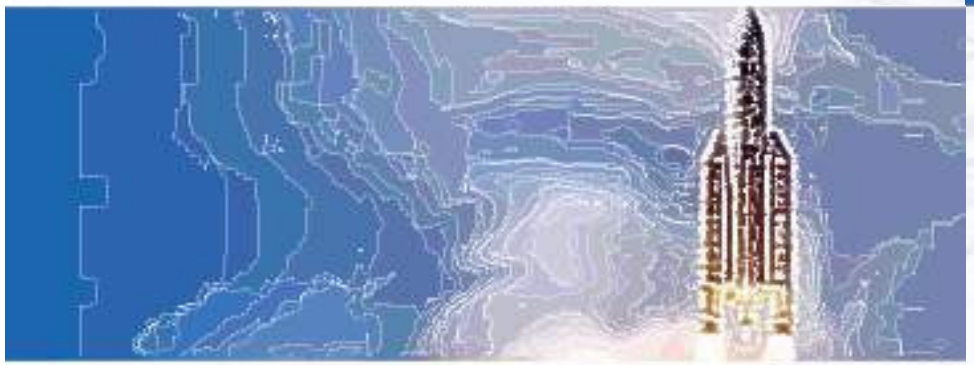
Avio
propulsione aerospaziale

Rzeszow Konferencaja
December 14, 2009



Avio innovation network

Franco Tortarolo
Head of R&TD

…last century…

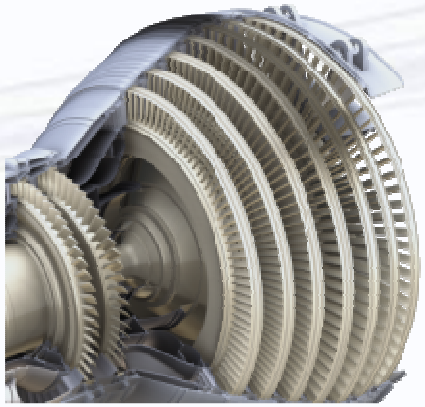
1903 …
Wright Flyer

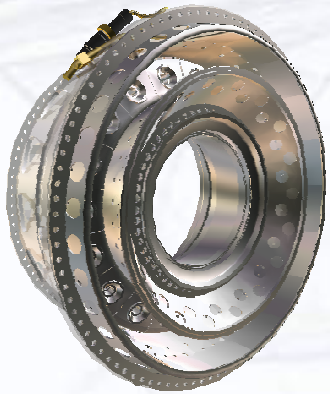
Today …
A380

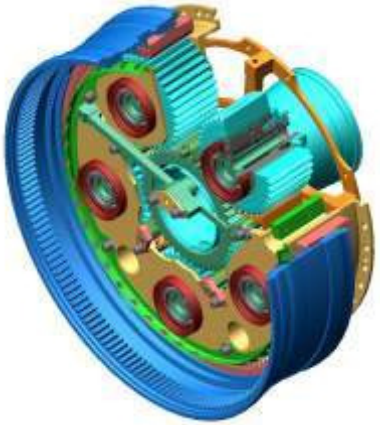
Tomorrow …
Green Aircraft

Avio

- **No. 1 in the world:**
  - **Accessory Gearbox**
  - **Power Transmission for helicopter and turboprop (independent)**
- **No. 1 in Europe for Solid Space Propulsion**
- **Eccellence in Turbines and Combustors**







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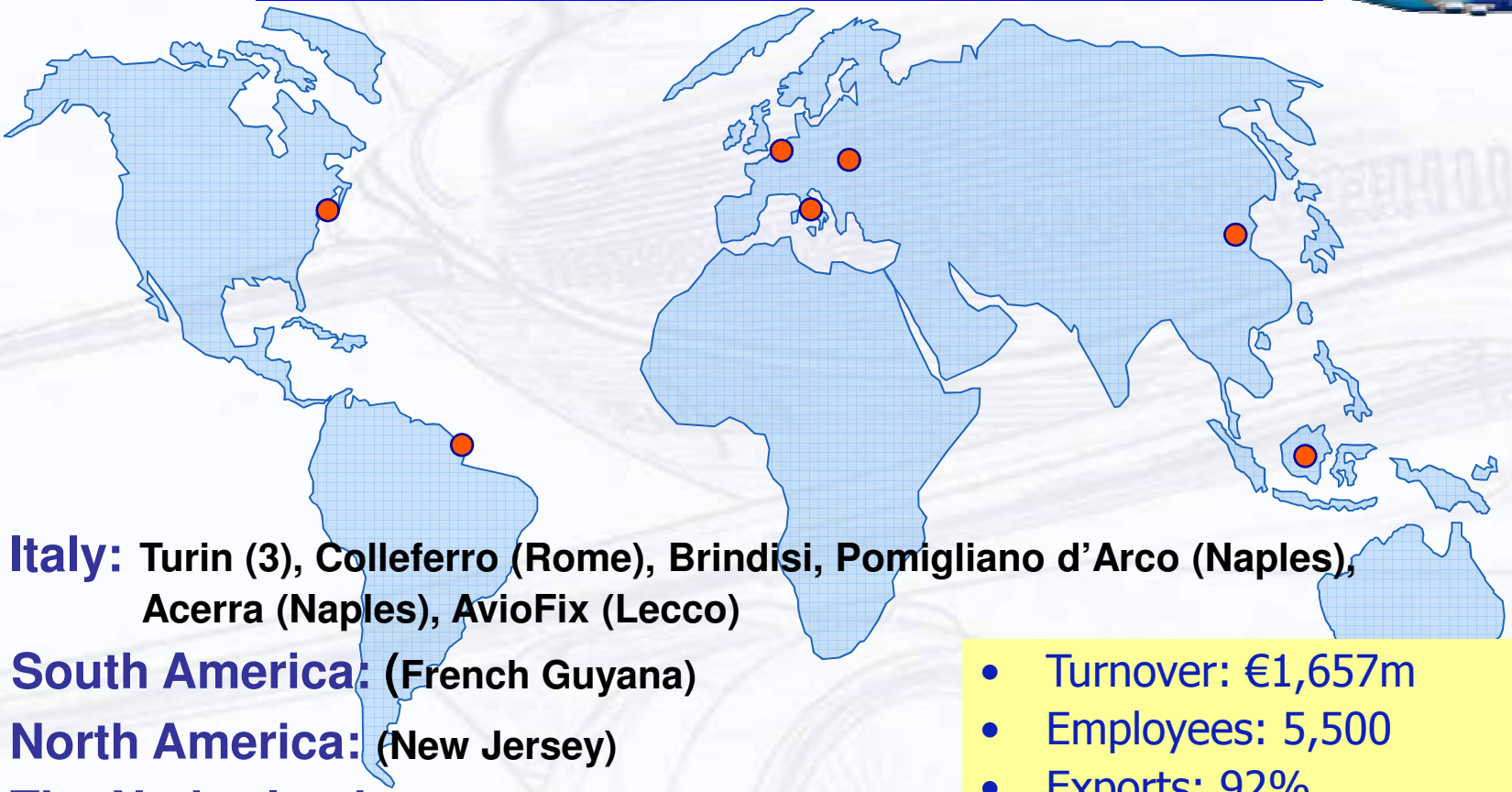
Avio in numbers



