The Future of Composites Manufacturing: An Automation Case Study of an Automotive Battery Box





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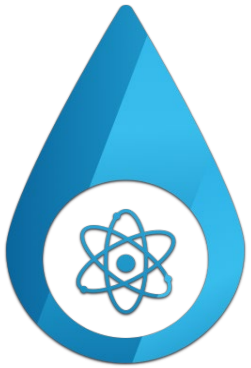
Contents

Airborne Group

High-tech SME

Facilities in
The Netherlands
and the UK



25-year legacy in design and manufacturing of Advanced Composites: Aerospace, Marine, Renewables, Industrial and Oil & Gas

Supplying automated and digital manufacturing systems, to radically industrialise composite manufacturing

Vision:
Digital, on-demand manufacturing platform

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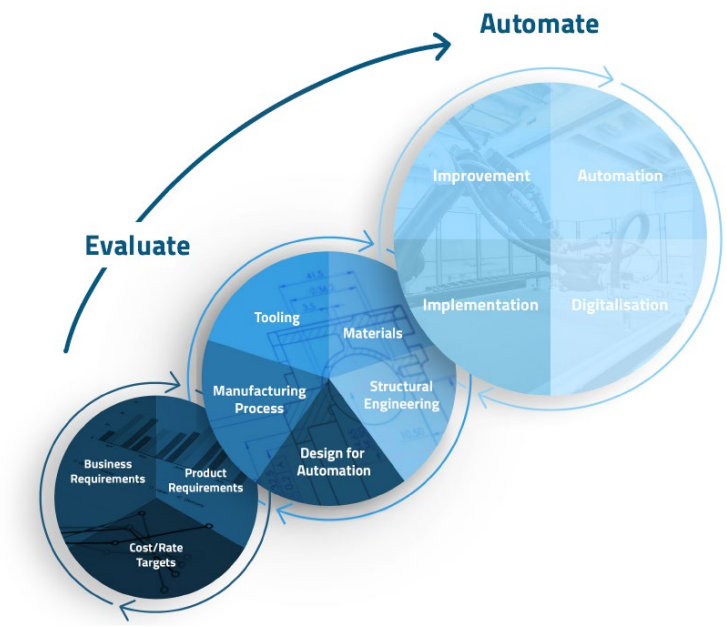
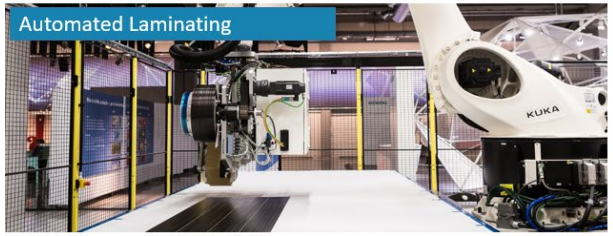
Your Industrialisation Partner

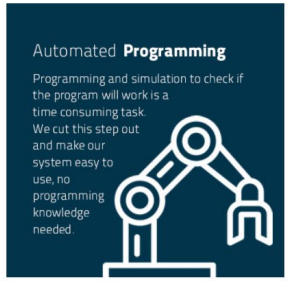


Automation Systems

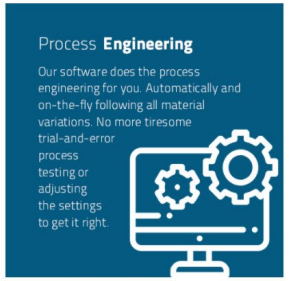


Digital Solutions

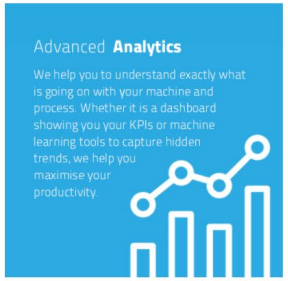
Automated Programming



Process Engineering



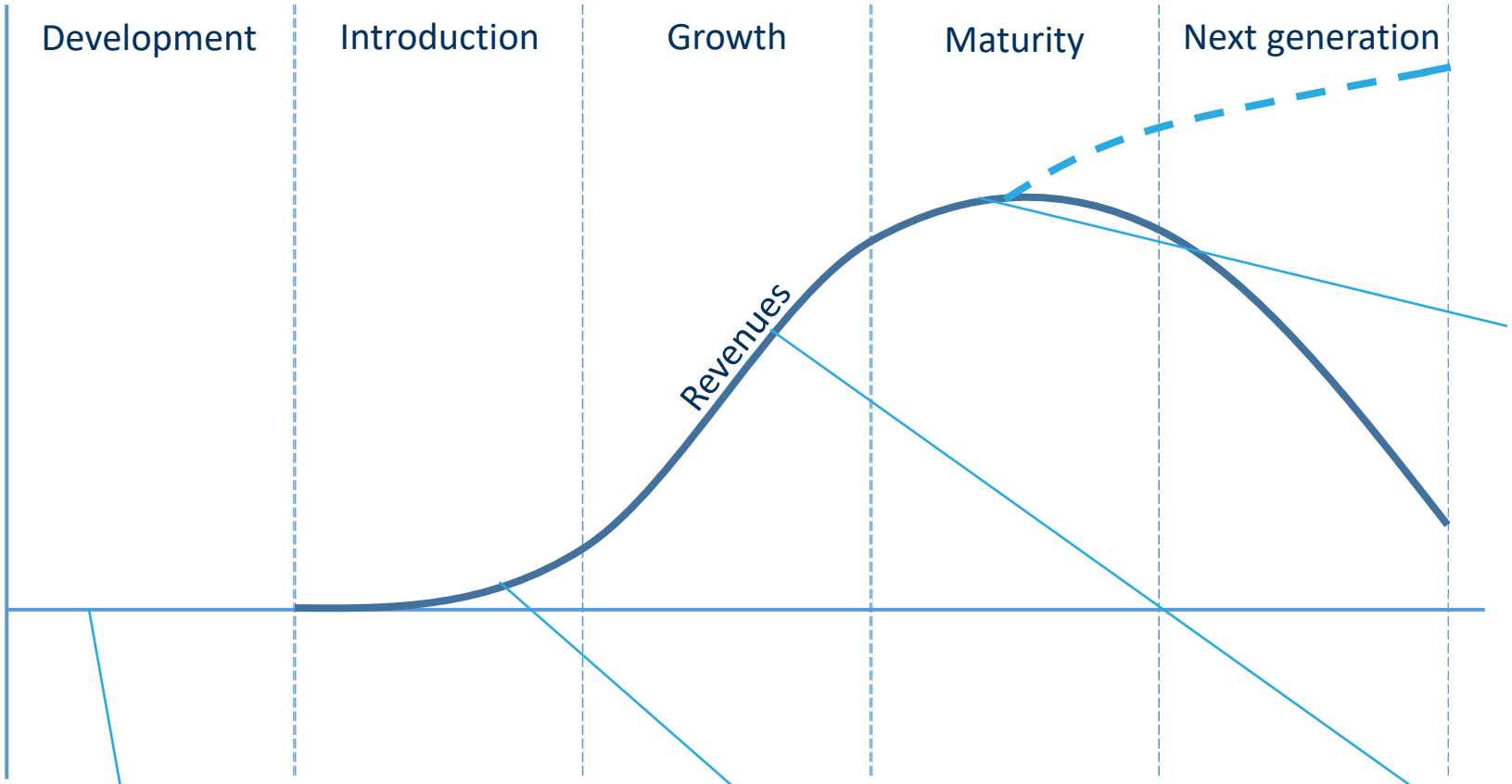
Advanced Analytics



Digital Integration

Design and Manufacturing services

Airborne's capabilities to support full development cycle



Airborne has a flexible business model including equipment-as-a-service to provide customers flexibility, less operational responsibility and less up-front investment

Airborne can support in product development to ensure materials and designs are optimised for automation

Airborne can provide industrialisation system engineering and manufacture composite prototypes

Airborne can provide production capacity by running the automated production systems for the customer during ramp up

What does automotive electrification mean for composites?

