P180 AVANTI EXPERIENCE

MAIN DESIGN DRIVERS:

- Low fuel consumption
- Maximum cabin room (stand-up cross section)
- Low cabin noise
- High cruise speed and flight altitude (jet-like)

P180 AVANTI II GENERAL SPECIFICATION

✈ MTOW	12050 lbs
✈ Payload	7 - 9 pax + 2 (1) pilots
✈ Max Operating Altitude	41000 ft
✈ Vmo/Mmo	260 KIAS / 0.70
✈ Max Cruise Speed	398 KTAS
✈ Max Range (LRC)	1507 nm. IFR res.
✈ Engines	2 PW&C PT6A66B (850 SHP)

P180 AVANTI: TIMELINE

- First wind tunnel test in 1979
- Program launched in 1981
- Gates Learjet joined in 1983 (withdrew in Jan. 1986)
- First flight Sept. 1986
- Certification March 1990
- First Delivery Sept. 1990
- Only 32 deliveries up to 1998

- Re-birth of Piaggio as *Piaggio Aero Industries S.p.A*. in November 1998 gave new light to the P180 program
- **104** P180 Avanti delivered up to present time

P180 AVANTI BREAKTHROUGHS

- Piaggio Patented 3-Lifting-Surfaces Aircraft Concept that revolutionized conventional twin turboprop design

- Fastest turboprop currently in service (Max Cruise=398 KTAS) and having the highest operational ceiling (41000ft)

- High Aspect Ratio (12) Natural Laminar Flow Wing (50%)

P180 AVANTI DIFFICULTIES

- Unconventional ***3-lifting-surface concept*** and ***natural laminar wing*** required extensive wind tunnel (WT) tests:

    – 100 hours of 2D pressurized high Mach and Reynolds WT tests at Ohio State University

    – 4000 hours of low speed WT tests at Piaggio and Wichita State University

    – 500 hours of transonic WT tests at Boeing- Seattle (1:7 model)

    – 100 hours of WT tests with aeroelastic 1:5.7 model at General Dynamics / Convair Division - San Diego

P180 AVANTI DIFFICULTIES

- Unconventional ***3-lifting-surface concept*** and ***natural laminar wing*** required an extensive certification tests campaign :
  - Numerous Special Conditions were necessary due to the unconventional 3LSC concept and laminar wing design
  - Stall adjustment incorporated in wing
  - 5000 flight hours hours were necessary to get the certification
  - Wing structural reinforcement incorporated in wing during structural tests (fatigue)

