Trends and history for composite development at Saab?

Per Hallander
Technical Fellow Composites Technology
Material & Process
SAABS FIRST FLYING CFRP COMPONENT, 1971
TRIM TAB, SAAB 105 RUDDER
Composites on The Gripen fighter

- Canard wing (sandwich)
- Wing (spars and skin)
- Fin (sandwich)
- Doors and fillets (sandwich)
Parts and systems for commercial aircrafts at Saab today

- Wing Structures
- Movables, High Lift Devices
- Passenger Doors, Cargo Doors, Emergency Doors
Optimized structural design
Low transverse strength and sensitive to impact damage

IMPACT

DENT MAY NOT BE DETECTABLE BY EYE OR MAY NOT EXIST DEPENDING ON IMPACT ENERGY LEVEL

NETWORK OF DELAMINATIONS AND FIBRE/MATRIX CRACKING (RATIO OF WHICH DEPENDS IN PART ON IMPACT ENERGY LEVEL)
Multifunctional materials; Carbon Nanotubes

Tubular hexagonal carbon structure

- Length: microns to millimetres
- Diameter: nanometres

• Morphology of carbon nanotube substrates
  - Yarns, papers, weaves, forests

Transmission Electron Microscopy picture of individual CNT
Courtesy of Fang Liu, Chalmers University

Scanning Electron Microscopy picture of CNT forest on substrate
Courtesy of Thirza Poot, Linköping University
Use of CNT for mechanical improvements
Mechanical performance of nanostitch
Saving weight on an airframe is a cross-disciplinary work.
Manufacturing technology
Tooling technology including process simulation
Structures technology
Saving weight on an aircraft is a hard work that requires cooperation across all technical disciplines.

- **Airframe**: ~37% of total weight
- **System**: ~63% of total weight
Multifunctional structures & light weight systems

Passive multifunctional structures
- Lightning strike protections
- Anti-icing surfaces
- Passive cooling
- Radar transparancy

Active multifunctional structures
- Health monitoring
- Morphing structures
- De-icing
- Energy management
  - Structural Batteries
  - Energy harvesting
  - Active cooling
- Inbuilt air-data sensors
Use of CNT and Graphene for electrical conductivity

Courtesy of Linnea Selegård

General applications of conducting composites (A) and schematic description of the percolation phenomenon (B) [Ma et al. Compos. Part A Appl. Sci. Manuf. 41:1345, 2010].
In addition also fibre optic sensors with Fibre Bragg Grating (FBG) can be used as tensile and temperature sensors.
Experimental tests - FBG
Sensing abilities of embedded vertically aligned carbon nanotube forests in structural composites
Strain sensing
Temperature sensing

a) 

b)
A Wide-Scanning Array Antenna of Connected Vertical Bowtie Elements Structurally Integrated within an Aircraft Fuselage
Array and radome

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**A Wide-Scanning Array Antenna of Connected Vertical Bowtie Elements Structurally Integrated within an Aircraft Fuselage**

Pebhat Chaudhuri, Jian Tang, Matthias Jeschke, Andrei Hristi, Ranjuan Liu, Per Hallander and Moritz Gehrke

**I. Introduction**

Modern aircraft typically use more than 30 antennas to provide access to onboard systems. These antennas contribute to the aerodynamic performance of the aircraft by creating additional drag, noise and turbulence as well as increasing the aircraft weight due to extra structural bulk. However, antenna coverage requirements for these particular missions are relatively small, and the performance of individual antennas can also affect the aerodynamic performance and fuel burn of the aircraft. Different antenna designs and production methods are therefore needed to meet these requirements.

An alternative to prototyping antennas is to use the conformal antennas, such as patch or comma elements, which are variable in size and shape. In this paper, the conformal antennas are shaped in such a way that they can be used to form a radome or radome segment. The antennas are fabricated using microelectromechanical systems (MEMS) technology and are then integrated into the aircraft’s fuselage.

**Fig. 1:** The implementation concept of the proposed structurally integrated radome forming array antennas on the aircraft fuselage.

A multifunctional fuselage structure with an integrated array segment, as shown in Fig. 1, can be utilized to avoid adding extra hardware. Aircraft fuselage and wing surfaces contain a large number of radome segments or radomes that are integrated in the form of conformal antennas which have been integrated into the fuselage and wing structures. The conformal antennas are then excited by a large array of smaller antennas by simply wiring the antennas into the fuselage. The conformal antennas are fabricated using microelectromechanical systems (MEMS) technology and are then integrated into the aircraft’s fuselage.

**Fig. 2:** A multifunctional fuselage structure with an integrated array segment, as shown in Fig. 1, can be utilized to avoid adding extra hardware. Aircraft fuselage and wing surfaces contain a large number of radome segments or radomes that are integrated in the form of conformal antennas which have been integrated into the fuselage and wing structures. The conformal antennas are then excited by a large array of smaller antennas by simply wiring the antennas into the fuselage. The conformal antennas are fabricated using microelectromechanical systems (MEMS) technology and are then integrated into the aircraft’s fuselage.
Thermoplastic Composites and AM (Additive Manufacturing)
Boeing: Circularity and sustainability for the composite community

- 100% sustainable aviation fuel by 2030
- Net zero carbon emissions by 2050
- Design for sustainability
  - Recycling
  - Light weight design
  - Sustainability sourcing
  - Reduced energy consumption
  - Efficient manufacturing process
- Circularity
  - Recycling
  - Circular services – extended life
  - Production systems – waste reduction
  - Light weight design
  - Sustainability sourcing
  - Reduced Energy consumption
- Recycling research at University of Nottingham
- Down stream recycling to infra structure materials and interiors for houses etc.)
- AFRA – Aircraft Fleet Recycling Association (Boeing, Embraer, SAFRAN)
Airbus about sustainability

- Working to deliver the world’s first zero-emission aircraft by 2035
  - LH2 tank
  - CFRP tank
  - Cryo temperature & thermal cycling
- DEMO of SAF A330 & A380 2022
- Fuel consumption reduce
  - 20 to 25% on A220, A320 NEO, A330 NEO and A350
- ECO design
  - End of life
  - Recycled materials
- The composite airframe- How to keep the attractiveness
Sustainability at Vestas

- Carbon neutrality 2030
- Design for circularity
- 90% increase in material recyclability
- Current resin system is recyclable
- Refurbishing of parts – reused blades
- Accept downstream recycling (interiors for houses etc.)
- Consumable recycling
Fibre recycling

- Carbon fibre reinforced plastics for sustainable society – Kenichi Yoshioka, Toray
  - ECOUSE – recycled fibres
- Lessons learned when assessing emerging composite materials using LCA (Life Cycle Assessment)
  - Lignin based carbon fibres 50% of strength and modulus compared to PAN based fibres
  - CFRP performs only better in LCA compared to GFRP if they can be recycled
  - GFRP not very recyclable
  - Clean power is needed to support manufacturing of clean N2 needed for CFRP recycle
Resin recycling

- Chemical recycling of bio based epoxy thermosets
- Cleavable epoxy resins designed for dissamble of thermosets – Stephen L Buchwatter 1966
Recycling of composites demands a great knowledge about composite design, structures, manufacturing and materials.
Thank you for listening!