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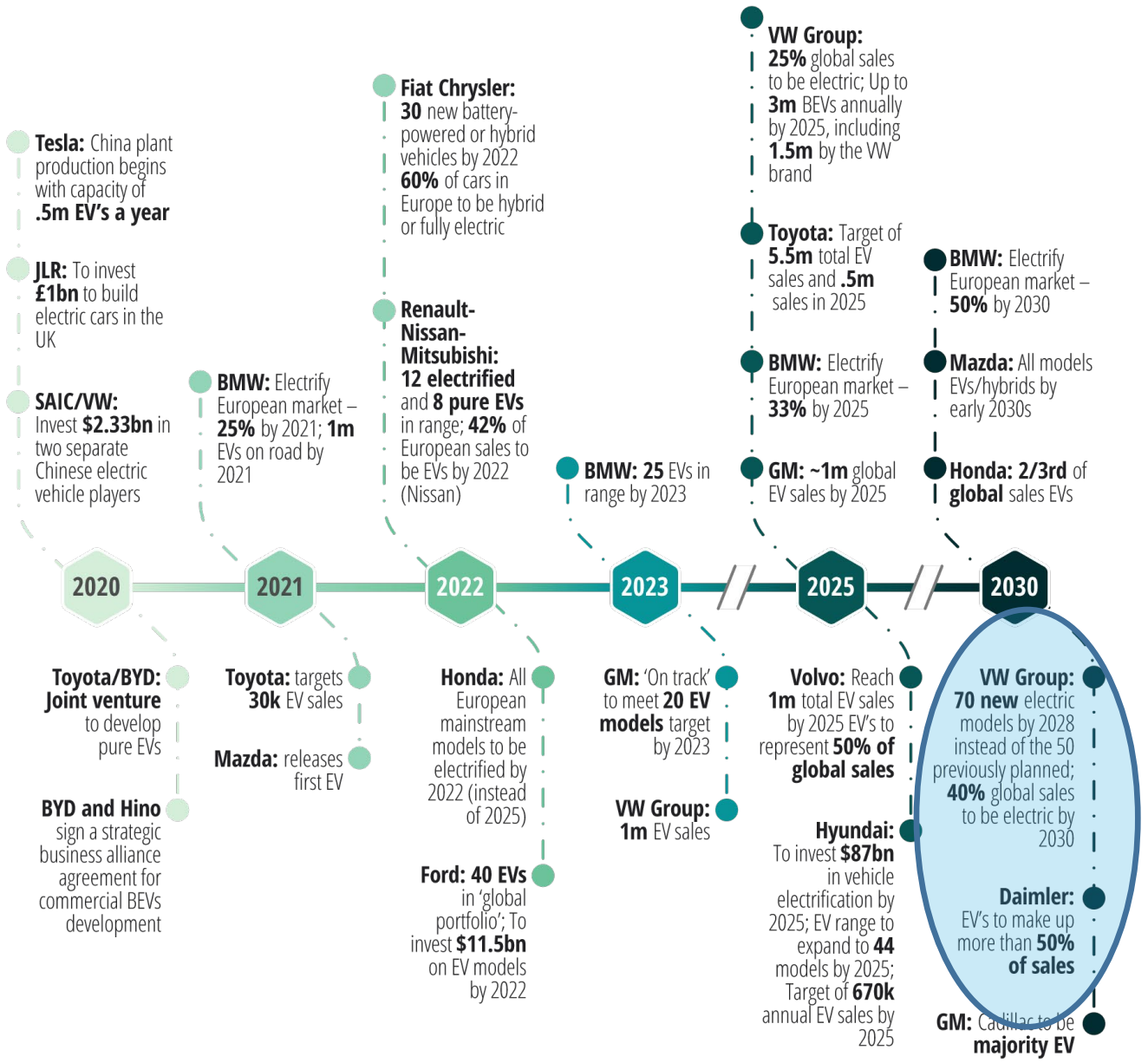
Trend: Electrification

Electric Vehicle (EV) fleet worldwide (2020): 10.5 mio

Global EV forecast, CAGR 29%, over the next 10 years

Total EV sales growth from 2.5 mio in 2020 to 31.1 mio by 2030

Timeline of strategic OEM targets for EVs



Source: Deloitte analysis[28]

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Growth factors

Policy and Regulation:

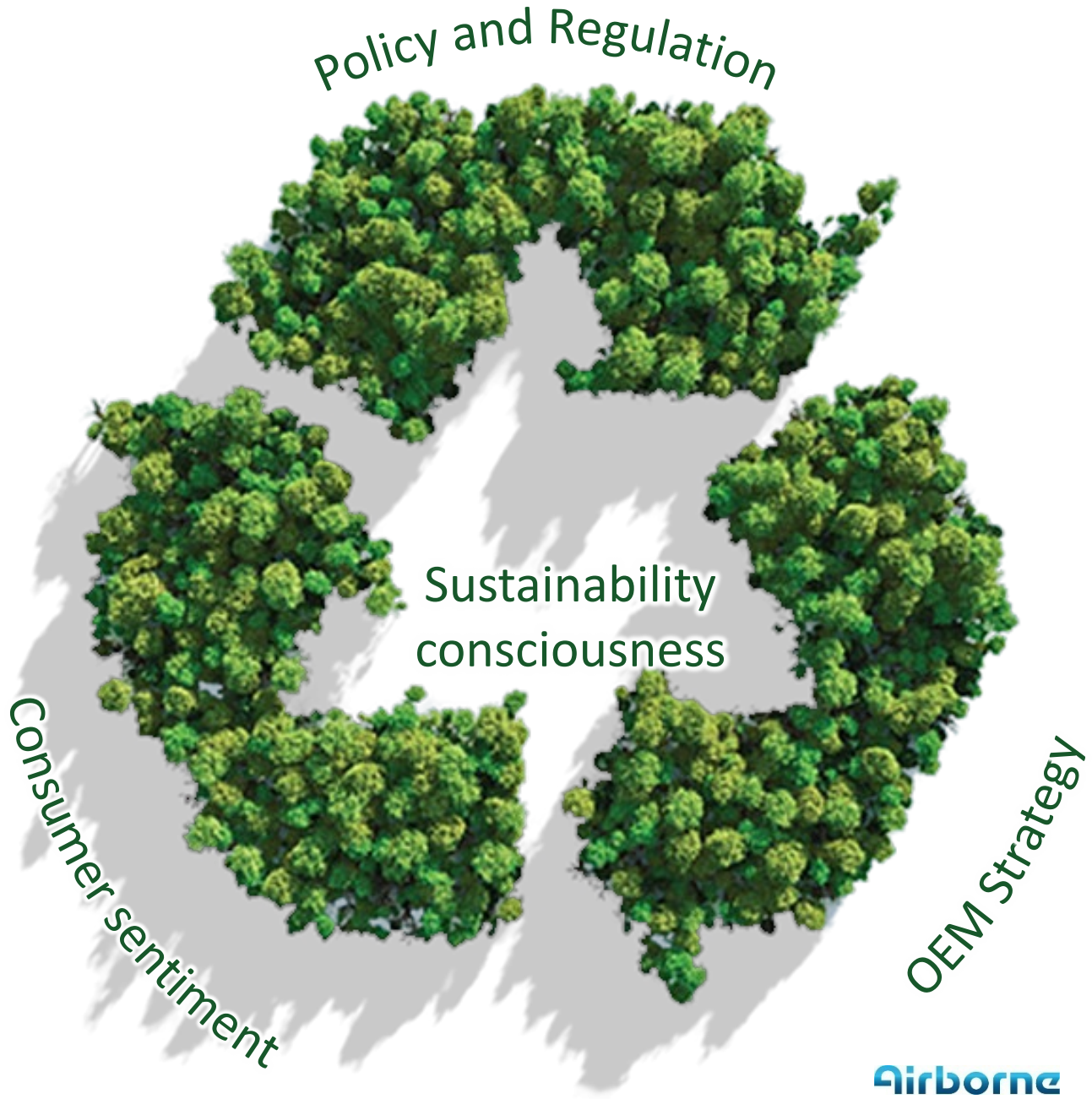
- Fuel economy and emission targets
- City access restrictions

Consumer Sentiment:

- Accessible infrastructure
- Improved vehicle range

OEM strategy:

