Technological Challenges for the Future of Rotary Wing

The AgustaWestland Path to the New Generation Tilt-rotor

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The AgustaWestland Path to the New Generation Tiltrotor

- 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 became 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
- RECONNAISSANCE
- 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
The AgustaWestland Path to the New Generation TiltRotor

Why the Helicopter role is still invaluable

- Safe, fast and efficient off-shore transport
- The only way to support and access pipelines, electroducts, remote sites
- Fast and reliable point to point connection
- Civil and military fast sea & land SAR ops
- EMS services on time, fast and everywhere

Heading for Continuous Success
The AgustaWestland Path to the New Generation TiltRotor

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 AgustaWestland Path to the New Generation TiltRotor

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
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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.
The AgustaWestland Path to the New Generation TiltRotor

Seeking for answers: new formulas

AW609

LIFT FROM ROTORS
YAW CONTROL FROM DIFFERENTIAL CYCLIC
LIFT FROM WINGS
PROPULSION FROM ROTORS
YAW CONTROL FROM DIFFERENTIAL THRUST

X2

LIFT FROM ROTORS
YAW CONTROL FROM ROTOR TQ
LIFT FROM ROTORS
YAW CONTROL FROM RUDDER
PROPULSION FROM PUSH-PROPELLER

X3

LIFT FROM ROTORS
YAW CONTROL FROM PROPELLERS
LIFT FROM WING + ROTOR
PROPULSION FROM PROPELLERS
YAW CONTROL FROM RUDDER

Heading for Continuous Success
The AgustaWestland vertical lift vision

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

Hovering & low speed
High Speed & Range
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The Industry Challenge

- Productivity
- Availability
- Versatility
- Comfort
- Low Noise

Company “Final Product” Aim

- Contains Time to Market
- FAR / CS... Regulations

MARKET REQUIREMENTS
Riding qualities

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

Operational capability

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

Bell and Agusta partner for the BA609 development

First BA609 flight

BA609 becomes AgustaWestland AW609
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
The AW609 Morphing Flight Controls

Conventional controls creating typical aircraft behaviors by different aeromechanic means

Transparent control phasing with nacelle angle

HELICOPTER

PILOT CONTROLS

PITCH
ROLL
YAW
THRUST

AIRPLANE

Technological Challenges for the Future of Rotary Wing

Heading for Continuous Success
The AW609: low noise emissions

- Low Noise
- Short Exposure Time
The AW609: typical Configurations

- **Standard:** 9 seats
- **VIP/Corporate:** 6-7 seats
- **Air Medical**
- **Search and Rescue**
- **Patrolling**

Cabin versatility for multiple applications
The AW609: typical Roles

- Offshore Passenger Transport (2 + 9 pax.)
- Search and Rescue
- Homeland Security
- Air Medical
- Corporate / VIP (2 + 4 pax.)
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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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

- LAND AS AIRPLANE
  - SMALL ROTOR
  - 4 BLADES ROTOR

- MAXIMIZE HOVER EFF.
  - MINIMIZE DOWNLOAD
  - TILTABLE OUTER WING

- SIMPLIFY TILTING MECH
  - ONE-PIECE TILTING MASS
  - STRAIGHT WING + TUBE
The ERICA Concept

- 4-blades advanced rotor
- Independent Tiltable wing
- Pressurized cabin
- Fly-by-wire controls
- Continuity of the tilting mass

Technical Specifications:
- MTOW: 11 tons
- PAX: 19/22
- Vmax: 330 Ktas
Technological Challenges for the Future of Rotary Wing

The ERICA Concept

Minimize the rotor download by tilting the wing 90 deg

Start tilting the wing to avoid barn door effect

Adapt the wing to attain best AoA

Hover

Low Speed

Conversion

Cruise

Heading for Continuous Success
The ERICA Project

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

- TRISYD DRIV SYSTEM & TILTING MECHANISMS
- DART ADVANCED ROTOR FOR TILT ROTOR
- ACT_TILT CONTROL SYSTEM FOR TILT ROTOR
- TILTAERO INTERACTIONAL AERODYNAMICS
- ADYN DYNAMICS AND NOISE
The NICETRIP Project

Nicetrip: 2006-2013
Integration of the technologies
Improvement of the design
The NICETRIP Project

NICETRIP project

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

Experimental testing validating critical aspects

- **Whirl tower full scale test**
- **Drive system functional test**
- **Air intake model test**
- **1:5 Powered model wind tunnel test**
- **Force model wind tunnel test**
- **Real time simulation**
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
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- Conclusions
• 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?

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