ZAL Center of Applied Aeronautical Research

Future.
Created in Hamburg.

Dr.-Ing.
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CoC Aircraft Manufacturing & MRO

ZAL Center of Applied Aeronautical Research

E-Lass Conference

Overview of assembly strategies in aircraft manufacturing

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Shareholders

20%	Free and Hanseatic City of Hamburg
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10%	German Aerospace Center (DLR)
3%	Technical University Hamburg-Harburg
3%	University for Applied Sciences
3%	Helmut-Schmidt-University
3%	University of Hamburg

Background

- founded in 2009 on the initiative of the Free and Hanseatic City of Hamburg (FHH) based on the leading-edge cluster **Hamburg Aviation**
- successful **Public-Private-Partnership**
- status as an independent small and medium sized enterprise
- ZAL TechCenter:
  building & infrastructures for research activities of aviation actors in Hamburg
  - area ~ 26,000 m²
  - work places ~ 600
  - R&T infrastructures ~ 13.7 M€
  - construction/financing costs ~ 82 M€

ZAL Research & Technology

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Aircraft Manufacturing & MRO

Additive Manufacturing
- Hybrid Construction
- Functional Integration

Robotic & Automation
- Human-Machine-Collaboration
- Lightweight Robots & Support Systems

Laser Shock Peening
- Peen Forming
- Fatigue Reduction

Cabin & Systems

Passenger Experience
- Acoustics & Vibration
- Lighting & Projection

Systems
- Data & Power Net
- Air & Power Systems
- Fuel Cell Technology

Future Cabin Architecture
- Cabin Flex & New Seating Areas

Digitalization Technologies

Monitoring, Diagnostics, Prognostics
- Business Understanding
- Data Acquisition
- Predictive Data Modeling
- Model Deployment

Digital Transformation
- Digital Products & Services
- Digital Processes
- New Business Models & Culture

Fuel Cell Lab

Cabin & Cargo Testrig

AVANT Testrig

Laser Shock Peening

Accoustic Lab

Virtual Reality Lab

Aircraft Assembly – Well established processes

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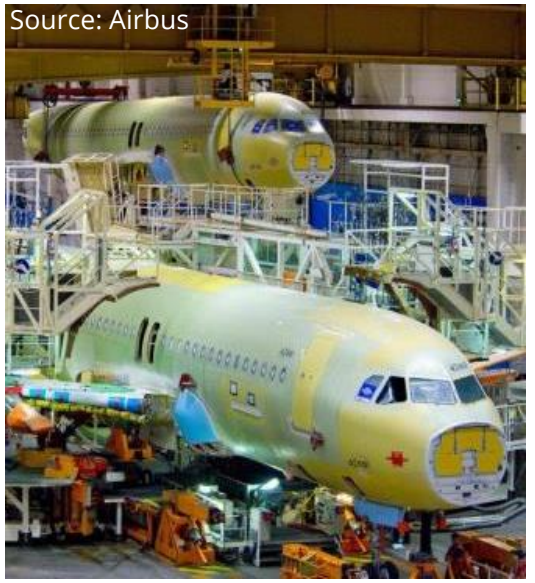
1970/1988