- Availability of models
- Affordability

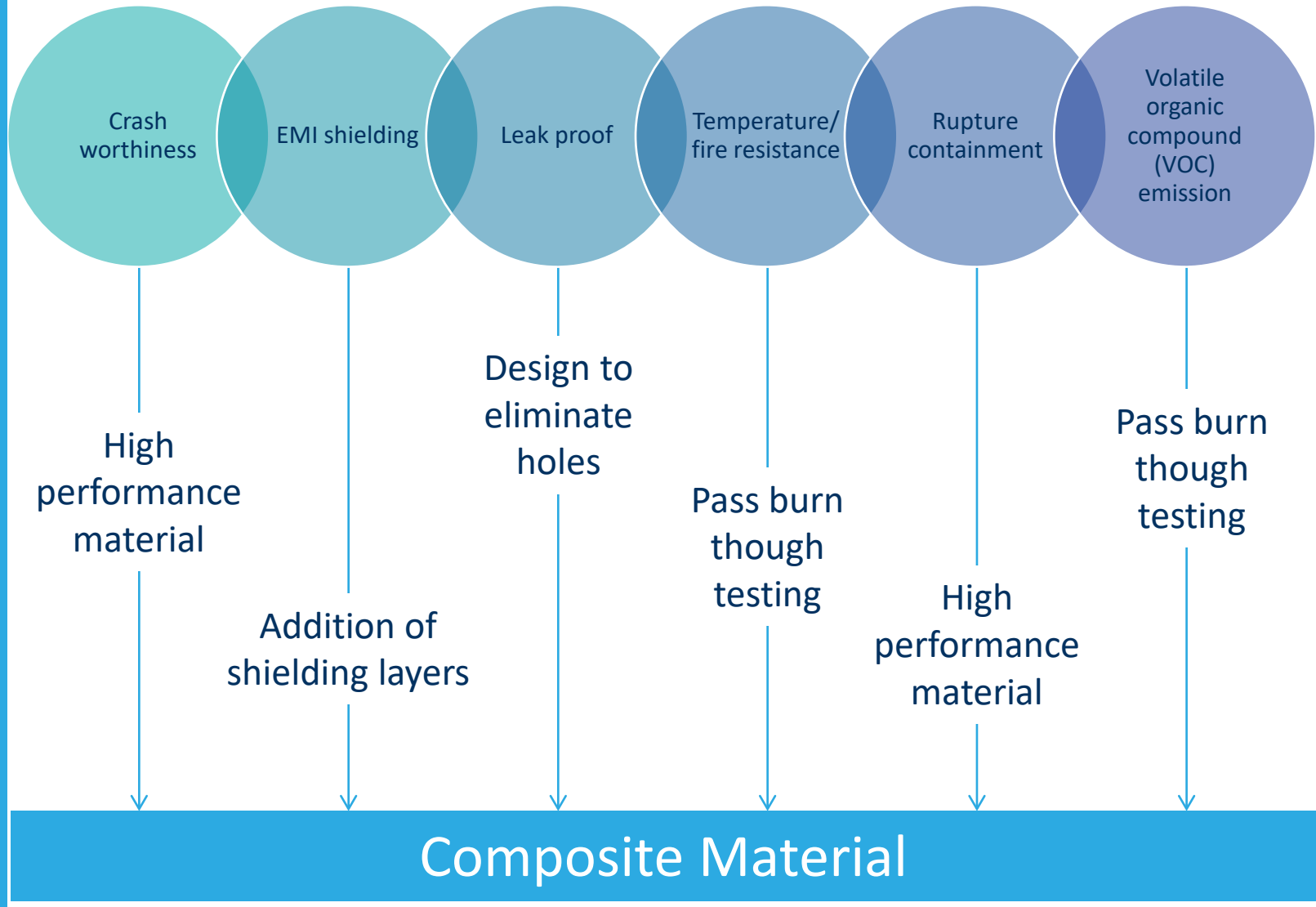


Battery boxes

A multitude of requirements in combination with cost & weight targets!

Composite material can meet them all in theory

Airborne design and manufacturing processes can ensure this in practice



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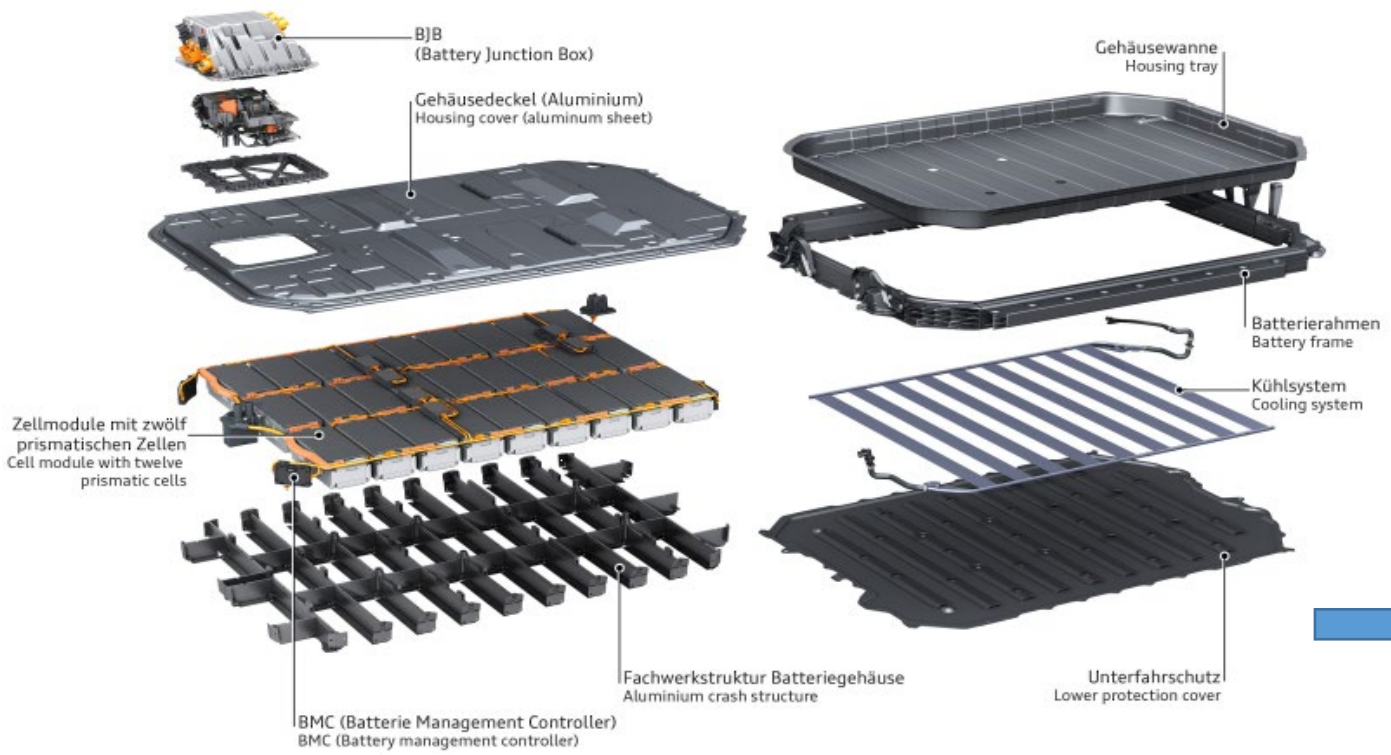
Example Battery Box construction

There are many solutions and configurations. Not all use composites but example shown uses SMC “lid”, metallic frame, and a glass reinforced thermoplastic lower protection cover.



Airborne Development Challenge:

- Example vehicle volume 100k units per annum
- Requires 2 min TAKT time
- How to process composites from lowest cost form at this rate?

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Case Study 1: Affordable Rate-Capable Composite Structures (ARCS) Thermoset Part

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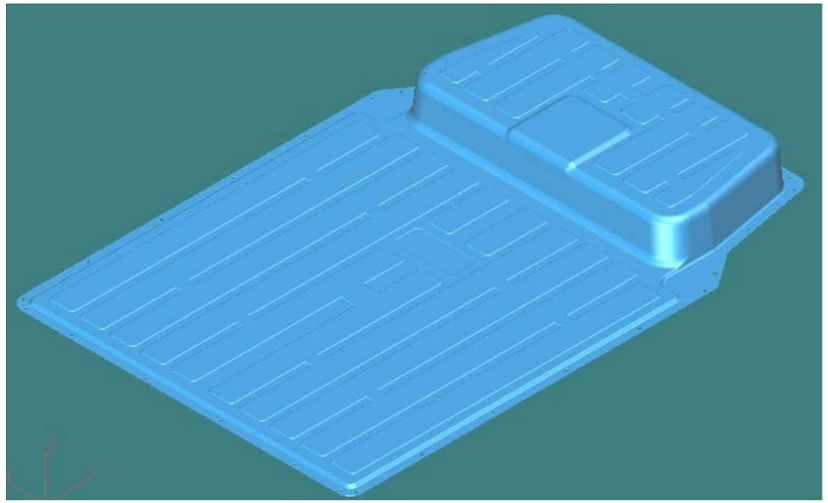
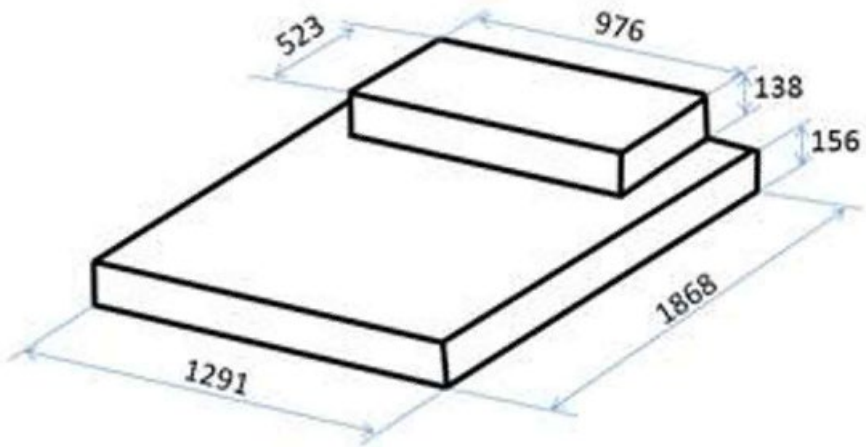
Project Overview





