Innovation in Tilt Rotor design: through NICETRIP to NextGenCTR

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Outline

• The Tilt Rotor research in Europe
• NICETRIP research programme
  • Purposes & Organisation
  • ERICA Tilt Rotor concept
  • Major achievements
• Tilt Rotor integration into Air Traffic Management (ATM)
• On-going research: Clean Sky and Clean Sky 2 – NextGenCTR
• Conclusions and Recommendations
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History of European Tilt Rotor researches

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**Background**

**Generic Research, EUROFAR**

**Single-disciplines projects**

**RHL, TILTAERO, ADYN, DART, TRISYD, ACT-TILT**

**Full-scale integration**

**Full-scale flying demonstrator**

**NICETRIP**

**Clean Sky 2 - NextGenCTR**
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Novel Innovative Competitive Effective Tilt Rotor Integrated Project (NICETRIP)

- The NICETRIP Integrated Project was proposed as part of a continuing European TILTROTOR programme aimed at the acquisition, validation and integration of Tilt Rotor technology by the European Aerospace and associated supplier industries

- Programme launch: October 2006
- Programme completion: December 2014
- Total programme budget: ~30 M€
NICETRIP main objectives

- General Architecture
- Detailed Design of Critical Components
- Full-scale Testing
- Scale-Model Wind Tunnel Testing
- Tilt Rotor Integration into ATM
NICETRIP consortium
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**‘ERICA’ Tilt Rotor concept**

- **Enhanced Rotorcraft Innovative Concept Achievement (ERICA):** the innovative Tilt Rotor concept conceived by AgustaWestland in the early 2000s.
- **ERICA concept is built on three pillars:**
  - Small rotor diameter
  - Tiltable wing
  - Structural continuity of tilting mechanism

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Take-Off Weight</td>
<td>11 tons</td>
</tr>
<tr>
<td>Passengers</td>
<td>19 / 22</td>
</tr>
<tr>
<td>Cruise Speed</td>
<td>330 kts</td>
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Programme major achievements

Numerical tools validation

- Flight Mechanics tools
- CFD codes
- Aeroelastic tools

![Graph showing hub loads (Non Rotating Frame) from balance - 4/rev](image)

![Graph showing CPM2 performance](image)
Programme major achievements

Aircraft Design

- General architecture & overall parameters
- Aerodynamic design & optimization
- Aeroelasticity design & optimization
- Structural dynamics
Programme major achievements

**Aircraft System Design**

- Airframe and wing
- Power plant
- Fuel system
Programme major achievements

Experimental Testing & Validation

- Force model (scale 1:8) wind tunnel test @PoliMI – Jul. 2008
- Air intake model wind tunnel test @ University of Liège – Feb. 2012
Programme major achievements

Experimental Testing & Validation

• Force model (scale 1:8) wind tunnel test @Polimi – Jul. 2008
• Air intake model wind tunnel test @ University of Liège – Feb. 2012
• Powered model wind tunnel test (scale 1:5) @DNW – Jul. 2013, @ONERA - May 2014
Programme major achievements

Experimental Testing & Validation

• Force model (scale 1:8) wind tunnel test @PoliMI – Jul. 2008
• Air intake model wind tunnel test @ University of Liège – Feb. 2012
• Powered model wind tunnel test (scale 1:5) @DNW – Jul. 2013, @ONERA - May 2014
• Whirl tower full scale test @AVIATEST - Dec. 2014
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Tilt Rotor integration into ATM

• **NICETRIP (2008)**
  • Standalone Real-Time Simulation sessions to assess flyability of procedures dedicated to Tilt Rotor operations
  • Distributed Real-Time Simulation in the Air Traffic Control (ATC) simulation platform to evaluate the impact of tilt-rotor operations on a complex airport scenario (Milan Malpensa)
Tilt Rotor integration into ATM

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  - Standalone Real-Time Simulation sessions to assess flyability of procedures dedicated to Tilt Rotor operations
  - Distributed Real-Time Simulation in the Air Traffic Control (ATC) simulation platform to evaluate the impact of tilt-rotor operations on a complex airport scenario (Milan Malpensa)

• Clean Sky – **TRAVEL** project (2015)
  - Further evaluation of the integration of Tilt Rotor on the ATC operations through piloted simulations
  - Evaluation of new Tilt Rotor IFR procedures in a complex airport, including low-noise procedures
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The Tilt Rotor in Clean Sky - Green Rotorcraft ITD

- Tilt Rotor research is currently carried out in two Clean Sky Green Rotorcraft (GRC) sub-programmes:
  - Drag reduction of airframe and non lifting rotating systems – GRC2:
    - *Fuselage, wing and empennage shape optimization* for drag reduction (GRC2)
    - *Engine installation* optimization for inlet and exhaust losses reduction (GRC2)
  - Environment Friendly Flight Paths – GRC5:
    - *Eco-flight VFR and IFR Tilt Rotor procedures* designed and tested at flight simulator (GRC5)
Clean Sky 2 – Fast Rotorcraft IADP

• Building upon the results of past and current research programmes, the Tilt Rotor research is currently mature enough to target at a fully-integrated aircraft demonstrator
• Within Clean Sky 2, a Horizon 2020 programme, AgustaWestland is co-leading the FastRotorcraft IADP (Integrated Aircraft Demonstrator Platform), with Airbus Helicopters.
• The programme aims to design, develop, manufacture and flight test a full-scale integrated demonstrator.
• The Fast Rotorcraft concept represents the optimal solution for the needs of aerial services operators.
• Different technologies provide complementary solutions for efficient coverage of a range of applications
The AgustaWestland vision for Fast Rotorcraft
Technical Challenges & Strengths to Meet Reqs’

- Advanced Fly-by-Wire flight control system
- Three modes of operation: Conventional, Short and Vertical Take-Off and Landing providing operational flexibility
- Efficient engines-nacelles integration for minimal drag and weight and maximum serviceability
- Tilting rotors and split transmission with fixed engine to permit flexible engine choices
- Fuselage design for dual use and maximum mission flexibility
- Landing gear supporting airplane, STOL and vertical take off and landing modes
- Aerodynamically efficient and low noise Prop-Rotor design
NextGenCTR Schedule

- **CleanSky outcomes**
- **Calls for Proposal**
- **CDR**
- **Prelim Studies, Architecture, Specifications**
- **Components & Subsystems Development & Testing**
- **First Flight**
- **Flight Validation**
- **Architecture, Technologies, Operations**
- **full production development**

Years:
- 2014
- 2015
- 2016
- 2017
- 2018
- 2019
- 2020
- 2021
- 2022
- 2023
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Conclusions

- European aerospace community is investing in **Tilt Rotor researches since the early 90s**
- The **NICETRIP project** has been recently completed (2014), achieving **important results** from final wind tunnel and whirl tower tests
- NICETRIP, Clean Sky and the previous research programmes allowed to gain a **significant level of experience and confidence on Tilt Rotor design, tools and configuration viability**
- The Tilt Rotor research in AgustaWestland and in the EU is **currently ready for the complete development of a new and fully-integrated aircraft demonstrator**
- In the framework of **Clean Sky 2** programme, AgustaWestland will lead a consortium of partners to **design, develop and fly the Next Generation Civil Tilt Rotor (NextGenCTR)**, marking a major milestone in the Tilt Rotor research and development
THANK YOU FOR YOUR ATTENTION