Clean Sky2 Additive Manufacturing research activities

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EASA European Aviation Safety Agency

Additive Manufacturing Workshop
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www.cleansky.eu www.easa.europa.eu

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Introduction to Clean Sky2 Initiative

Clean Sky 2, part of the EU's Horizon 2020 Framework Programme, is the largest research programme in aviation ever launched in Europe. Building on and extending the scope and technological gains from the first Clean Sky programme, Clean Sky 2 works towards more ambitious goals and extends its reach across longer-term and lower-TRL actions, for nearly all sectors of aviation, in order to:

- Accelerate the adoption of new technology into the global fleet, meeting society's need for air transport with a minimal environmental impact and addressing both the EU's contribution towards the Energy Union and the threat of global climate change;
- Complete the journey towards full accomplishment of the ACARE SRIA Goals for 2020;
- Kick-start the progress towards the ACARE SRIA goals for 2035-2050;
- Enable a technological leap in the face of existing as well as emerging competitors.

CLEAN SKY 2 OBJECTIVES

	CLEAN SKY 2 2014-2024	FLIGHTPATH 2050
$-CO_2$	TO -20% -30%	-75%
$-NO_x$	TO -20% -30%	-90%
	TO -20% -30%	-60%

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Clean Sky JOINT UNDERTAKING

Introduction to Clean Sky2 Initiative

Three Innovative Aircraft Demonstrator Platforms (IADPs)

Integrating technologies and major systems innovations; demonstrating and validating their potential at the full vehicle level, towards future aircraft configuration.

Large Passenger Aircraft

Regional Aircraft

Fast Rotorcraft

Three Integrated Technology Demonstrators (ITDs)

Developing and integrating new technologies, with demonstrator projects validating these at major system level.

