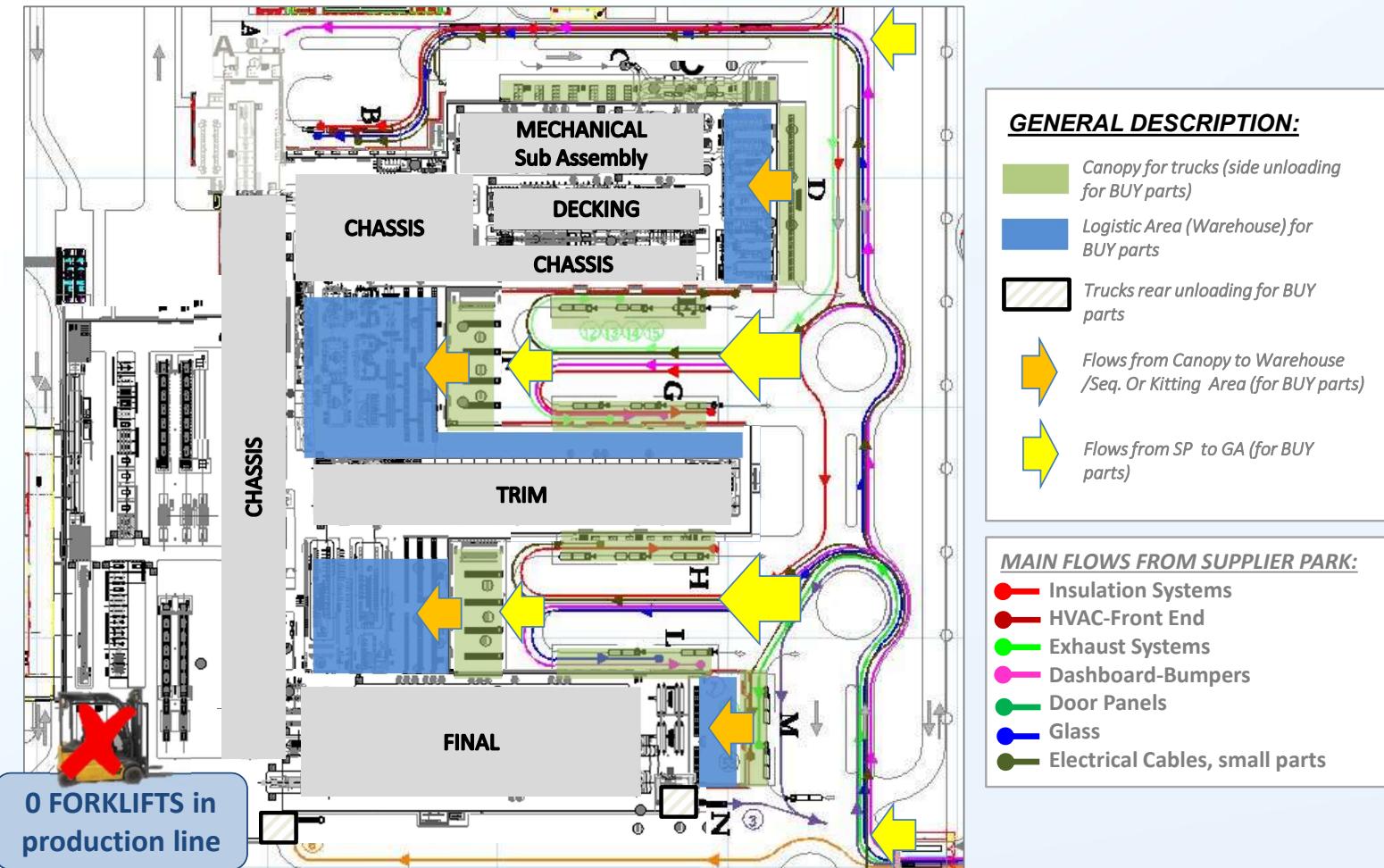
- ✗ Non flexible, according to type;
- ✗ Non reconfigurable



