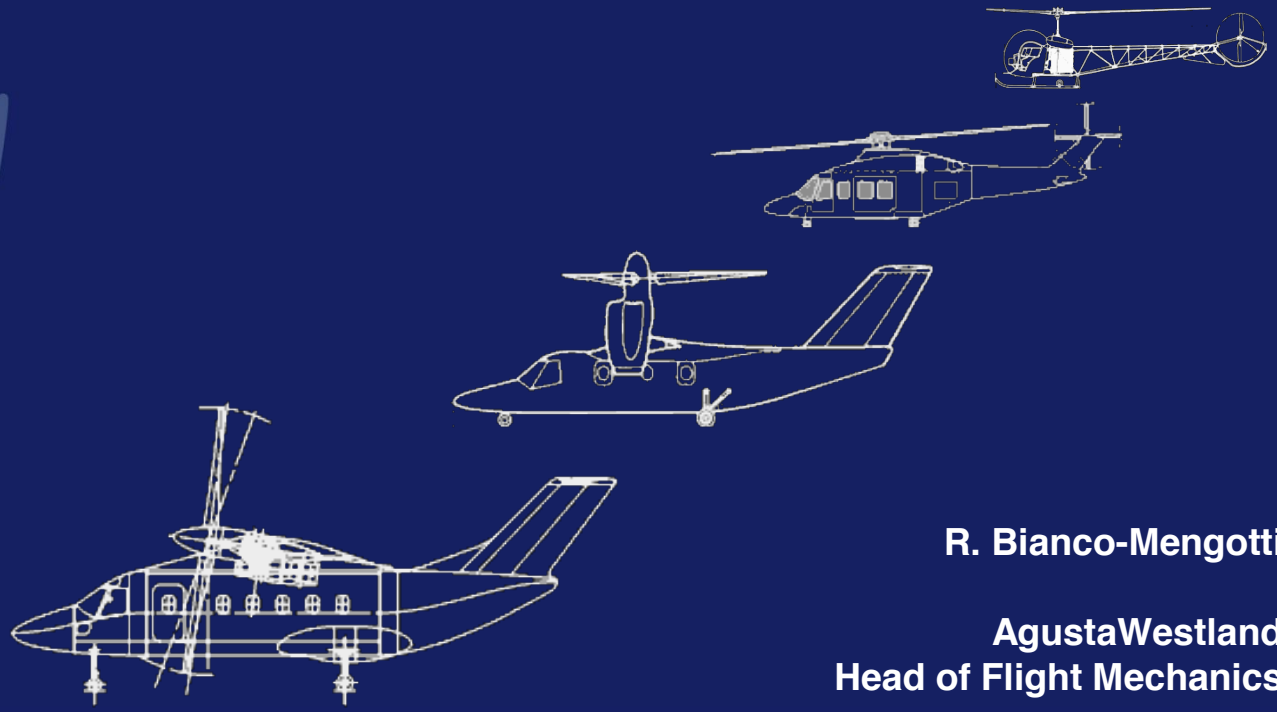
Technological Challenges for the Future of Rotary Wing

The AgustaWestland Path to the New Generation Tilt-rotor



R. Bianco-Mengotti

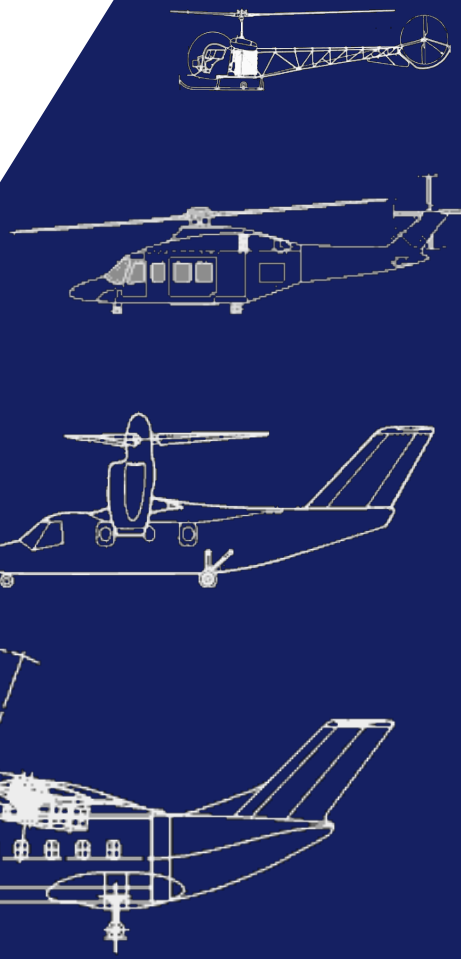
AgustaWestland
Head of Flight Mechanics

Centro Alti Studi per la Difesa
Rome, 22/11/2012

The AgustaWestland Path to the New Generation Tiltrotor

AgustaWestland
A Finmeccanica Company

- Helicopter Design Challenges
- The AgustaWestland answers
- The Advanced Helicopter
- The AW609 TiltRotor
- The New Generation Tiltrotor
- Conclusions



Why the Helicopter role is still invaluable

- Following a long series of attempts and more than 35 years after the first successful fixed wing flight, the helicopter found its stable configuration and become a product
- Today, after 75 years, the helicopter's unique capabilities are still unbeatable in a number of military and civil roles

COMMERCIAL

RESCUE & HELI-AMBULANCE
POLICE
CIVIL PATROL
LAND SURVEY
AERIAL WORK
ISOLATED SITE REFURBISHMENT
OIL & GAS PLATFORM SHUTTLE
POINT to POINT TRANSPORT
VIP / CORPORATE

MILITARY

ANTI-TANK
RECONNAISANCE
TROOP CARRIER
COMBAT SAR.
MARITIME (ASuW, ASW)
PARA-MILITARY ROLES

Why the Helicopter role is still invaluable

Where low speed capabilities are essential, the helicopter as we know it is still the best solution, in particular:

