

# Composites Industrial Revolution in Aerospace: using Virtual Manufacturing to Get It Right

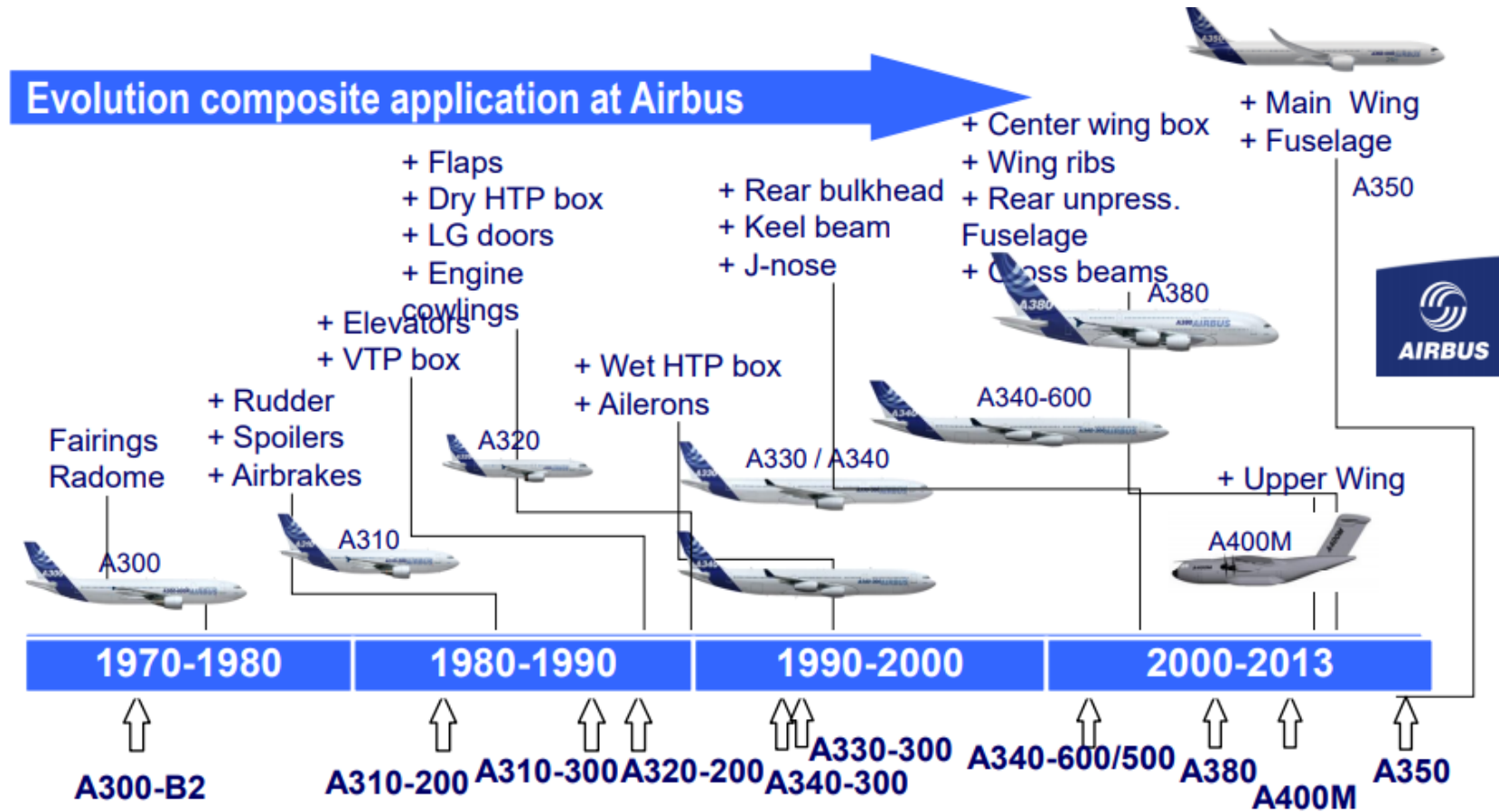
Subtitle

Sjoerd VAN DER VEEN  
May 2021

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# Composite materials in civil aviation – some history



# Airbus in the United States

**\$48 Billion**  
in aircraft-related  
expenditures in  
the U.S. in the  
last three years  
alone

Supporting over  
**275,000 Jobs**  
in **40+** U.S. states

**4,000+**  
Airbus employees

The U.S.  
represents **40%**  
**of global  
procurement**  
for Airbus.