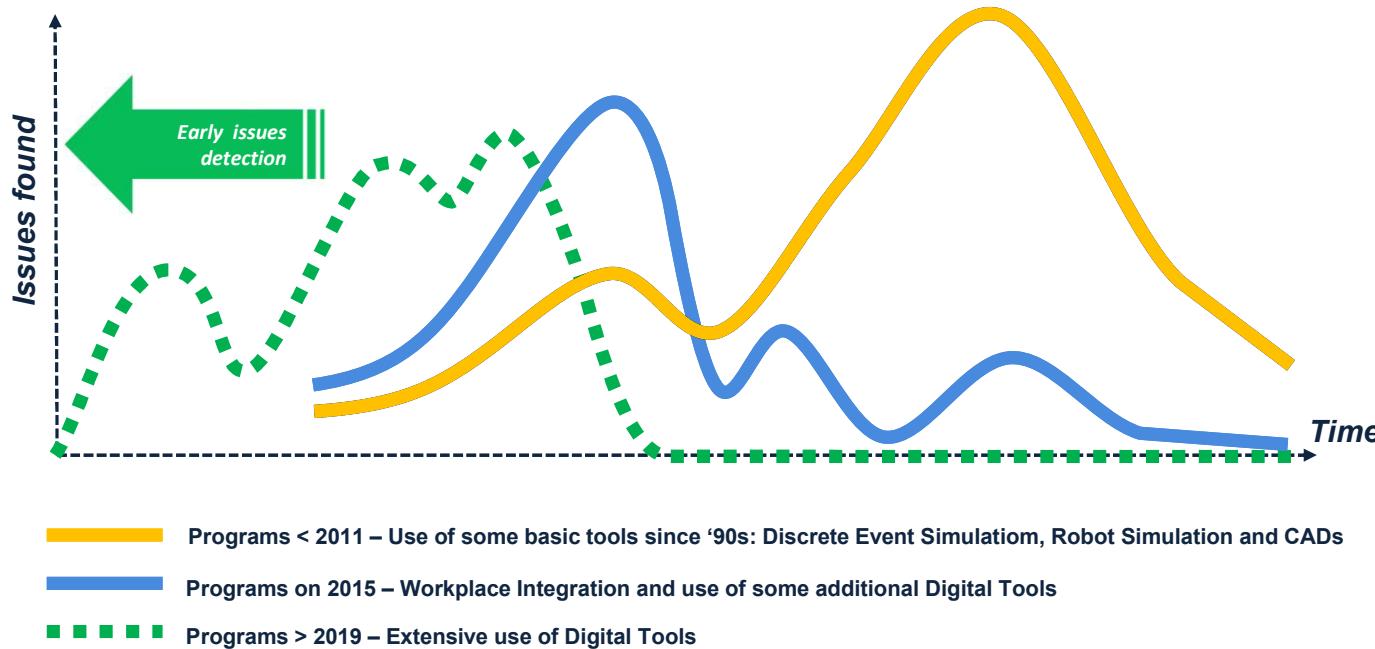
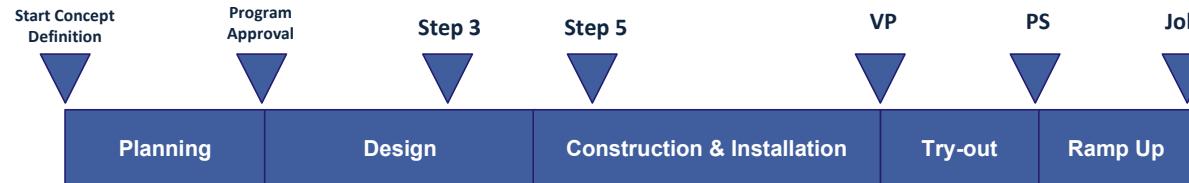
Assembly shop ideal layout