THE MOST EFFICIENT, thanks to the physics of low disk loading

THE SAFEST, thanks to OEI and autorotation capabilities

THE HIGHEST-PAYLOAD CARRIERS, thanks to efficiency and low empty weight

MOST MANOEUVRABLE AND AGILE, using thrust for control power

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A Finmeccanica Company

Why the Helicopter role is still invaluable

Safe, fast and efficient off-shore transport

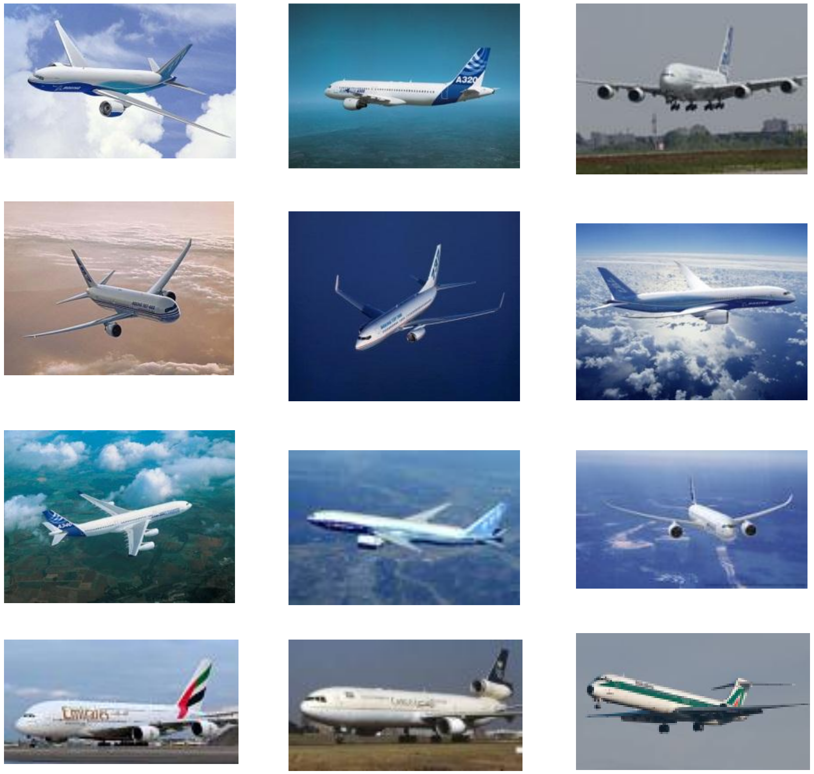
The only way to support and access pipelines, electro-ducts, remote sites

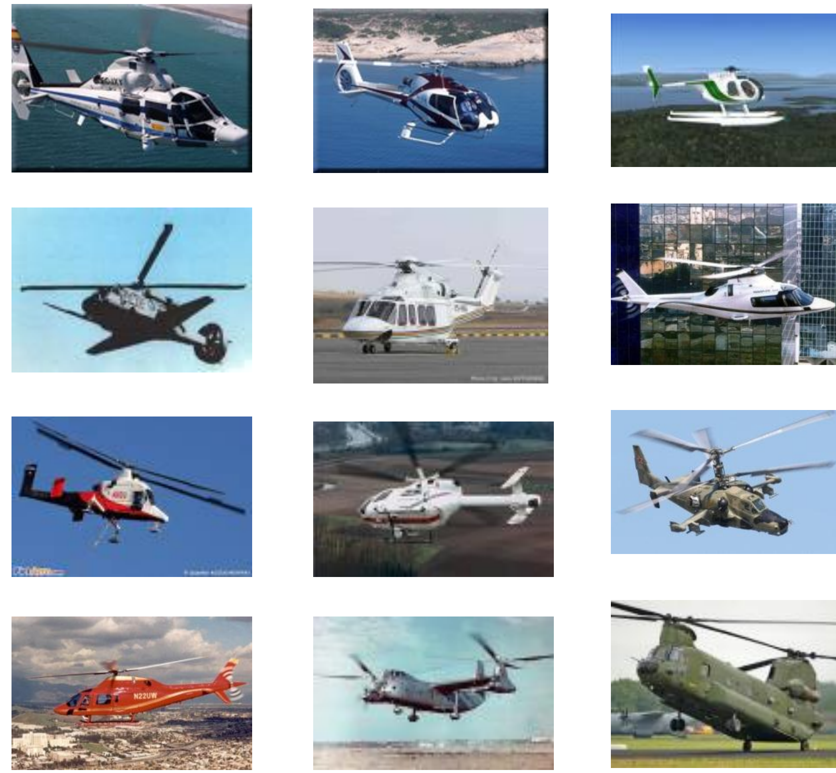
EMS services on time, fast and everywhere

Fast and reliable point to point connection

Civil and military fast sea & land SAR ops

Helicopter: the Design of a young machine





AIRPLANE CONFIGURATION DESIGN

- ROLE BASED, VERY OPTIMIZED AND STABLE CONFIGURATION
- ALMOST MANUFACTURER INDEPENDENT: INDEX OF A VERY CONSOLIDATED DEVELOPMENT

HELICOPTER CONFIGURATION DESIGN

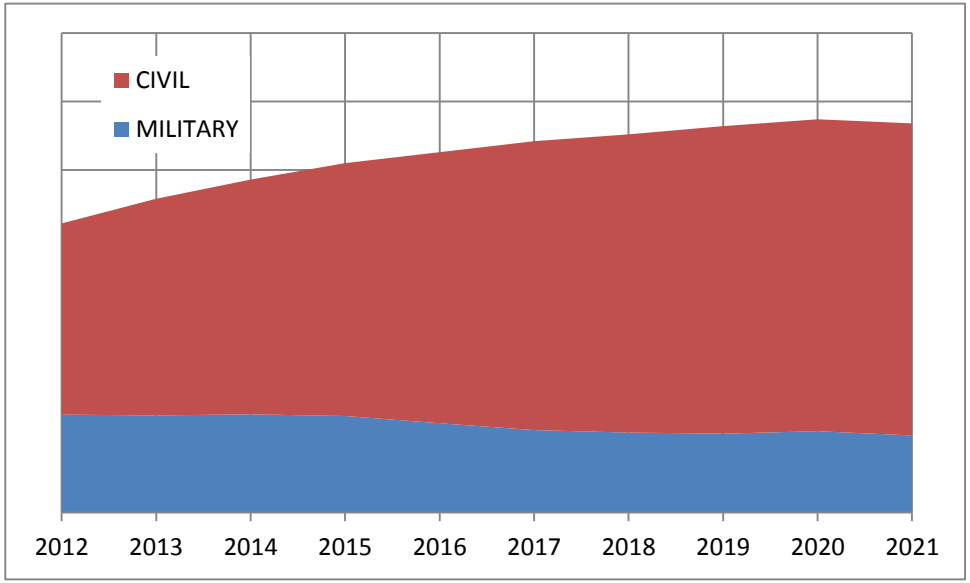
- MANUFACTURER PECULIAR CONFIGURATION
- SPECIFIC ROLES DICTATE CONFIGURATIONS
- DEVELOPMENT MATURITY STILL ON-GOING

DESIGN A NEW HELICOPTER IS STILL A HIGHLY “*CREATIVE*” CHALLENGE

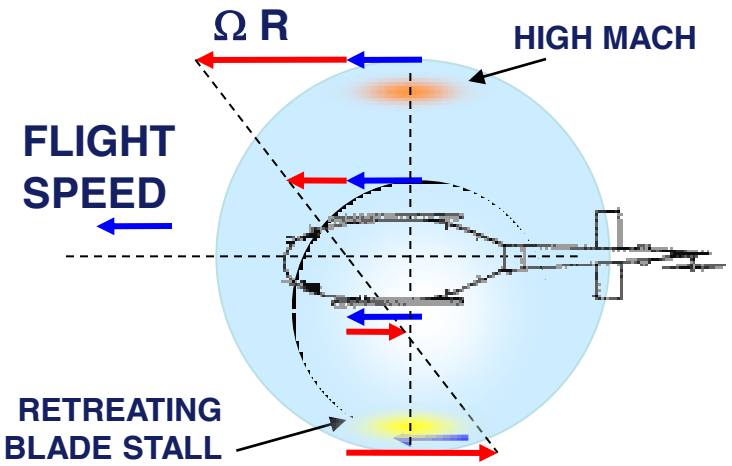
The Market Perspective

INCREASING DEMAND :

