# Additive Manufacturing & Composite Materials a disruptive technology transforming the Aviation Industry

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**STC WORKSHOP**
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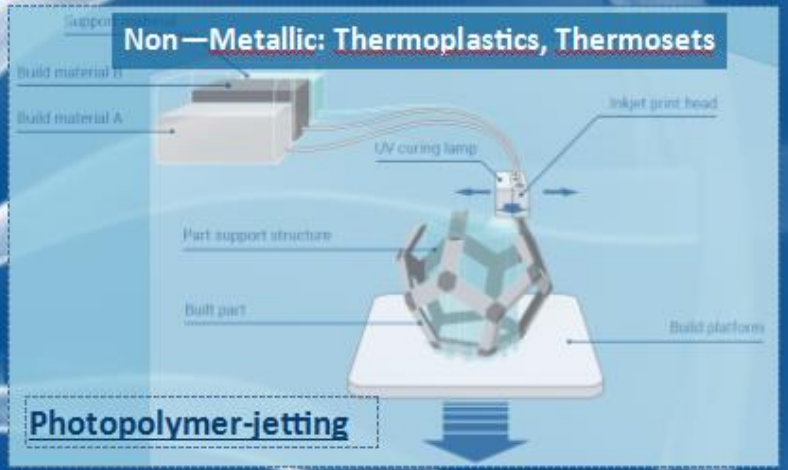
# A Disruptive Technology Transforming Aviation Industry: Additive Manufacturing (AM)

**AM: Making parts by adding material layer upon layer as opposed to removing material from a solid block.**

## Many Materials & Many Processes

**Metallic: Titanium, Steels, Aluminium alloys,...**


**Non—Metallic: Thermoplastics, Thermosets**




## Many Applications

- Airframes
- Engines
- Systems
- Cabin Interiors
- Modification & Repairs

AIRBUS · SAFRAN · ROLLS ROYCE · ZODIAC AEROSPACE

# A Disruptive Technology Transforming Aviation Industry: Additive Manufacturing (AM)

## *PRESENT & FUTURE BENEFITS* proposed by industry & media

**Fast prototyping & acceleration of production time:**

Design changes produced in development parts in days, not weeks

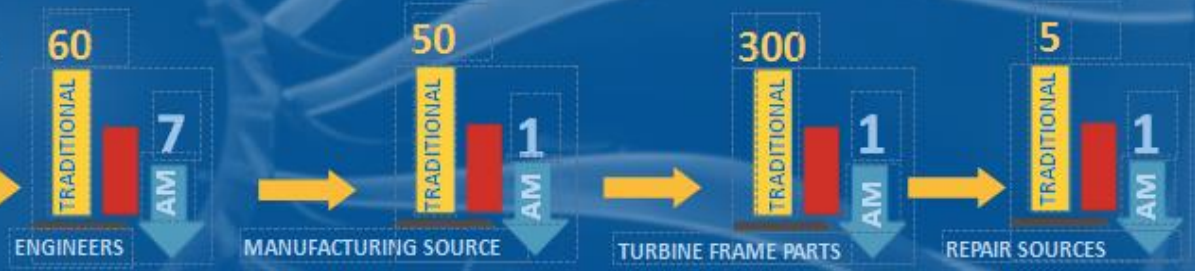
Rapid technology evolution… e.g. progression from single laser to multiple laser printers

**Reduced part count:** Example: The LEAP fuel nozzle is now only one complex part


Complex design features not possible using conventional methods, optimised fuel burn & increased efficiency

**Reduced workforce:** Example:

PRODUCTION OF A TURBINE FRAME




**Environmental**

**Reduced fossil fuel consumption & global carbon footprint:**

Less waste in AM 'Additive' process than conventional 'Subtractive' Manufacturing processes

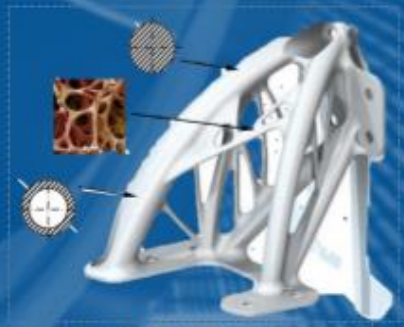
Conventional milling can generate 95% of waste material

Energy wasted producing the material, and then removing it…

Reduced transportation

AM parts are built closer to the market, using local raw resources

Parts produced on demand reduce storage costs



BIONIC Structure

**Optimised designs** (efficient design, weight saving)

# A Disruptive Technology Transforming Aviation Industry: Composite Materials

## COMPOSITES, a long established use in safety critical applications

**GA and Rotorcraft**

Examples: Principal Structural Elements(PSE) structure and Critical Part applications.