Assembly shop ideal layout vs. Logistic Flow



Process definition: Front Loading

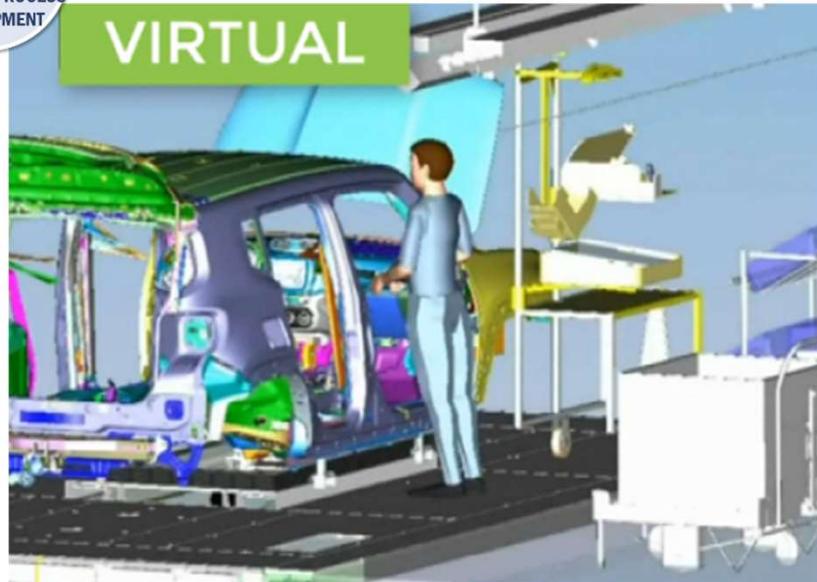


Scope of “Front Loading” leveraging on Digital Tools:

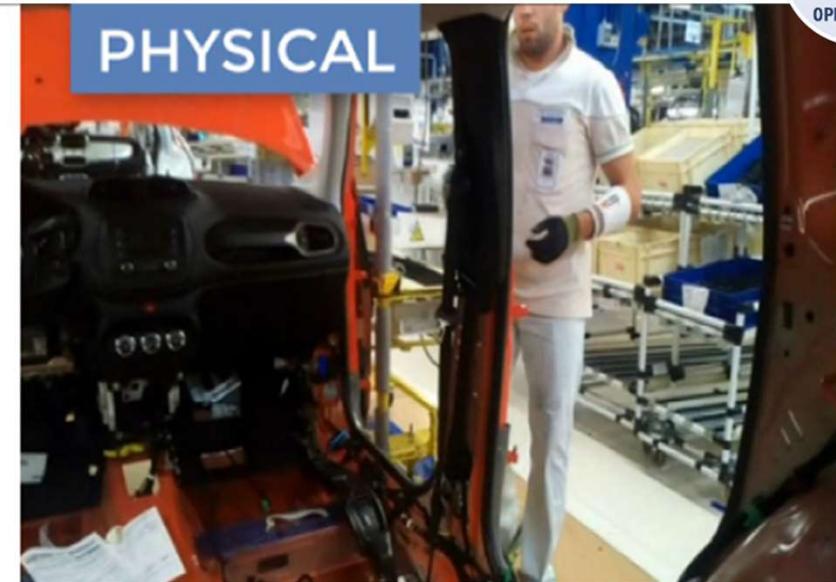
Anticipate changes
when the cost are zero
or at the lowest

Mitigate the risk
of numerous and
significant change after
installation

Front Loading: Digital Twin

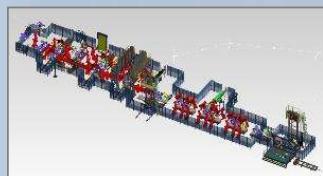


DIGITAL TWIN



Digital Manufacturing Validation - Planning

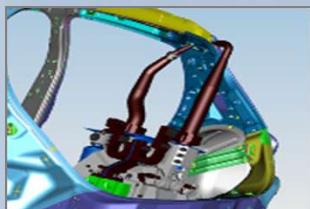
Process 3D layout



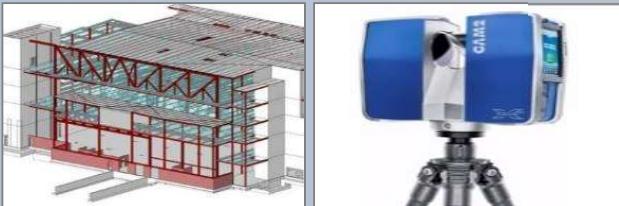
Throughput Simulation (DES)