**Largest  
export  
customer**  
of the U.S.  
aerospace  
industry



**AIRBUS**

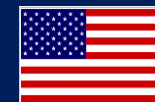
# Airbus' Major U.S. Facilities



- Manufacturing
- Engineering and Innovation
- Other Facilities
- Training
- Spare Parts Center



Fort Rucker, AL  
Huntsville, AL  
Mobile, AL  
San Jose, CA  
Aurora, CO  
Englewood, CO  
Fort Collins, CO  
Washington, DC  
Cape Canaveral, FL  
Miami, FL  
Atlanta, GA  
Wichita, KS  
Columbus, MS  
Grand Prairie, TX  
Plano, TX  
Webster, TX  
Ashburn, VA  
Chantilly, VA  
Dulles, VA  
Herndon, VA – US HQ



**AIRBUS**



# Aerospace today: Safety



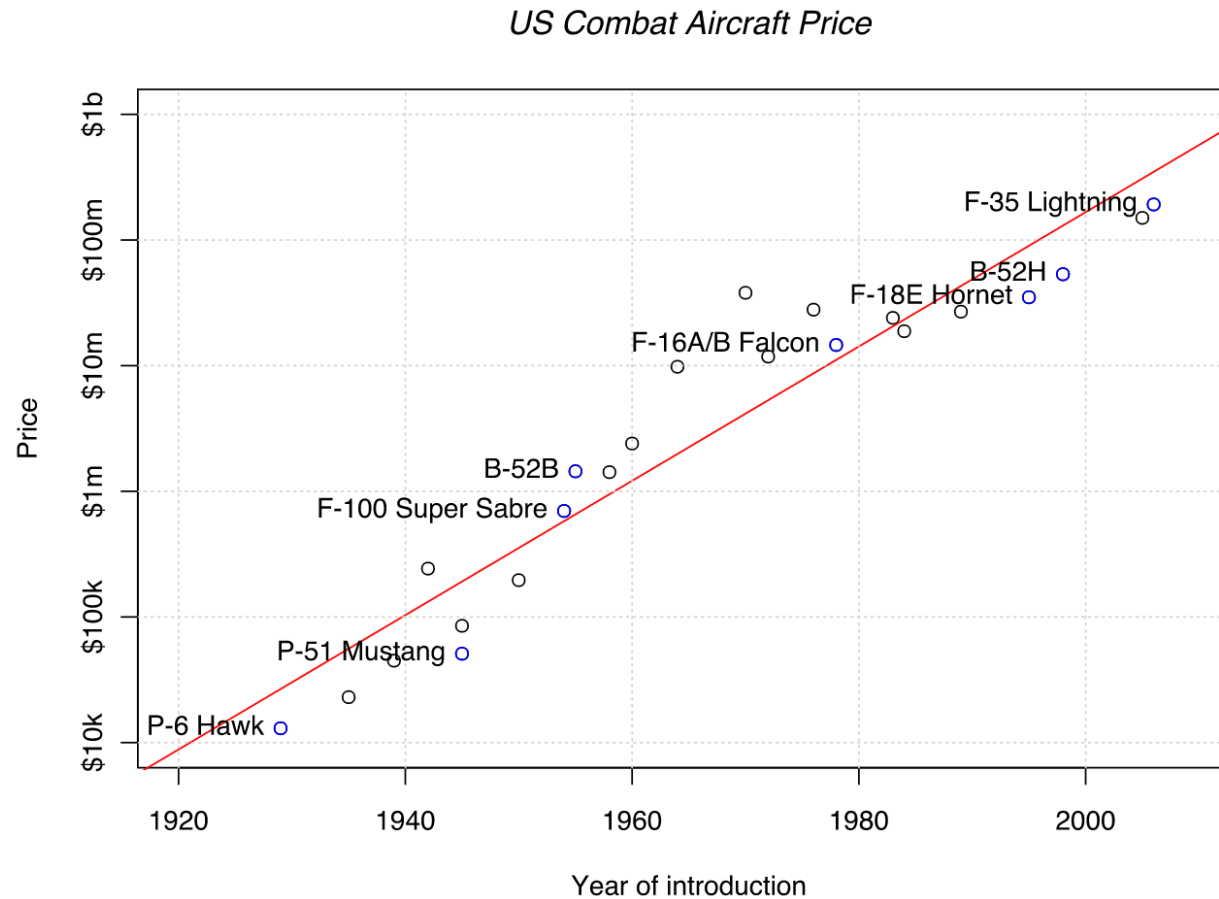