- ✓ Transport of people and materials
- ✓ Point to point (VIP, corporate…)
- ✓ Offshore (Oil rigs support)
- ✓ Short range transport
- ✓ Search & Rescue
- ✓ Military air mobility
- ✓ Security / Patrolling

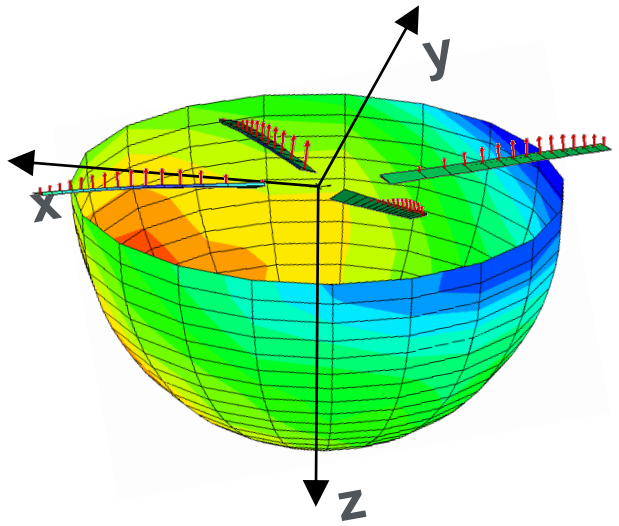


The Helicopter Limitations



- ✓ productivity
  - ➢ Not all weather
  - ➢ Low Speed / Range
  - ➢ High operating costs

- ✓ Environmental impact
  - ➢ Noise
  - ➢ Pollution
- ✓ Public acceptance / Comfort
- ✓ Maturity of rules in the ATM



The AgustaWestland Path to the New Generation Tiltrotor

AgustaWestland
A Finmeccanica Company

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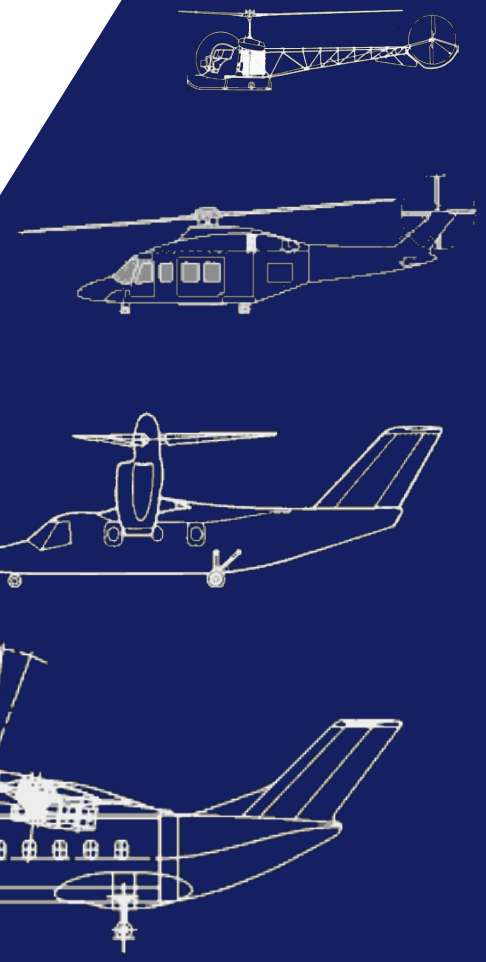

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Seeking for answers: new formulas

We are facing a crucial point in rotorcraft history: today several solutions are considered by industry to increase rotorcraft performance and capability.

- **AW609 - tiltrotor formula: lift produced by rotors in H/C mode and wing in A/C mode, propulsion produced by rotors, yaw control by rotors. No anti-torque required**

- **Sikorsky X2 - coax-compound: lift produced by rotor, propulsion produced by propeller, yaw control by rotors. No anti-torque required**

- **Eurocopter X3 - compound: lift produced by rotor and wing, propulsion by propellers, yaw control and MR torque reaction through the propellers**

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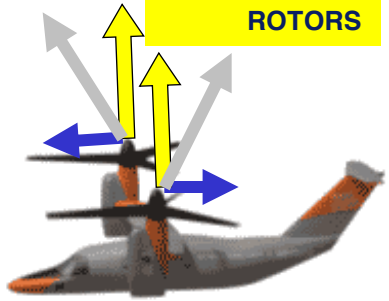
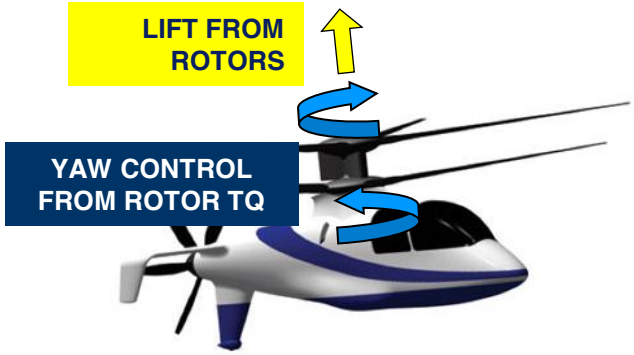
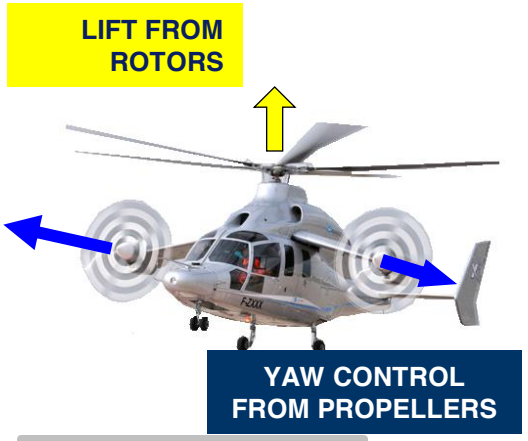
Seeking for answers: new formulas