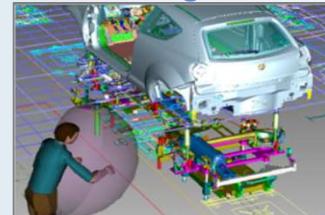
Feasibility analysis



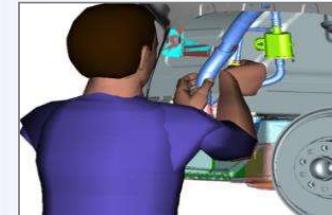
Building Modeling & Reverse engineering



Virtual Design Review



Ergonomics



Immersive Technology



Robotic simulation
OLP - VC

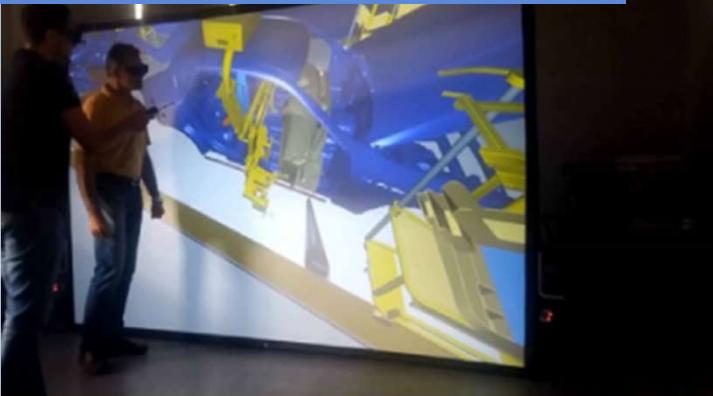


Building Modeling & Feasibility Analysis

Building Modeling & Reverse engineering



Feasibility analysis



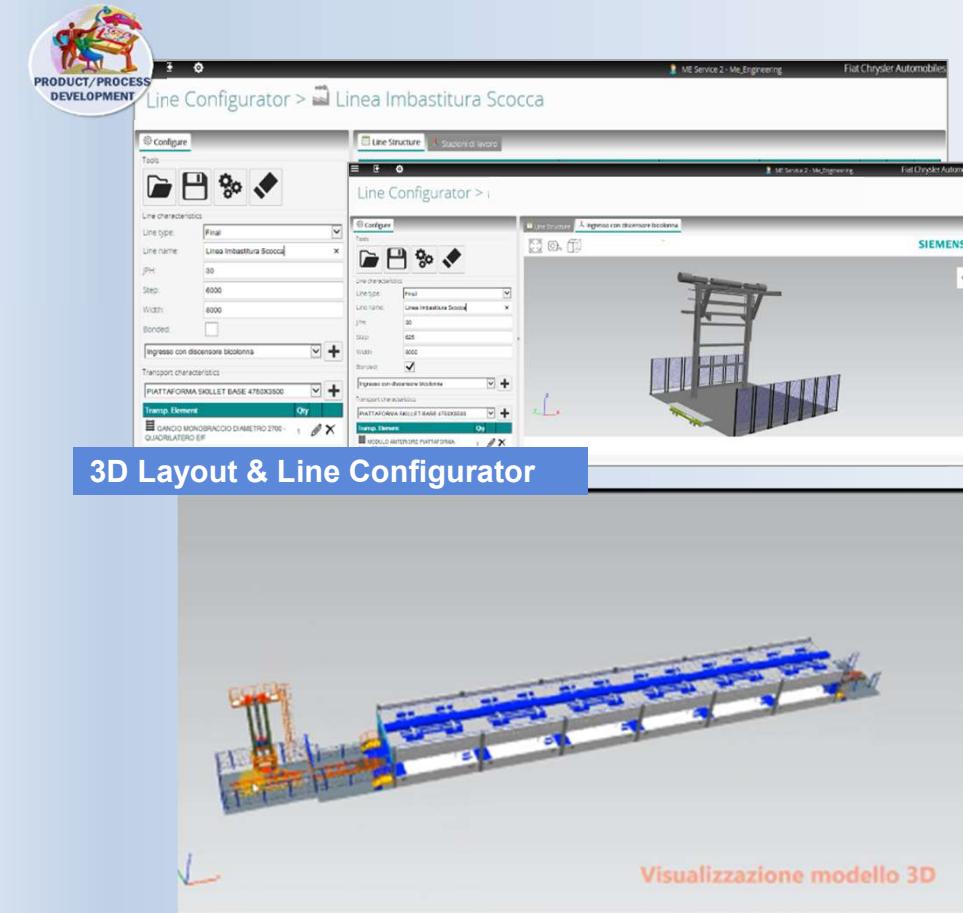
Description

- Using laser scanning technology allow Facility Managers to quickly capture highly complex as-built geometry of buildings and project sites as well as their assets such as power components, machinery and pipe work

Description

