CEAS TCAD

UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

DIPARTIMENTO DI INGEGNERIA INDUSTRIALE

SEZIONE INGEGNERIA AEROSPAZIALE

5th SCAD
(Symposium on Collaboration in Aircraft Design)

(12th -14th October, 2015)

Introduction

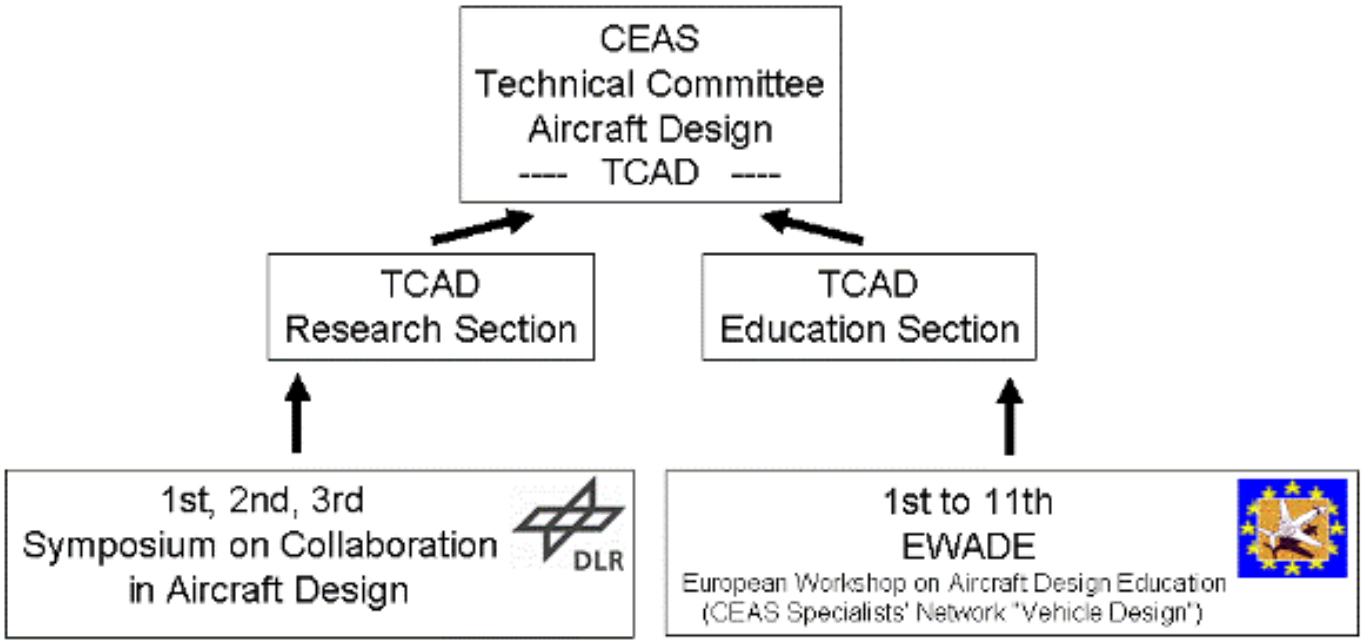
Fabrizio Nicolosi

TCAD started with the aim to better **harmonize research in aircraft design** and combine this with **education in aircraft design** by establishing a dedicated CEAS Technical Committee in Aircraft Design.

- In the past there was an Aeronautical Network called "Vehicle Design“
- For teaching, education and research activities in aircraft design there was the European Workshop on Aircraft Design Education (**EWADE**).

The **CEAS approved** on March 2013 the proposal to form a **Technical Committee in Aircraft Design** (TCAD).

CEAS TCAD



COUNCIL OF EUROPEAN AEROSPACE SOCIETIES

CEAS

3AF AAAR AIAE AIDAA DGLR FTF HAES NVvL PSAA RAeS SVFW TsAGI

CEAS TCAD

Information exchange, collaboration, cross-validation, harmonization of research in aircraft design.

TCAD regular meeting => **SCAD** (Symposium on Collaboration in Aircraft Design)

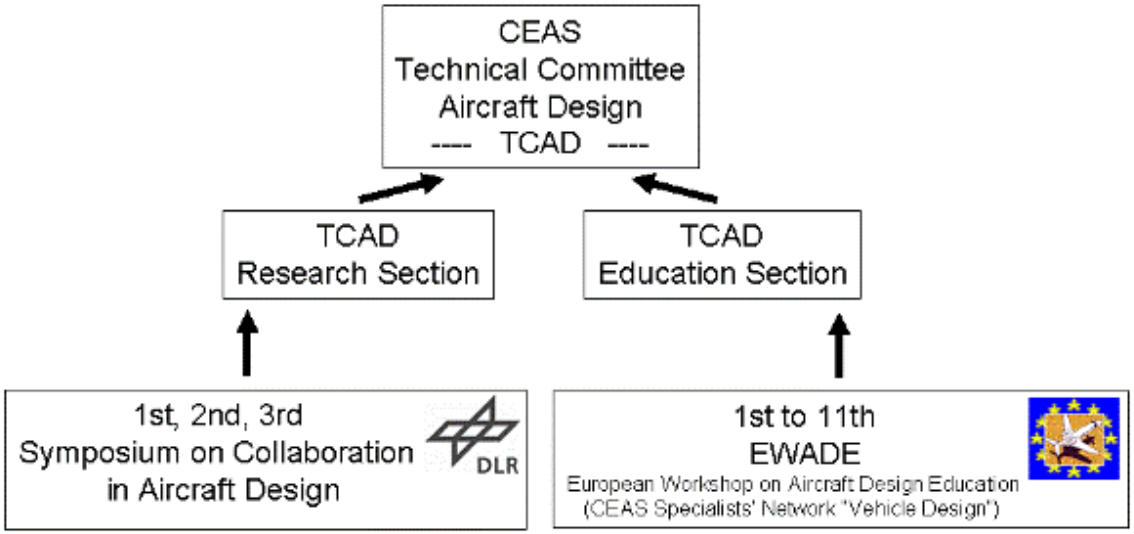
For Education in Aircraft Design **EWADE**