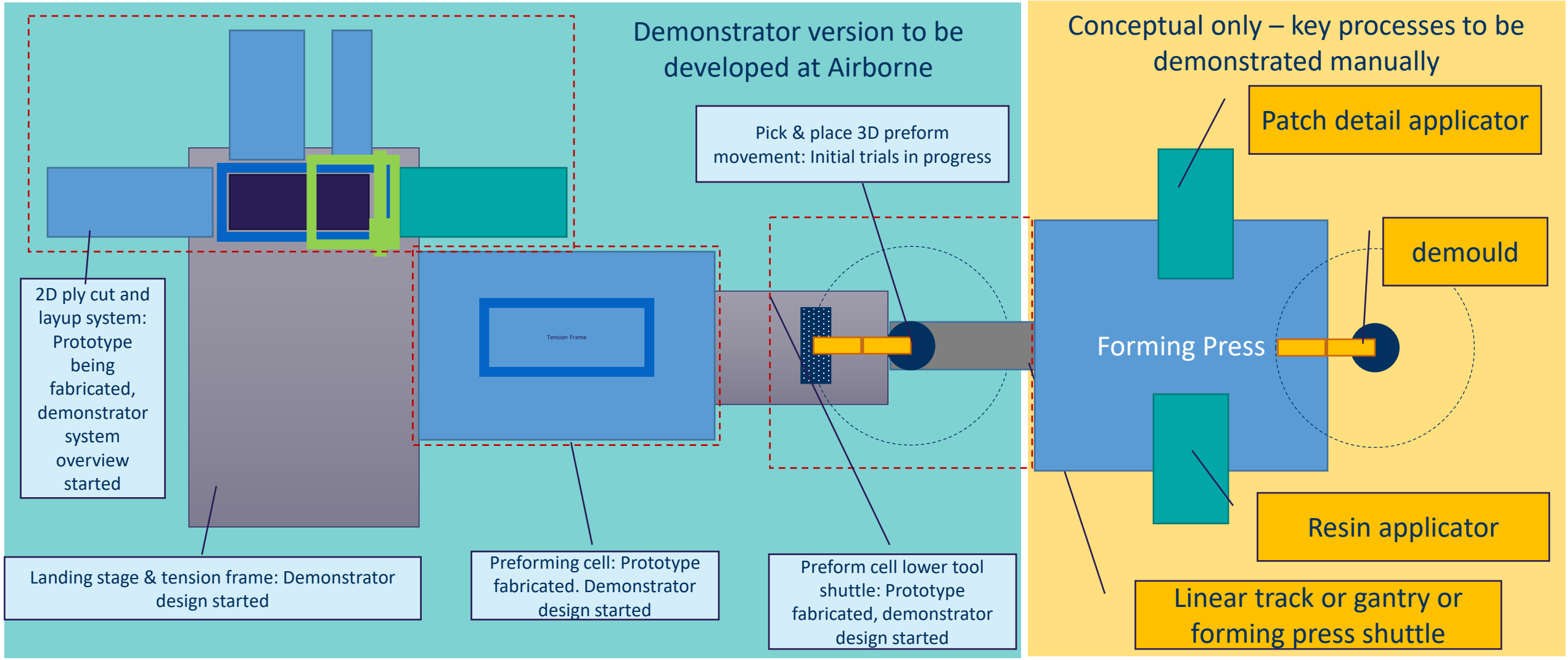
- Project aim is to develop an automated production line for the manufacture of the lid of a battery box for an electric vehicle from NCF and Epoxy using liquid compression moulding, with 2 minute TAKT time.
- Partners include:
  - Cranfield University – Preforming concept development
  - AMRC – General support & tooling
  - GKN Automotive – Press, infusion and cure process
  - Sigmatex (project lead) – NCF machine development
- Use case provider 1: Nissan
- Use case provider 2: Jaguar LandRover

Part funded with UK public money by Innovate UK through Advanced Propulsion Centre