HOVER

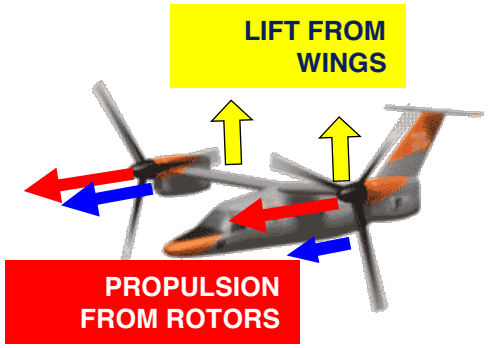


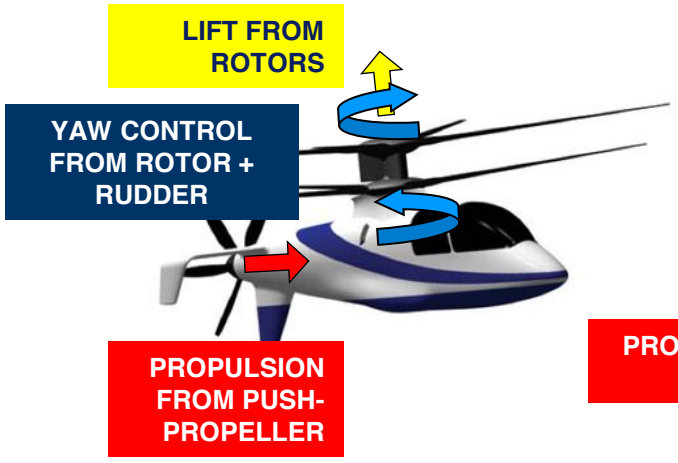


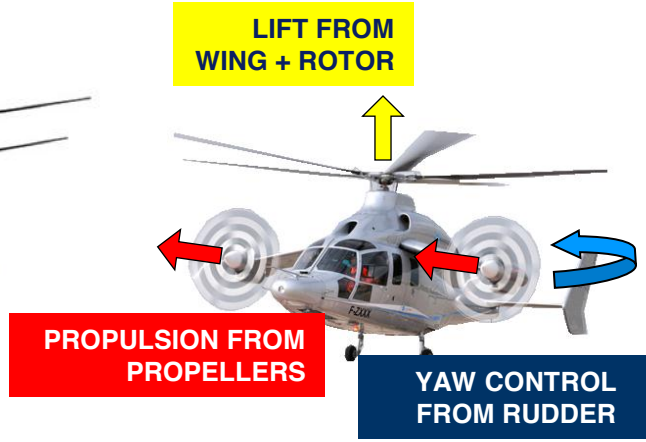


AW609 | **X2** | **X3**

CRUISE







The AgustaWestland vertical lift vision

Hovering & low speed

THE TWO AVENUES in AgustaWestland Evolution

ADVANCED HELICOPTER
- All Weather
- Low Workload
- More speed and range
- More comfortable
- Quieter
- Low pollution
- Crashworthy

TILTROTOR
- Breakthrough Technologies
- High productivity
- High speed
- Long range
- High versatility

High Speed & Range

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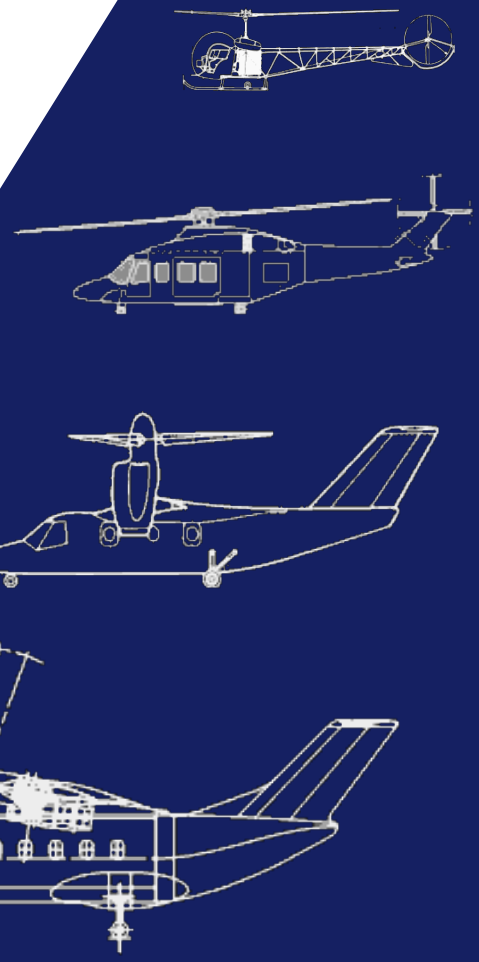

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The Industry Challenge

MARKET REQUIREMENTS

- Productivity
- Availability
- Versatility
- Comfort
- Low Noise

FAR / CS… Regulations

Company "Final Product" Aim

Contain Time to Market

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The Advanced Helicopter

Operational capability

- Handling qualities (under various conditions)
- All weather helicopter
- Multirole platforms

Riding qualities

- Comfort
- Low Vibes for different users in one helo (VVIP/SAR/utility)

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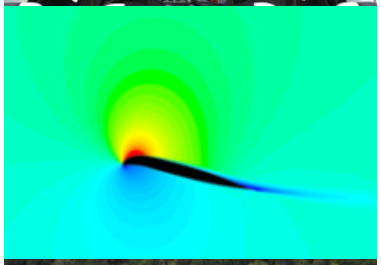
The Advanced Helicopter



Enabling Technologies

- Adaptive rotor speed
- Active controls
- Electrical systems
- Advanced integrated avionics
- Internal Noise passive / active abatement technologies
- Family philosophy

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A long way to the AW609 TiltRotor

Need to expand Helicopter performance since the Fifties

1955

1973

1989

1993

Tiltrotor was one of the few successful formulas experimented in the ’50s-’70s

Bell (and Boeing) pursued the Tiltrotor concept, successfully flying four machines before launching the BA609, first commercial Tiltrotor

1998 Bell and Agusta partner for the BA609 development

2003 First BA609 flight

2011 BA609 becomes AgustaWestland AW609

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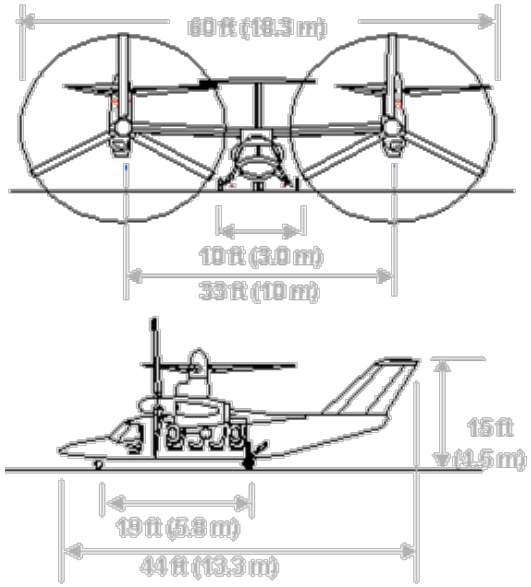
The AW609 Main Characteristics



- MTOW: 7630 kg (8180 kg STOL)
- Useful Load: 2,500 kg (3050 Kg STOL)
- Engines: 2 x PT6C-67A (1,940 shp)
- Accommodation: 2 pilots + 9 pax (std. config)
- Max cruise speed: 275 ktas
- HOGE ISA 5,000 ft
- HIGE ISA 10,000 ft
- Ceiling 25,000 ft

- A versatile platform combining the best characteristics of helicopters and turboprop aircrafts
- Twice the speed and range of conventional helicopters
- Pressurized Cabin
- State-of-the-Art Avionics Technology