12 Meetings

12th Workshop: 2015 TU Delft
11th Workshop: 2013 Linköping
10th Workshop: 2011 Naples
9th Workshop: 2009 Sevilla
8th Workshop: 2007 Samara
7th Workshop: 2005 Toulouse
6th Workshop: 2004 Brno
5th Workshop: 2002 Linköping
4th Workshop: 2000 Turin
3th Workshop: 1998 Bristol
2nd Workshop: 1996 Berlin
1st Workshop: 1994 Madrid

EWADE promoters

E. Torenbeek, S. Chiesa, R. Martinez-Val, D. Schmitt (former Head of future project at AIRBUS)



SCAD (Symposium on Collaboration in Aircraft Design)

Previous SCAD Symposia

[4th SCAD - Symposium on Collaboration in Aircraft Design, Toulouse, 2014]
[3rd SCAD - Symposium on Collaboration in Aircraft Design, Linköping, 2013]
[Collaboration in Aircraft Design --- 2. CPACS/RCE Symposium, Hamburg, 2012]
[Kollaboration im Flugzeugentwurf --- 1. CPACS/RCE Symposium, Hamburg, 2011]

TCAD list :
More than 100 Researchers (European and NON-European)

In USA there is a similar Committee :
AIAA Aircraft Design Technical Committee

- **Meeting at AIAA conferences**
- **AIAA Aircraft Design Award**
- **….**

This 5° SCAD Edition :

About **80 participants** registered:

Italy (35), Germany (17), France (7), Sweden (5), UK (4), Poland (1), Switzerland (3), Belgium (1), Netherland (2)

5 from USA (NASA, Darcorp)

1 from CANADA (Bombardier)

1 from Russia (TsAGI)

1 from Ukraine (Ivchenko)

14 Companies:

Alenia Aermacchi (Italy)
Piaggio Aerospace (Italy)
Tecnam (Italy)
AIRBUS (International)
SAAB (Sweden)
Bombardier (Canada)
Fokker (Netherland)
Ivchenko (Ukraine)
Thelsys (Germany)
CFS Eng. (Switzerland)
Darcorp (USA)
TWT GmbH (Germany)
Bauhaus Luftfahrt (Germ
NOESIS (Belgium)

7 AIRCRAFT Manufacturer

7 Research Centres

DLR (Germany)
ONERA (France)
CIRA (Italy)
NLR (Netherland)
ATI (UK)
NASA (USA)
TsAGI (Russia)

13 Universities

Federico II Naples
Politecnico Torino
Politecnico Milano
Università Pisa
Università del Salento

RWTH Aachen
TU Delft
TU Berlin
Univ. of Southempton
Univ. of Leeds
Linkoping University
KTH Stockholm

Some considerations About AIRCRAFT DESIGN
(using also some thoughts of D. Schmitt, from E. Torenbeek recent book)

- Faculties of aerospace engineering sometimes (often in the past) consider the basic disciplines such as aerodynamics, lightweight structures, flight mechanics and space technologies as the fundamentals to provide the envelope for aeronautics and space for the engineering students.

- Aircraft design was **normally not considered a specific discipline** worthy of inaugurating a specific chair. In the 70-80's there were some Universities having a specific chair for aircraft design (i.e. TU Delft, UNI Naples, and some un USA).

- A similar view can also be seen in industry. Management was not fully convinced that the aircraft design had the same importance and role as the big engineering departments like aerodynamics, structures, systems, propulsion and cabin.

- At beginning of 2000, Industry discovered that they did not have enough engineers with sufficient global knowledge to understand the total aircraft as a complex system.
  => Need of 'aircraft architects' and 'aircraft integrators'
  => 'Aircraft design' discipline is of prime importance.

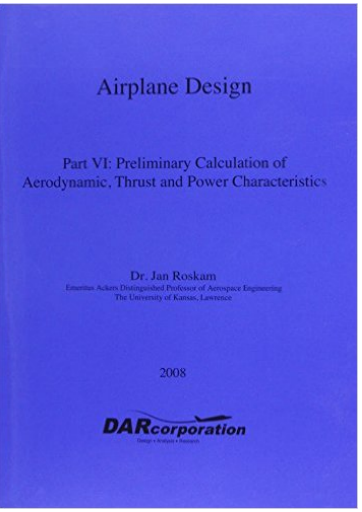
Some considerations About AIRCRAFT DESIGN
(by D. Schmitt, from E. Torenbeek recent book)

- There is, however, a huge discrepancy between industry and Research Centres or Universities with regard to integrated aircraft design.
- Industry claims and wishes that universities as well as research centres should not look too closely at aircraft integration; this is seen as the unique role of industry.
- Industry claims to be the only partner, who knows the market demand and who has to consider the right design approach with respect to time, cost, quality and risk before deciding on a new product and its introduction onto the market.
- Industry therefore would like to keep the universities out of the domain of aircraft design, and do not want to give too many details to the scientific community, on how to prepare an innovative aircraft design.

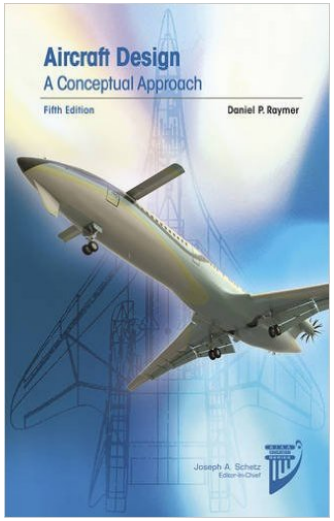
- **On the other hand**, students and young engineers have to be trained and have to learn and understand the basic features of aircraft design at university during their studies.
- Students are primarily not so much fascinated by details of low speed aerodynamics or the detailed design of a fuselage frame compared to designing an aircraft.

