"PERSPECTIVES of FUTURE DEVELOPMENTS of VERTICAL FLIGHT"

The Point of View of Industry

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CEO of AGUSTAWESTLAND Company
SUMMARY

1. The roles of Vertical Flight
2. Limitation of the helicopter
3. The two solutions
   - The advanced helicopter
   - The Tiltrotor
4. The Industry Goals
5. The Advanced Technologies
6. From technologies to product
7. AGUSTA: the Future has began
   - The AB139
   - The BA609
1. The roles of Vertical Flight
THE ROLES OF VERTICAL FLIGHT

UNIQUE ABILITIES OF THE HELICOPTERS

- Hovering
- Take-Off and Landing in a restricted area, not prepared terrains and with obstacles
THE ROLES OF VERTICAL FLIGHT

Increasing demand:

- Transport of people and materials
- Point to point connection (VIP, corporate…)
- Offshore
- Short range transport
- Search & Rescue
- Military air mobility (Peace keeping)
- Security
2. Limitations of the helicopter
LIMITATIONS OF THE HELICOPTER

- Low productivity
  - Low speed
  - High operating costs
- Environmental impact
  - Noise
  - Pollution
- Public acceptance
- No rules in the ATM
3. The two solutions

- The advanced helicopter
- The Tiltrotor
THE TWO SOLUTIONS

PERSPECTIVE OF FUTURE DEVELOPMENT OF VERTICAL FLIGHT

Helicopter Evolution
- All Weather
- More performing
- Quieter
- Safer
- More comfortable
- Low pollution

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

Hovering
Speed
Range
Cruise
INDUSTRY GOALS

- Lower costs
- Increased performance
- Payload
- Range
- Endurance
- Community acceptance
- All weather
- Air Traffic Procedures
SUMMARY

5. The Advanced Technologies
The technology solutions play an important role to achieve the industry goal...

- Dynamics
- Aerodynamics
- Simulations
- Structures
- Avionics
ADVANCED TECHNOLOGY SOLUTIONS: AERODYNAMICS

• Higher Rotor efficiency (hover/forward flight)
  - higher payload
  - higher productivity

• Full Navier-Stokes codes
  - noise reduction
  - rotor/fuselage interaction

• Enhancement of the Wind Tunnel tests
  - active flow control
  - active fiber composite
  - study of new configurations (T/R)
ADVANCED TECHNOLOGY SOLUTIONS: DYNAMICS

- Active Rotor Control (flaps, twist, tip…)
  - reduction of rotor/fuselage vibration
  - reduction of noise
- Enhancement of the experimental tests
  - systems characterisation
- Vibration Monitoring Systems
  - rotors, drive shafts…
- Stability enhancement
  - Study of new configurations (T/R)
Traditional Metallic Structure

Composite Solutions

...making compliance with the new stringent requirements:

✓ Crashworthiness
✓ Bird Strike
✓ Engine disk burst impact

Introduction of the damage tolerance
• Development and validation of the flight mechanics codes

• Evaluation and improvement of the VTOL handling qualities

• Development of flight simulators with Pilot and hardware in the loop
  ➢ Advanced control laws
  ➢ Automatic emergency manoeuvres
  ➢ load reduction
ADVANCED TECHNOLOGY SOLUTIONS: AVIONICS

MAN-MACHINE INTERFACE

- Helmet Mounted Display
- Side Stick
- Direct Voice Input
- Tactile Control Feedback
- Differential GPS
- Terrain Obstacle Database
- 3D flight path

- Extend Operational Envelope
- Reduce Pilot Workload
- Increase Pilot Situation Awareness
6. From Technologies to product
FROM TECHNOLOGIES TO PRODUCT

ADVANCED TECHNOLOGY SOLUTIONS

- Aerodynamics
- Dynamics
- Structures
- Simulation
- Avionics

MARKET

Available resources and Collaboration Network

REQUIREMENTS
FROM TECHNOLOGIES TO PRODUCT

CIVIL

Medical Service
VIP
Search & Rescue
Border Patrol
Law Enforcement
Light Utility
Scout
Naval Operation
Training

IFR
Useful Load
Cabin Size
Range
Speed
Hot & High Comfort
Operating Costs

MILITARY

The competitive performance diamond

An example: the AGUSTA A109
FROM TECHNOLOGIES TO PRODUCT

ERICA
The European Advanced Tiltrotor

AGUSTA

24th Icas Congress, Yokohama, Japan. August 29th – September 3rd, 2004
SUMMARY

7. AGUSTA: the Future has began
**AGUSTA: THE FUTURE HAS BEGUN**

**SUGGESTED LONG RANGE VTOL TECHNOLOGY GOALS**


<table>
<thead>
<tr>
<th>ATTRIBUTE</th>
<th>CURRENT LEVEL</th>
<th>AGUSTA TODAY</th>
<th>2022 TARGET</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VEHICLE EFFICIENCY</strong></td>
<td>Hover = 0.78</td>
<td>0.8</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>L/D x Prop. Eff. = 7 at V cruise</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td><strong>CRUISE SPEED</strong></td>
<td>Helicopter = 170 Kts</td>
<td>180 Kts</td>
<td>200 Kts</td>
</tr>
<tr>
<td></td>
<td>Tiltrotor = 250 Kts</td>
<td>275 Kts</td>
<td>350-400 Kts</td>
</tr>
<tr>
<td><strong>EXTERNAL NOISE</strong></td>
<td>FAA Requirements</td>
<td>-3 dB below req.</td>
<td>60% Reduction</td>
</tr>
<tr>
<td><strong>COCKPIT INTEGRATION</strong></td>
<td>Pilot Aiding</td>
<td>Pilot behaviour integrated in the machine</td>
<td>Operator “directs” vehicle</td>
</tr>
<tr>
<td><strong>ALL-WEATHER</strong></td>
<td>Limited Icing Capability</td>
<td>FULL ICING (EH101)</td>
<td>No-Restriction to icing</td>
</tr>
</tbody>
</table>
AGUSTA: THE FUTURE HAS BEGUN