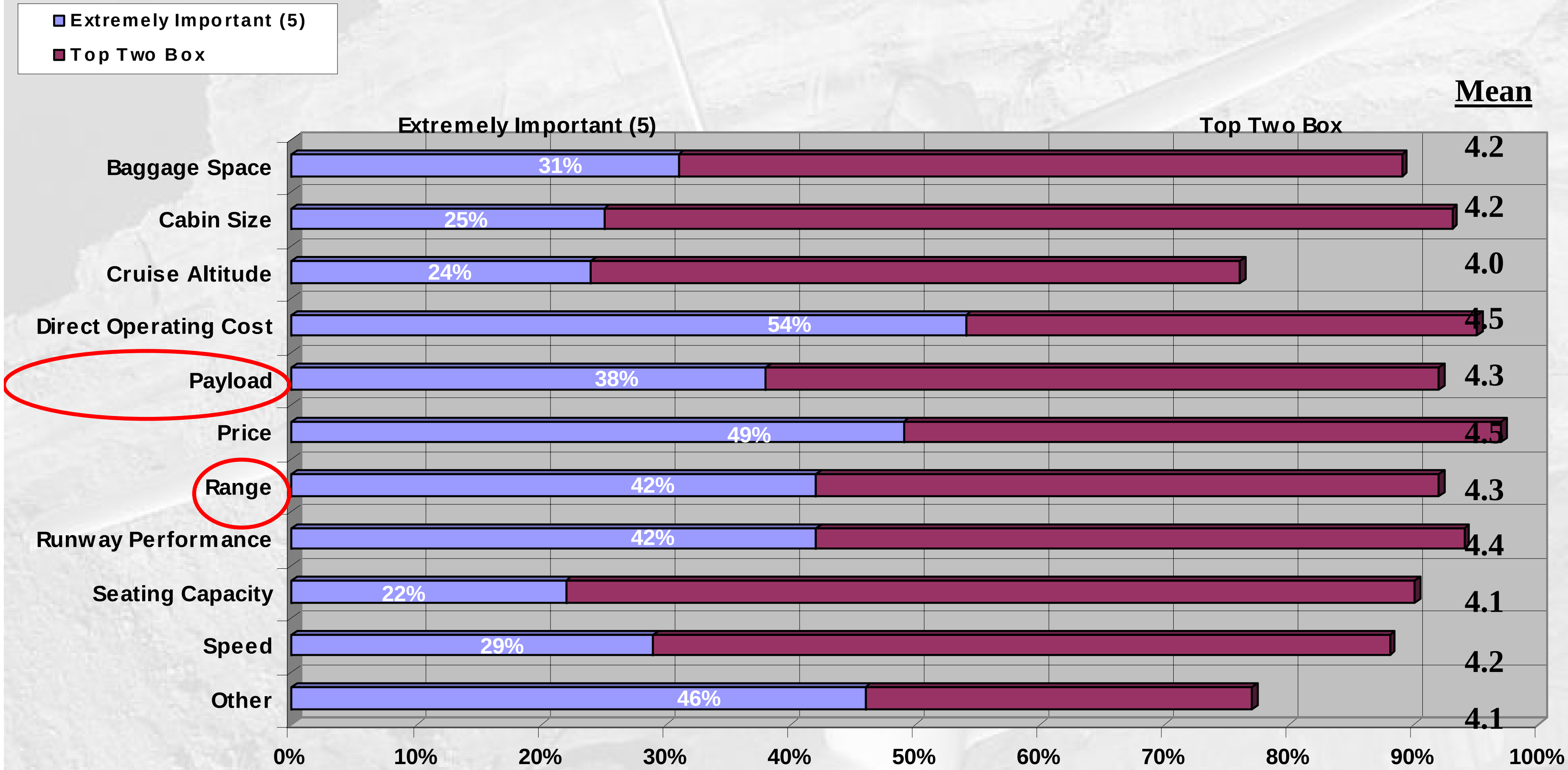
P180 AVANTI LESSON LEARNED

- Proper risk assessment is key. New aircraft concepts and technologies need to be thoroughly investigated well before the program go ahead.

- Knowing the market environment and having good timing is key when defining a research strategy, and A/C specs.

- Robust innovative concept can survive in the years through changing scenarios

CURRENT RESEARCH DRIVERS



PIAGGIO RESEARCH

- Piaggio Aero's Research Strategic Plan aims to a strong increase the competitiveness of current and future product.

- The key drivers to develop a technology readiness plan were selected looking to current and future needs of business aviation.

- Selected key drivers:
  - Reduce Manufacturing & Maintenance costs.
  - Improve Comfort and Safety.
  - Improve Environmental Impact.