- The scientific approach to **aircraft design is therefore a major topic for the universities** and has to be part of the aeronautical engineering curriculum.

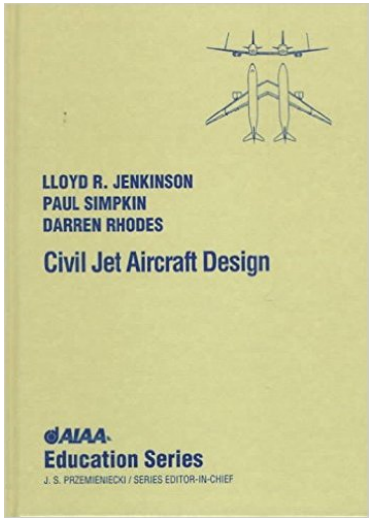
Recent AIRCRAFT DESIGN Books



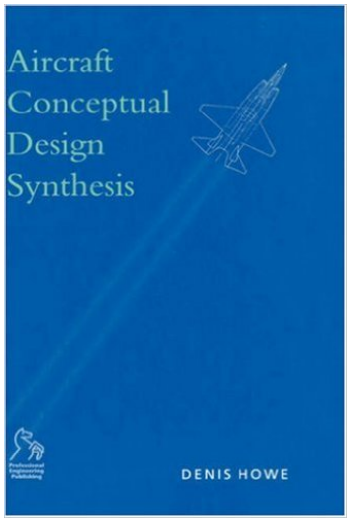
Roskam (1980-2010)



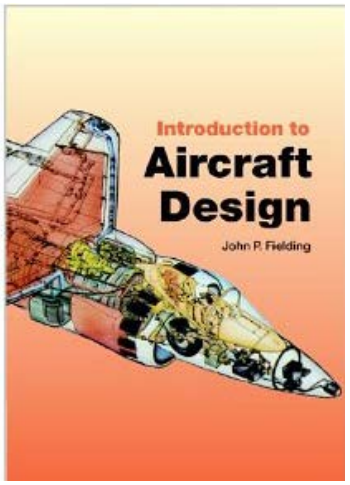
Raymer



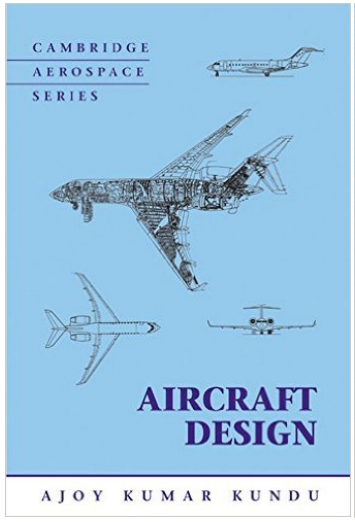
Jenkinson (2000)



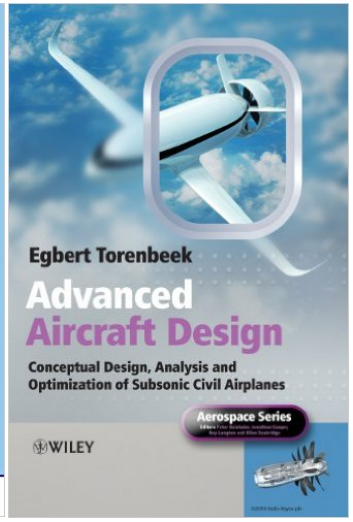
D. Howe (2000)



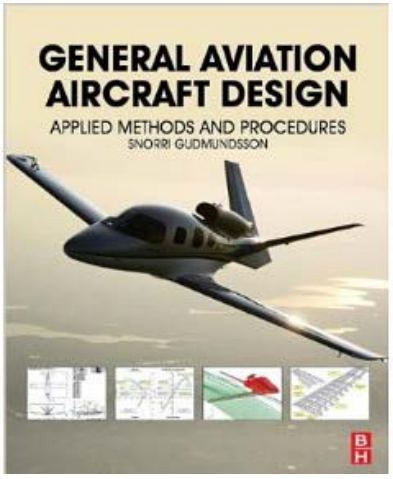
Fielding (1999)



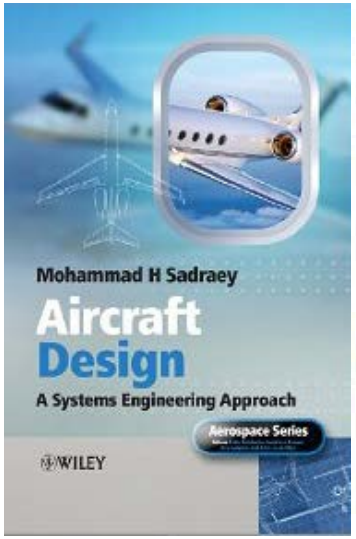
Kundu (2010)



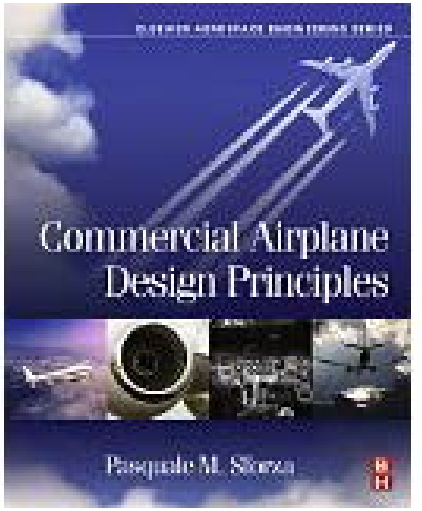
Torenbeek (2013)



Gudmundsson (2014)



Sadray (2013)



Sforza (2014)