<https://www.pinterest.com>

# Aerospace today: Performance



<https://www.pinterest.com>

# Aerospace today: Cost

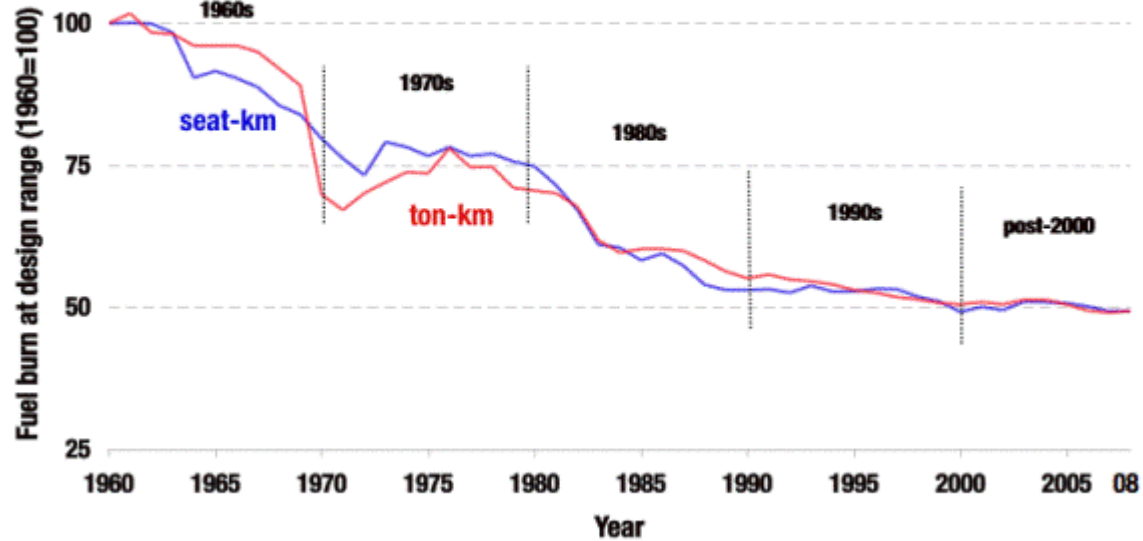


Augustine’s Laws, law #16: “In the year 2054, the entire defense budget will purchase just one tactical aircraft. This aircraft will have to be shared by the Air Force and Navy 3½ days each per week except for leap year, when it will be made available to the Marines for the extra day.”



# Aerospace today: Sustainability

Historical trends in fuel burn for new jet aircraft, 1960-2008



ICCT (2009). "Efficiency Trends for New Commercial Jet Aircraft, 1960 to 2008."