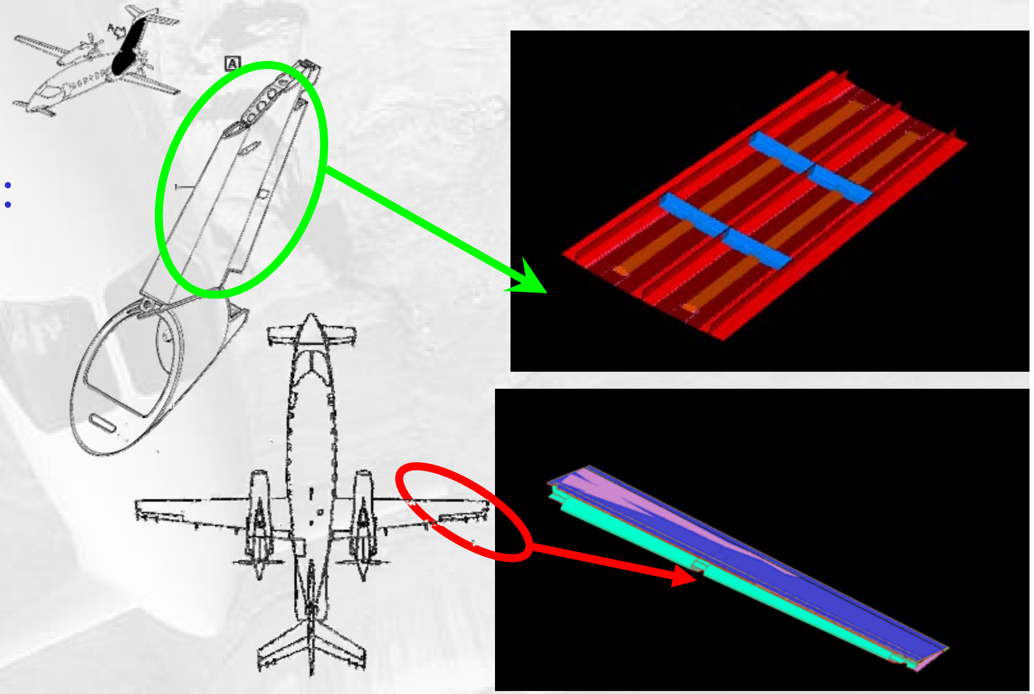
ADVANCED COMPOSITES Project

PIAGGIO AERO

- OBJECTIVES:
  - Development of innovative composite structures
  - Improvement of the Liquid Molding techniques

• 20% Weight Reduction
• 20% Cost Reduction
• 50% Design Time Reduction

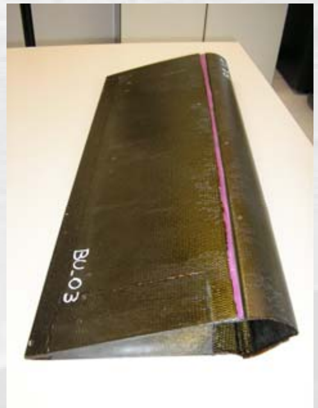
- IMPLEMENTATION PROCEDURE:
  - Use the P180's vertical stabilizer and aileron as reference to develop the Liquid Infusion and the RTM techniques structures respectively



ADVANCED COMPOSITES Project

PIAGGIO AERO

- SOME RESULTS:
  - Material properties database
  - Design and optimization of the moulds
  - Design and realization of reduced components to validate the technology



FRICTION STIR WELDING Project

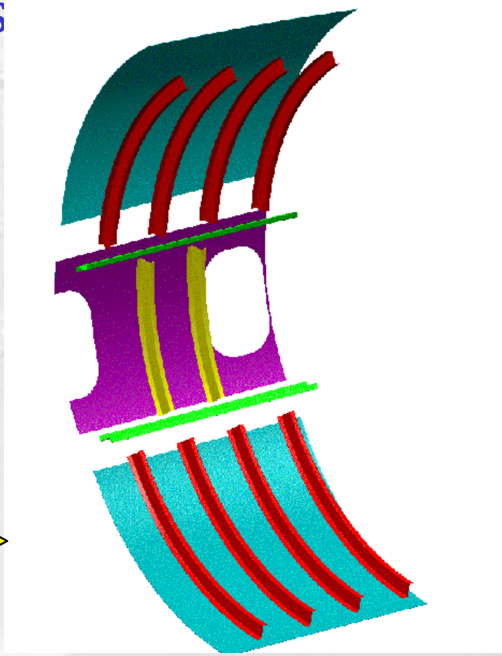
High structural integration

with drastic reduction of part numbers to allow:

WEIGHT REDUCTION → Reduced fuel consumption; Higher performances; Increased payload

