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" PERSPECTIVES of FUTURE DEVELOPMENTS of VERTICAL FLIGHT "

The Point of View of Industry

Author:

A. Caporaletti

CEO of AGUSTAWESTLAND Company

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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

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SUMMARY

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

Evolution

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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

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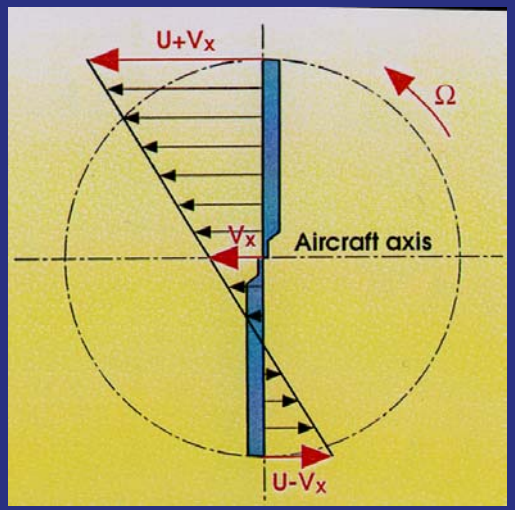
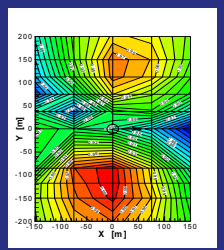
2. Limitations of the helicopter

LIMITATIONS OF THE HELICOPTER

- **Low productivity**
  - ⇨ **Low speed**
  - ⇨ **high operating costs**
- **Environmental impact**
  - ⇨ **Noise**
  - ⇨ **Pollution**
- **Public acceptance**
- **No rules in the ATM**





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SUMMARY

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

Hovering

TILTROTOR

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

Speed
Range
Cruise

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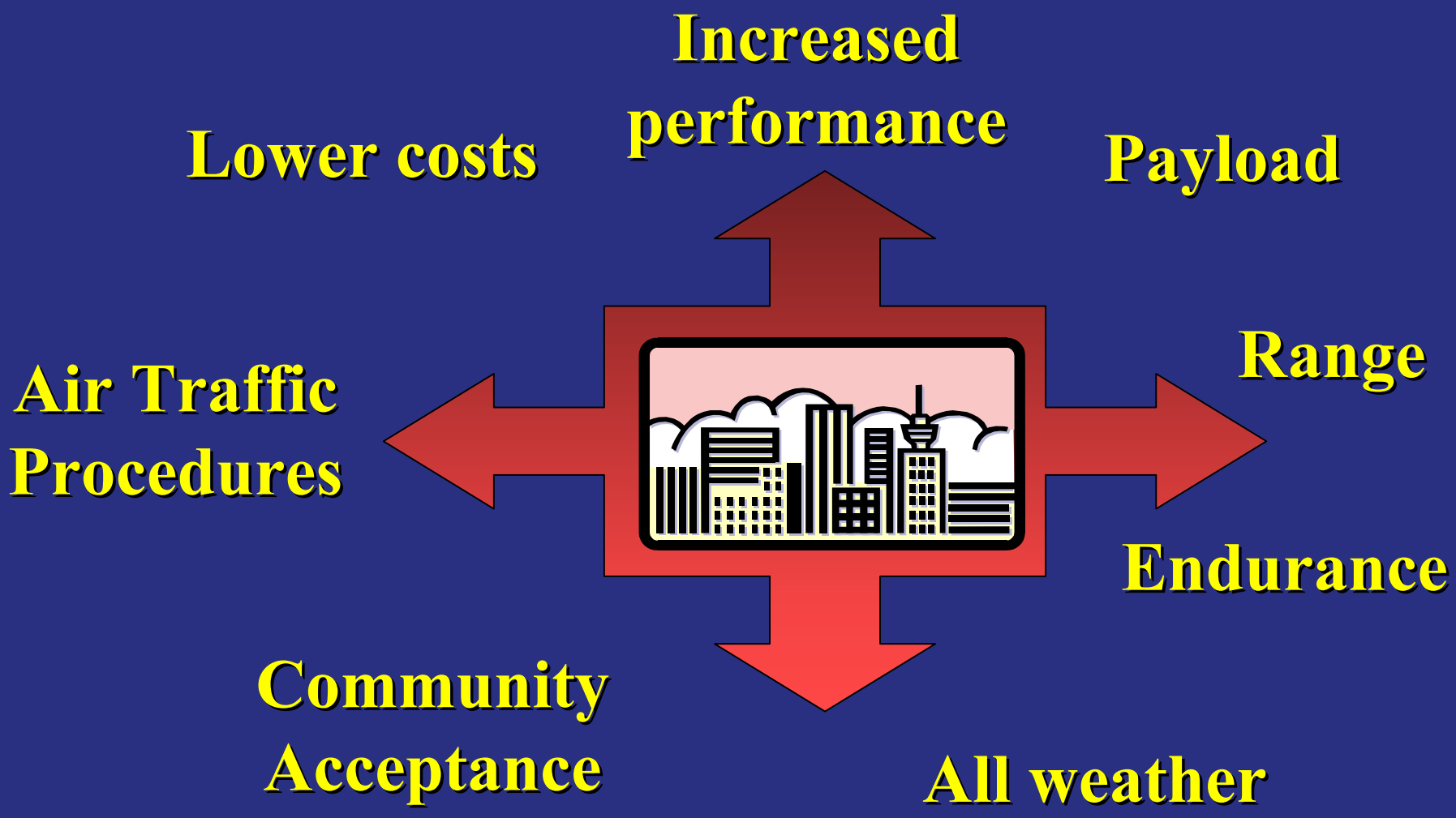
INDUSTRY GOALS