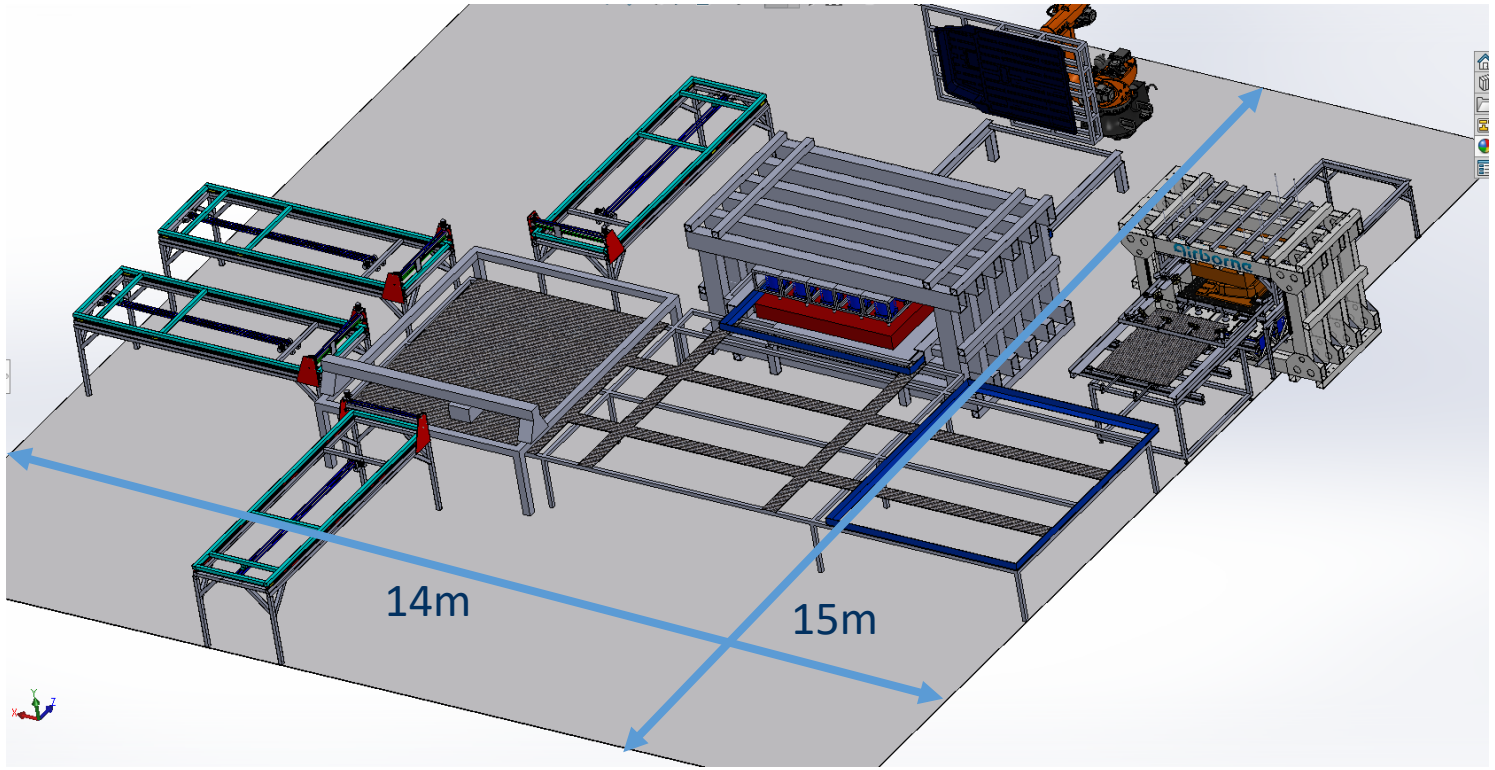
Conceptual Plan of Process

Operational Digital Twin Architecture

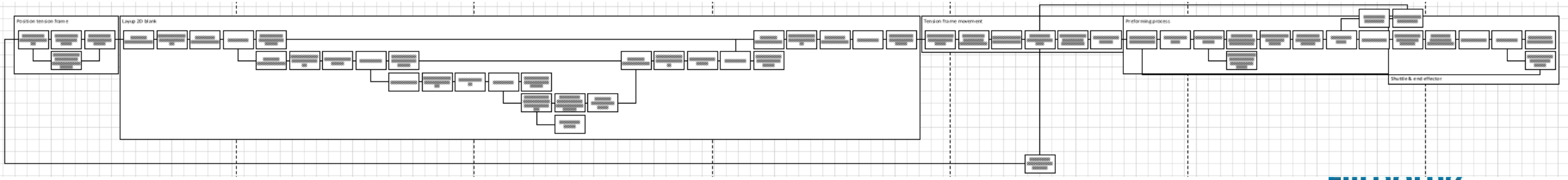
Power and Control System Architecture



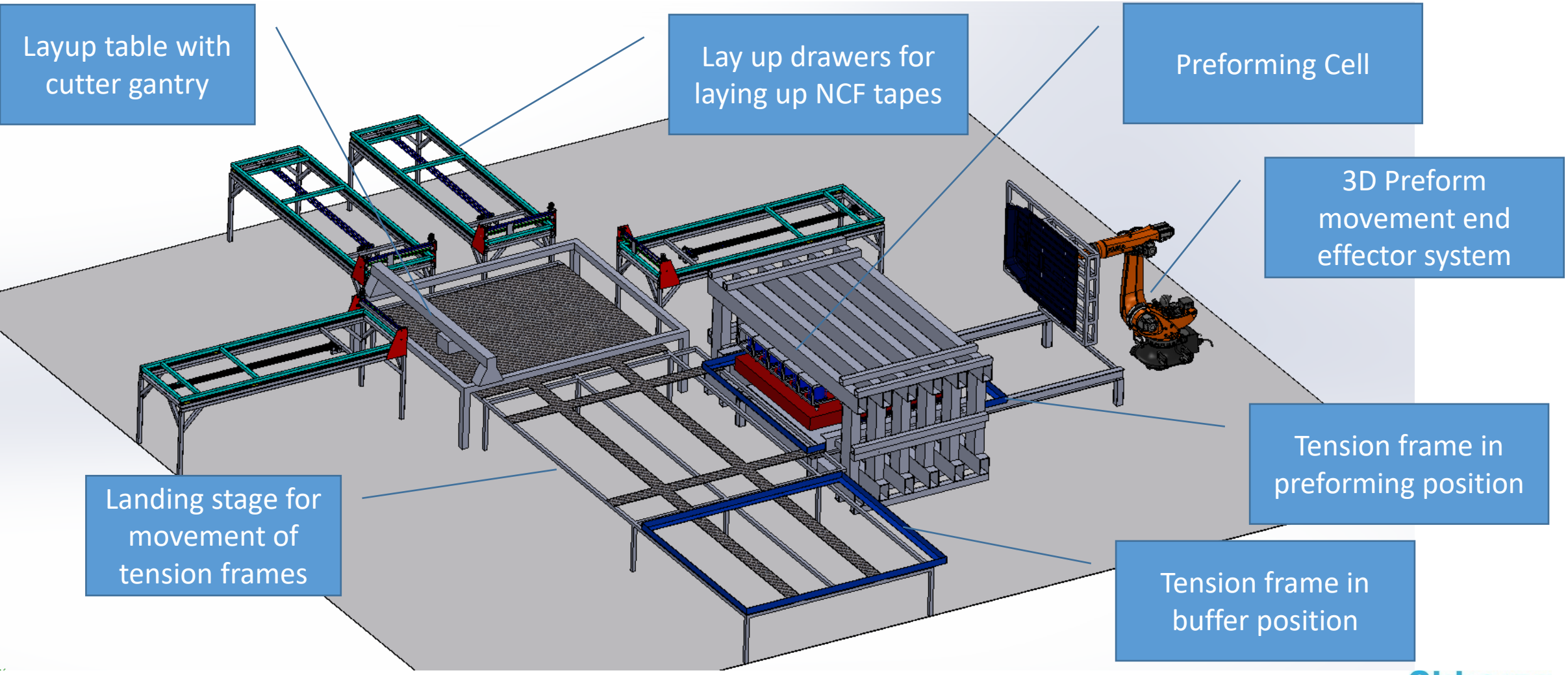
System Level Design



- System level design using
  - PFMEA
  - Value stream mapping
  - System architecture design



System Level Design



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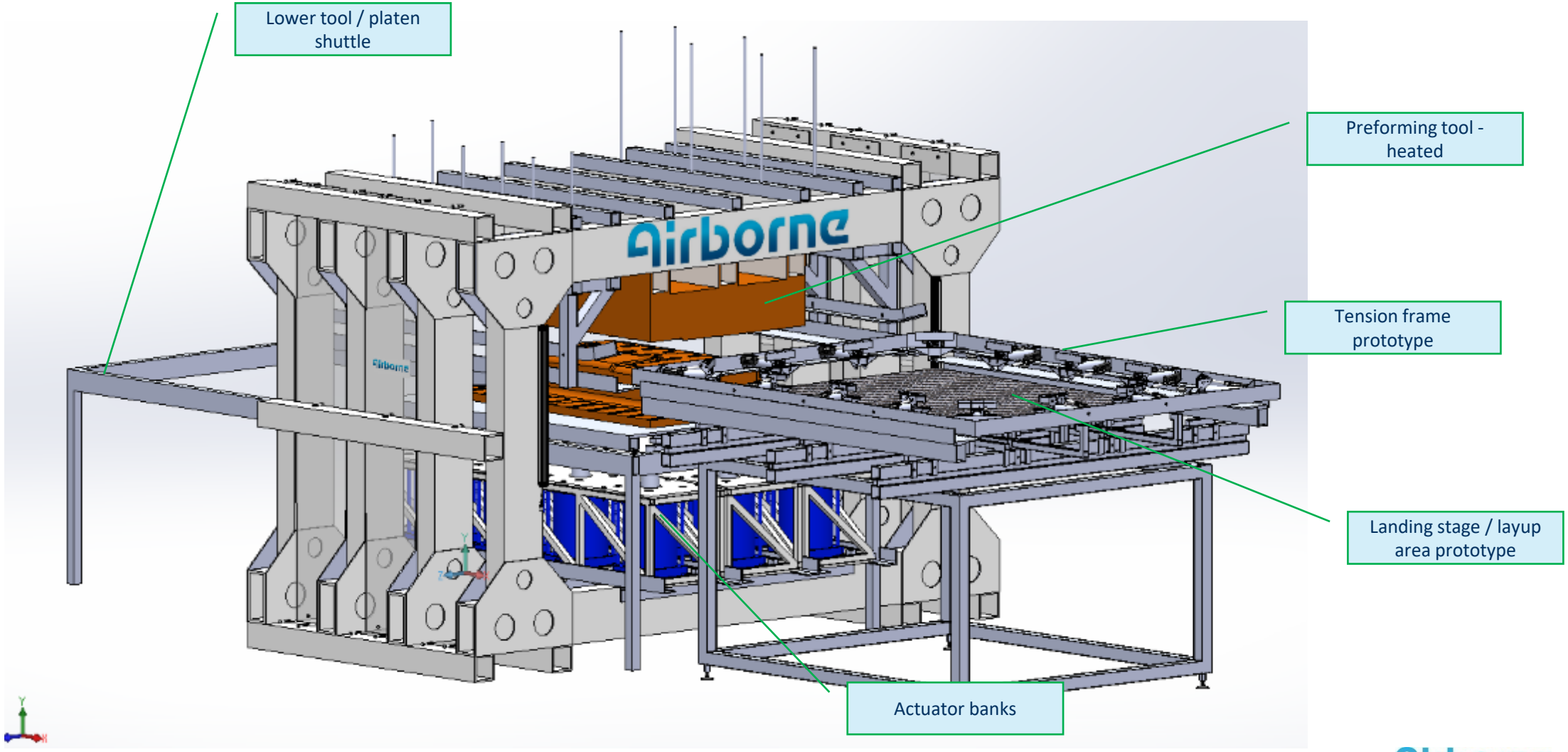
Automated Process Development – 3D forming machine concept