COST REDUCTION → Easier assembling; Easier maintenance

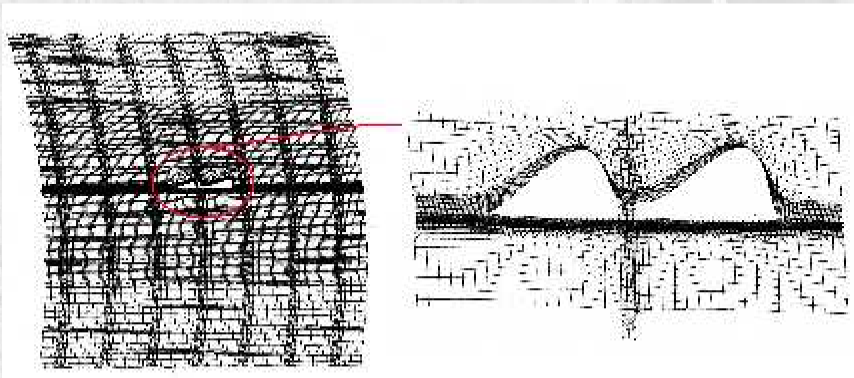
NEW DESIGN CONCEPT →

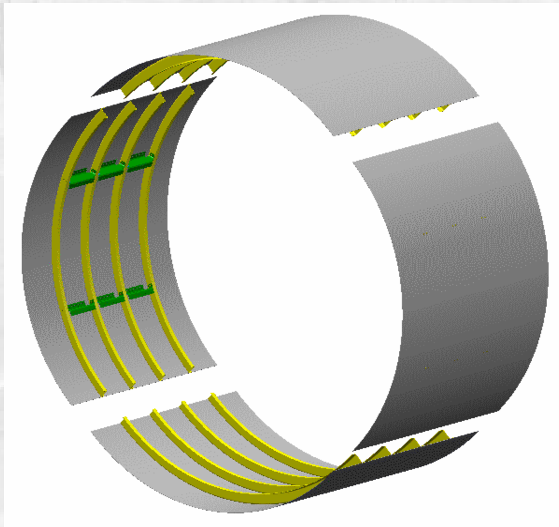


FRICTION STIR WELDING Project

- Built a Fuselage barrel to be tested under operative fatigue loads,
-
- Achieved results on the damage tolerance behavior of welded primary structures.

Crack propagation FEM simulation

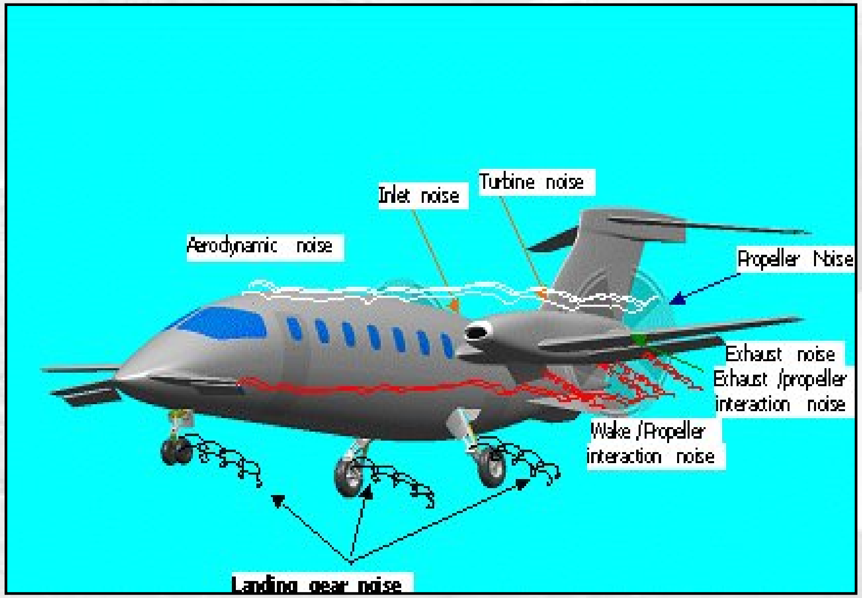


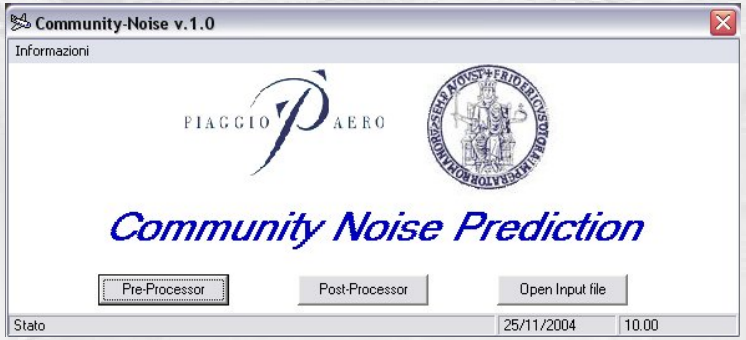


MINIMUM EXTERNAL NOISE Project

PHASE 1: Tools Development

Development of user friendly numerical Tools for prediction of noise components sources and estimating overall community noise

