The future of Rotary Wing: the Tilt Rotor

CESMA - 2nd Symposium on rotary wing

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The future of Rotary Wing: the Tilt Rotor

TASK

To explore the VTOL Tilt Rotor aircraft in the light of the today’s basic requirements for Rotary Wing systems
The future of Rotary Wing: the Tilt Rotor

PURPOSE

To assess the feasibility for future military operations
AGENDA

• VTOL concept
• Today Basic Requirements
• Aircraft flight envelopes & gap
• Capabilities
• Helicopter & Airplane mode
• Infrastructural platforms
• Advantage vs Disavantages
• Technologies drivers
• Military and Civil Aircraft
• NGCTR – Clean Sky Program
• Conclusion
Vertical Take Off & Landing (VTOL) Aircrafts

Fixed Thrusters

One Main, One Anti-Torque

Two Equal Size

Vectored Thrusters

Thruster Tilting

Exhaust Deflection
VTOL concept

V/STOL aircraft family
Today Basic Requirements

- Speed
- Range
- Payload
- Flexibility
- Efficiency
- Autonomy
- Productivity
- Sustainability
Aircraft flight envelopes & gap
Capabilities

Spot to spot time [hrs]

Distance [nm]

- Helicopter
- Turboprop
- Jet
- Tilt rotor
Capabilities

R = 250 NM
T: 1h

D = 500 NM
T: 2h
Capabilities

Hovering capability vs. Cruising speed
Helicopter & Airplane mode

Helicopter mode

- **Pitch:** Pilot moves cyclic fore and aft
- **Roll:** Pilot moves cyclic left and right
- **Thrust:** Pilot moves collective up and down
- **Differential Longitudinal Cyclic**
- **Collective Pitch**
- **Yaw:** Pilot moves pedals left and right
- **Differential Collective Pitch**

Airplane mode

- **Pitch:** Pilot moves cyclic fore and aft
- **Roll:** Pilot moves cyclic left and right
- **Thrust:** Pilot moves collective up and down
- **Elevator**
- **Flaperons**
- **Yaw:** Pilot moves pedals left and right
- **Differential Collective**
Infrastructural platforms

City Area

Built-up Area
Advantage vs Disadvantages

Good Hover/Loiter Efficiency

Moderate Downwash

Good Max Speed

Good Cruise Efficiency (Range)

Good Maneuverability - All Speeds

Attitude Independent of Speed/Acceleration

Ground Safety/Damage (No Tail Rotor)

Greater Operating Width

Conversion

Rotating Component RCS

Moderate Vibration Environment

Increased Empty Weight

Complexity (2 Vectored Thrusters)
Technologies drivers

- Rotors
- Transmissions
- Engines
- Structures and Materials
- Flight Controls
- Systems
- Shipboard Compatibility
- Survivability
- Reliability
- Costs
A **Civil Aircraft** is defined as:

"A machine that can derive support in the atmosphere from the reactions of the air other than the reactions of the air against the earth’s surface" (International Civil Aviation Organization – ICAO and European Aviation Safety Agency - EASA)

or

"Any vehicle that is capable of atmospheric flight including the installed equipment (hardware and software)" (European Defence Agency - EDA, European Military Airworthiness Document - EMAD1)

A **Military Aircraft** is defined as:

"An Aircraft (including UAS) designed and/or operated for military use and/or registered or intended to be registered on the military register of a Military Airworthiness Authority" (EDA - EMAD1)
Military rotary wing platforms
For the Military rotary wing platforms, led to a mission success based approach to get maximum capabilities from equipment.
Typical Military rotary wing platforms roles are: Scout; Attack; Anti-Submarine Warfare (ASW) and ASuW; Combat Search and Rescue (CSAR); Cargo/VertRep; Utility.

Civil rotary wing platforms
The Civil rotary wing platforms had/have to perform economically in commercial environment to maximize revenue while complying with certification requirements aimed at providing safety.
Typical Civil rotary wing platforms roles are: Emergency Medical Services (EMS)/Search and Rescue (SAR); Utility/Aerial Work; Passenger transport/VIP, Platforms.
These two (military and civil) different approaches led to two completely different certification approaches:

- A military aircraft was designed to fulfil a mission (operative requirement) complying with a certification basis.
- A civil aircraft is designed to comply with a civil certification base (EASA/FAA etc.) in order to have an aircraft able to fulfil a commercial need.
Today, under military process (contracts), the requirements to be met are categorized under:

• airworthiness;
• performance.

The compliance demonstration to the airworthiness requirements leads to the certification (fit for flight).

The compliance to the performance requirements provides qualification (fit for purpose).

This latter approach (fit for purpose) is not envisioned under civil processes.
Dual-Use concept

1950s to 1980s
Military Basis → Commercial Variant

2000s
Military Variant ← Commercial Basis

Future
Military Variant ← Common Baseline → Commercial Variant
NGCTR – Clean Sky Program
Conclusion

Maturity

Sustainability

Mentality
Questions?