**Many other evolving applications**

Examples: propellers, fan blades, seats, undercarriage

# A Disruptive Technology Transforming Aviation Industry: Additive Manufacturing (AM) & Composite Materials

R&D

**Materials R&D Key Themes**

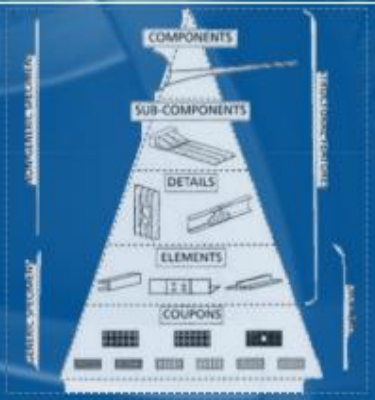
Damage modes

Manufacturing defects

Statistics strategy

Test Analysis Pyramid

Modelling and simulation methods




## EASA partnership with EU funded projects:

Materials themes including AM and Composites

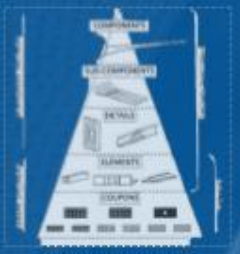
The Clean SKY Joint Undertakings received EU funding for research on the environmental benefits of AM.

Total of: 18 Clean Sky projects with 40 entities (universities, SME and Industries).

Main interest: Chemical and micro mechanical studies for manufacturing (New Powders), modelling & simulations methods (Developing and validating AM and composite numerical tools used in various applications), validation/process optimisation of AM manufacturing.

Within the Horizon 2020 programme DG research and innovation allocated important EU funding for five AM projects, total EU contribution €20.25 million out a total contribution of 215 million € for Aviation. This to promote a smart, green and integrated transport policy.

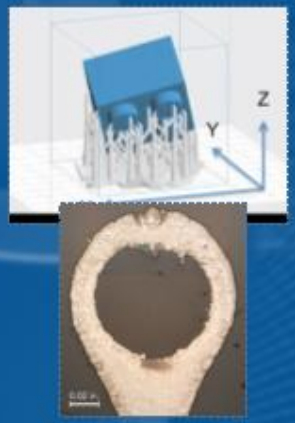
# “Material and process” Changes - Disruptive Technologies Additive Manufacturing (AM) & Composite Materials



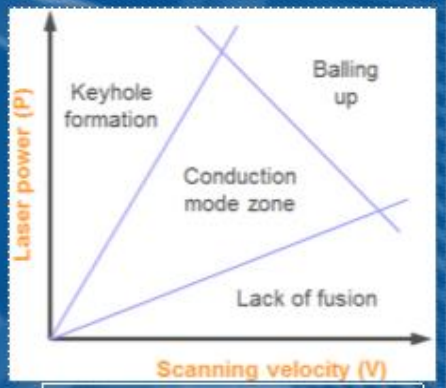
**‘ENGINEERING PROPERTIES’ dependent upon ‘MATERIAL and PROCESS’ … built into part or repair**

**Requires appropriate interaction between DOA, POA, Maintenance, and Material Suppliers**

## IMPACT FOR EASA




- Rapid European product application development … increasingly safety critical applications
- Changing (more integrated) relationship between design, production, and continued airworthiness activities
- DOA - POA interface (impact upon design allowables)
- DOA - PART 145 interface (impact upon design allowables)
- Extensive global sub-contracting within/between design, production, and continued airworthiness activities
- Understanding impact upon ‘ENGINEERING PROPERTIES’ (COMPETING DAMAGE MODES)
- Understanding the TEST ANALYISIS PYRAMID
- Understanding MANUFACTURING DEFECTS, sensitivity to ‘key parameters’, machine parameters, raw material , production and handling
- Statistical strategy (DATA SCATTER)
- Increased use of shared databases
- TRAINING necessary for industry and regulators to keep up with technology advances and applications
- Moving towards analysis in place of test
- Process control monitoring replacing inspections
- Consider need to change rules & guidance material … performance based regulation
- Identify potential environmental risks… mitigate by working closely with industry
- DAMAGE DETECTION… and repair


**Define operating window**

EASA
European Aviation Safety Agency

# EASA AM Strategy - EASA AM WG – subject contacts

(as identified in CM-S-008 "Additive Manufacturing" ):

- Shared responsibilities via subject contacts
- Co-ordinated through EASA AM WG, e.g. internal meetings etc.