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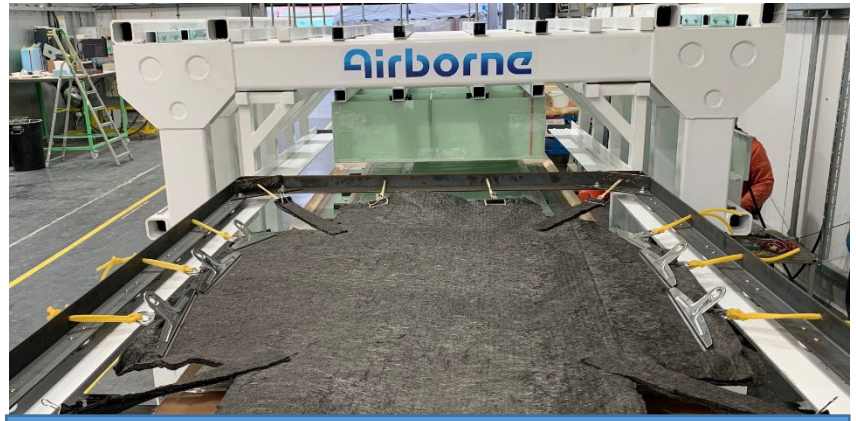
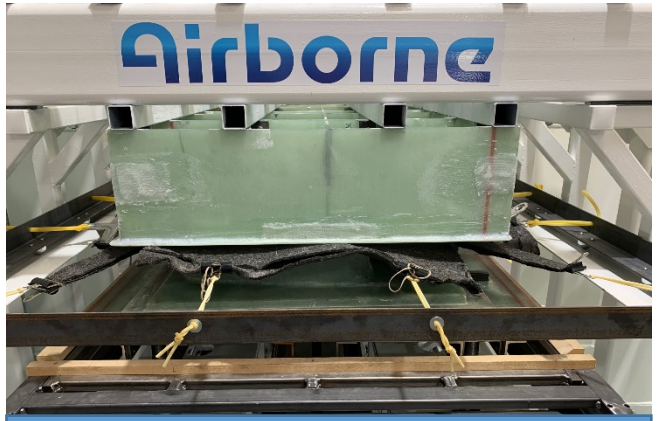
Development of 3D forming press

Front view of prototype 3D preforming cell

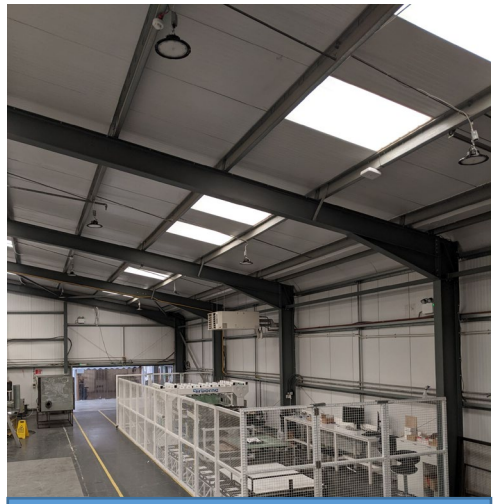
- First we developed a small scale prototype cell, based on a concept of a self-reacting frame.
- Trials run offline to develop a suitable process using cost effective materials e.g MDF frames
- Process development included use of tension frame to hold material during pressing
- Development of machine including pneumatics and control systems
- Material pressed between male and female form
- Material patterns developed to manage drape; shear; wrinkling; overlaps and necessary final part thickness/material orientation requirements.



Tension frame with 2D blank mounted



Tension frame in position between tool halves



Press inside guarded cell

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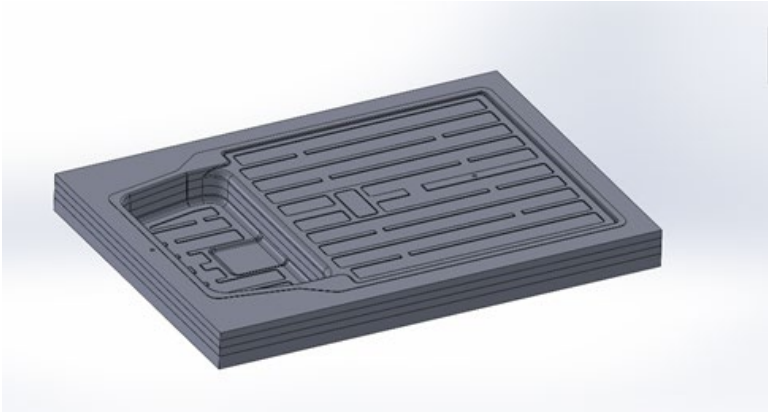
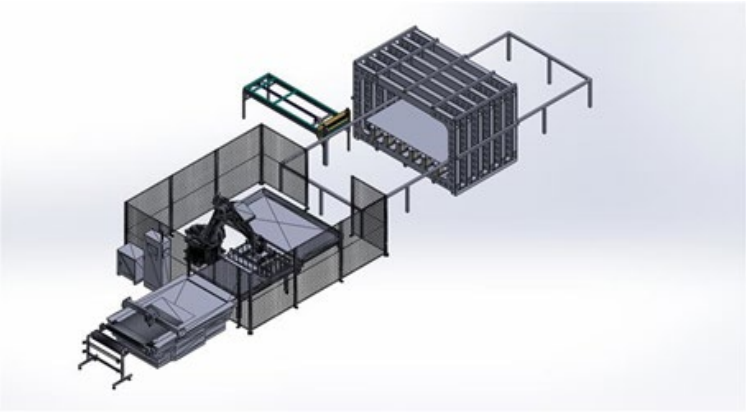
ARCS Conclusion

Project still has 9 months to run until completion. Targets:

- Airborne 3D forming press at full scale to be completed
- Installation of automated process showing cutting → pick & place preforming 2D → pressing to 3D → transport to injection/pressing process at Tier 1.
- Run at rate demonstration with 2 min TAKT
- Commercial demonstrator component to be made
- Basic digital twin of process to be developed.





With thanks to APC; Innovate UK; Sigmatex; Nissan; JLR; GKN Wheels & Structures; Cranfield University; AMRC Sheffield;

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Case Study 2:
Processing Thermoplastic Tapes at high rate