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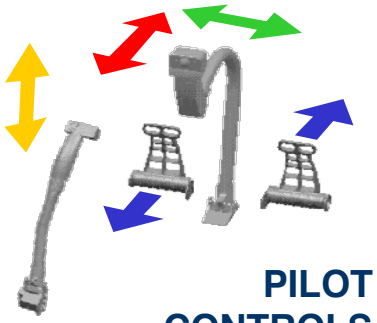
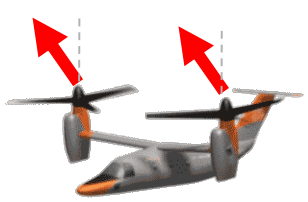
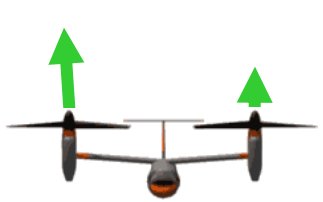
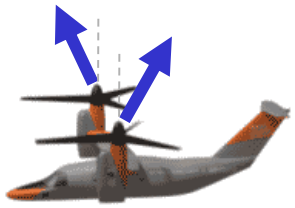
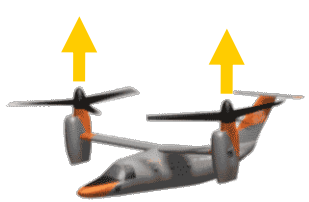
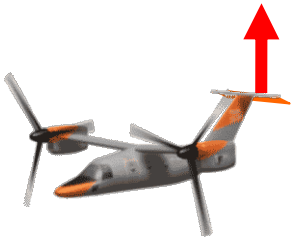
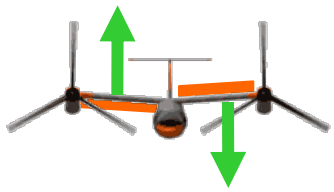
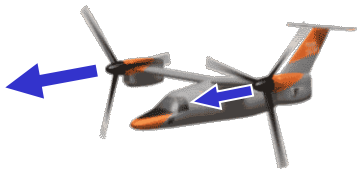
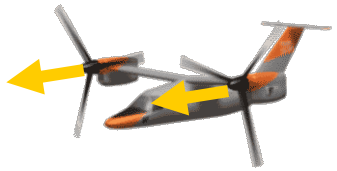
The AW609 Morphing Flight Controls



PILOT CONTROLS

Conventional controls creating typical aircraft behaviors by different aeromechanic means

Transparent control phasing with nacelle angle

	PITCH	ROLL	YAW	THRUST
HELICOPTER				
AIRPLANE				

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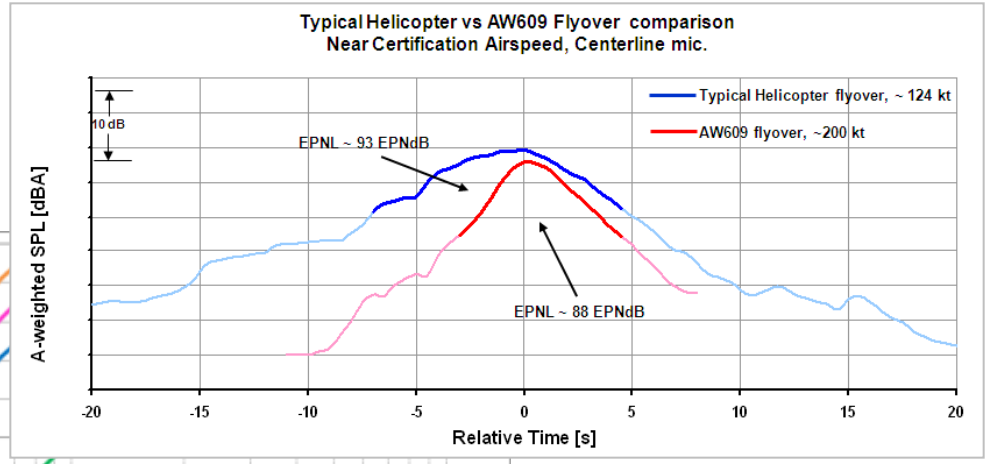
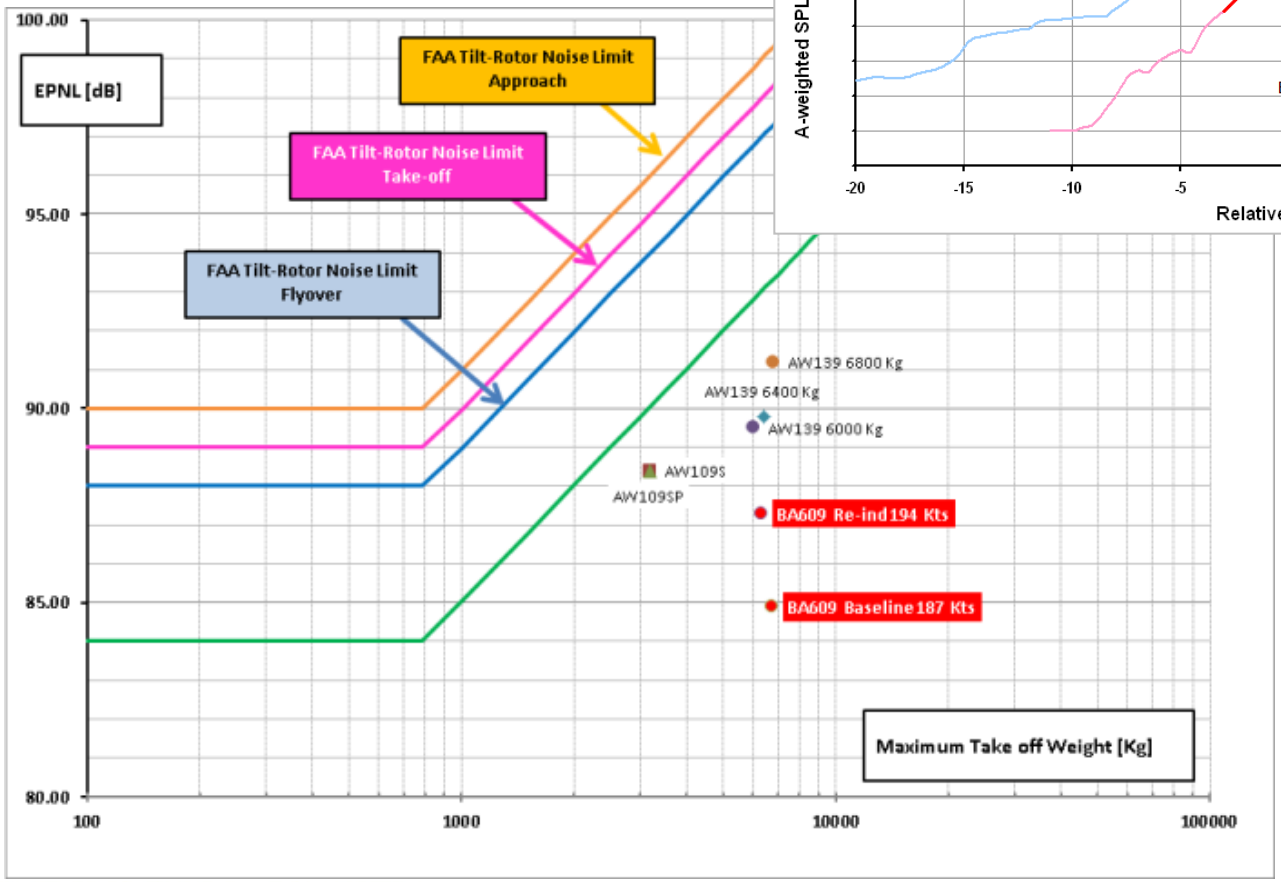
The AW609: low noise emissions