## Introducing Airbus ZEROe

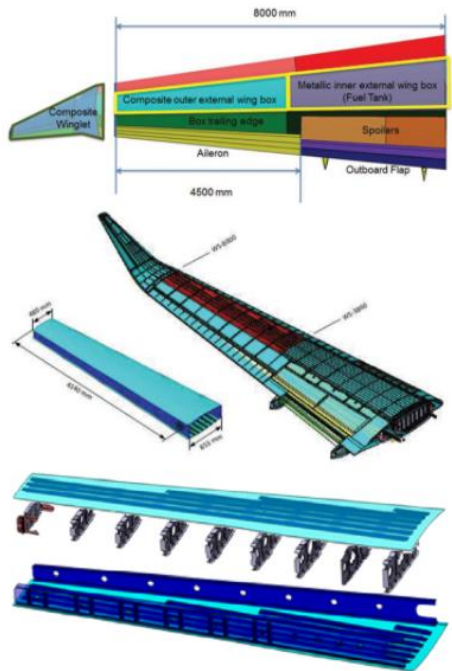
<p>Turboprop</p>	<p><b>&lt;100</b> Passengers</p> <p>Hydrogen Hybrid Turboprop Engines (x 2)</p>	<p><b>1,000+nm</b> Range</p> <p>Liquid Hydrogen Storage &amp; Distribution System</p>
<p>Blended-Wing Body</p>	<p><b>&lt;200</b> Passengers</p> <p>Hydrogen Hybrid Turbofan Engines (x 2)</p>	<p><b>2,000+nm</b> Range</p> <p>Liquid Hydrogen Storage &amp; Distribution System</p>
<p>Turbofan</p>	<p><b>&lt;200</b> Passengers</p> <p>Hydrogen Hybrid Turbofan Engines (x 2)</p>	<p><b>2,000+nm</b> Range</p> <p>Liquid Hydrogen Storage &amp; Distribution System</p>

**AIRBUS**

# *Industrialising carbon fibre reinforced primary structure:* “Wing of Tomorrow”



# Industrialising carbon fibre reinforced primary structure: Infused wing boxes

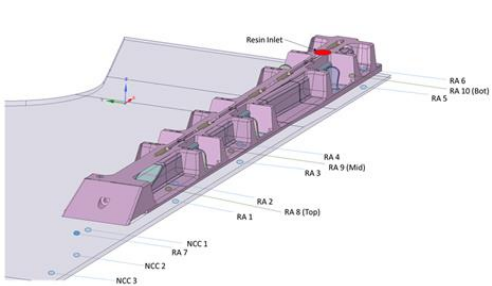
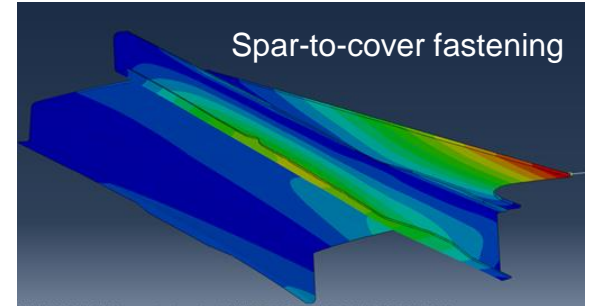
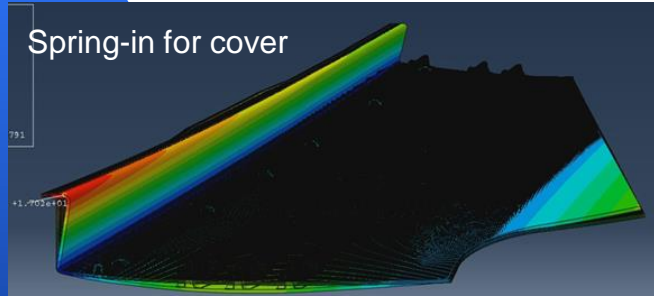
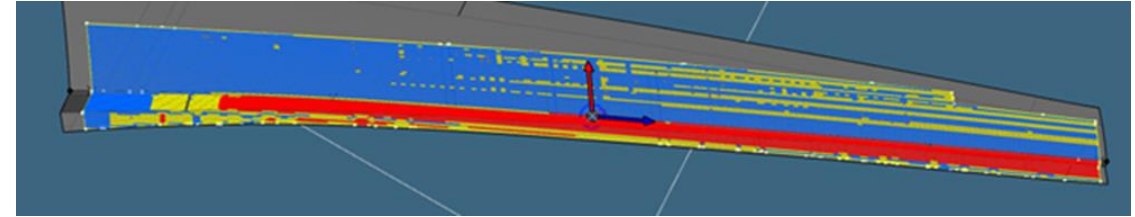