| | | |
|---|---|---|
| - Cert. Directorate (Chief Expert - Airframe) | R. Minter | - richard.minter@easa.Europa.eu |
| - Structures | S. Waite (EASA AM WG chair) | - simon.waite@easa.europ.eu |
| | W. Hoffmann | - wolfgang.hoffmann@easa.europa.eu |
| - Propulsion | O. Kastanis | - omiros.kastanis@easa.europa.eu |
| - Systems | M. Weiler | - michael.weiler@easa.europa.eu |
| - Cabin Safety | T. Ohnimus | - thomas.ohnimus@easa.europa.eu |
| - DOA | O. Tribout | - olivier.tribout@easa.europa.eu |
| - POA | S. Pernet | - samuel.pernet@easa.europa.eu |
| - Maintenance | R. Tajas | - rosa.tajes@easa.europa.eu |
| - ETSO | TBD | |

https://www.easa.europa.eu/sites/default/files/dfu/EASA%20CM-S-008%20Additive%20Manufacturing.pdf

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# A Disruptive Technology Transforming Aviation Industry: Composite Materials

**Definition:** A combination of two or more materials (reinforcing elements, fillers, and composite matrix binder), differing in form or composition on a macro scale. The constituents retain their identities; that is, they do not dissolve or merge completely into one another although they act in concert. Normally, the components can be physically identified and exhibit an interface between one another.

**Includes :**

- Polymer Matrix Composites (PMCs)
- Ceramic Matrix Composites (CMCs)
- Metal Matrix Composites (MMCs)
- Sandwich Structures
- Bonded Structures

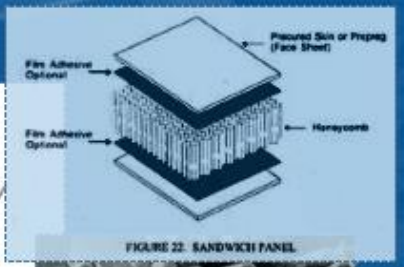
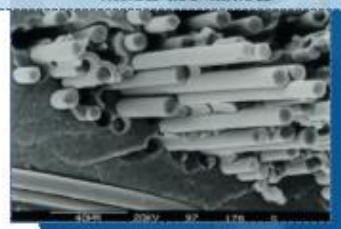
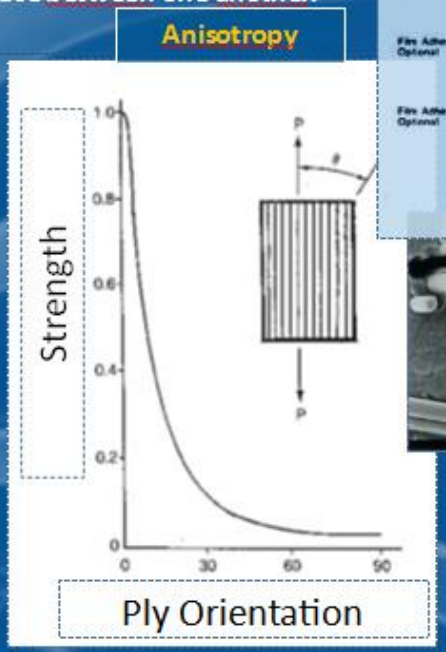


FIGURE 22. SANDWICH PANEL






**DESIGN CHALLENGES:**

'ENGINEERING PROPERTIES' dependent upon 'MATERIAL and PROCESS'

Anisotropy - properties vary with load application direction

competing damage modes - some difficult to detect

environmental sensitivity

**EASA Composite Materials Safety Strategy (CMSS)*** Increasingly segmented and globalised industry

CMSS-1: identify ,and act upon, high level internationally recognised common safety themes in conjunction with other regulators and industry

CMSS-2: identify, prioritise, and act upon, safety themes of more specific interest to European regulators and industry: Sandwich Structures, Composite Seats, Composite STCs, extending the AFF/HFF Shared Database

* aligned with European Plan for Aviation Safety (EPAS), EASA Safety Management Systems (SMS), and Operational Suitability (OSD ) strategies