7 in Italy: Turin (3), Colleferro (Rome), Brindisi, Pomigliano d'Arco (Naples), Acerra (Naples), AvioFix (Lecco)

2 in South America: (French Guyana)

1 in North America: (New Jersey)

2 in The Netherlands: (Eindhoven, Woensdrecht)

1 in Poland: (Bielsko-Biala)

5 Representative Offices: Rome (Italy), Beijing (China), Singapore, Warsaw (Poland), Bruxelles (Belgium)

- Turnover: €1,657m
- Employees: 5,500
- Exports: 92%
- R&D investment: € 200m

Avio propulsione aerospaziale

Avio is involved in main civil programs

TRENT 900 GENx 2B (A380)

GE90 (B777)

CF6-80 (B747, B767, A330, A300, MD

CFM-56 (B737, A320 family)

PW4000 (in competition with CF6-80)

PW2000 (B757, C17 military transport)

V2500 (A320 family)

GENx Boeing 787 Dreamliner

SaM146 (Sukoi Superjet 100)

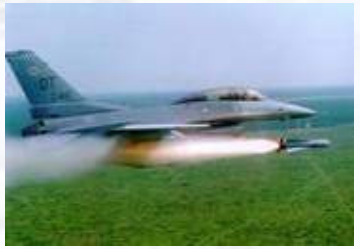
PW308 (Raytheon Hawker Horiz Dassault Falcon 2000EX BizJet

PW150 (Bombardier Q400)

PW100 (ATR 42)

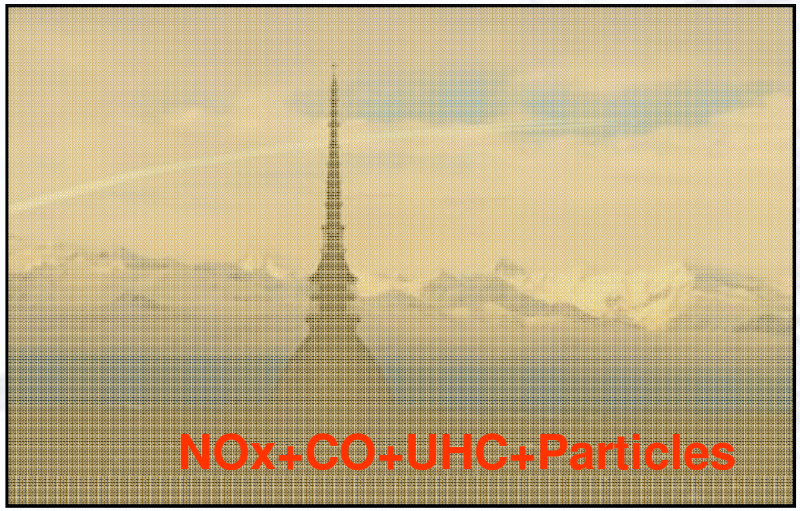
…and main military programs

EJ200	T700/CT7	TP400	F136/F135
			
Eurofighter/Typhoon	**Apache, Black Hawk, EH101, NH90, Cobra**	**A400M**	**F-35**

RB199	F119	F110
		
TORNADO	**F-22 Raptor**	**F-16 and F-15**

The challenges for R&T

From ACARE Goals to *Green Engine*



ATM Contribution

Aircraft Contribution

Engine Contribution

- Reduce specific fuel consumption by 20%
- Reduce NOx by 60% to 80%
- Reduce noise by 6 dB
- Reduce accident rate by x5
- Reduce operational cost
- Halve time to market

Engine Configuration Driven by:

Low Noise, Low Emissions, and Low Cost of Ownership

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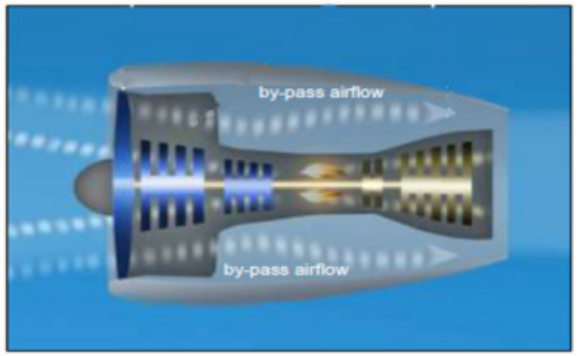
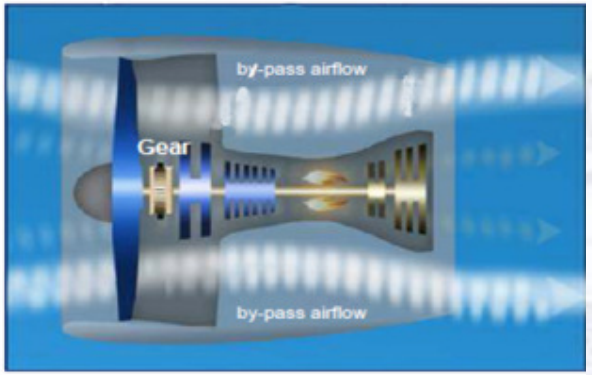
Which is the way?