Airframe

Engines

Systems

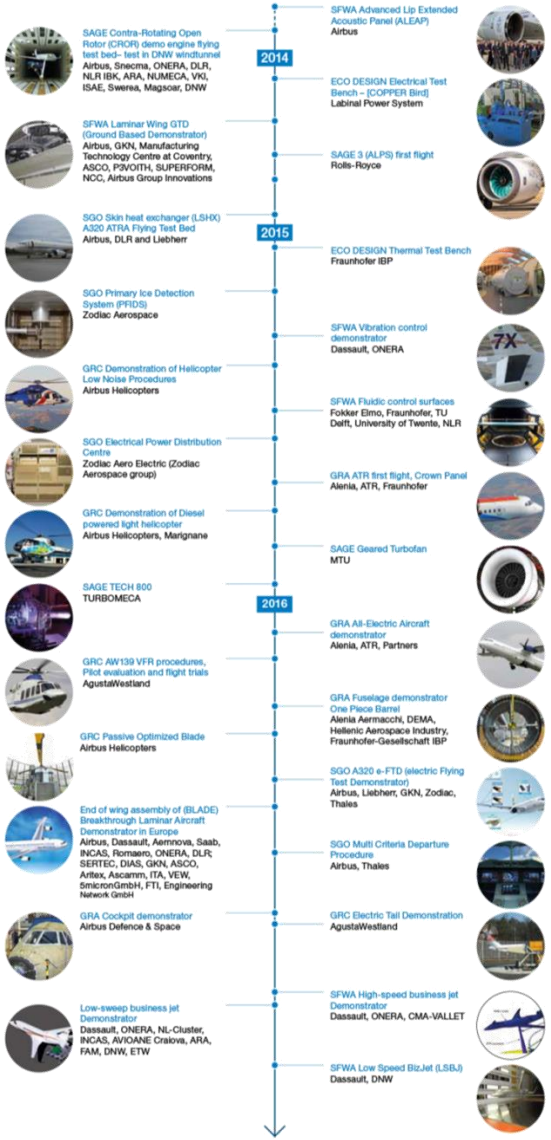
Two Transverse Activities

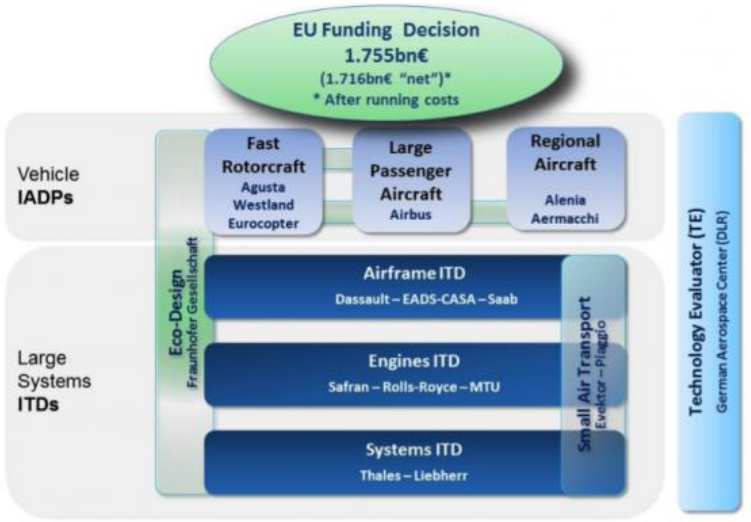
Focusing on specific applications and technology challenges across the IADPs and ITDs enabling synergies to be exploited between different platforms through shared projects and results.

Small Air Transport

Eco Design

CLEAN SKY DEMONSTRATORS





Building on Clean Sky, going further into integration at full aircraft level
*And developing new technology streams for **the next** generations of aircraft*

Additive Manufacturing

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Additive Manufacturing for Integrated Technology Demonstrators

From Cleansky to Cleansky2….

Additive Manufacturing for Thermoplastics

- Stereo-lithography
- Selective Laser Sintering (SLS)
- Fused Deposition Modelling

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Additive Manufacturing of Metallic Materials

- Binder jetting
- Material extrusion
- Powder bed fusion
- Directed Energy Deposition

SLM | EBM | DLD

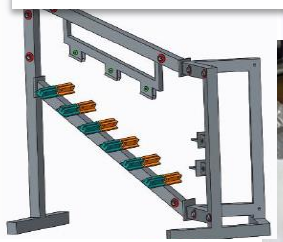
A/C seat covers

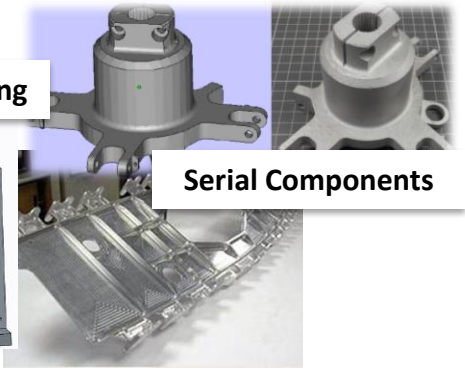
A/C piping

Interiors

Clean Sky 2

Assembling Tooling





Serial Components

- Clean Sky contributed to the development of AM processes towards to Aviation standards. Nowadays, new generation aircrafts are incorporating hundreds of printed parts (mainly for interiors) .
- As step forward, CleanSky2 research activities are targeting AM for serial components and/or for heavy complex A/C structural items. This is very challenge as for the A/C certification aspects.

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Additive Manufacturing for Integrated Technology Demonstrators

- More than 18 Clean Sky 2 projects and about 10Me funding
- More than 40 entities (universities, SME and Industries) across 12 EU and Associated Countries

MAIN AREAs of INTEREST

- Chemical and (Micro)mechanical studies for manufacturing process optimization
- Modelling and simulations methods for AM
- Manufacturing Process optimization
- Validation of AM manufacturing processes at high TRL

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Expected Goals in CLEANSKY2

- AM manufacturing Process Optimization for reliable operations.
- To improve Mechanical performances of AM components (Fatigue, Erosion, shape deviation)
- Weight reduction in comparison with current design (e.g To reduce 25% the weight of individual parts of metallic airframe structures)
- Reduction of manufacturing costs.
- Reduction of time-to-market of A/C parts due to the design optimisation (e.g accounting for distortions as alternative to current trial and error approach).
- Manufacturing of Complex items joint-less
- Waste Reduction. Additive Manufacturing technologies will boost the optimisation of the design following the eco-design considerations Moreover, the buy to fly ratio will be improved and the use of raw material will be reduced.