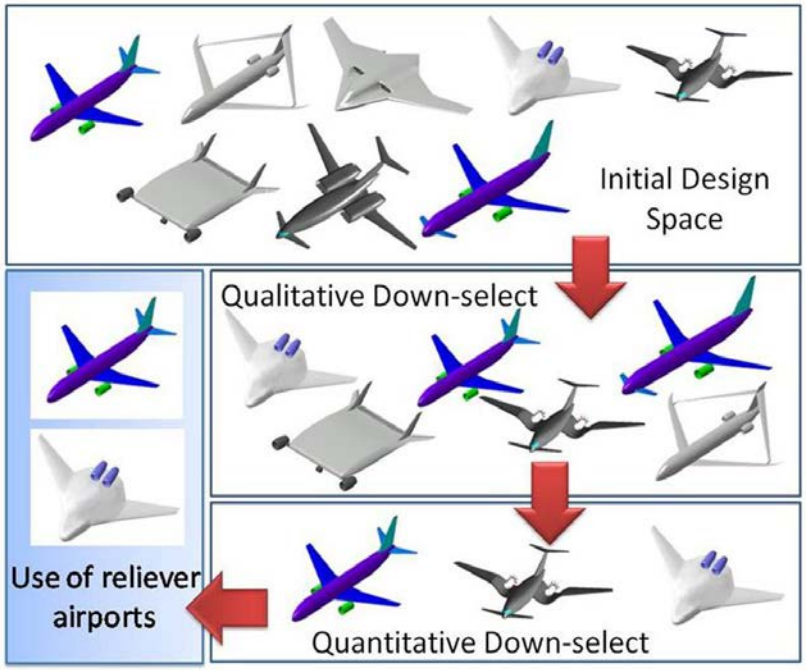
RESEARCH ACTIVITY IN AIRCRAFT DESIGN

- NEW CONFIGURATIONS
- NEW DESIGN METHODS and TOOLS
- NEW ANALYSIS TOOLS
- NEW TECHNOLOGIES … and THEIR INTEGRATION
  (material, morphing structures, flow control, electric propulsion)

Maybe we also should think to …… NEW Operational Environment (different Airport..)

THE MAIN DESIGN GOALS are :

- Reduced production cost
- Reduced DOC (Operational cost)
- Reduced fuel consumption
- Reduced Noise and Emissions
- Reduced required field length
- Increase pax (1000 passengers aircraft ?)
- Reduced maintenance cost and time
- Increase passenger comfort
- Increase safety level



RESEARCH ACTIVITY IN AIRCRAFT DESIGN

AIRCRAFT DESIGN APPLIED TO NEW "*CONVENTIONAL*" AIRCRAFT (or Modified version)

Boeing B787 Composite

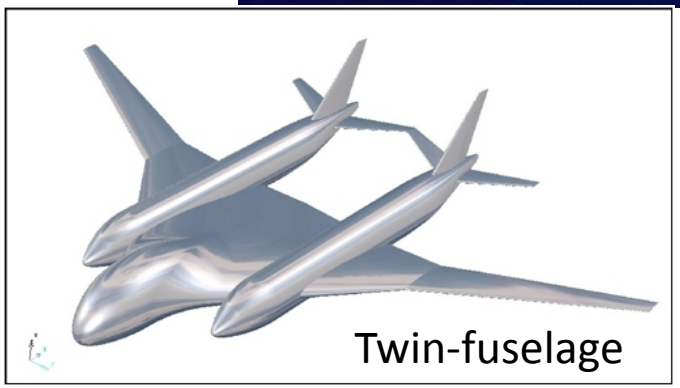
AIRBUS A350

ATR 72 – 600 (Avionics)
ATR 72 *NEO* ?

B747-800 Stretched fuselage
New engines (B787)
Fly-by-wire

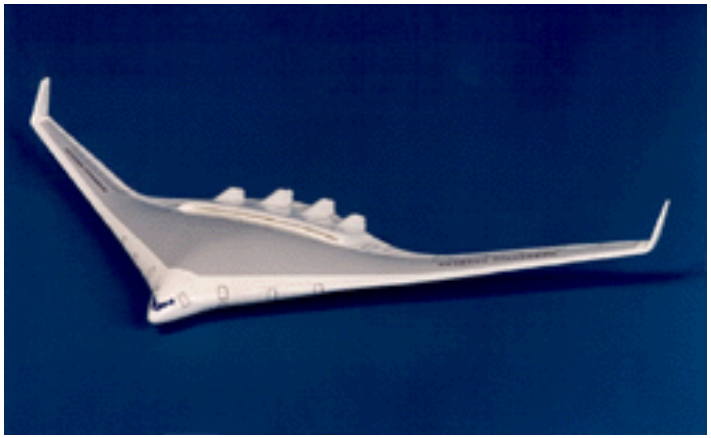
AIRBUS A320 *NEO*
(New Engine Option)
Sharklets , (DOC reduced -8%)

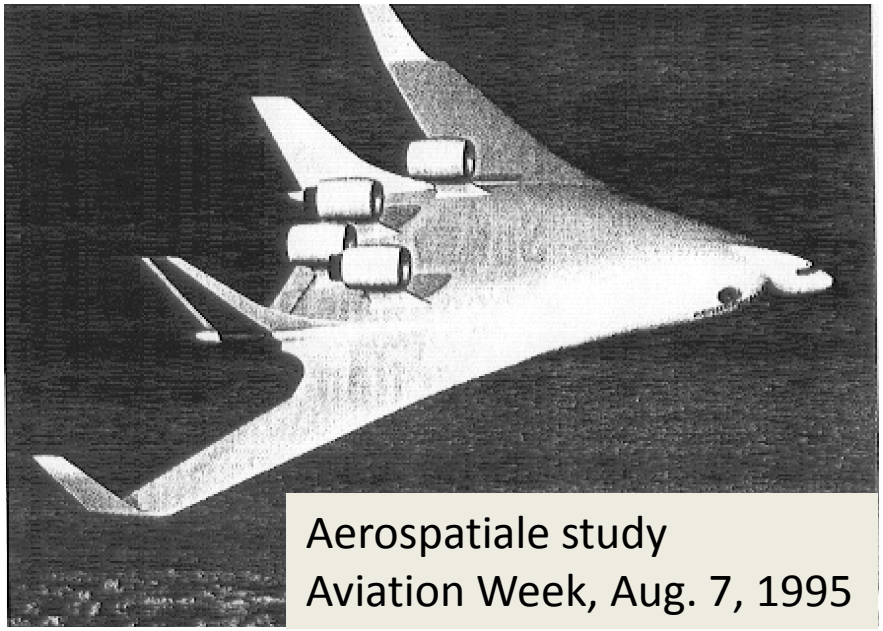
What Will Airplanes of the Future Look Like?