Source: Boeing


Source: Airbus

2016


Source: Airbus


Source: Airbus

Market requirements

20-year General Market Forecast

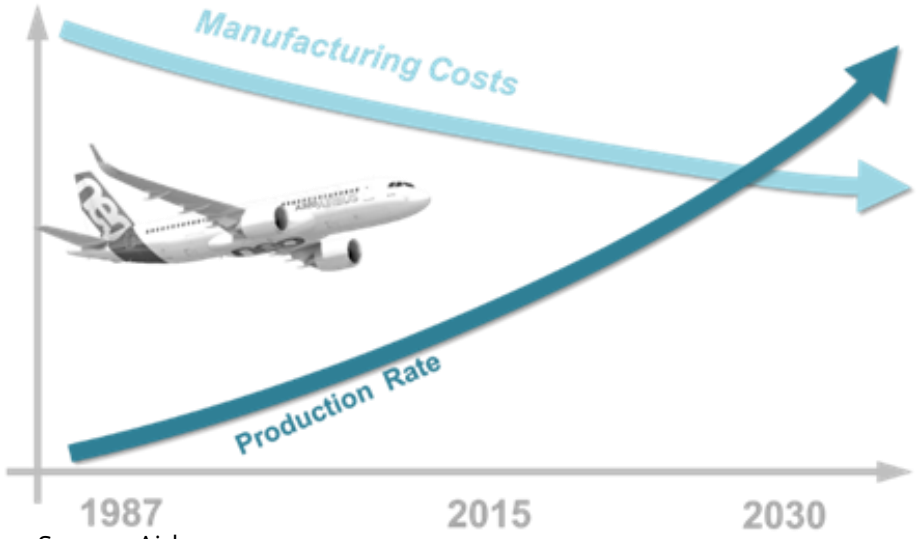
22,100

7,800

1,500

Source: Airbus

31,400 new aircraft



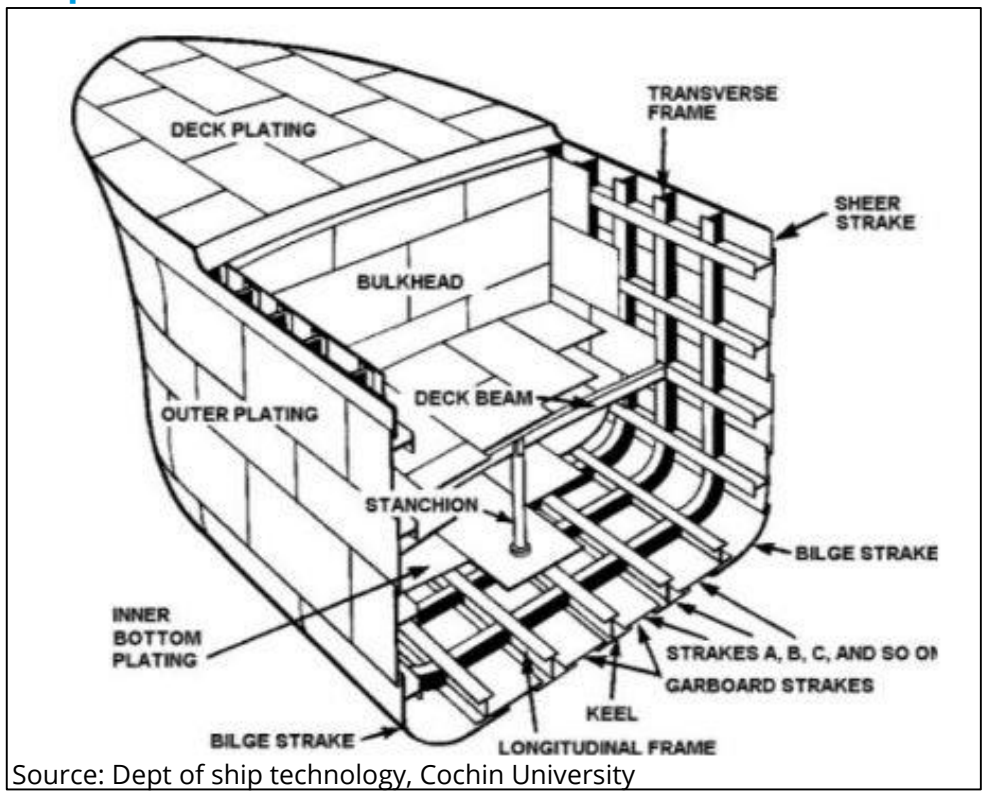
Source: Airbus

- **Traffic will double in the next 15 years**
- **Potential for more than 30000 deliveries in the next 20 years**

- **High increase of the production rate**
- **High customization capability**
- **High ramp up speed**
- **Complex global supply chain**