# A Disruptive Technology Transforming Aviation Industry: Composite Materials

Wood and fabric

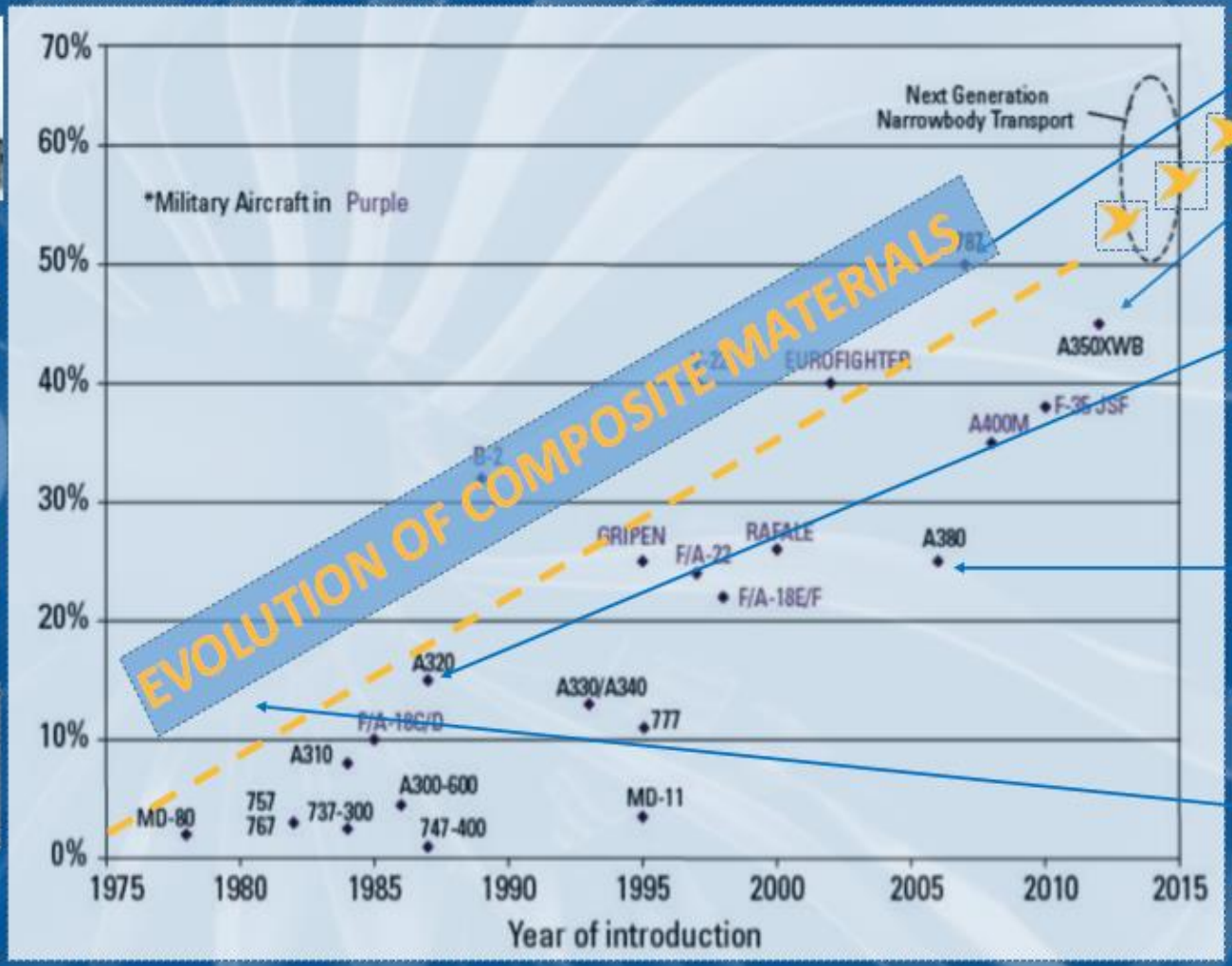
Lilienthal

1917 Metals (Duralumin)

Junker J1

1940 sandwich

Bonded balsa plywood




B787, A350 fuselages

A320 empennage

A380 Glare crown

ATR otbd wing box

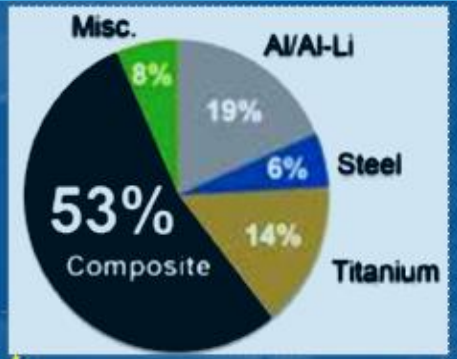
**Rapid evolution in Large passenger aircraft applications.**