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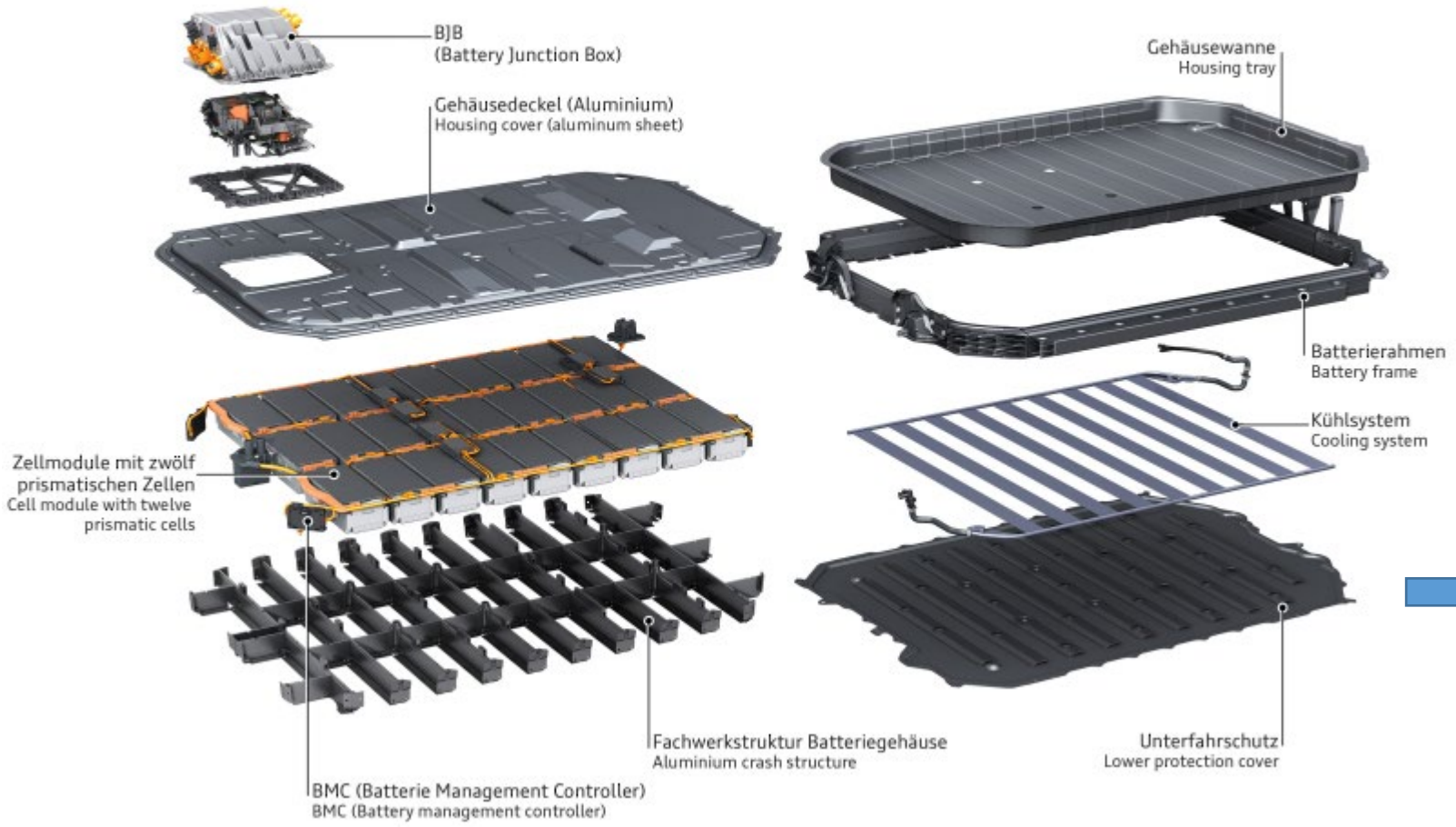
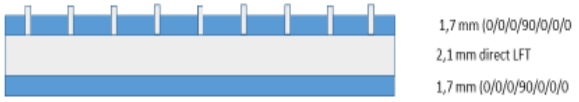
Example Battery Box construction

There are many solutions and configurations. Not all use composites but example shown uses SMC “lid”, metallic frame, and a glass reinforced thermoplastic lower protection cover.



- Typical construction for this component is glass/polypropylene sandwich using UD tapes for skins, and core from Direct LFT



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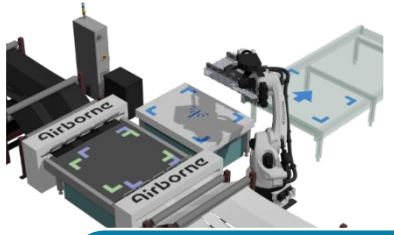
Forming Process (for this example component)

UD Tape Supply



Multi-Tape Preforming Line

Airborne Product

Combine with D-LFT & Press Consolidation

Trimming, finishing, inspection

Airborne System Integration Capability

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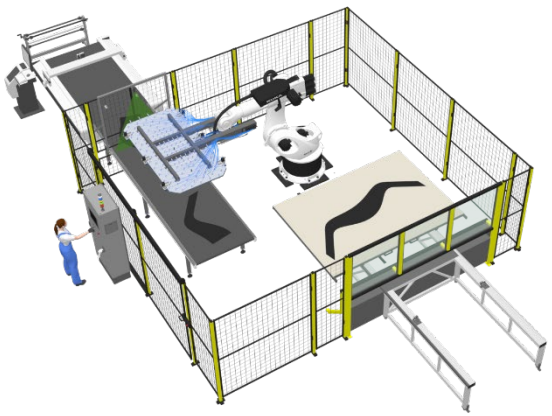
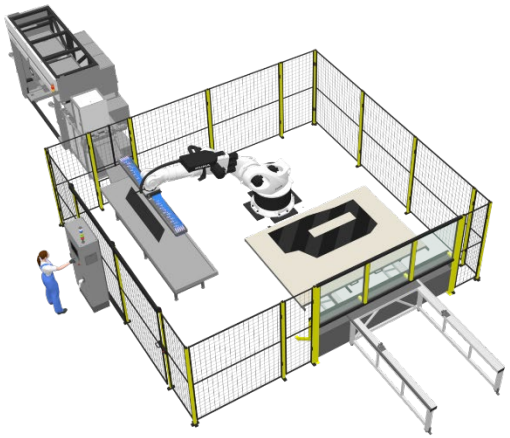
Building blocks

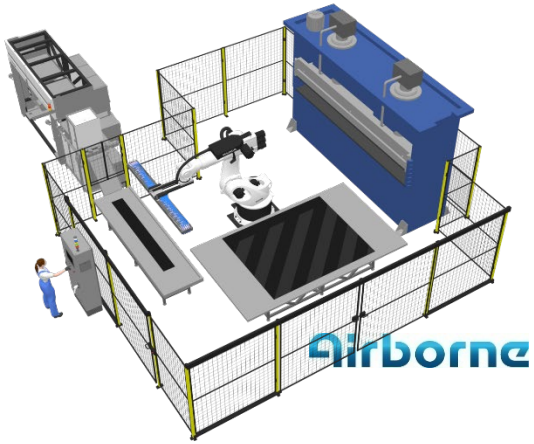
- Tape feed / shapes
  - Cutting table -> all shapes possible
  - Tape feeder -> simpler
  - Multi-tape tape feeder -> high output
  - Laminate cutting / trimming can be integrated

- Quality control
  - Visual cameras for defects, laminate quality
  - Gap measurement
  - Thickness and geometry measurement
  - Welding quality measurement

- Offloading
  - By robot, integrated with downstream process
  - Shutter table
  - Conveyor belt

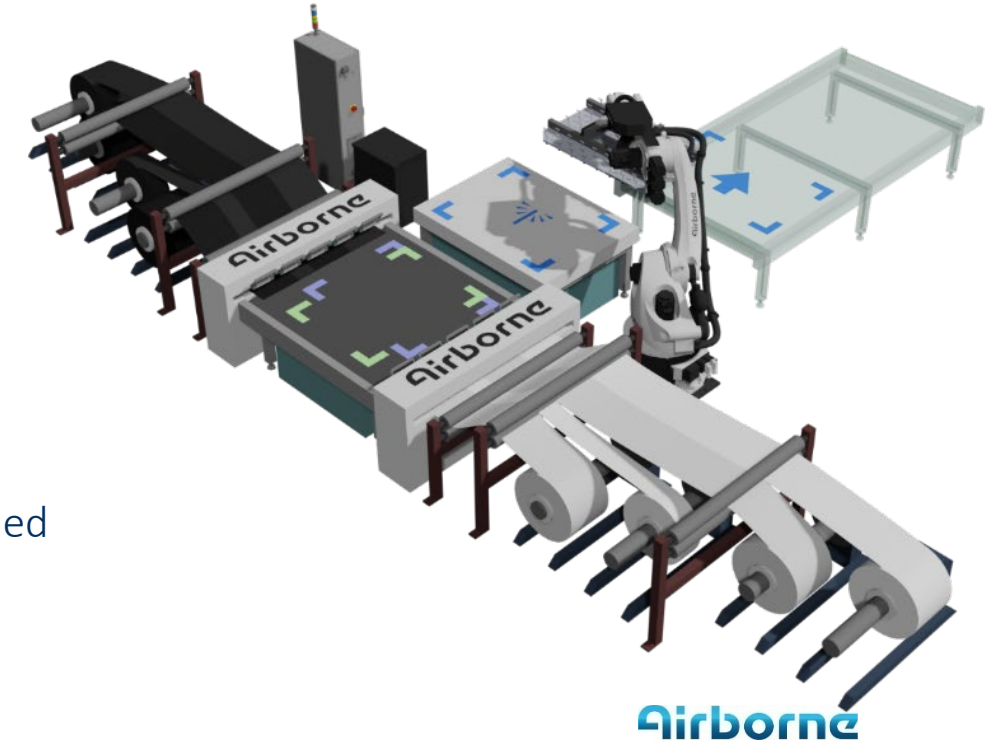






Multi-tape Automated Preforming

- Based on Airborne's Automated Preforming technology:
  - Cut plies to length/shape
  - Pick & Weld: pick & place with spotwelding to create a tailored blank
- Multi-tape feed
- 0/90 laminates, 1500x2000mm
- Spot-welded stacks
- Offloading to downstream process
- Output: 200.000 laminates / year
- Option for 2 material type feeding
- Advantages:
  - Fast: full layer is handled per cycle
  - Flexible: can do any shape or layup or material
  - Scalable: functionalities can be added, modules can be multiplied
  - Multi-axials can be integrated