From ship to plane - Resemblance

Ship structure



Source: Dept of ship technology, Cochin University

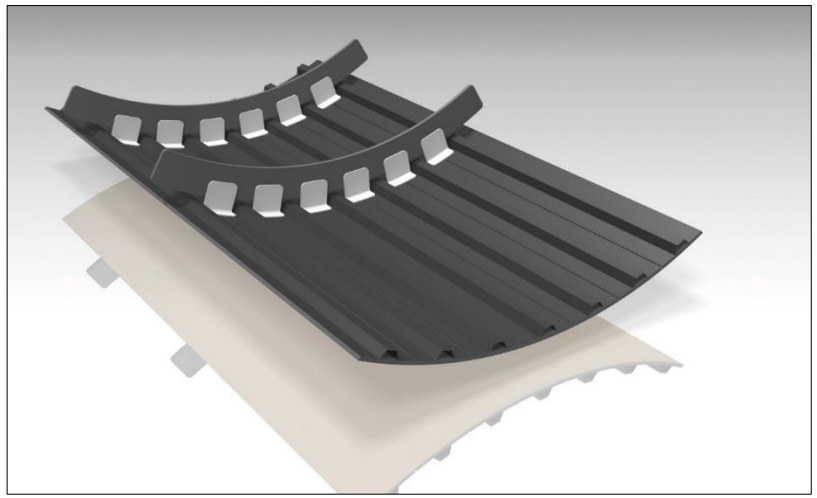
A320 Section

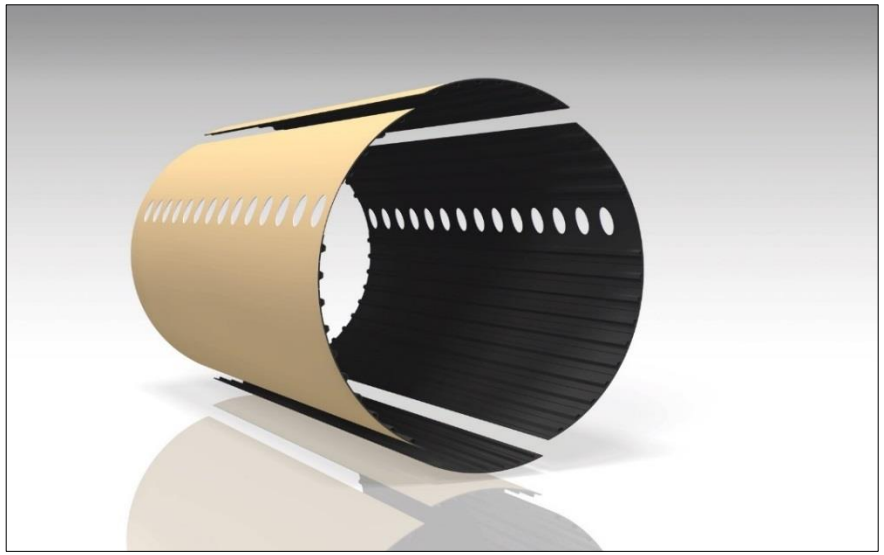

Source: RUAG Aerostructures

- **Stiffening elements (frames)**
- **Pressure hulls**
- **Shell based construction**

Manufacturing strategies – From shell to fuselage

Shell assembly





Barrel design

Source: Boeing


Source: Boeing

Aircraft production - Extensive manual workload


Source: Airbus

- **Manual workload along the whole value chain**
- **Very complex processes**
- **Non ergonomic workplaces**