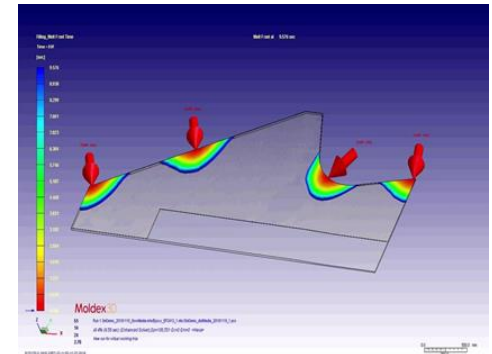
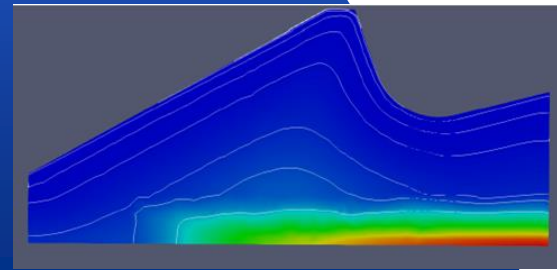
# *Industrialising carbon fibre reinforced primary structure:* Infused wing boxes



# Industrialising carbon fibre reinforced primary structure: Infused wing boxes

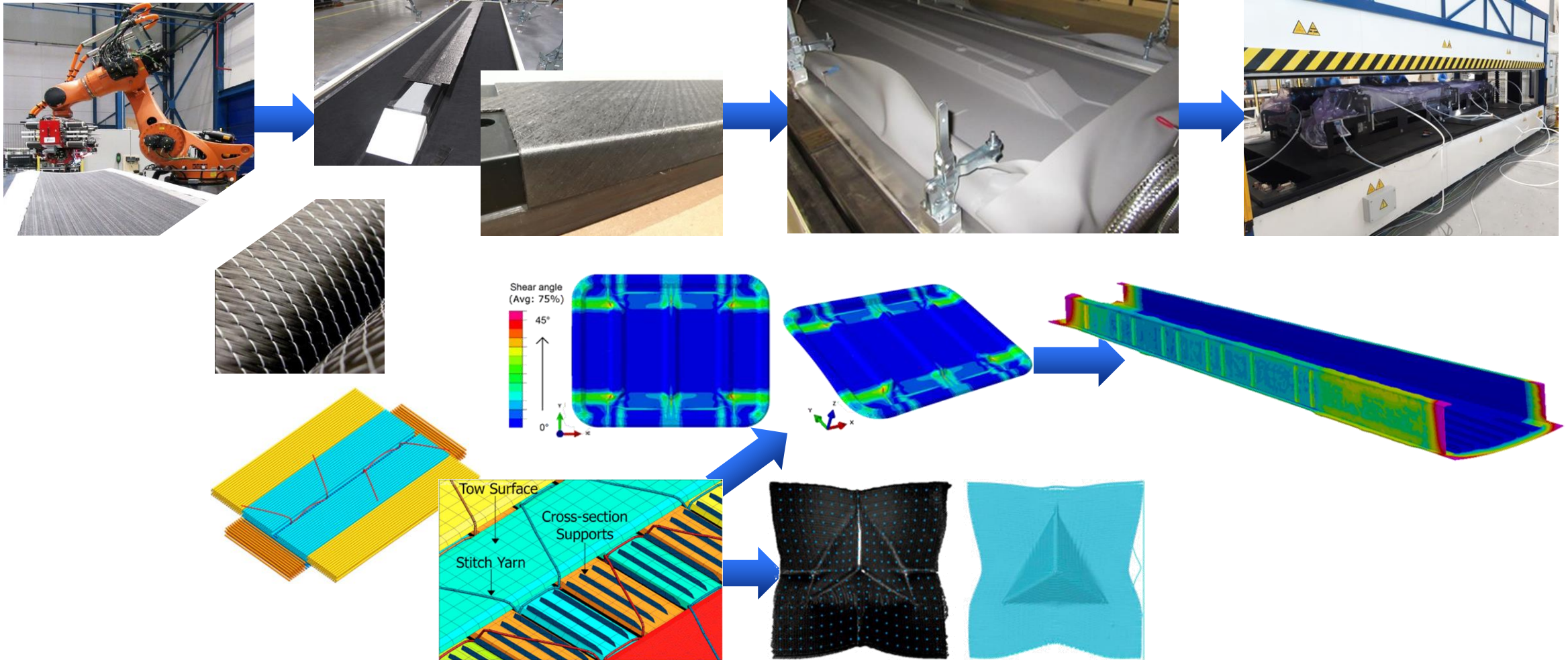


Scale →



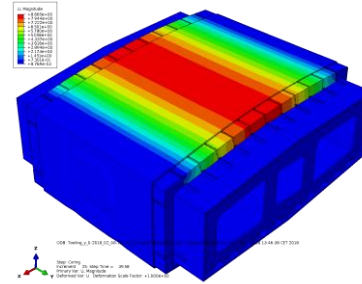
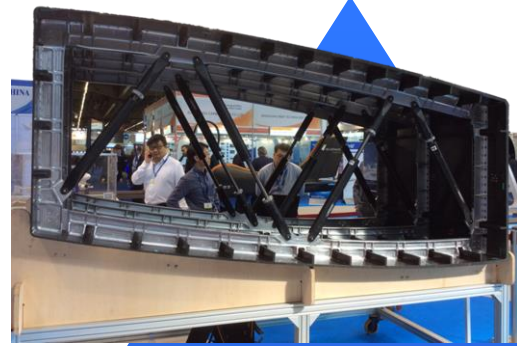


# Industrialising carbon fibre reinforced primary structure: Infused wing boxes

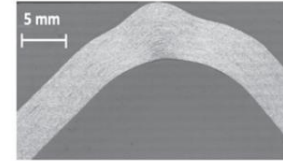




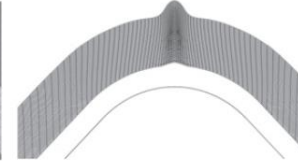
# Industrialising carbon fibre reinforced primary structure: Pre-preg wing boxes



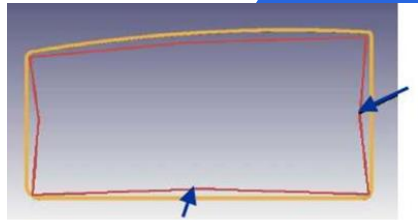
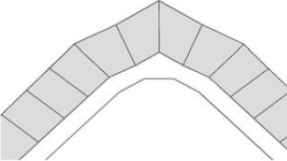
Micrograph:



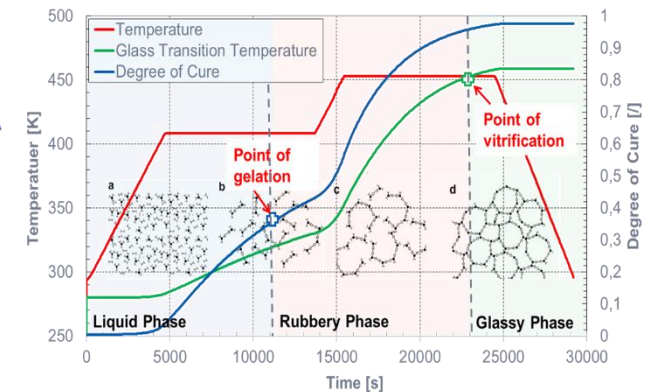
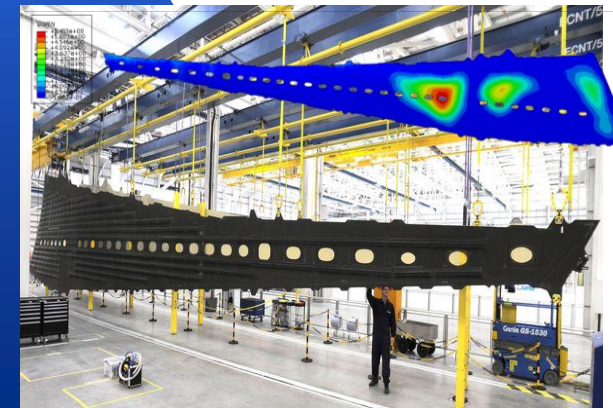
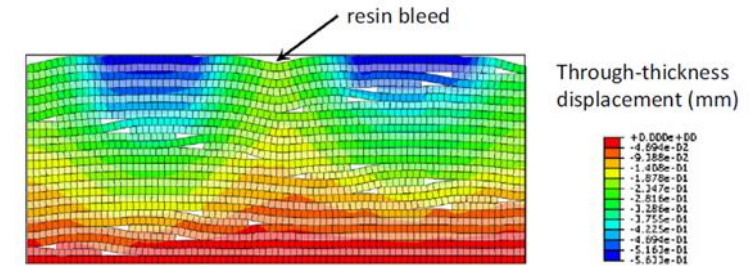
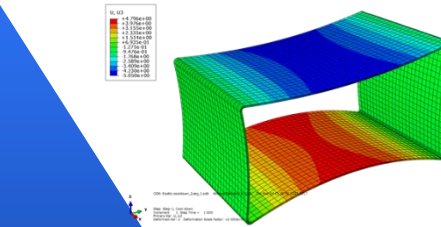
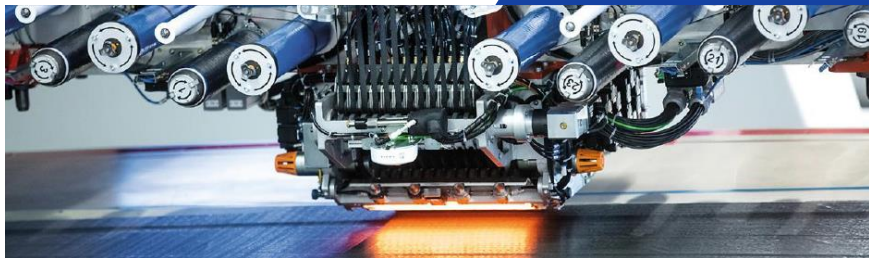
High fidelity model  
(75.70 CPU Hours):



Kinematic enrichment  
approach (2.11 CPU Hours):



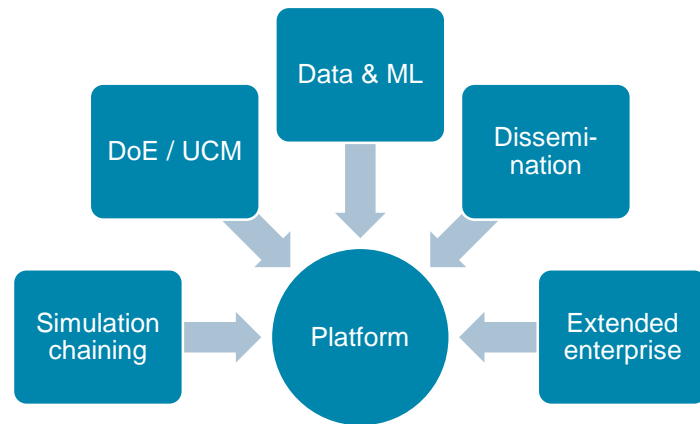
Maxi spring-back = 4 mm  
=>To be anticipated in future tool design