- Low Noise
- Short Exposure Time





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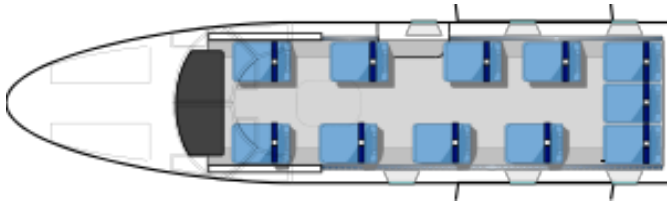
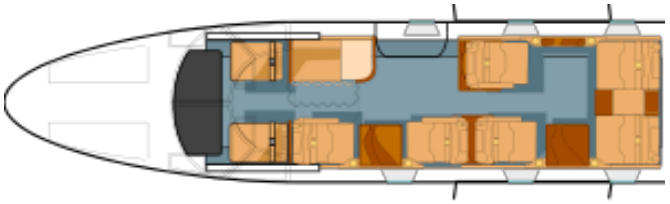
The AW609: typical Configurations

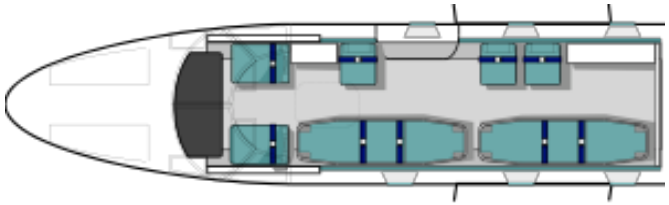
Standard: 9 seats



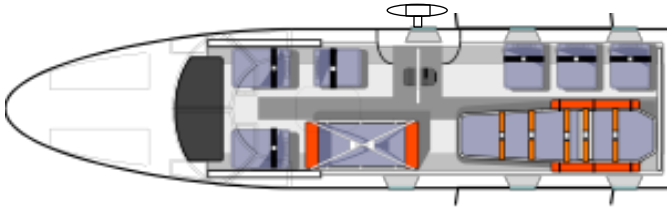
VIP/Corporate: 6-7 seats



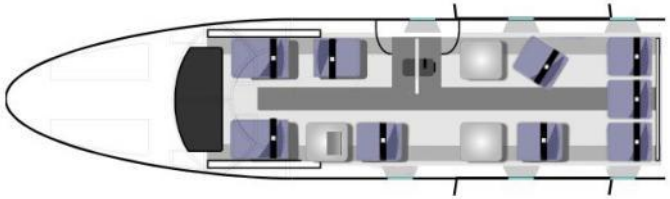
Air Medical



Search and Rescue



Patrolling



Cabin versatility for multiple applications

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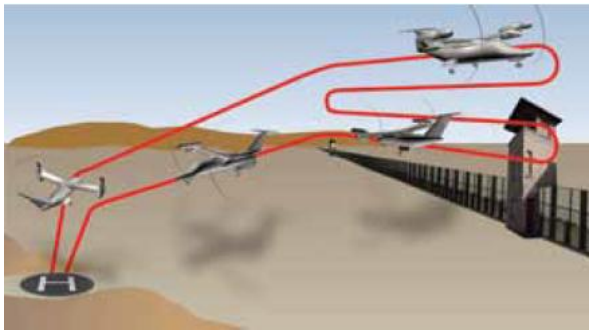
A Finmeccanica Company

The AW609: typical Roles

Offshore Passenger Transport (2 + 9 pax.)

Search and Rescue

Homeland Security



Air Medical

Corporate / VIP (2 + 4 pax.)

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The AW609: a First in Aviation

- **FIRST** Multi-role Certifiable Tiltrotor
- **FIRST** New Category to be certified since 1946
- **FIRST** Full-FBW GA aircraft
- **FIRST** pressurized rotorcraft to be certified

Cat.A (OEI) safety standard
Ice Protection
Triplex full FBW FCS
Rudderless yaw control
Low noise / Smooth ride
Rotors Connected for OEI
Triplex Full Fly-By-Wire FCS
Rudderless Yaw Control
Level 1 Handling Qualities
Autorotation Demonstrated

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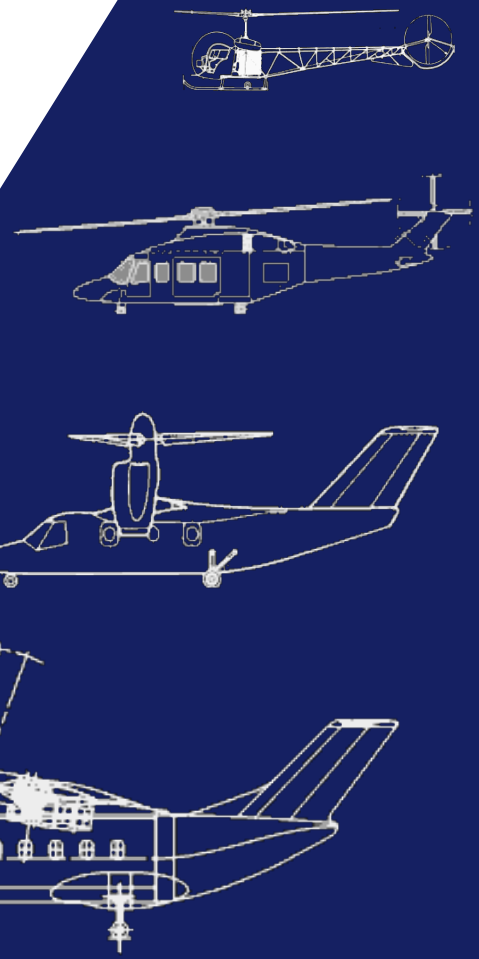

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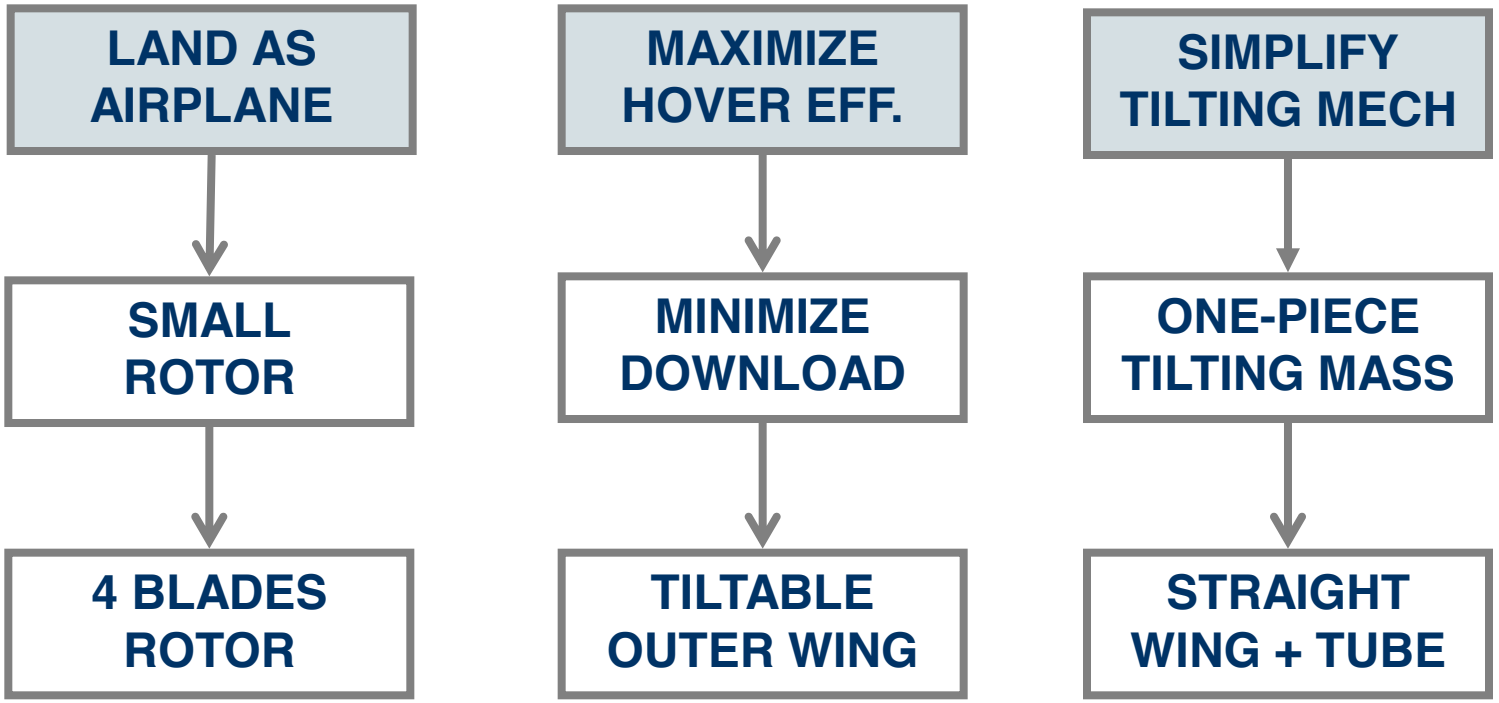
The next Challenges