Conventional Turbofan

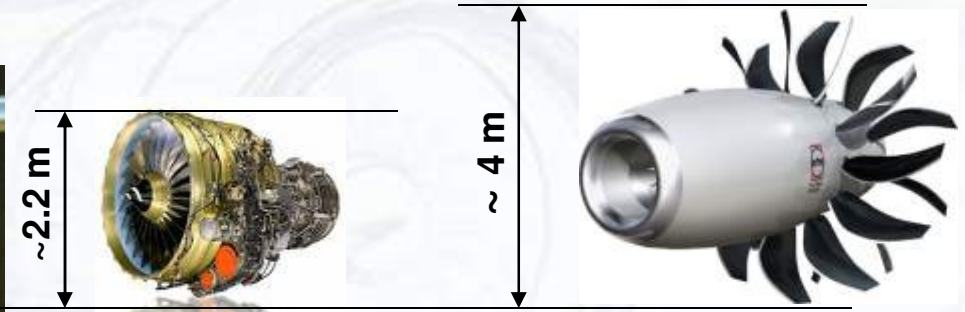


To increase the By-Pass-Ratio

Radical Architectures



- New engine architectures
- Technological Step Change
- Integration with airframers



CFM-56 Open Rotor

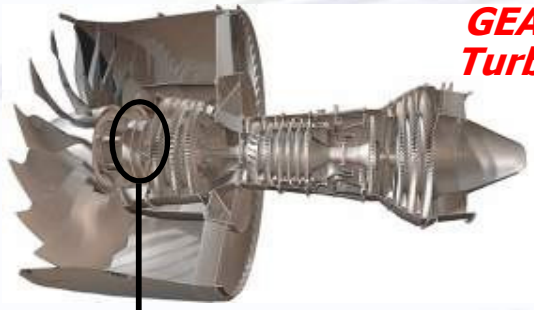
Radical Architectures

"duct"

"unduct"

Conventional

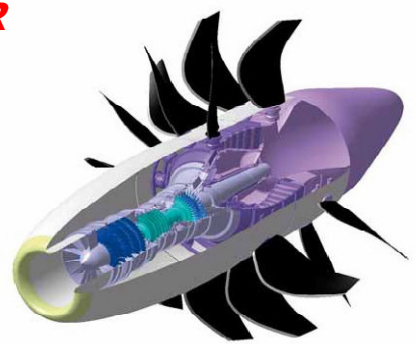
GEARED Turbofan



Low Speed Fan, driven by LPT via reduction gearbox

OPEN ROTOR

Puller



Pusher

Contro-rotanting propellers driven by turbine:

- "high speed" via a reduction gearbox

or

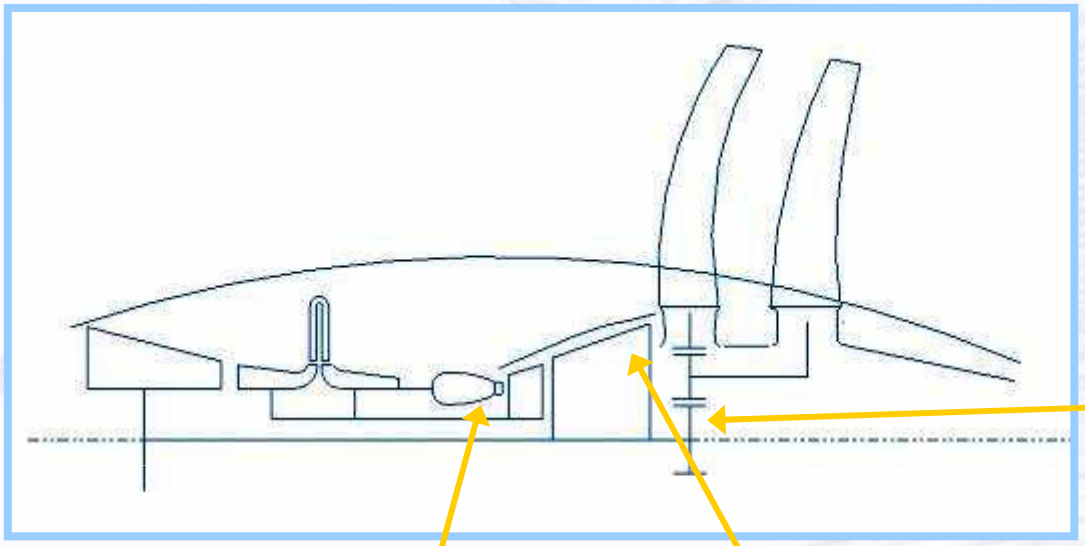
- "low speed" contro-rotanting (*Pusher only*)