5. The Advanced Technologies

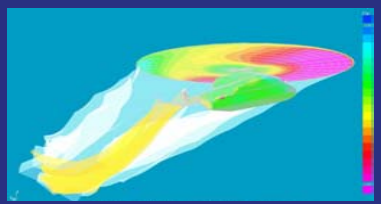
ADVANCED TECHNOLOGY SOLUTIONS

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

SIMULATIONS

DYNAMICS

AERODYNAMICS



AVIONICS

STRUCTURES

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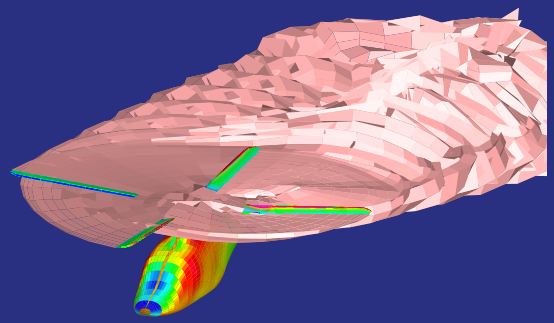
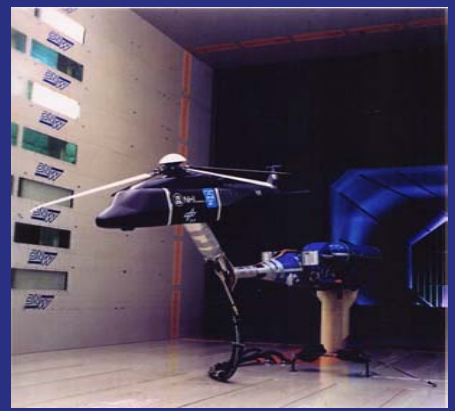
ADVANCED TECHNOLOGY SOLUTIONS: AERODYNAMICS

- **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)