AB139

BA609
The AB139
AGUSTA: THE FUTURE HAS BEGUN - AB139

Commercial Helicopter derived from the Military A149

- ENGINES: P&WC PT6C-67C
- ENGINES CONTROLLED BY FADEC
- WEIGHT 6 ton
- PAYLOAD 2.5 ton
- SPEED 167 kts
- RANGE >400 nm
Primary structure of aluminum alloy and nomex/aluminum panels.

Fiber composite material are used for the secondary structure.

Better fuel tanks position

- High space in the cabin
- Better lift/drag ratio
- Better crashworthiness characteristic
- Light weight
- Passenger cabin floor low over the ground for easy loading and unloading
AGUSTA: THE FUTURE HAS BEGUN - AB139

MAIN ROTOR

Aerodynamically and dynamically optimised

TAIL ROTOR

Canted:
- Shorter mast
- Higher performance
AGUSTA: THE FUTURE HAS BEGUN - AB139

Avionics System

Primus Epic™ Avionics System
(Honeywell)

Electronic Display System

✓ Navigation and Engine data
✓ Systems parameters
✓ Caution, warning and advisory annunciation
✓ Windows-style Operating System
✓ Voice Command System
✓ Central Maintenance Computer
**AGUSTA: THE FUTURE HAS BEGUN - AB139**

### HOGE AEO Comparison

<table>
<thead>
<tr>
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<th>Present Helicopters</th>
<th>AB139</th>
</tr>
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<tbody>
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<td>HOGE index</td>
<td>0.82</td>
<td>1.19</td>
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</tbody>
</table>

### PRODUCTIVITY INDEX of Medium Twin Engine Helicopters

<table>
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<th>AB139</th>
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</thead>
<tbody>
<tr>
<td>Productivity Index</td>
<td>4.07</td>
<td>6.58</td>
</tr>
</tbody>
</table>
$\frac{MMH}{FH} = \left( \frac{MMH}{FH} \right)_{SCHED} + \frac{MTTR}{MTBF}$
SUMMARY

The BA609
AGUSTA: THE FUTURE HAS BEGUN - BA609

Capacities

- Crew: 1-2
- Passengers seats: 6-9
- Baggage comp. Volume: 1.42 m³

Propulsion

- Two P&W PT6C-67A (1940 Shp each)

Weights & dimensions

- Max take off weight: 7250 kg
- Empty weight: 4760 kg
- Useful load: 2500 kg
- Rotor Diameter: 7.9 m

Performance

- Max Cruise Speed: 275 kts
- Max Range: 750 nm
- Cruise Altitude: 7620 m
AGUSTA: THE FUTURE HAS BEGUN - BA609

Missions

- Aeroambulance
- Offshore Resources Development
- Search and Rescue
- Training
- VIP / Corporate

AGUSTA

24th Icas Congress, Yokohama, Japan. August 29th – September 3rd, 2004
AGUSTA: THE FUTURE HAS BEGUN - BA609

Cruise Speed (Knots)

Altitude (Ft)

- 40,000
- 30,000
- 20,000
- 10,000
- 0

- 0 50 100 150 200 250 300 350

Helicopter

BA609

Business

Turboprop

V_cruise

275 Kts

High cruise altitude
Nacelle tilting mechanism

- Satisfy severe safety requirements
- Double telescoping ballscrews
- Interconnecting shaft
- Angular displacement transducer
Rotor System

- 3 blades
- optimal twist for hover and cruise
- gimbal joint
- different elastomeric components
- deicing system
Drive System

- Interconnecting shaft
- Drive of both rotors in case of engine failure
- No asymmetric flight or controls
AGUSTA: THE FUTURE HAS BEGUN - BA609

Flight Control System

- Core of the BA609
- Fly-by-wire
  - minimise pilot workload
  - satisfy handling qualities req.
- Conversion from H/M to A/M and reverse
- Conventional helicopter cockpit controls
- Triplex flight control computers

- Control laws fully tested through Pilot-in-the-loop flight simulation techniques.
- Thousands of virtual maneuvers
- 3 dedicated simulators with pilots and hardware in the loop
- Optimised handling qualities of the aircraft
- Tested all possible failures and emergency procedures.
CONCLUSIONS

- In the airspace future, the vertical flight will have a greater importance than today
- The goals of the rotorcraft industry are to integrate the technology into business
- AGUSTA, with the two last products, the AB139 and the BA609, has begun the future
- Finmeccanica, the AGUSTA shareholder, has decided to strengthen the helicopter sector as one of its main core business
- Finmeccanica announced the agreement with GKN for the acquisition of the latter's 50% shareholding in AgustaWestland.
- Agusta will benefit of greater resources to reinforce its position to stay in the forefront of the vertical flight business of the two guiding avenues of both the conventional helicopter and the revolutionary Tilt-Rotor.