Lower Noise

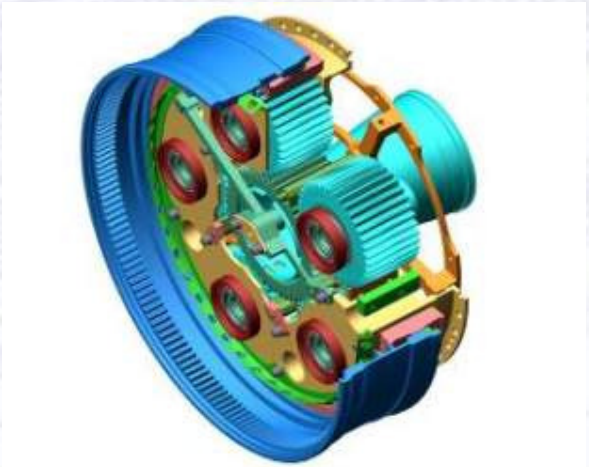
Lower SFC

Impact and opportunities for Avio products

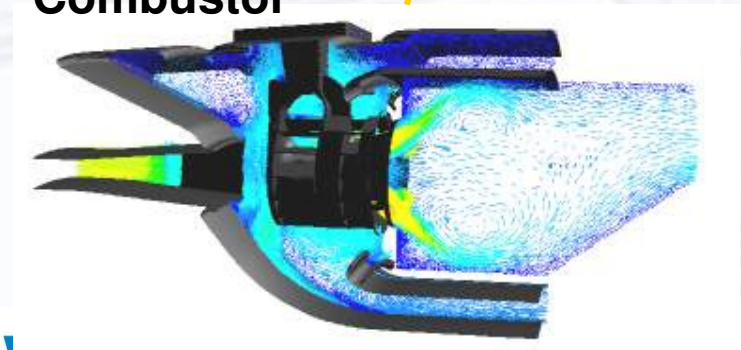
New Engine Architectures Needs

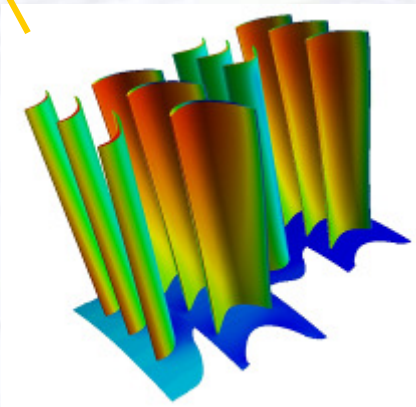


High Power Density Transmission Systems High Reliability



Ultra low NOx Combustor

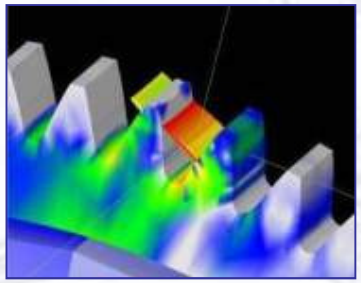




Light Weight - Low Noise - High Efficiency Turbines

Power Gearbox Research Drivers

INNOVATIVE GEAR DESIGN METHOD

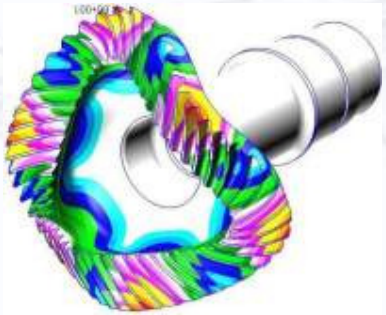


Innovative Gear Design Method for full use of material capabilities to increase power density, efficiency and reliability

HIGH LOAD CAPACITY BEARINGS

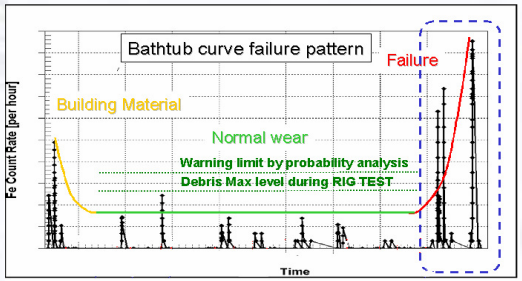
Journal Bearings, Integral Bearing Race, Ultra High Hardness Materials

SYSTEM DYNAMICS



Fully integrated Transmission System Dynamics Simulation

HEALTH MONITORING AND PROGNOSTIC



Incipient gears and bearing failure using oil debris and vibration monitoring

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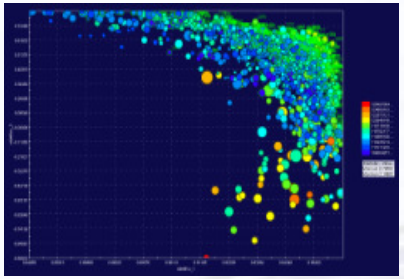
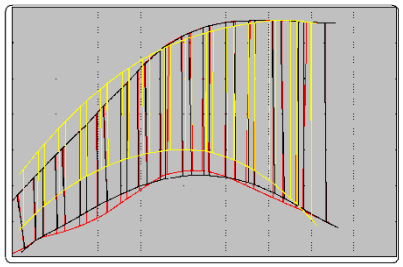
Low Pressure Turbine: Research Drivers

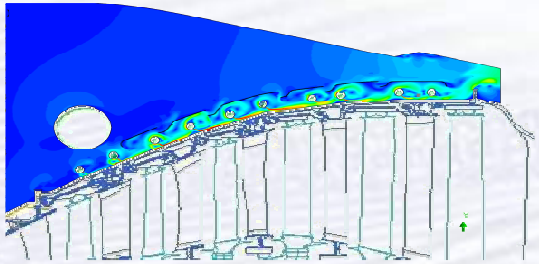
MULTIDISCIPLINARY OPTIMIZATION





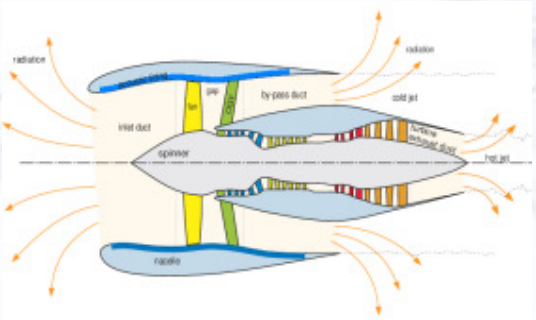
LPT Performance through multidisciplinary design optimization and 3D CFD Calculation

ACTIVE THERMAL CONTROLS



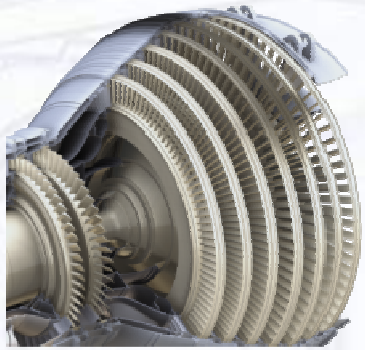
Active clearance control has a strong impact on engine performance improvement and reduction of engine to engine SFC variation