- Product and Process Feasibility that consists on various verification about Safety, Ergonomics, Quality performance and Design for Manufacturing. The workplace is simulated through 3D modeling coupling the mathematical model of the product

3D layout & Line Configurator

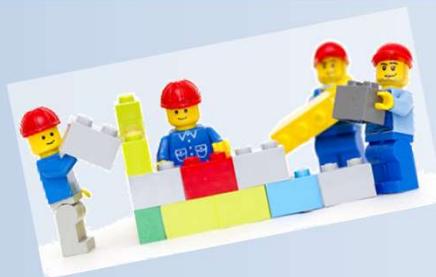


Description

- Line configurator is a tool to quickly sketch new production lines in 3D by using best practices solutions and evaluating CapEx.

The system has been developed (and copyright) by Stellantis with Siemens in order to grant integration with PLM

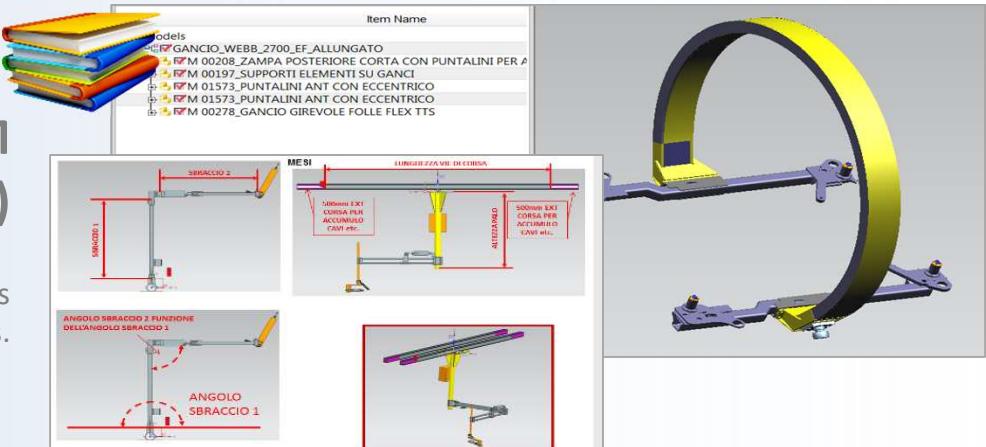
3D layout & Line Configurator



Design lines using «blocks» in an user-friendly environment

Use OOM
(object oriented modelling)

Each block as a 3D representation (integrated with PLM) and represents “best practices” of technological process solutions.