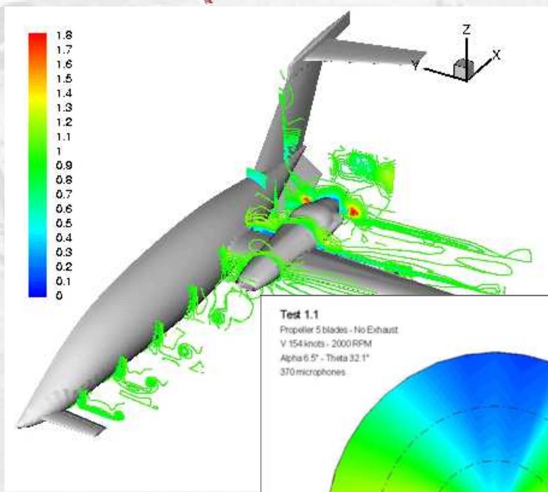


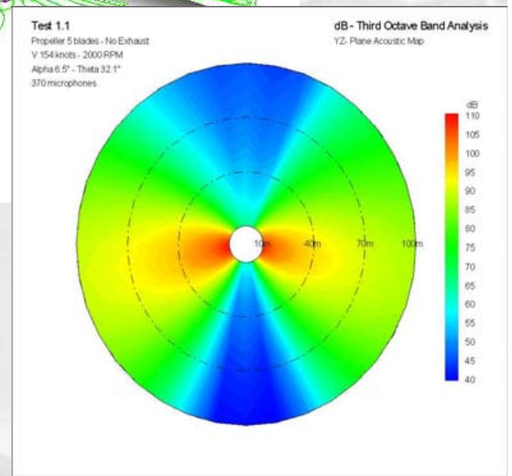


MINIMUM EXTERNAL NOISE Project

PHASE 2 : Computational aeroacoustics.

- Evaluation of aeroacoustic performance of pusher propeller
- Assessment of main noise sources
- Optimization of external noise
  - -forward speed
  - -propeller RPM
  - -engine exhaust position
  - -shape and number of propeller blades
  - -wake effect in installed configuration