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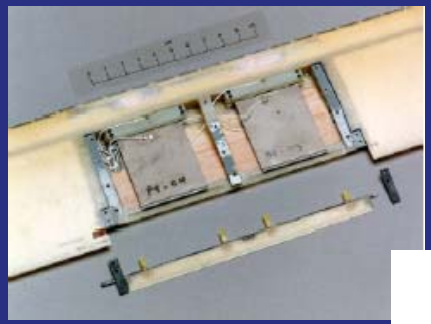
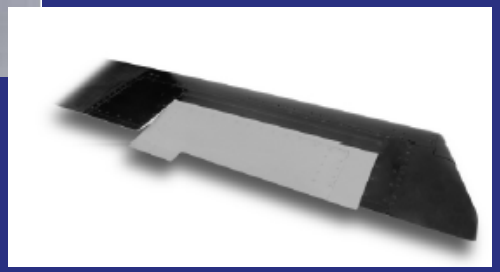
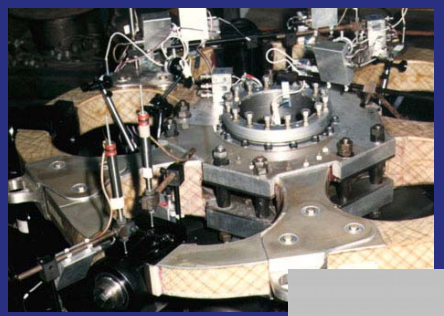
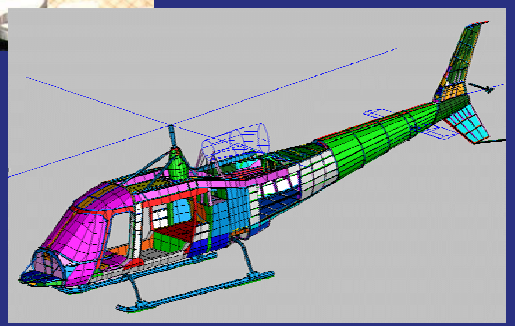
ADVANCED TECHNOLOGY SOLUTIONS: DYNAMICS









- **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)

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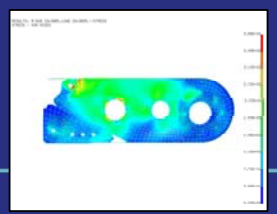
Traditional Metallic Structure

Composite Solutions

…making compliance with the new stringent requirements:

- ✓ Crashworthiness
- ✓ Bird Strike
- ✓ Engine disk burst impact

Introduction of the damage tolerance



ADVANCED TECHNOLOGY SOLUTIONS: SIMULATION

- 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

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ADVANCED TECHNOLOGY SOLUTIONS: AVIONICS

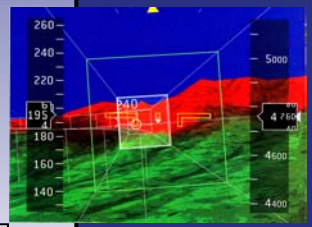
MAN-MACHINE INTERFACE

Helmet Mounted Dysplay

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

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6. From Technologies to product

FROM TECHNOLOGIES TO PRODUCT

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FROM TECHNOLOGIES TO PRODUCT

The competitive performance diamond

An example: the AGUSTA A109

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FROM TECHNOLOGIES TO PRODUCT