Cost evaluation

Models also have cost information allowing engineers to quickly evaluate costs of new lines

Cost Database

Throughput Simulation



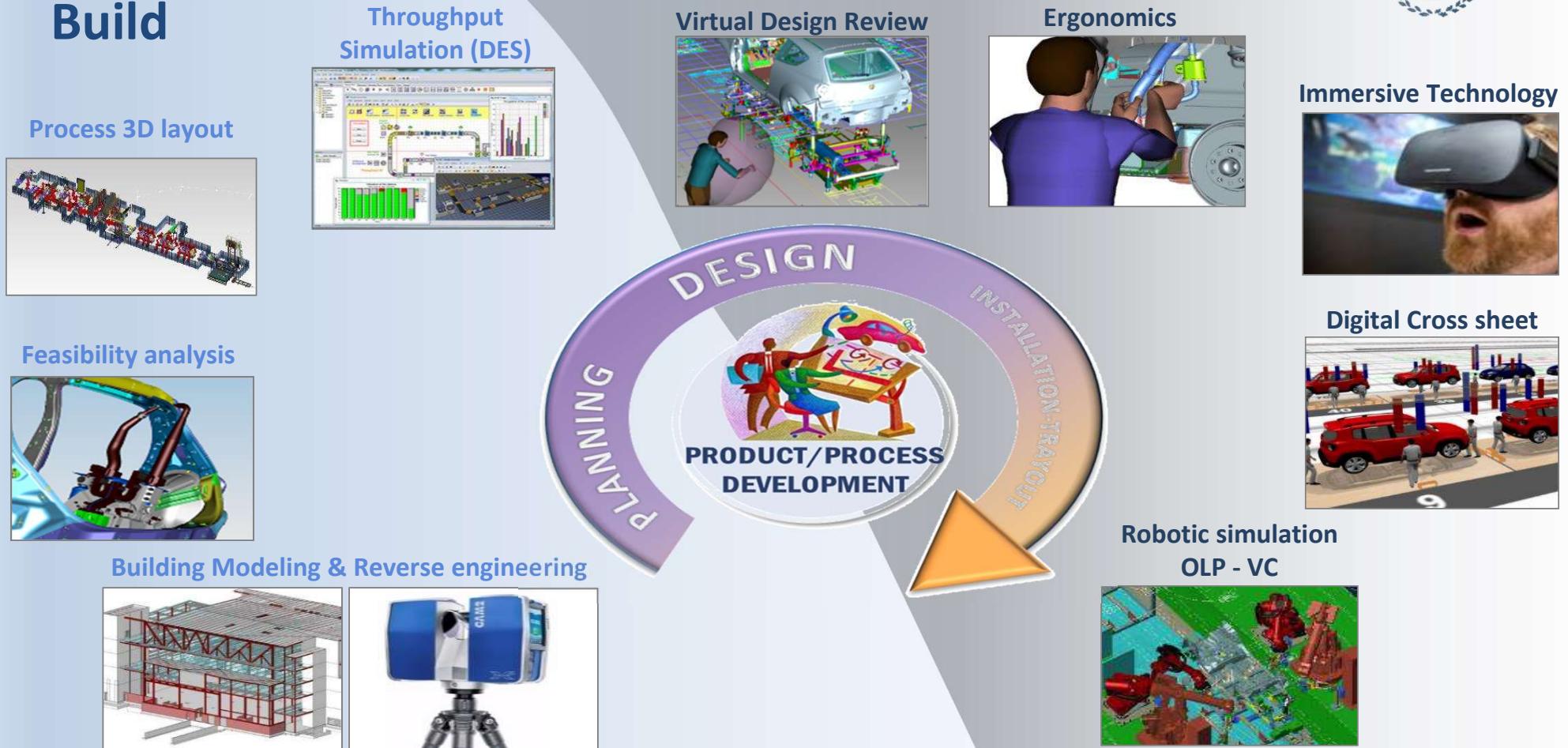
Throughput Simulation



Description

- Application tool that predicts plant performance (primarily production volumes) and sizes key manufacturing planning inputs: cycle times, buffer strategies, number of pallets/carriers, availabilities, etc. Its Purpose is to:
 - ✓ validate key aspects of plant layout and process design as it relates to throughput and investment.
 - ✓ identify wastes, losses, and production bottlenecks.
 - ✓ allow what-if experiments and validation before investment approval and physical build.