LOW NOISE DESIGN



Turbine Noise by design, through integrated Aerodynamic & Acoustic approach

LIGHT MATERIALS

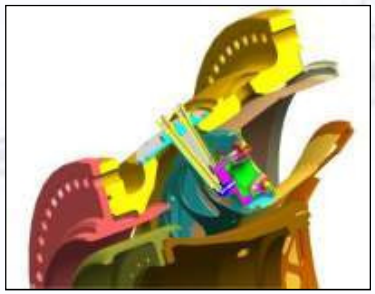


Low density alloy with good specific strength, corrosion/oxidation resistance and low cost manufactoring process

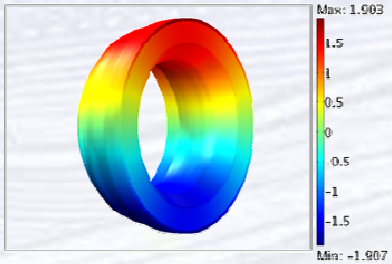
Combustion: Research Drivers

Challenge: Reduce Emissions

Ultra Low NOx (ULN) Injection System

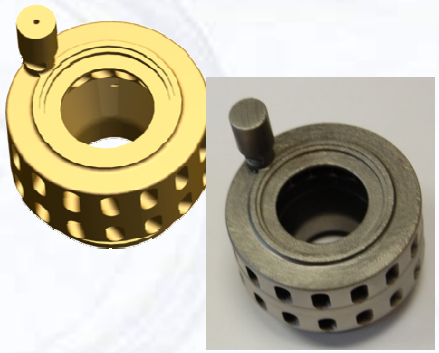


Thermo-acoustic numerical / experimental investigation



Alternative fuels characterization for ULN Combustion stability

Powder Sintering High Temperature Material



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From crisis to competiveness

Global crisis is pushing cost product reduction as essential

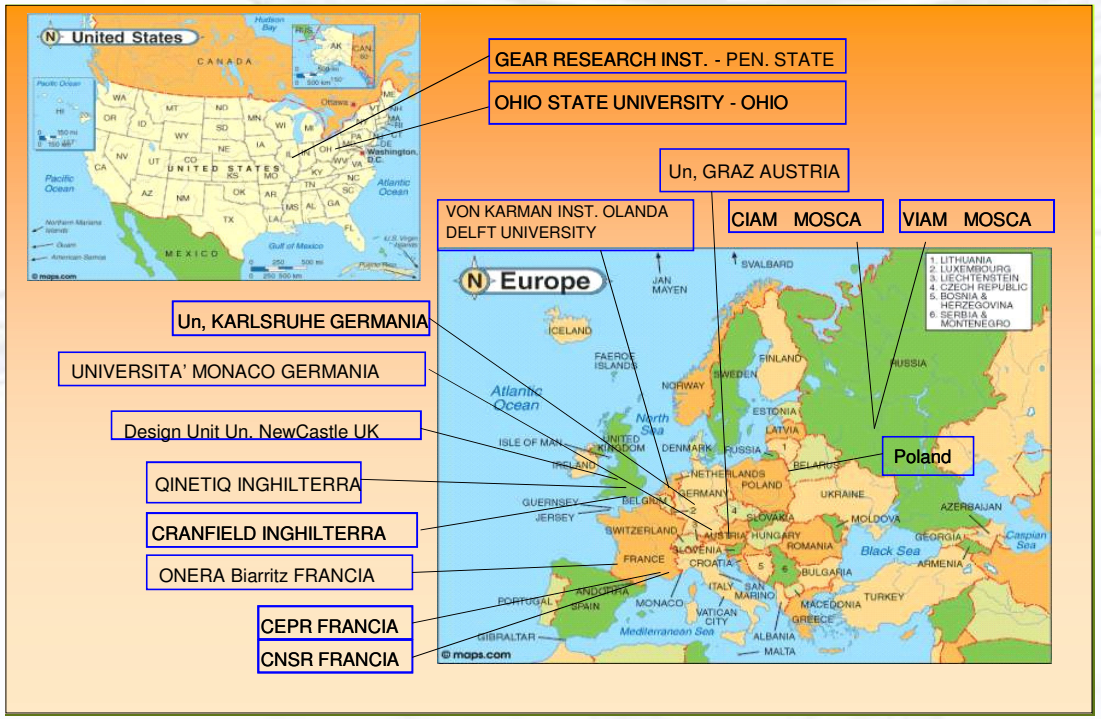
- R&T is a strategic asset to meet this goal
- R&T shall prioritize product cost in the research effort via:
  - Alternative materials
  - New process
  - Design optimization
  - Cross fertilization
  - ….

Avio approaching the challenges

Avio approach to R&T

Since many years Avio research has been based on:

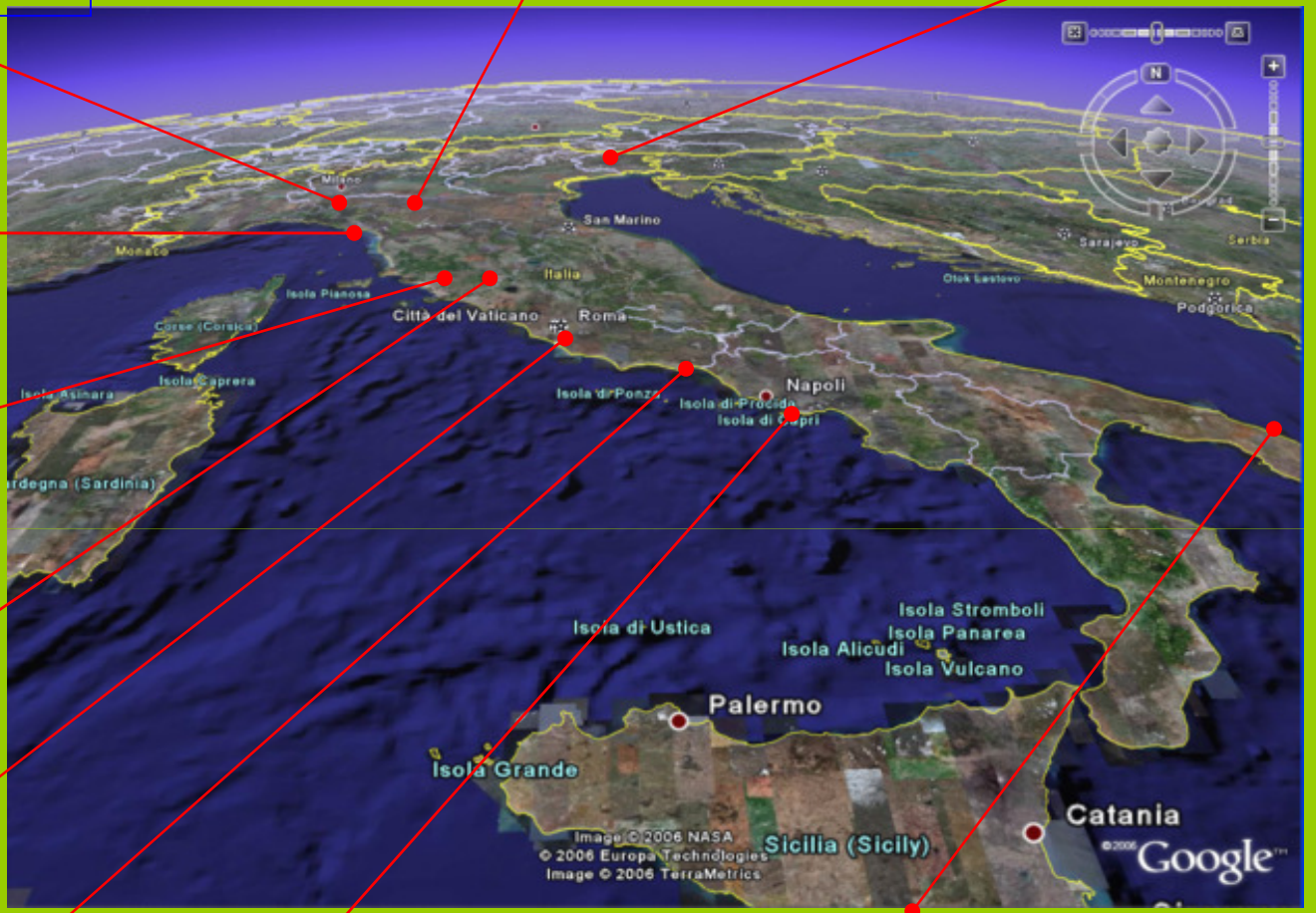
- National and European Programs (FP 5,6,7; CleanSky)
- National / International collaborations with Universities and Research Centers



Politecnico Torino
Turbomachinery,
Aeromechanics, Materials

Politecnico Milano
Lifing

Nanofab
Nanotech



Univ. Genova
Experimental
Fluidodynamics

Univ. Pisa
Mechanical
Transmission

Univ. Firenze
Computational
Fluidodynamics

Univ. Roma
Space Propuls.

Univ. Cassino
Creep

Univ. Napoli/CIRA
Combustor

Univ. Lecce
E-Engineering
Manufact. Process

From single Collaborations to Partnership

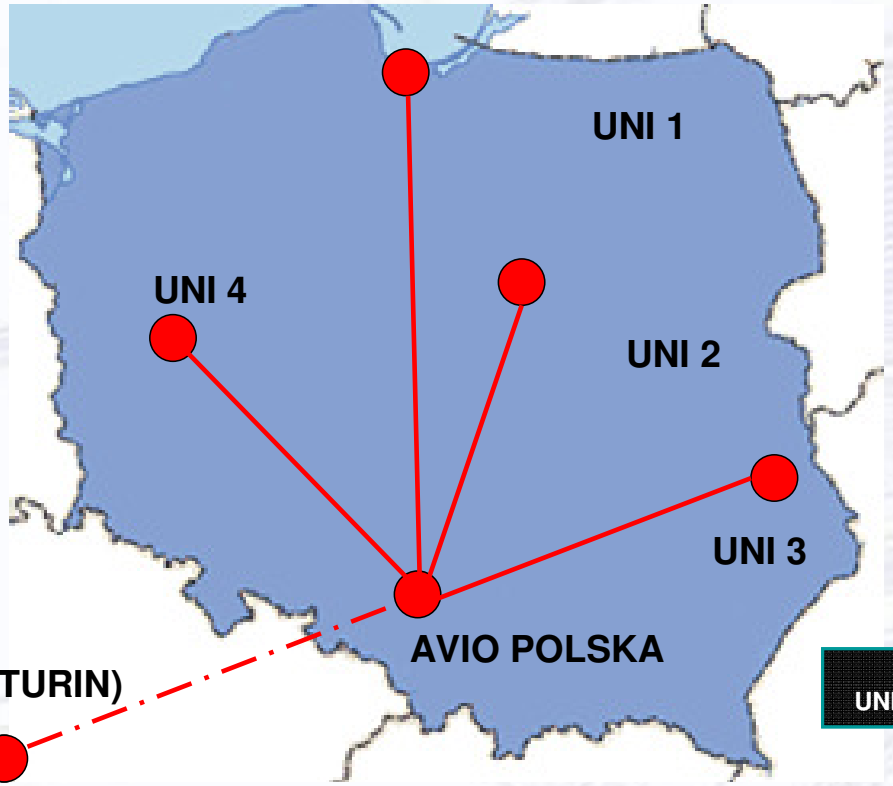
Pragmatic approach towards:

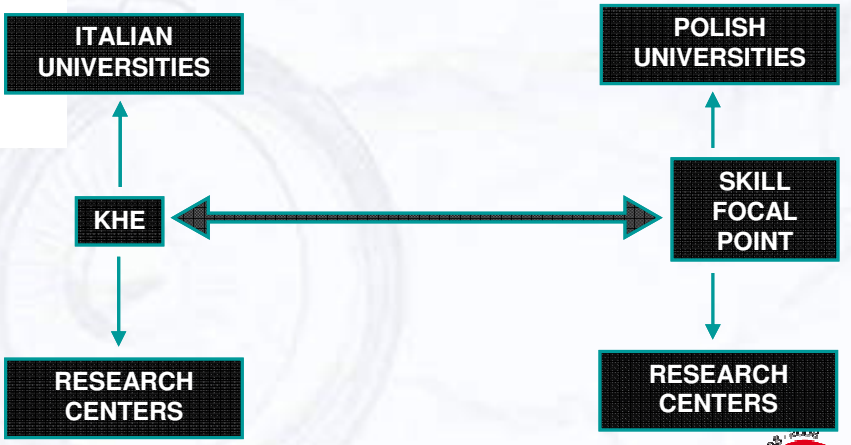
- Research Network based on partnership:
  - Avio
  - Research Institutes / Universities
  - SME's
- Selective collaboration:
  - Proven competencies
  - Stability
  - Cost sharing and returns among Partners
- Common "*green*" objectives
- Science ⇨ Technology ⇨ Application

EXPECTATIONS & ROLES

AVIO NEEDS CONTINOUS GROWTH IN KNOWLEDGE	• "ENGINE" OF THE SYSTEM • BRIDGE TOWARDS BUSINESS OPPORTUNITIES • PATH TOWARDS EUROPE
RESEARCH INSTITUTIONS NEEDS TO TEST KNOWLEDGE ON "REAL" CASES	• BASIC RESEARCH SEAT • SOURCE FOR KNOWLEDGE AND SKILLED PEOPLE • IT NEEDS TO TEST THE KNOWLEDGE ON "REAL" CASE
SME's NEED "BRIDGES" TOWARDS LARGER WORLDS	• "NICHE" KNOWLEDGE • FAST RACTION TIME • FELXIBILITY

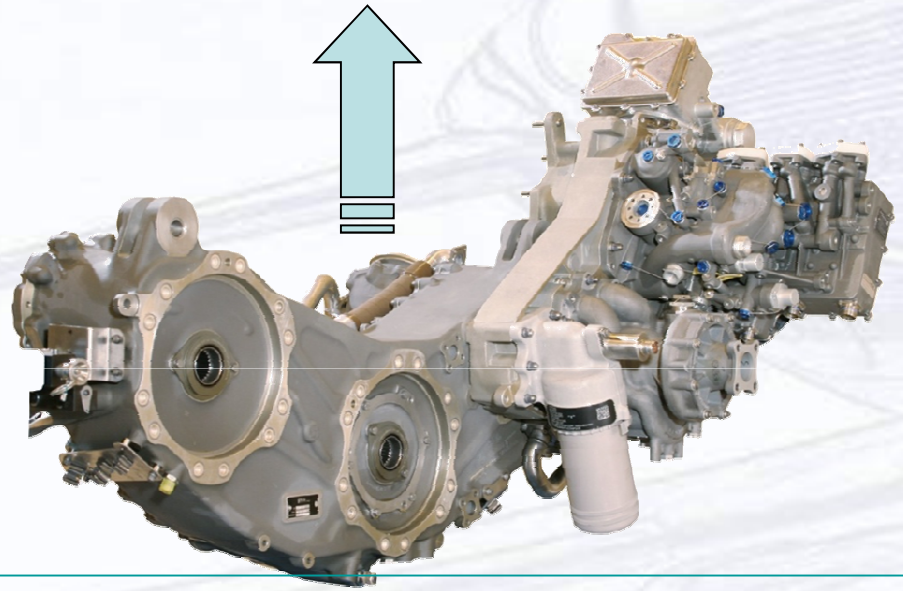
Network In Poland





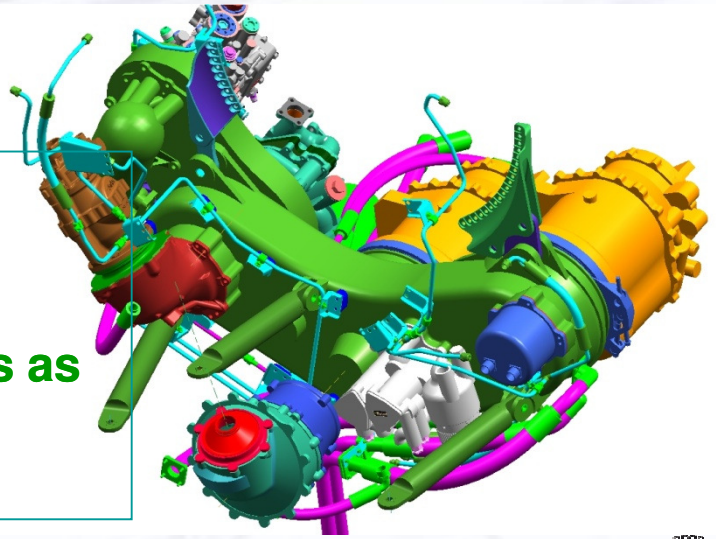
R&T Area of interest: Accessoy Gear Box

Effective step change on Gearbox cost: target -40% in 3 years



Areas to be investigated:

- Technologies
- Materials
- Special Processes



Approach:

- medium term results
- "cross fertilization" with existing technologies as an alternative and simplification to existing industrial processes ('quick-win')