What Will Airplanes of the Future Look Like?

BWB Blended Wing Body





Aerospatiale study
Aviation Week, Aug. 7, 1995

Liebeck, R.H. "Design of the Blended Wing Body Subsonic Transport."
AIAA Journal of Aircraft, January–February 2004

BWB Projects

Type	Country	Date
AVIC 601-S	China	
Boeing X-45C	USA	2002
Boeing X-48	USA	2007
Dassault nEUROn		
Lockheed Martin RQ-170 Sentinel		2007
Lockheed Martin RQ-3 DarkStar	USA	1996
McDonnell XP-67	USA	1944
Miles M.30	UK	1942
Northrop Grumman X-47 Pegasus	USA	2003
Silent Aircraft Initiative		2003
Stout Batwing		
Westland Dreadnought	UK	1924

What Will Airplanes of the Future Look Like?

BWB Blended Wing Body

BWB-17 NASA-Stanford, 1996
5.2 m span scaled model flight

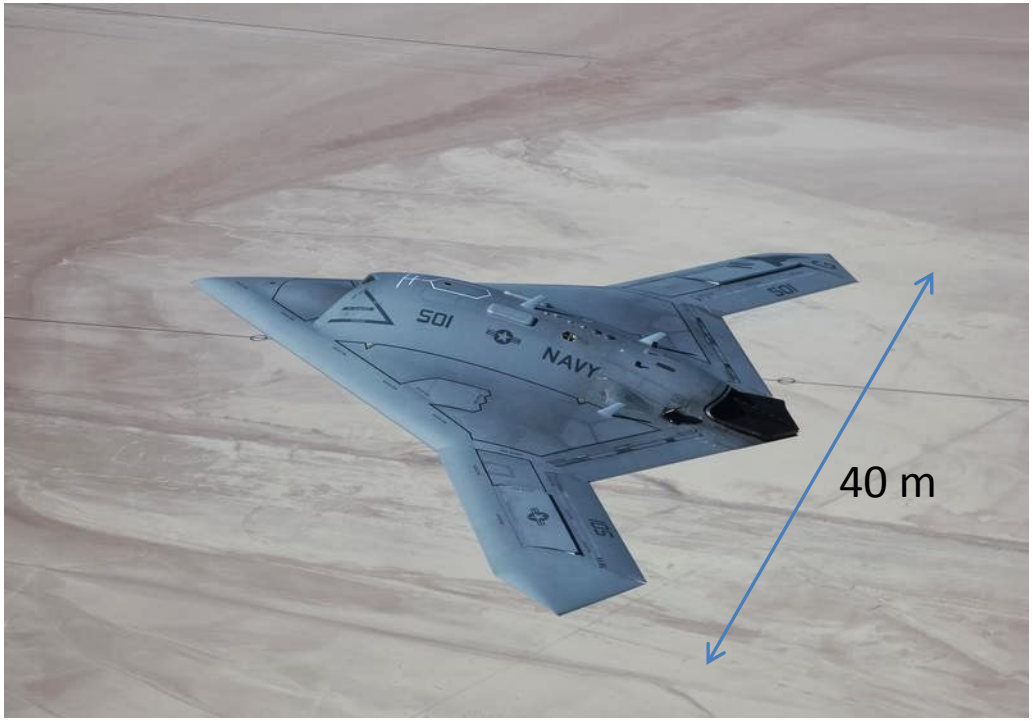
NASA - Boeing X-48 2006
6.4 m span military UAV Entry in service 2020

Not Only “paper airplanes”

NASA X-48C model, FLIGHT TEST, 2012

What Will Airplanes of the Future Look Like?

BWB Blended Wing Body
Big Unmanned Vehicle



RQ-180 Unmanned Aircraft , Northrop-Grumman
American stealth unmanned aerial vehicle (UAV) surveillance aircraft.
Wingspan: 130 ft (40 m), Max weight about 15 tons.
Endurance 24 h, Range 1200 nm.
Begin production in 2014

What Will Airplanes of the Future Look Like?

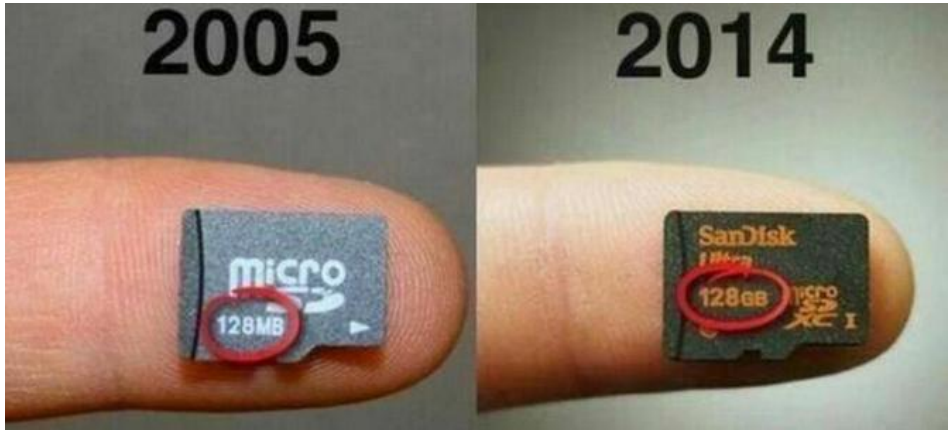
BWB Blended Wing Body

A VISION ON THE FUTURE

Commercial aircraft
2050
(Boeing-NASA)