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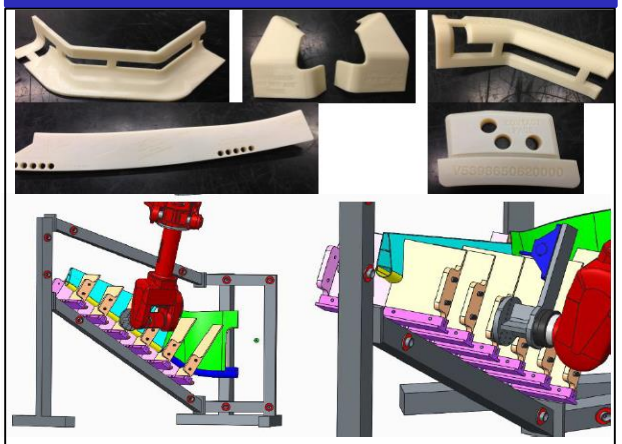
AM for competitive Business-jet and Large Aircraft

- Technology affordable for serial production
- Low Cost Manufacturing (Assembling tooling)
- Lighter A/C Components
- Manufacturing of complex geometries joint-less.
- Waste Reduction

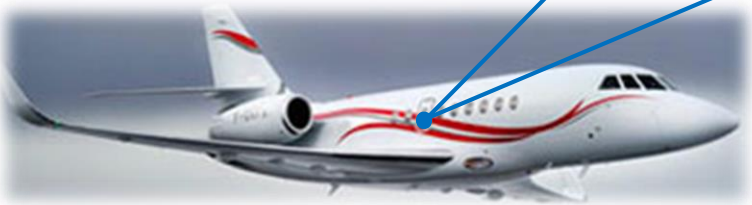
Hinge, Main Exit Door of Business Jet

Powder Bed Fusion (PBF) - Aluminium

Tooling for winglet and TE assembling



Fused Deposition Modelling (FDM) - Thermoplastic



Bracket for A350 XWP (*)

Sintering Laser Manuf. (SLM) - Ti-6Al-4V

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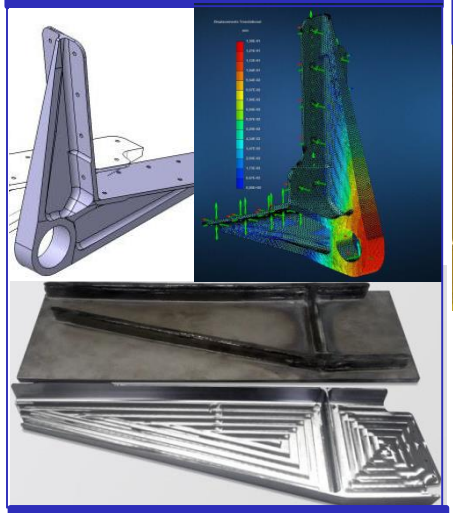
(*) "http://www.3dprinter.net/airbus-incorporate-3d-printing-technology-aircraft-manufacturing."

AM for Regional and Small Aircraft Transport

- Technology affordable for low volume production
- Low Cost Manufacturing technology
- Complex geometries joint-less.
- Large components for A/C and/or Helicopters

Novel Tilt-rotor Drive System housing

NLG Support fitting



Electron beam manufacturing - TI-6AL-4V

Engine Ducts and fairings

Powder Bed Fusion (PBF) - Aluminium

A main drive system housing is a large part, so alternative, innovative approach will be investigated, in the field of Directed Energy Deposition DED.

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AM supporting next generation A/C engines

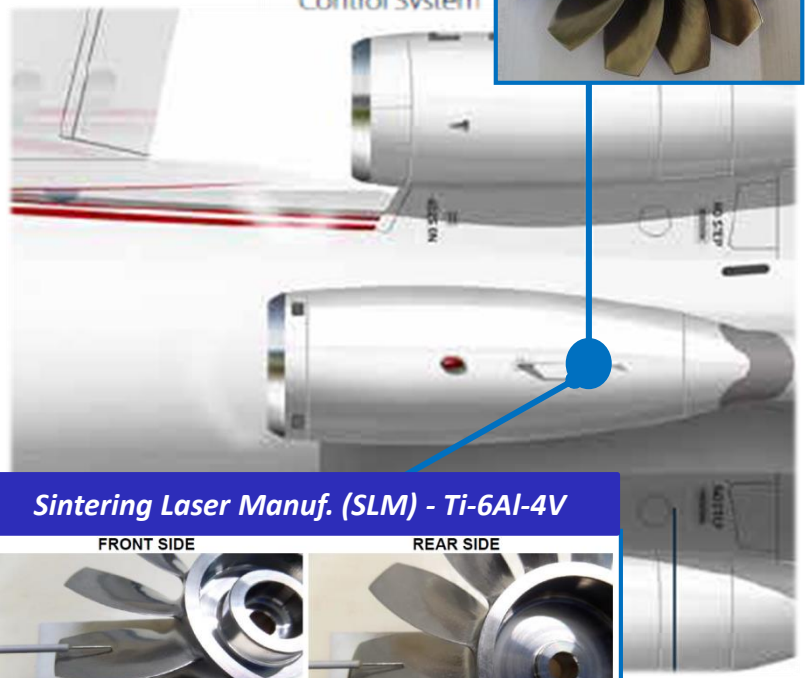
- AM will be a breakdown technology for next generation engines (VHBR, OR)