Need to further improve tiltrotor capabilities and efficiency

Possibility to exploit new concepts and improved technologies

Opportunity for Europe to fill technology gap



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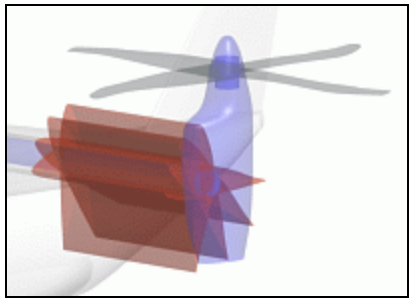
The ERICA Concept

MTOW	11 tons
PAX	19/22
Vmax	330 Ktas

4-blades
advanced rotor

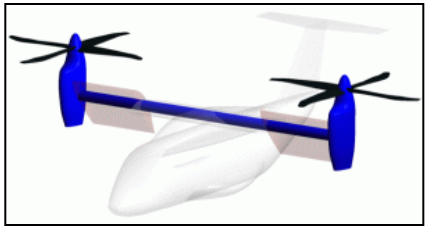
Pressurized
cabin

Independent
Tiltable wing



Fly-by-wire
controls

Continuity of the
tilting mass



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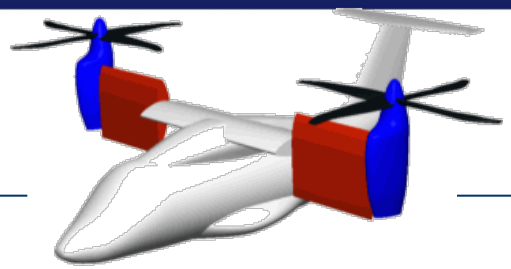
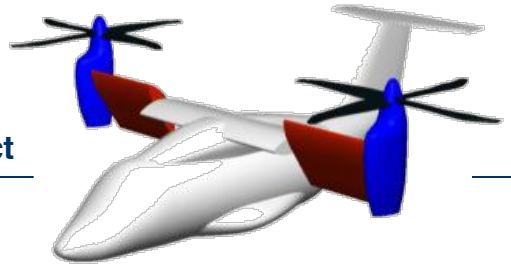
The ERICA Concept

Minimize the rotor download by tilting the wing 90 deg



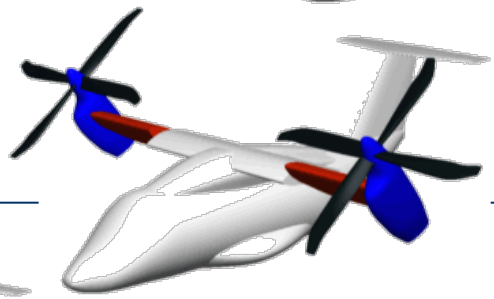
Hover

Start tilting the wing to avoid barn door effect

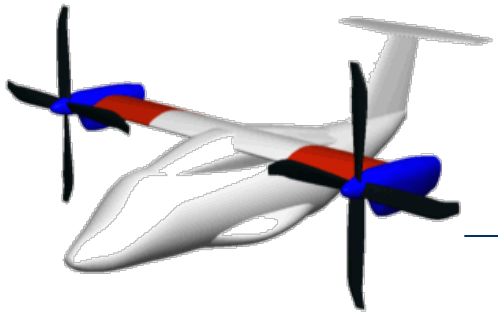


Low Speed

Adapt the wing to attain best AoA



Conversion



Cruise

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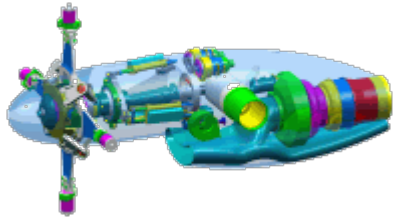
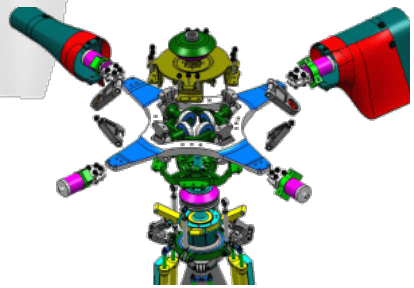
The ERICA Project

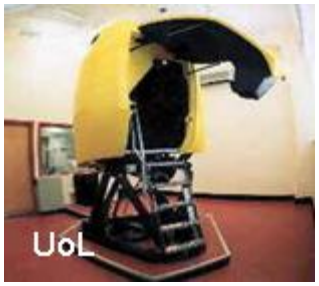
Erica project: 2000-2005
5 Critical Technology Projects concerning key aspects of the ERICA concept



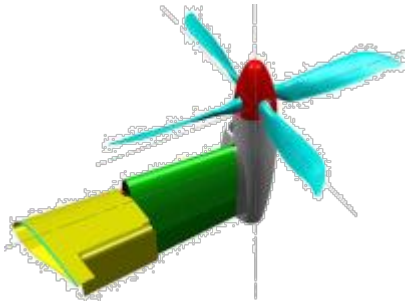
TRISYD
DRIVE SYSTEM &
TILTING MECHANISMS