BWB Concept coupled with Innovative Propulsion Systems (Electric)

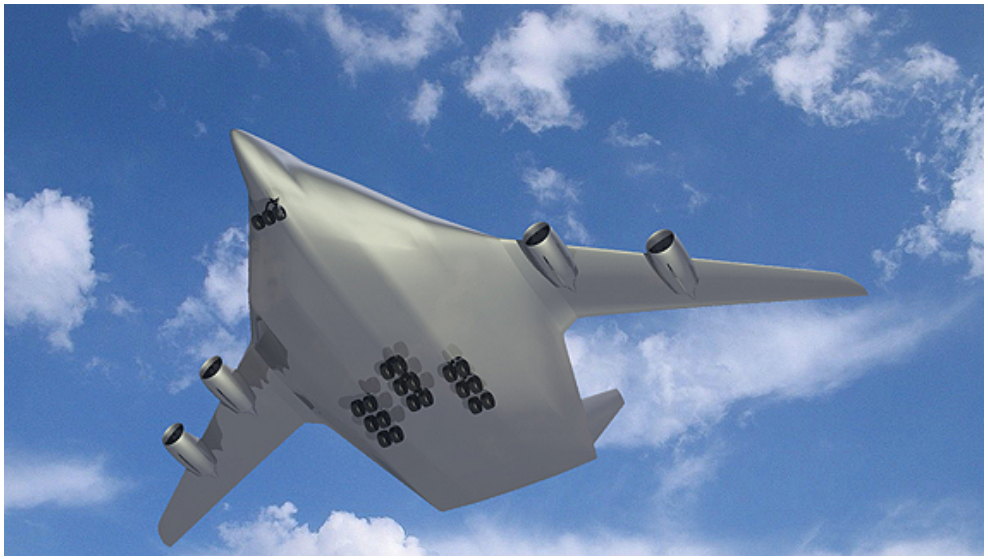
Technology evolution of digital storage (2005-2014)
From 128 Mb to 128 Gb



What Will Airplanes of the Future Look Like?

BWB in Europe

ACFA 2020 (Active Flow Control)



European Project **NACRE** (New Aircraft Concepts Research) has this wide-body aircraft in mind for future flyers, designed for long-haul flights and able to accommodate up to 750 passengers. Measuring 65 meters long, 19 meters high with a wingspan of nearly 100 meters, the maximum take-off weight of the simulated flying wing is roughly **700 tons.**

EU-funded FANTASSY project

What Will Airplanes of the Future Look Like?

Formation flight

Airbus has this concept in mind that could be more fuel efficient because of its long, curled wings, a U-shaped tail, and a lightweight body.
This could be the way planes look in 2030, Airbus says, and will have advanced interior systems, and be much quieter than current aircraft.

What Will Airplanes of the Future Look Like?

What about Supersonic ?

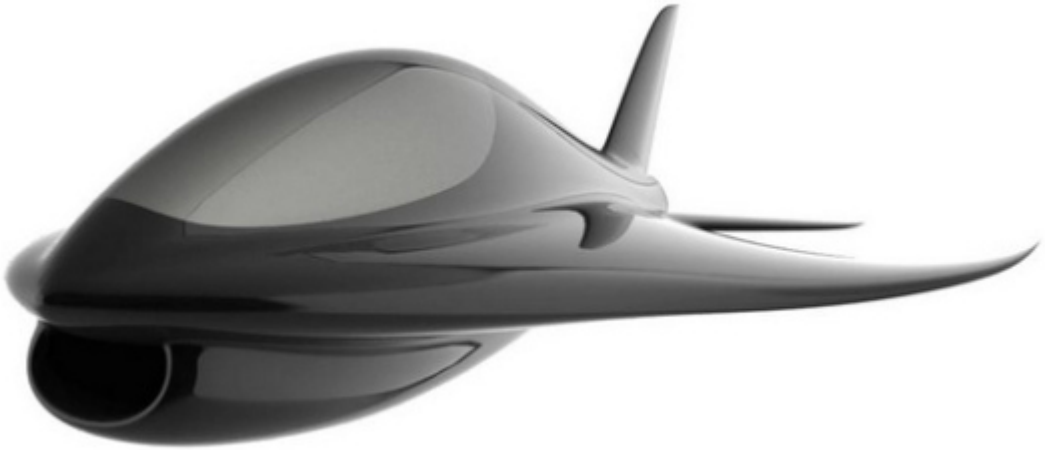
This supersonic aircraft concept by Boeing is nicknamed Icon II has V-tails and upper surface engines, and can carry 120 passengers in a two-class, single-aisle interior, and can cruise at Mach 1.6 to Mach 1.8 with a range of about 5,000 nautical miles.

What Will Airplanes of the Future Look Like?

Truss-braced wing

Another concept from Boeing is the **SUGAR Volt** – which includes an electric battery gas turbine hybrid propulsion system. Hybrid electric propulsion also has the potential to shorten takeoff distance and reduce noise.

What Will Airplanes of the Future Look Like?



This one is called the **SmartFish**, and utilizes a “lifting body” design, which means that the entire aircraft works to provide lift, rather than just the wings. The concept for this plane is a slender shape and composite material construction, which means less drag, and thus less thrust required for flight. The wing and fuselage form one integrated, futuristic-looking design. This plane can fly without slats, flaps, or spoilers, meaning increased fuel efficiency.

What Will Airplanes of the Future Look Like?

eConcept EADS's Hybrid-Electric Airliner

EADS IW, with Rolls-Royce and Cranfield University, is working on the Distributed Electrical Aerospace Propulsion (DEAP) project funded by the UK Technology Strategy Board.

The EADS IW concept uses a single large turbine engine to generate electricity to power six ducted fans that provide thrust. This allows propulsive and thermal efficiency to be optimized separately. The turbine engine can be optimized for thermal efficiency (turning fuel into shaft power) while the ducted fans increase effective bypass ratio and therefore propulsion efficient (turning shaft power into thrust).