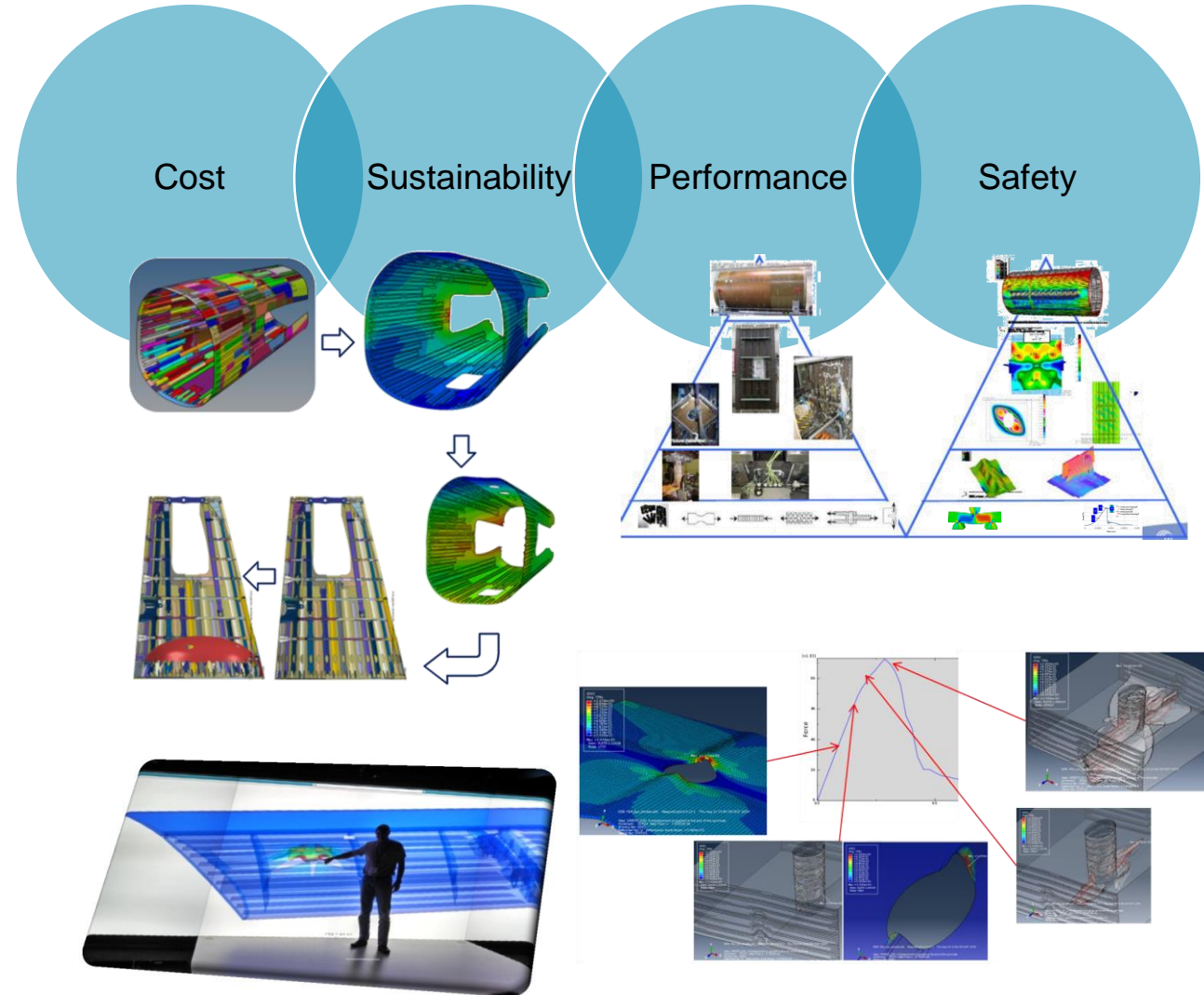
Complexity ↑

# Digitalisation as enabler

- Digital tools: link product cost, sustainability, performance and safety → product design
- “*Industrially* strategic dimensions” of digitalization:
  - *Tool dimension*:
    - “It’s *almost* not important what the tool can do, it’s more important that it’s fully connected and a real platform”:



- *People dimension*:
  - Training, culture change
  - Partners!



# Outlook

- Composite materials have a bright future in aerospace: the right material at the right place
  - Mixed-material structures
  - Highly integrated designs, more challenging in assembly
- Cost is more important than ever:
  - RC
  - NRC
- Concurrent co-design of product + industrial system is key for the future
  - Increase predictive capability in some areas, both in MPS and EoD
  - Chain all the way from MPS through Virtual Testing. Validation of simulation and up-scaling by simulation, minimize physical testing.
  - Speed up and integrate in MBSE
  - Sustainability fully integrated: LCA, Virtual Disassembly, manufacturing robustness, re-use, re-cycling
- Automation of manufacturing, assembly, disassembly, re-use and recycling



# Thank you

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