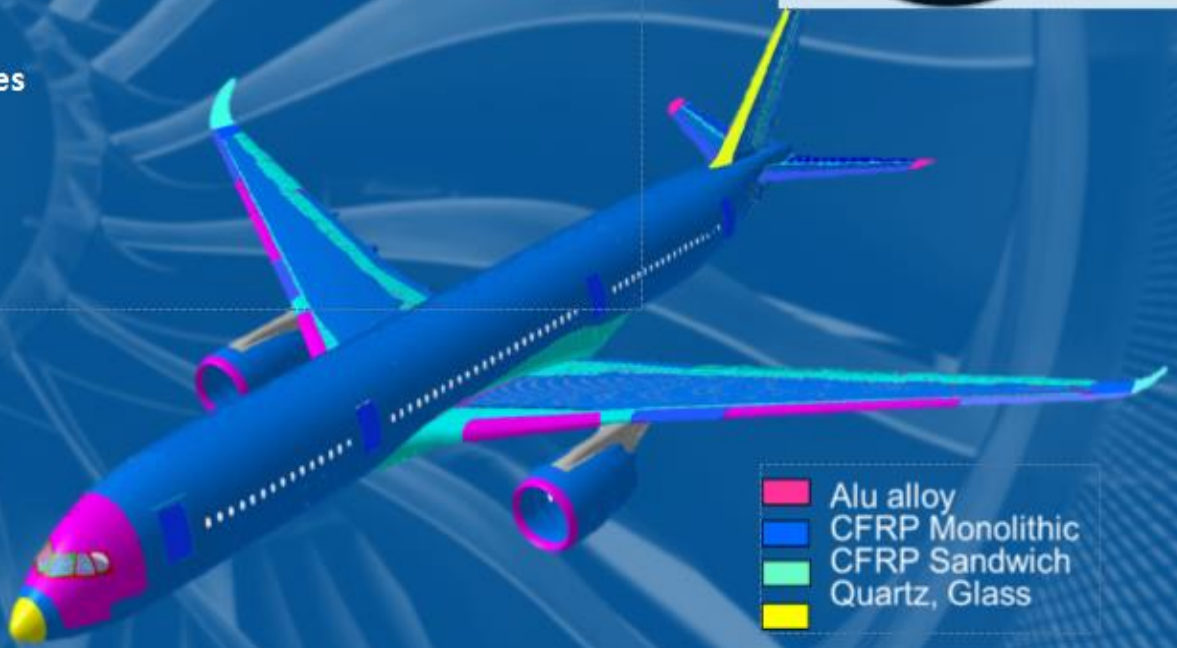
# A Disruptive Technology Transforming Aviation Industry: Composite Materials

**Important recent rapid extension of applications to include**

**safety critical large passenger - pressure hull and wing box**

- Engines - fan blades
- Systems
- Cabin interiors
- Modifications and repairs
- new/developing material forms
- undercarriage landing gear & seat frames
- Ceramic & Metal Matrix Composites




A350 XWB

AIRBUS

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# Thank you.

# Questions ?

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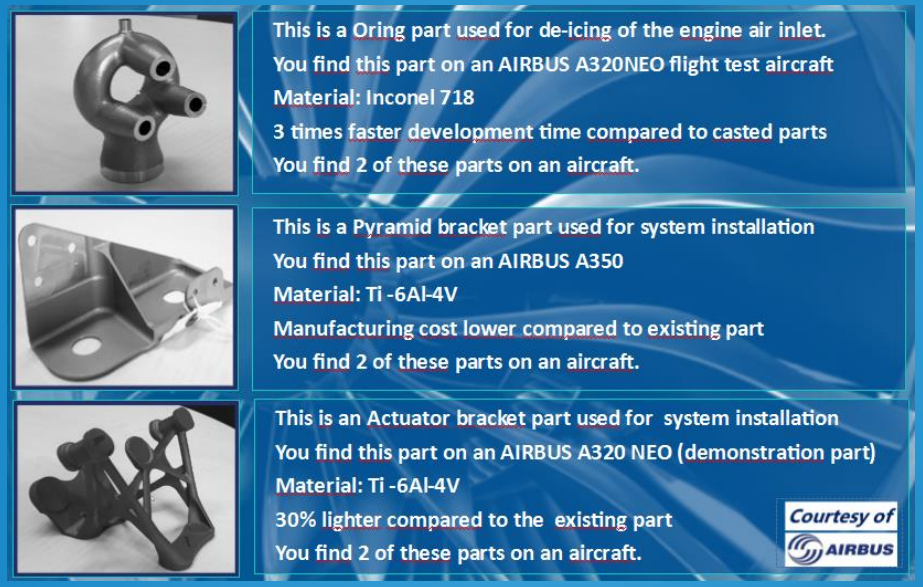
# On display




## Feel free to pass by on the 1st Floor

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