AGUSTA Collaboration Network

FROM TECHNOLOGIES TO PRODUCT

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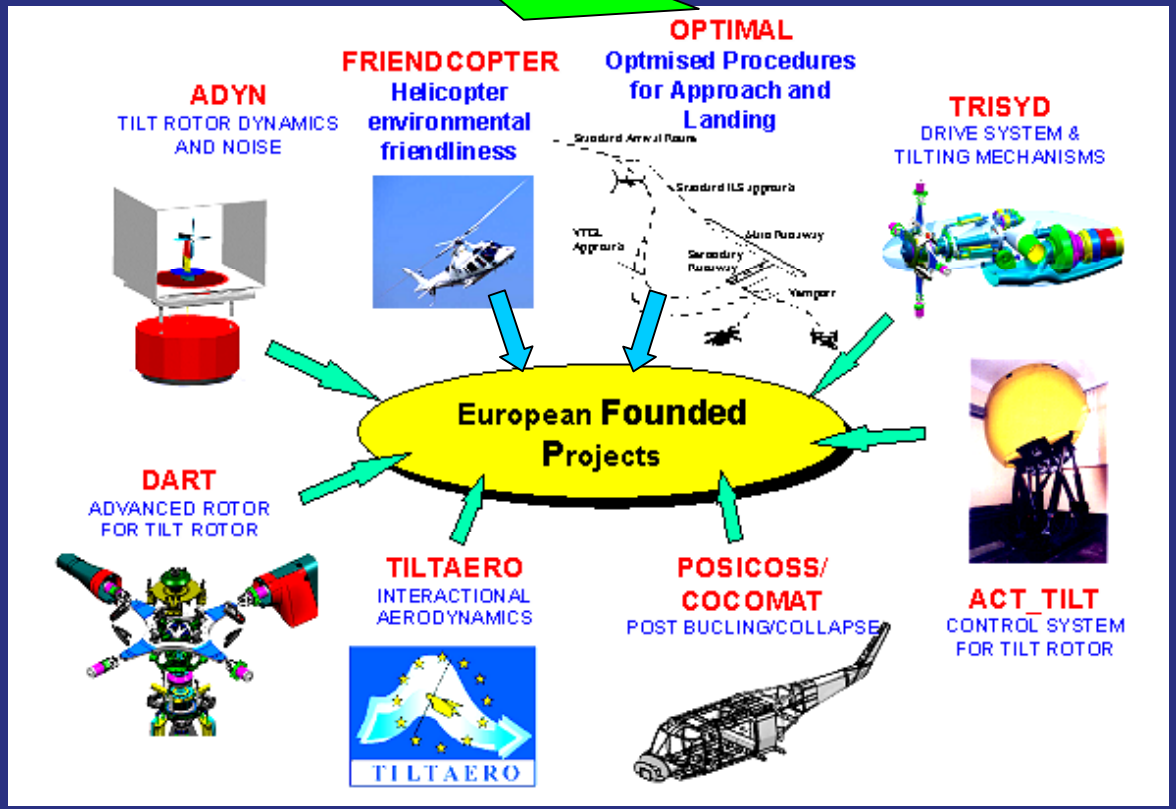
The European Advanced Tiltrotor



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7. AGUSTA: the Future has began

AGUSTA: THE FUTURE HAS BEGUN

SUGGESTED LONG RANGE VTOL TECHNOLOGY GOALS G.Price, "Prospects for the future of the Vertical Flight", AIAA/ICAS "The Next 100 Years", 14-17 July 2003, Dayton, Ohio			
ATTRIBUTE	**CURRENT LEVEL**	**AGUSTA TODAY**	**2022 TARGET**
VEHICLE EFFICIENCY	Hover = 0.78	**0.8**	0.87
	L/D x Prop. Eff. = 7 at V cruise	**10**	13
CRUISE SPEED	Helicopter = 170 Kts	**180 Kts**	200 Kts
	Tiltrotor = 250 Kts	**275 Kts**	350-400 Kts
EXTERNAL NOISE	FAA Requirements	**-3 dB below req.**	60% Reduction
COCKPIT INTEGRATION	Pilot Aiding	**Pilot behaviour integrated in the machine**	Operator "directs" vehicle
ALL-WEATHER	Limited Icing Capability	**FULL ICING (EH101)**	No-Restriction to icing

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AGUSTA: THE FUTURE HAS BEGUN