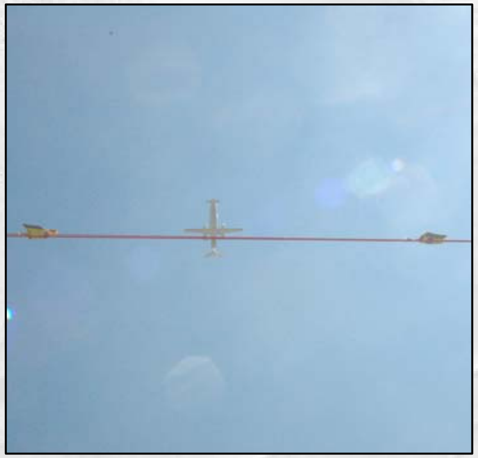


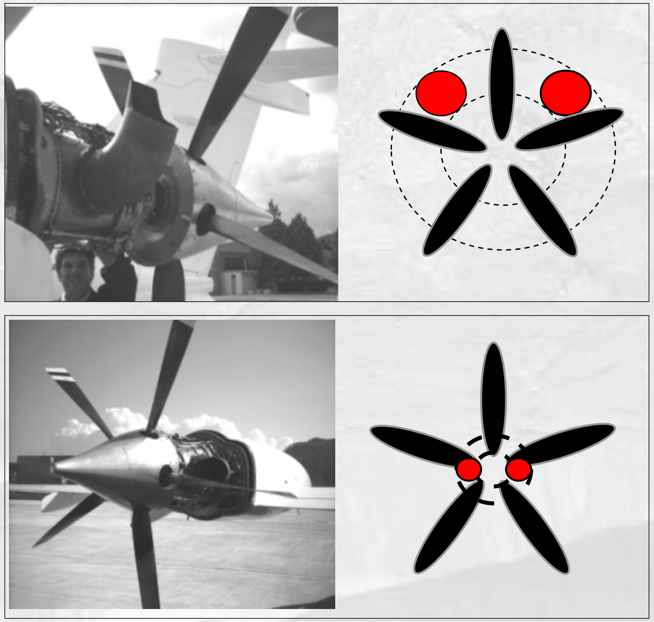


MINIMUM EXTERNAL NOISE Project

PHASE 3 : Ground and Flight Tests

- Better understanding of noise generation mechanics,
- Validation of theoretical noise prediction methods,
- Definition of best flight trajectories for noise reduction in take-off and landing





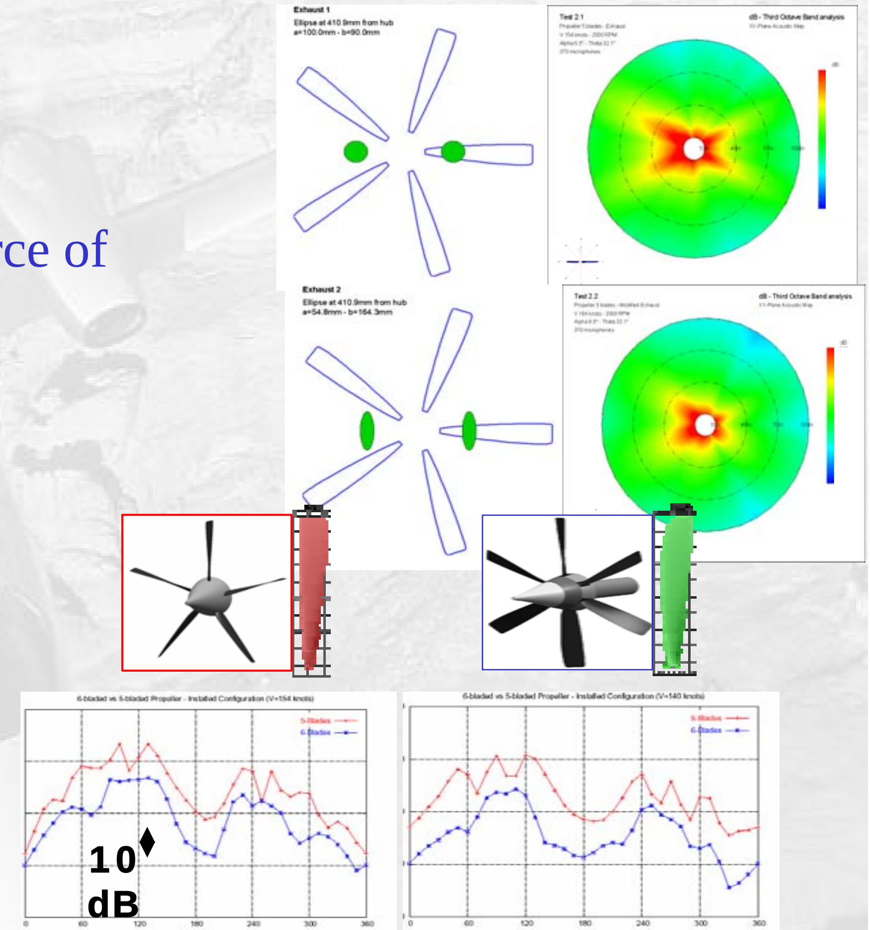
MINIMUM EXTERNAL NOISE Project

- MAIN RESULTS

– impingement of the engine exhaust in the propeller and the wings wake is a major source of external noise