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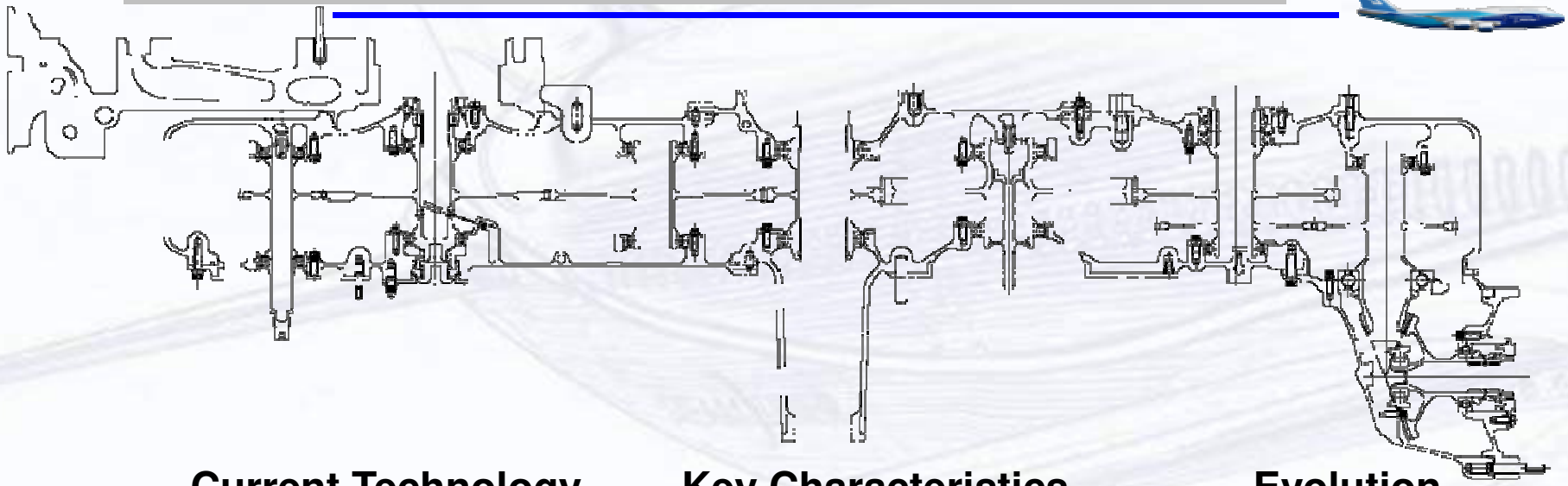
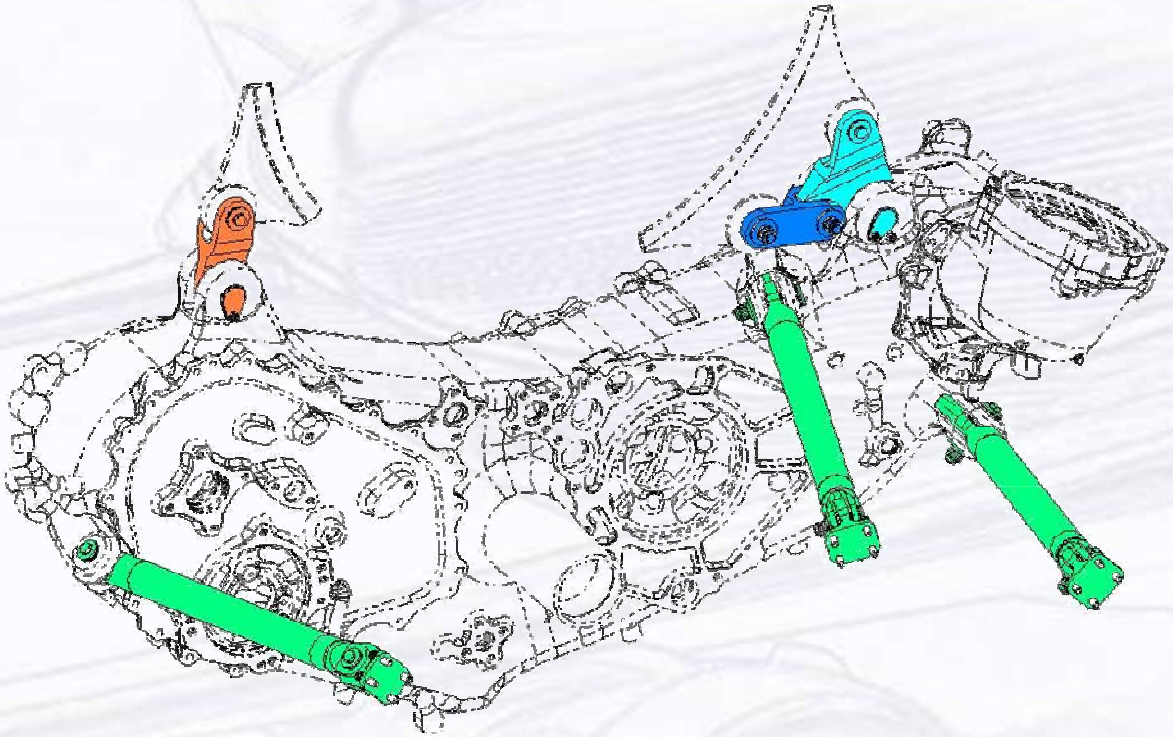
AVIO Gearbox Design Evolution Lines



	Current Technology	Key Characteristics	Evolution
Housings & Minor Parts	aluminium alloys cast or hog out	structural strength temperature & fire resistance	plastic/composite materials
Gears	100% carburized and ground AISI9310 steel	bending fatigue and surface wear resistance	gear technology adequate for gear use ↓ Cost Optimized Technology used everywhere stress levels are less challenging

AVIO Gearbox Design Evolution Lines



	Current Technology	Key Characteristics	Evolution
Links	High strength steels	structural strength fire resistance	composite materials

Accessories: Oil Pump Unit

- **Type of pump**: Volumetric rotor pump
- **Typical Configuration**:
  - several air/oil scavenge stages (4 -7) in parallel, all discharging flow into a Common Outlet
  - 1 lube supply stage
  - 1 Single external common input shaft
  - pumping elements can be distributed on one shaft or more shafts with internal gears
- **Input Shaft Speed**: 7000 rpm max @ 100 % engine speed
- **Range of Exctracted Power**: 25 HP max
- **Operating Fluid**: Lubricating Oil per MIL-L-23699, HTS class
- **Operating oil temperature**: -54°C to 180°C

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Thank you for the attention