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AB139

BA609

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The AB139

AGUSTA: THE FUTURE HAS BEGUN - AB139

Commercial Helicopter derived from the Military A149

- ENGINES: P&WC PT6C-67C
- ENGINES CONTROLED BY FADEC
- WEIGHT 6 ton
- PAYLOAD 2.5 ton
- SPEED 167 kts
- RANGE >400 nm

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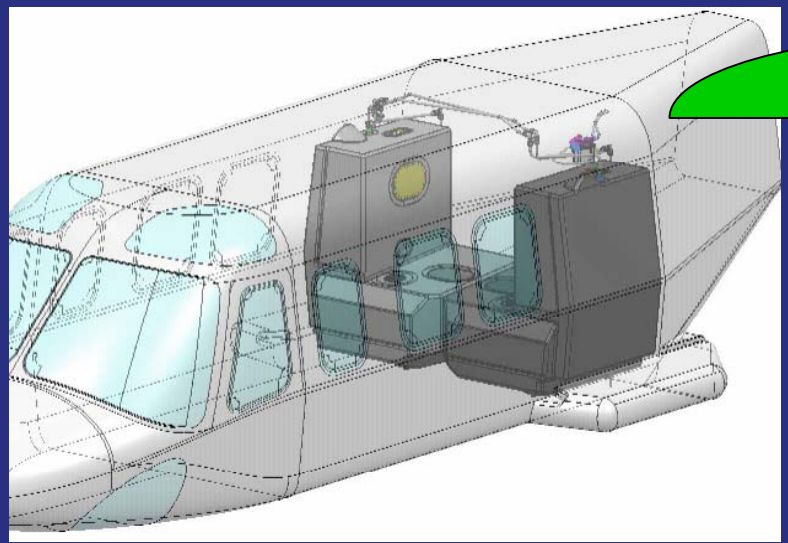
AGUSTA: THE FUTURE HAS BEGUN - AB139



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

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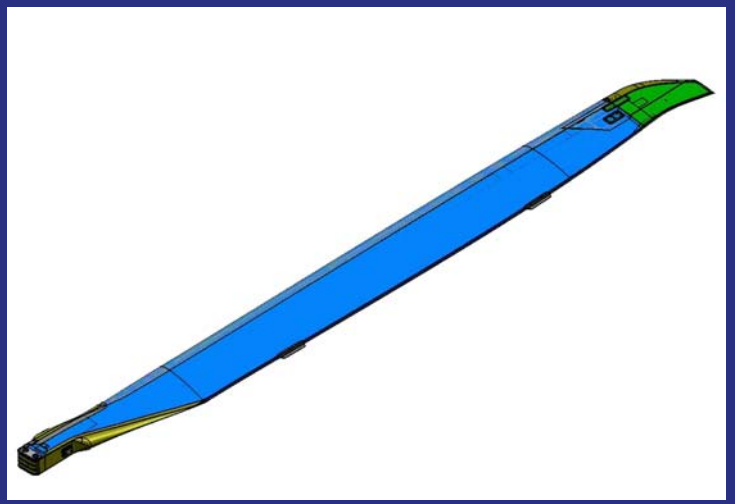
MAIN ROTOR



Aerodynamically and dynamically optimised

TAIL ROTOR

Canted:

- **Shorter mast**
- **higher performance**

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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 Maitenance Computer