Source: Airbus

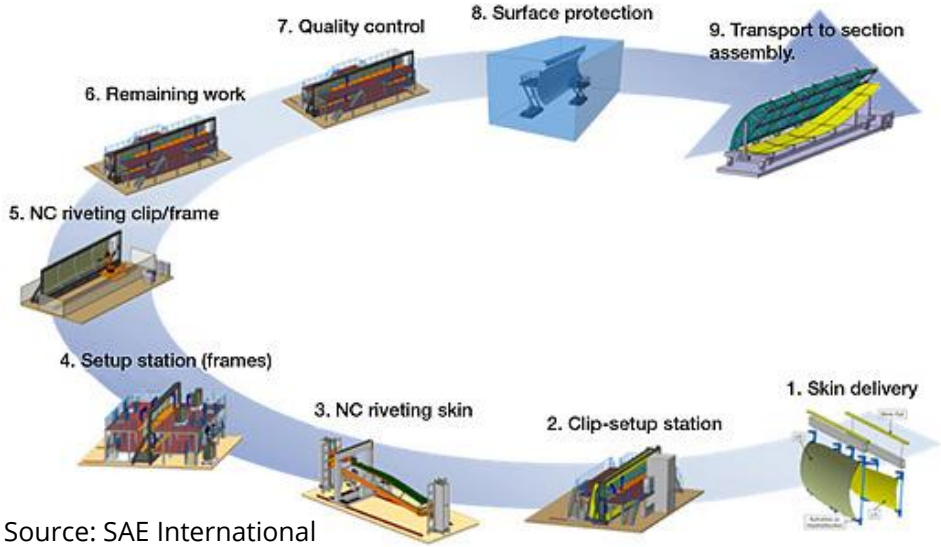

Source: Airbus

Aircraft production – Automation strategies

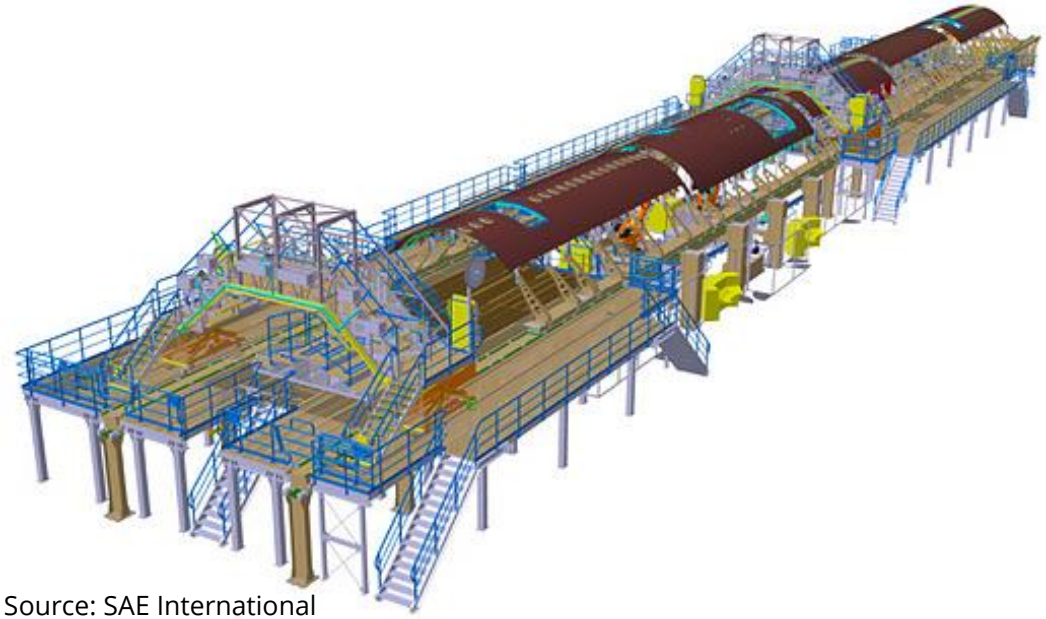

Source: press-inform / VW


Source: Airbus

- **Full automation not possible due to todays aircraft design**
- **First full automation in components/shell production**
- **Future design needs to consider automation demands**