Turbines

Structures

Transmissions

Additive manufacturing titanium fan wheel for Environmental Control System



Sintering Laser Manuf. (SLM) - Ti-6Al-4V

- Achieved results are promising in terms of mechanical, fatigue, corrosion as well as environmental impact and manufacturing costs.

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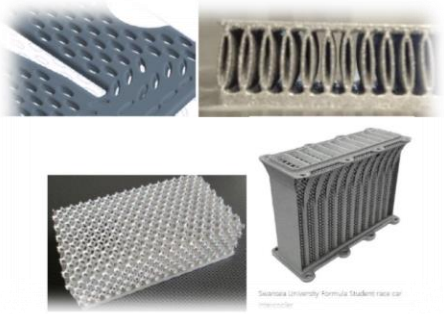
Way forward…

OPTIMIZATION OF THE SELECTIVE LASER MELTING-SLM PROCESS

To conduct studies on the systematic adaption of laser and process parameters for specific geometric features that are relevant to topology optimized designs of metal aircraft parts and particular to fittings of cargo doors (e.g AlSi10Mg).

COMPLEX COMPACT HEAT EXCHANGER DESIGN.



New fin shapes/ structures Channels and connections can be thought for performance enhancement and complex shape realization, facilitating integration. Predictive models or laws (thermal and pressure drop) to be developed. Characterization and experimental validation on samples.

A/C COMPONENTS DESIGN AND MANUFACTURING

Design and manufacturing (by means of additive manufacturing technologies) and qualification of components (as wing seals, fuselage structural fitting) to obtain the Permit to Fly. Parts shall be delivered for complete flight demonstrator and for on ground full scale test.

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Way forward…

- Components will be manufactured to fit with Aeronautical quality standards. Interactions with Certification authorities are also expected for those technologies that are part of flight demos.

- CS2 projects (e.g Innovative alloy development for structural part fabrication with Additive Manufacturing Technology – AlForAMA) will contribute to the validation of AM standards as identified by CEN/TC 438, ISO TC261 and ASTM F42:
  - Qualification and certification methods
  - Design guidelines
  - Test methods for characteristics of raw materials
  - Test methods for mechanical properties of finished AM parts (such as non-destructive testing)
  - Material recycling (re-use) guidelines
  - Standard protocols for round robin testing
  - Standard test artefact, enabling a comparison of AM processes, materials and machines on a part level
  - Requirements for purchased AM parts
  - Harmonization of existing ISO/ASTM terminology standards

- Strong interactions with AM-Platform (European Technology Platform in AM) are also expected to account for standardization of processes as developed in past EU projects (e.g FP7- SESAM project).

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CleanSky promoting Additive Manufacturing research Activities

Additive Manufacturing Demonstrator showed at Le Bourget (June 2015)

Additive Manufacturing Demonstrator showed at Le Bourget (June 2017)

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Thank you
for your attention

See more information
on www.cleansky.eu

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Clean Sky 2

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DLR
AIRBUS DEFENCE & SPACE
evektor
Fraunhofer
LIEBHERR
MTU Aero Engines
PIAGGIO AERO
Rolls-Royce
SAFRAN
SAAB
THALES

Disclaimer

The content of this presentation is **not legally binding.** The proposed content/approach is based on the consultation with the "National States Representative Group" and the "Task Force " of the *Clean Sky 2* Programme Proposal