– Increasing the number of blades from 5 to 6, reducing the propeller RPM

– Blade tip sweep has a lower impact

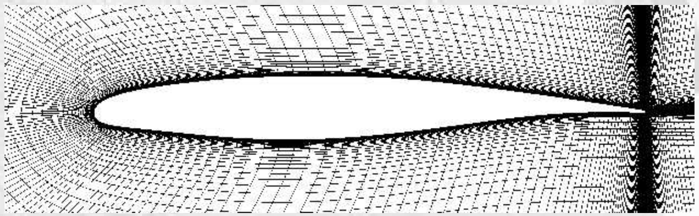


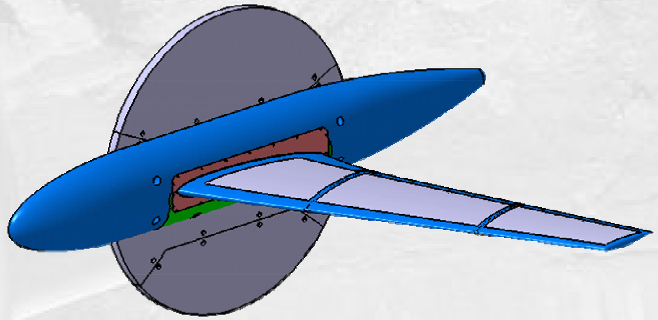
Average Noise Reduction 5.3 dB

Average Noise Reduction 7 dB

NATURAL LAMINAR WING Project

- OBJECTIVES:
  - Development of design & optimization methodologies and tools
  - 2D transonic NLF airfoil design and optimisation.
  - 3D wing design (target of 10% less drag than modern supercritical wings).





NATURAL LAMINAR WING Project

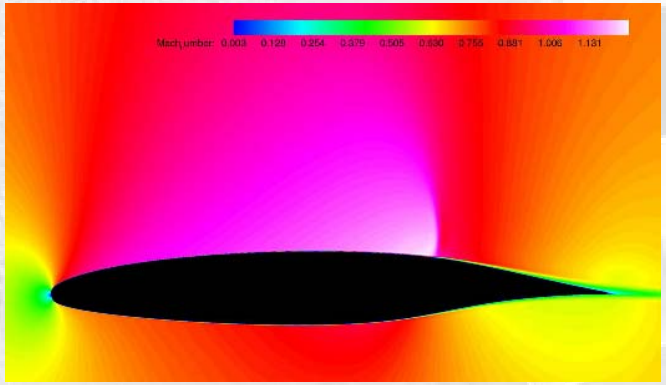
- IMPLEMENTATION PROCEDURE
  - Application of state of the art transition prediction methods,
  - numerical optimization tools, and innovative CFD methodologies for NLF airfoil design and optimization design
  - 2D transonic wind tunnel tests for validating numerical methods
  - 3D transonic laminar wind tunnel tests for validating numerical methods

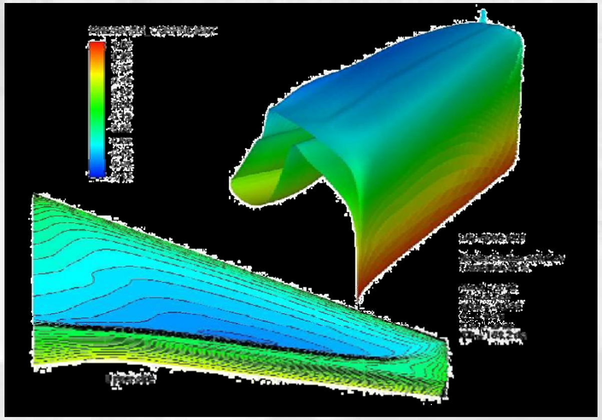
CIRA PT1

NATURAL LAMINAR WING Project

MAIN RESULTS:

- Integrated design and optimization tool for Transonic NLF Airfoil was developed
- 2D transonic wind tunnel tests validated the methods and tools used for transition prediction and airfoil optimization
- Design and optimization of a transonic NLF airfoil was succesfully conducted
- 3D wing HS wind tunnel tests in progress (Dec.2005)





A RECIPE FOR COMMERCIAL SUCCESS?

- Aiming at becoming the pioneer at many different fronts can be very messy…
- Proper risk management at the early stages of a program is essential.
- Commercially speaking, the early follower is in most cases more successful than the pioneer!
- In civil aviation evolution has being shown to be a wiser path compared to revolution given the importance of safety assurance.