Source: SAE International


Source: SAE International

Aircraft production – Automation strategies

Automotive industry with linear development from electrification to automation

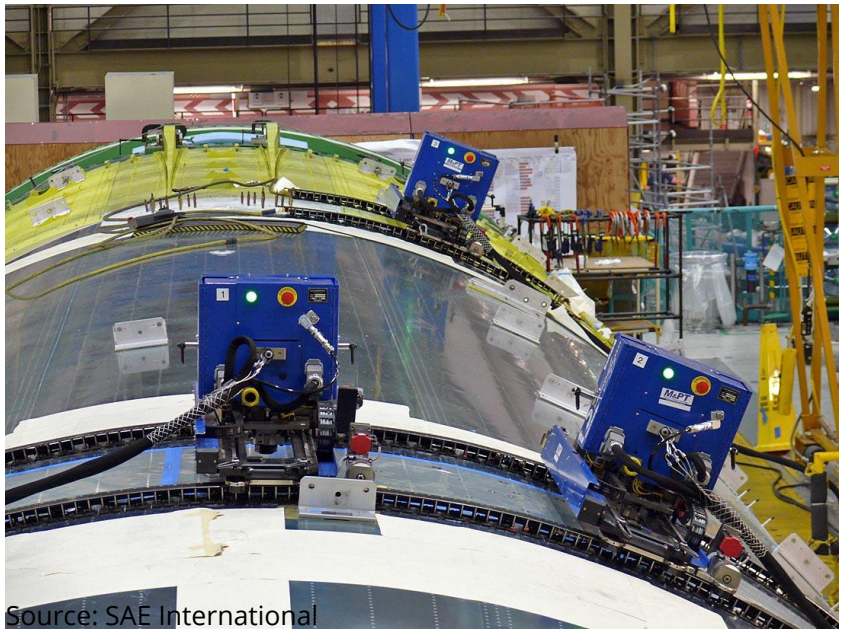
Industry 1.0 - Mechanizing → Industry 2.0 - Electrification → Industry 3.0 - Automation → Industry 4.0 – Cyber Physical Systems

Aviation industry with a higher manual work and less automation partly develops I4.0 directly from 2.0

Sources: Spiegel.de, FAZ.net, Flugrevue.de, Premium Aerotec

Aircraft manufacturing – Automation systems

Source: KUKA


Source: SAE International


Source: SAE International

- **Automation cells to avoid extensive manual workload**
- **Specific solutions for todays aircraft design**