What Will Airplanes of the Future Look Like?

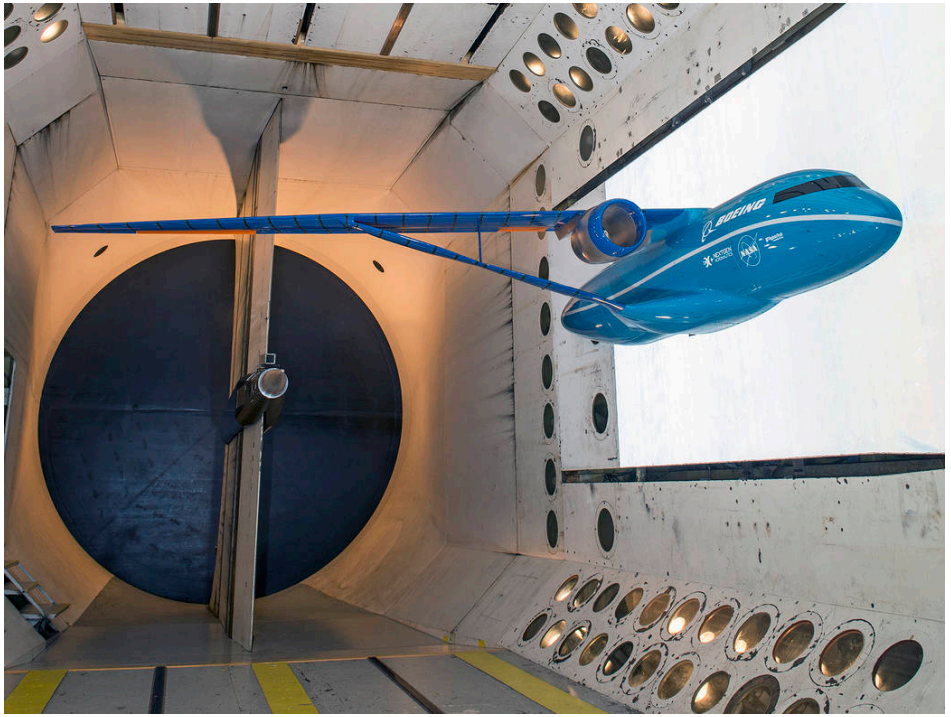
Volt Air EADS – AIRBUS Electric Airliner

Zero-emissions, high-density, battery-powered aircraft that rethinks the design of conventional commercial aircraft in order to allow for the swapping out of a emissions heavy jet engine for an earth-friendly battery system. The plane is powered by highly efficient superconducting electric motors which drive counter-rotating, shrouded propellers located at the rear of the plane. The significance of this plane isn't centered on the engineer's decision to plop a battery inside, but from the team at EADS understanding that in order to make electric aircraft a reality, we'll have to rethink not only the engines, but the propulsion systems and the airframe design as well."

Not Only “paper airplanes” !

2014 Testing electric propulsion, NASA Langley

Not Only “paper airplanes” !



SUGAR Volt (NASA-Boeing)
Boeing Transonic wind-tunnel
Aeroelastic tests for assessment of aeroelastic qualities

Not Only “paper airplanes” !

D8 Double-Bubble Project
(MIT – NASA)

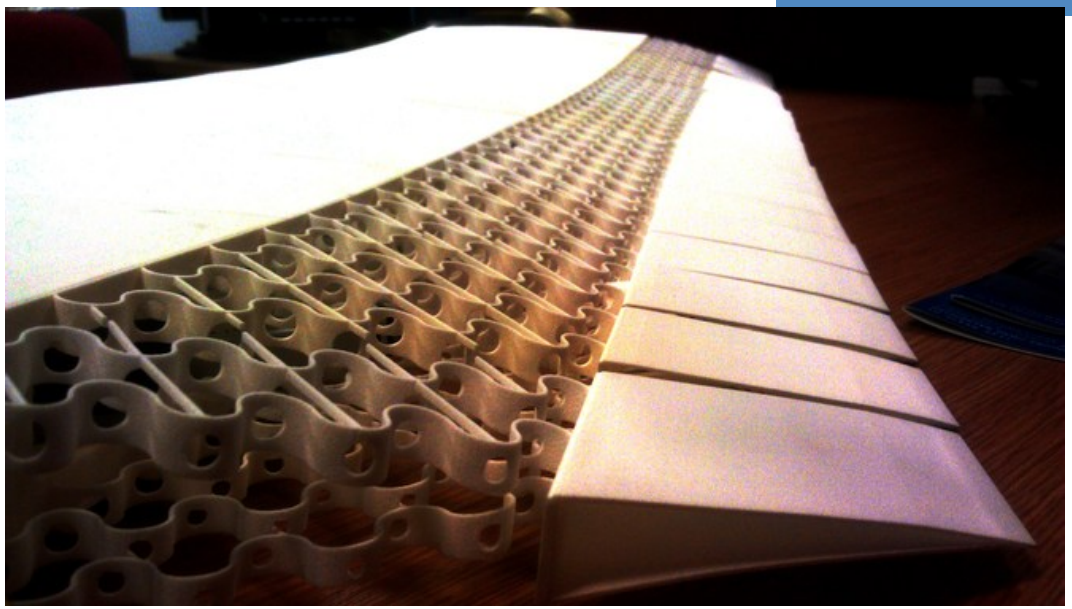
WIND-TUNNEL TESTS
At NASA Langley

What about technology ?

MORPHING STRUCTURES

Adaptive Compliant Trailing Edge (ACTE) (NASA)
Flexible trailing-edge wing flaps

Flight tests at Armstrong Flight Research Center



Skeleton of trailing edge of wing morphing wind-tunnel demonstrator concept , University of Bristol

What about technology ?