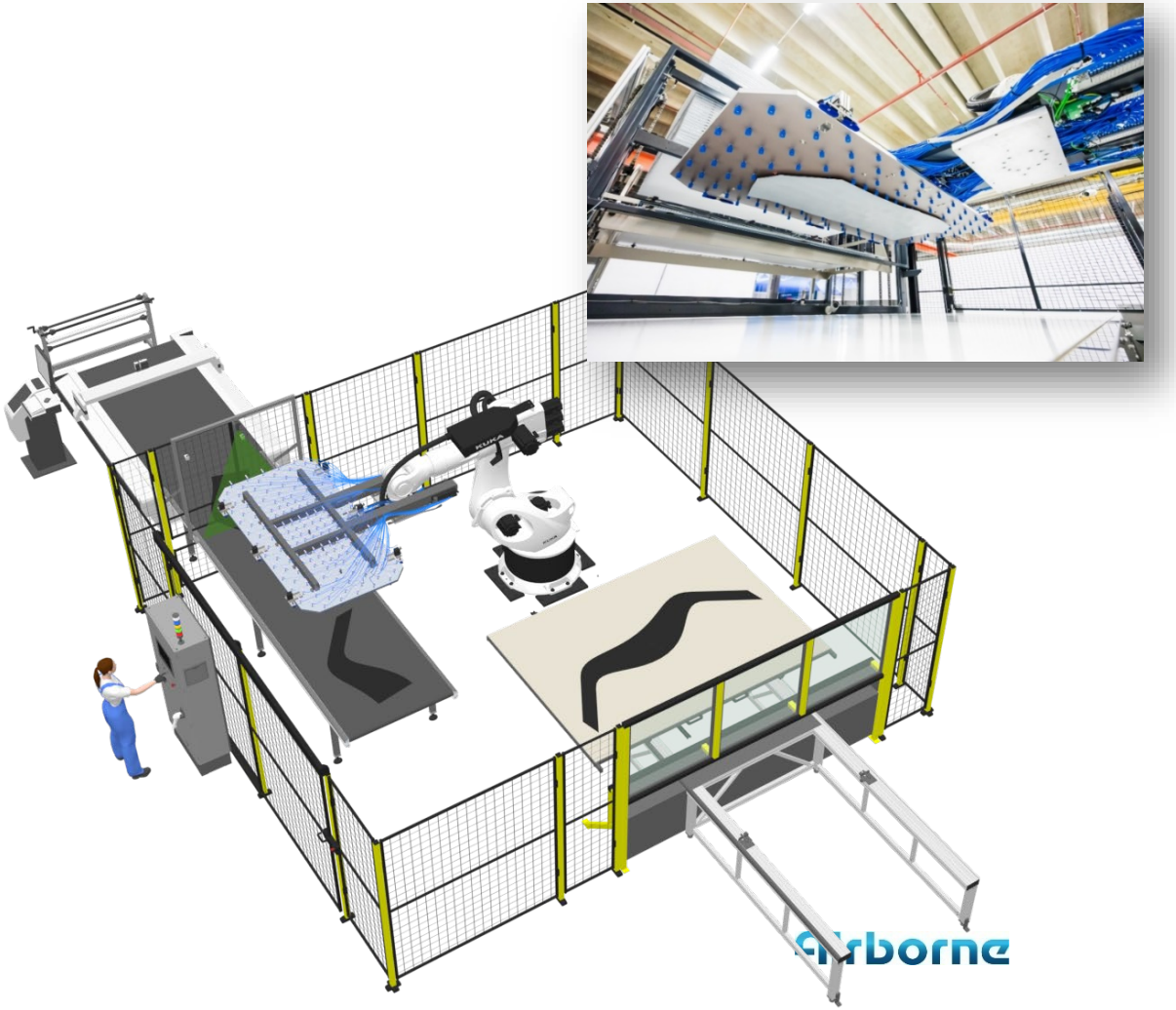


Automated Preforming system

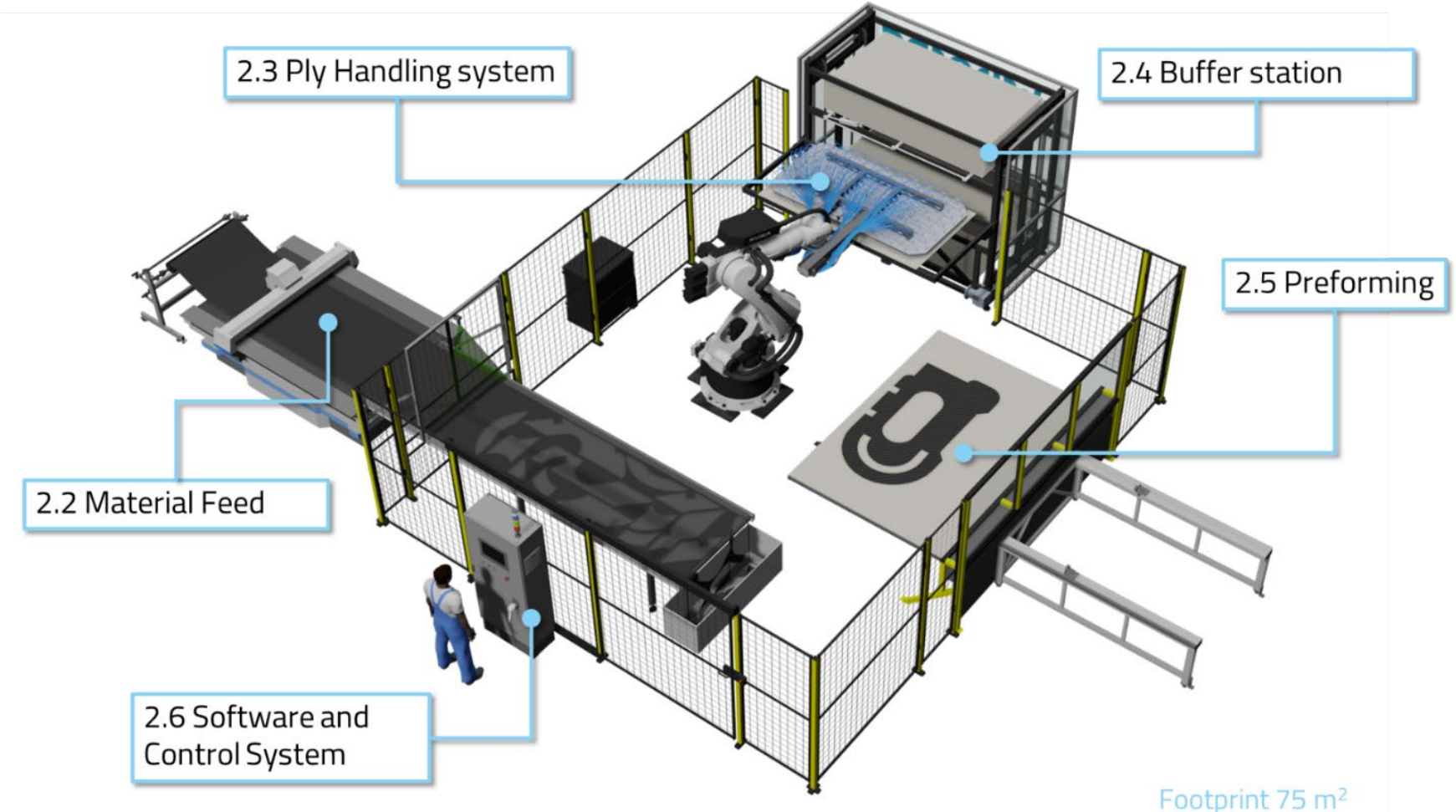
Suitable for Thermosets or Thermoplastic materials:

- Robotic cell to manufacture tailored blanks
- Airborne ‘Pick & Weld’ technology
  - Spot welding
- Dry fibre, impregnated thermoset or thermoplastic composite
- Integrated with ply cutter or stand-alone

- No programming required – in the software
- Fast, robust and flexible
- Output: ~ 20.000 – 200.000 parts/year



Kitting + Preforming



Footprint 75 m²
(max. l 14 m, w 9 m, h 3.5 m)

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Automated Preforming
by Pick & Weld

https://youtu.be/3-qUn4v2gGU

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