Factory of the future concepts

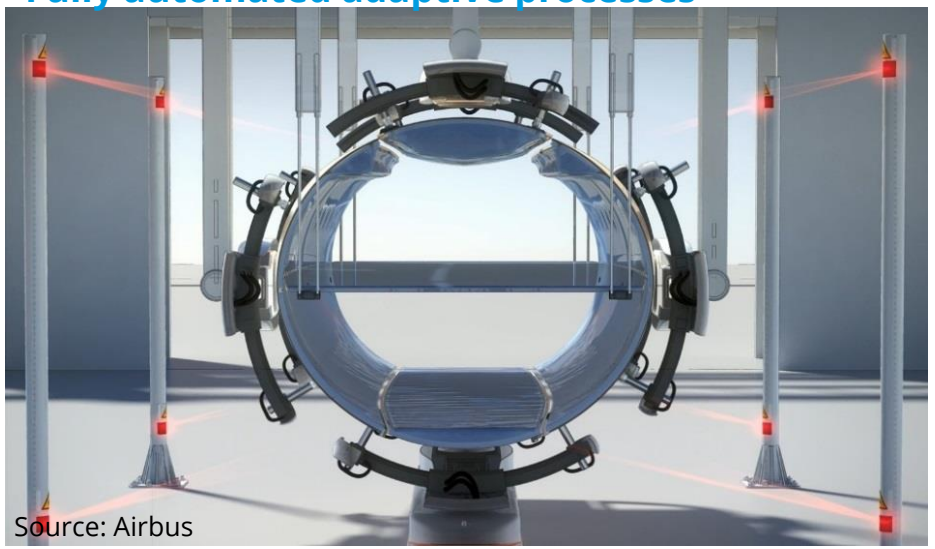
Changed shell design

Source: Airbus

Design based on assembly requirements

Source: Airbus

Fully automated adaptive processes



Source: Airbus

Factory of the future concepts

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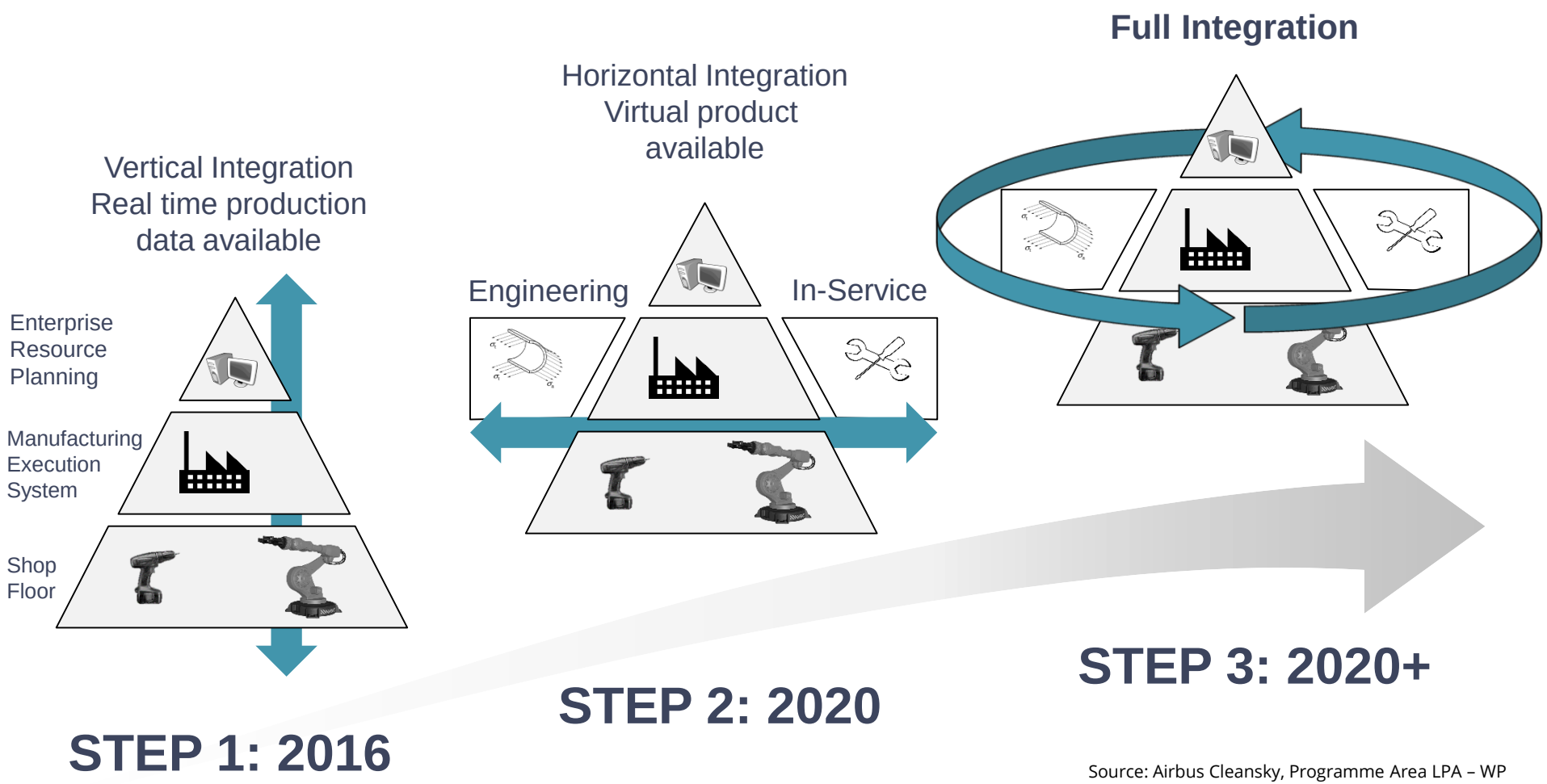
Major components with high integration level

Modular design for easy customization

- **Selective automation**
- **Collaborative automation (increase of ergonomic environment)**
- **Standard industrial robotic systems**
- **Flexible automation systems to get a high degree of utilization**
- **ALM as enabler for manufacturing & assembly**
- **New assembly methods to achieve a high degree of utilization of automation systems**

The three Steps to the future



Source: Airbus Cleansky, Programme Area LPA – WP 2.2.3 – Technologies for Future Aircraft Factory

ZAL Technology Demonstration Center

Thank you for your attention

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