Digital Manufacturing Validation – Design & Build



Virtual Design Review & Ergonomics



Virtual Design Review



Ergonomics



Description

- The Virtual Design Review (VDR) is a methodology to validate at an early stage the design of machinery, equipment and layouts. The aim is to optimize the design in accordance with product & process standards to grant safety, quality target, maintainability, ergonomic, etc.

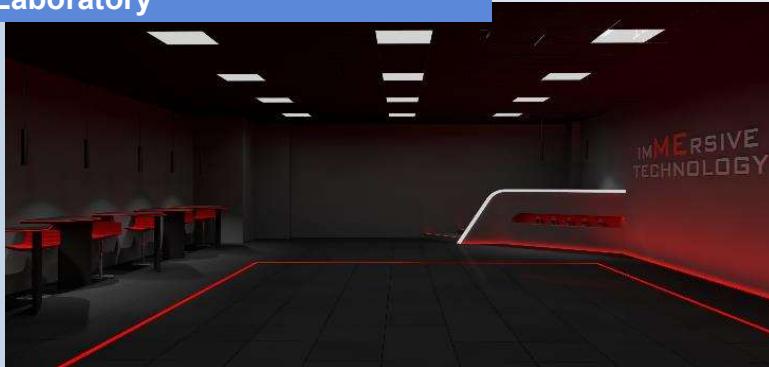
Description

- Ergonomic simulation allows to evaluate human factors related to production tasks in a virtual environment at an early stage of product and process development, when physical equipment and facilities are not available.

ImMERSive Technology



Laboratory



Virtual Reality devices



Description

- The imMERSive technology virtual reality center is a laboratory to support ME activities for new programs:
 - ✓ Evaluation of different scenarios since planning phase with digital twin
 - ✓ Manufacturing Plants exploration via 3D scanning
 - ✓ Suppliers Design Review sessions with immersive technology
 - ✓ Product/process feasibility analysis with collaborative working session
 - ✓ Ergonomic analysis with interactive simulation
 - ✓ WPI support for plant people with remote sessions

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Digital Cross sheets



Digital Cross sheet



Description

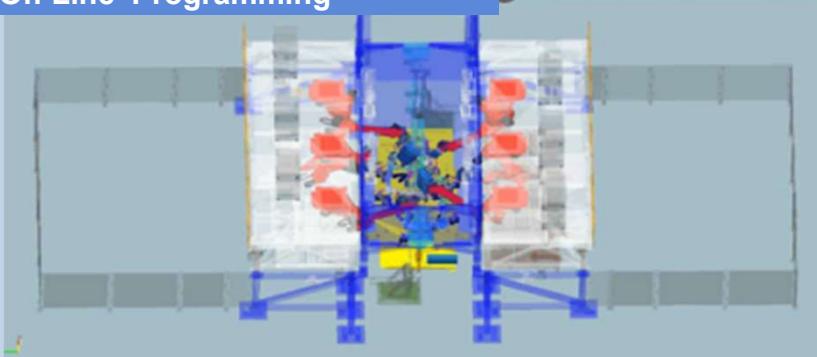
- The digital cross sheet has been developed to integrate in a single visual environment all information required to draft a new or modified production line.
- Main feature are:
 - ✓ 3D visualization
 - ✓ Product & Process Sheets integrated viewing
 - ✓ Best Practices, EEM and EPM integrated viewing
 - ✓ Operation and manpower workstation definition
 - ✓ Visual reporting of average worker assignment, highlighting most critical workstations

Off Line Programming & Virtual Commissioning

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Off Line Programming



Virtual Commissioning



Description

- Off-line programming (OLP) is a robot programming method where the robot program is created through a graphical 3D model in a simulator.

Description

- The virtual commissioning (VC) allows to validate the real control system in order to improve the simulation of automatic stations and reduce the ramp up time at the shop floor after installation

Investments vs. Costs

A rough comparison for a brand new vehicle process in an High Cost Country (i.e. West Europe) shows different impact of different processes on Investments or Costs