Flight tests at Boeing, Seattle, April 2015

Flow control applied on a vertical tail of a B757

For the Active Flow Control Enhanced Vertical Tail Flight Experiment on board the ecoDemonstrator 757, 31 tiny devices called sweeping jet actuators were installed on the aircraft's vertical tail to see what – if any – effect they have on the aerodynamics of the tail and rudder surfaces.

Results from these tests suggested future aircraft designers may be able to **scale down the size of the vertical tail by about 17 percent** and **reduce fuel usage** by as much as **0.5 percent**, which quickly adds up to big savings.

What about technology ?

High Speed Smart Wing Flight Demonstrator (Clean Sky)

Low-drag laminar smart wing

Large scale flight test of passive and active flow and loads control solutions

What about technology ?

ATR Flying Demonstrator (Clean Sky GRA, Alenia/ATR)

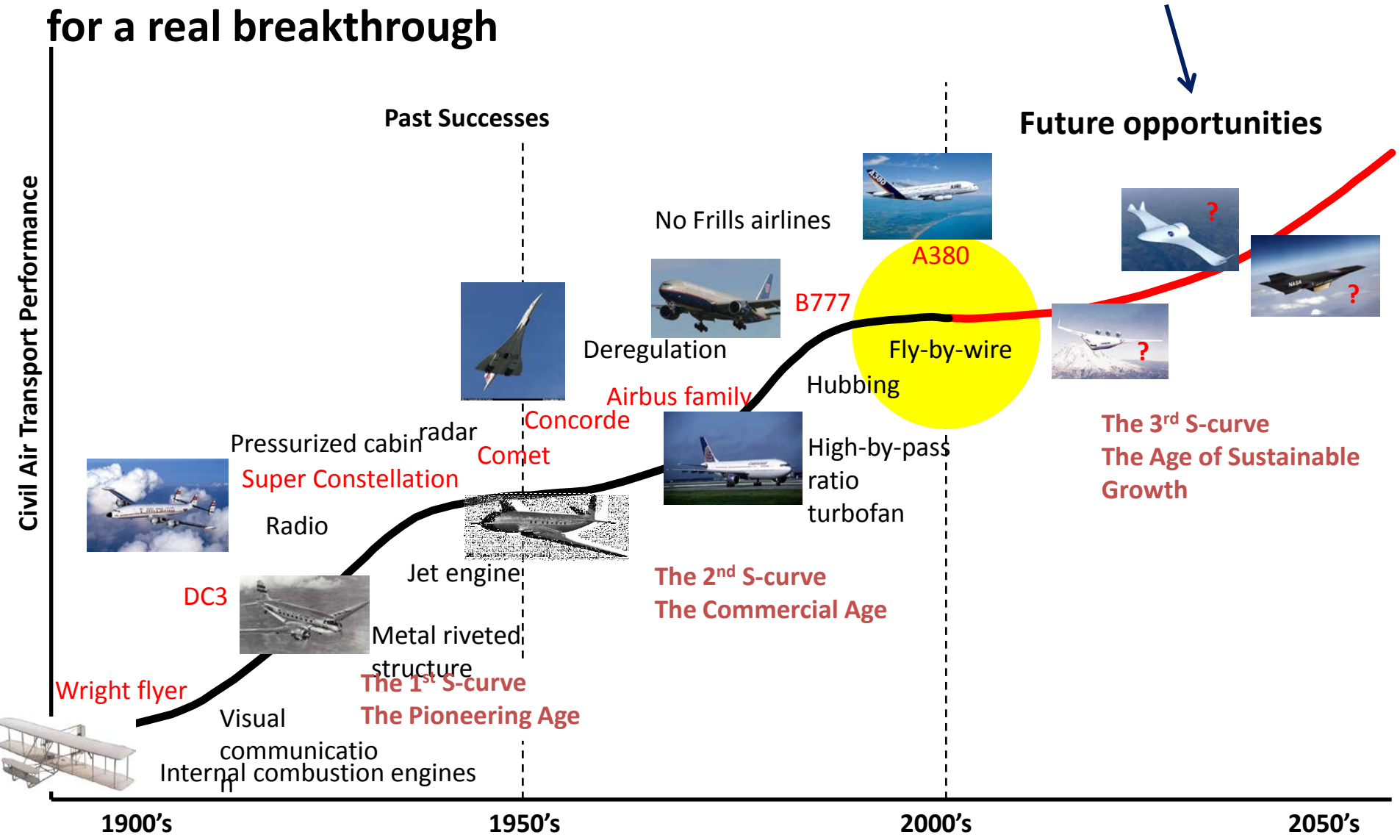
The first flight has taken place of the ‘green’ ATR 72 Flying Demonstrator as part of a European Clean Sky programme to test new and more effective composite insulating materials and acoustic damping on regional aircraft. The demonstrator has been conceived by ATR and its joint shareholder Alenia Aermacchi, and an entire aluminium section of the upper fuselage on the test aircraft has been replaced with an innovative composite panel.

Conclusions

- **RESEARCH on project addressing AIRCRAFT DESIGN for innovative solutions must be financed and supported**
- **Universities plays an important role**
- **STRONG benefits coming from a more integrated activities of Industry, Universities and Research Centres**
- **Maybe INDUSTRY must be more open to release some data to the scientific community to improve future design**

Conclusions

STRONG INVESTMENTS and Withstand RISKS are NEEDED for a real breakthrough



5th SCAD

Some special thank to:

- ***All people attending the workshop***

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- ***CIRA (for support and technical tour)***
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- ***Dr. Moore for accepting the invitation***

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- Dr. Moore for accepting the invitation

- ***ALL MY COLLABORATORS !!***

THANK YOU

and …. ENJOY the SCAD meeting

Interesting Video:

YOUTUBE Electric Aircraft
Video 1
https://youtu.be/w5t8VdLpsOA

Video 2
https://www.youtube.com/watch?v=PIHBDaySH6U

Video 3
https://www.youtube.com/watch?v=71blB6hNV0g

https://www.youtube.com/watch?v=aORE7C8y1sw

The Super-Efficient Future of Air Travel (documentario)