DART
ADVANCED ROTOR
FOR TILT ROTOR



ACT_TILT
CONTROL SYSTEM
FOR TILT ROTOR



TILTAERO
INTERACTIONAL
AERODYNAMICS

ADYN
DYNAMICS
AND NOISE

AgustaWestland
A Finmeccanica Company

The NICETRIP Project

Nicetrip: 2006-2013

Integration of the technologies

Improvement of the design

ERICA PLATFORM

GENERAL ARCHITECTURE

FULL SCALE TESTING

DETAIL DESIGN OF THE CRITICAL COMPONENTS

TILTROTOR IN ATM

WIND TUNNEL SCALED TESTS

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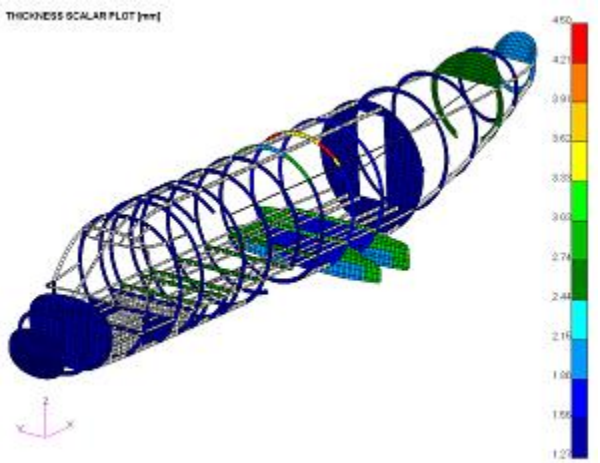
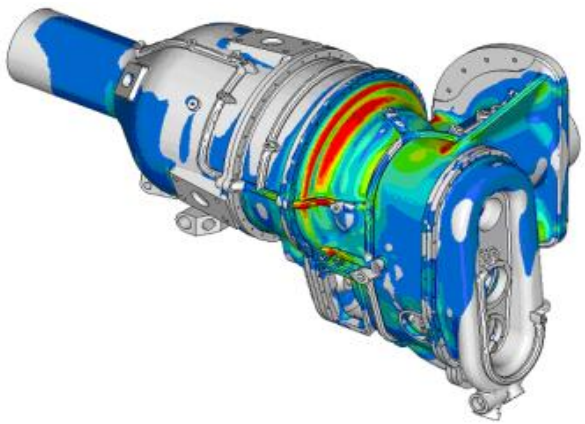
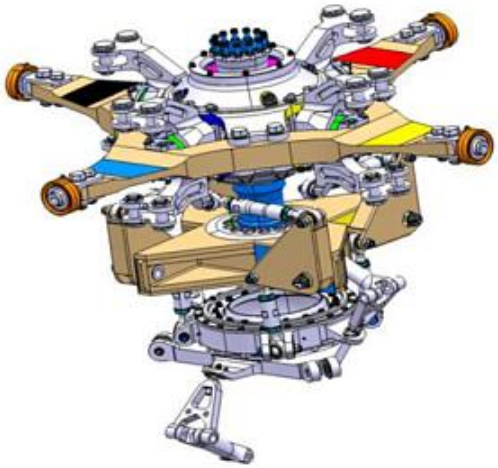
The NICETRIP Project

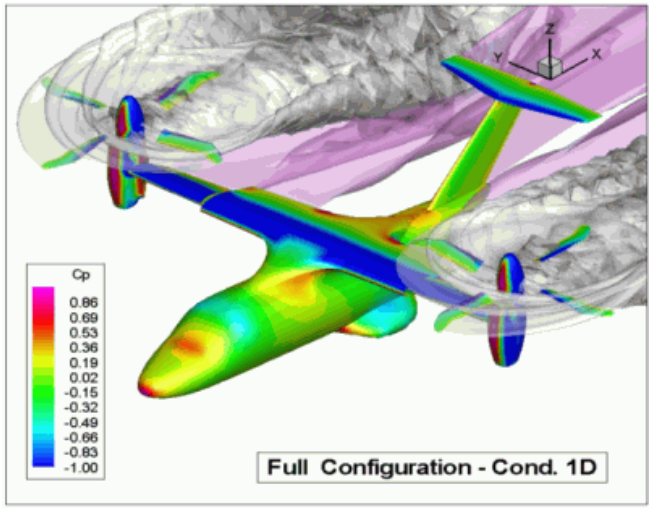
NICETRIP project

Studies and analytical results covering: aerodynamics, structures, hub design, dynamics, drive system etc.









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The NICETRIP Project

NICETRIP project

Experimental testing validating critical aspetcs

Air intake model test

1:5 Powered model wind tunnel test

Whirl tower full scale test

Drive system functional test

Force model wind tunnel test

Real time simulation

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A Finmeccanica Company

The New Generation Tiltrotor - Cleansky II project

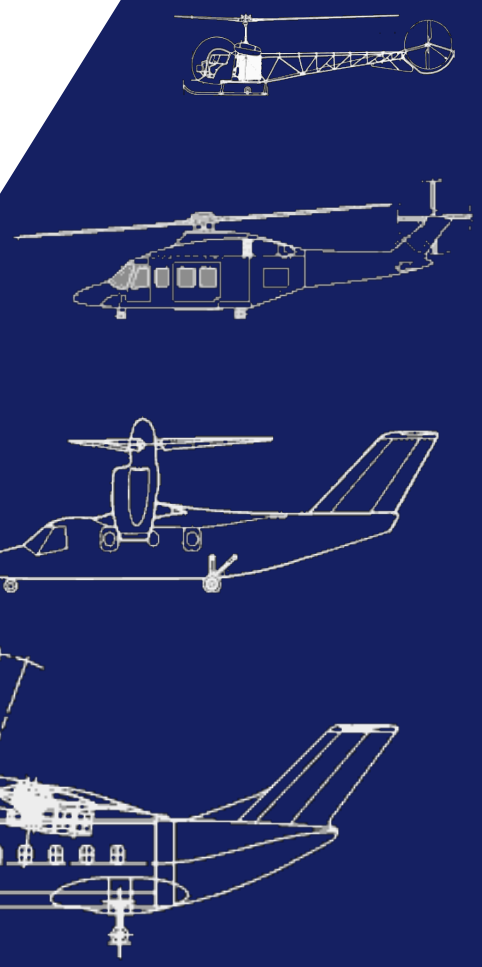
- Exploiting the ERICA design
- Starting tiltrotor family concept
- Demo aircraft by 2020
- Product after few years

- Development lead by AgustaWestland partly under the CSKY2 JTI umbrella
- AgustaWestland coordinator of a team of OEM / suppliers / research institutions in Europe
- Drivers: design to weight/cost, green contents, low noise, new materials and technologies

The AgustaWestland Path to the New Generation Tiltrotor

AgustaWestland
A Finmeccanica Company

- Helicopter Design Challenges
- The AgustaWestland answers
- The Advanced Helicopter
- The AW609 TiltRotor
- The New Generation Tiltrotor
- Conclusions



The AgustaWestland Path to the New Generation Tiltrotor

AgustaWestland
A Finmeccanica Company

- Helicopter is unbeatable for hover and low speed but has limitations with speed, altitude and range
- Today AgustaWestland is pursuing two ways to cover market needs
- The advanced helicopter, represented by the first AgustaWestland product “family” (AW169 – AW139 – AW189)
- The Tiltrotor: the AW609, nearing certification, and the ERICA/NICETRIP tiltrotor projects, paving the way for the next tiltrotor generation

Thanks for your attention

Questions?

Technological Challenges for the Future of Rotary Wing

The AgustaWestland Path to the New Generation Tiltrotor

R. Bianco-Mengotti

AgustaWestland
Head of Flight Mechanics