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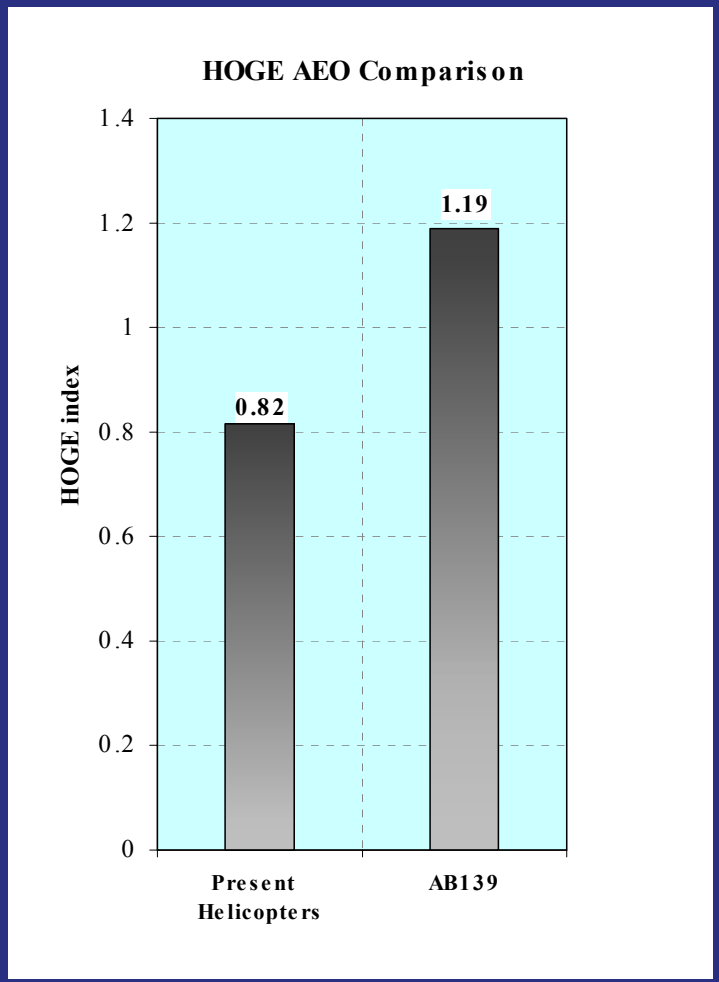
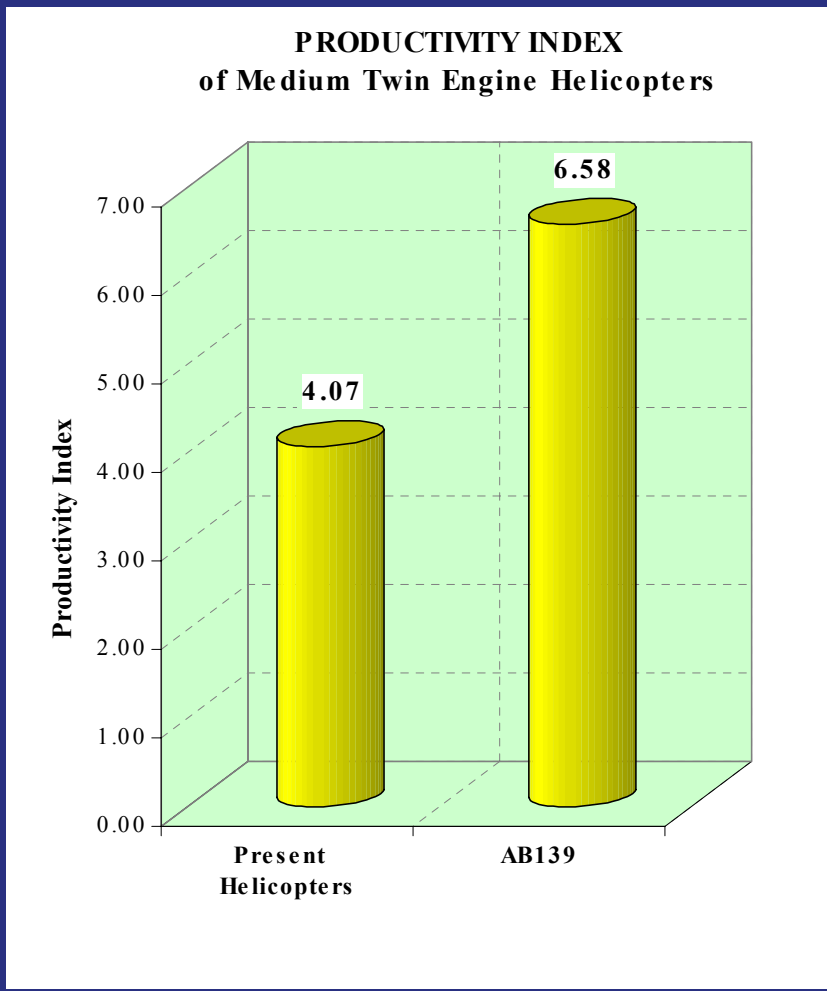
Performance





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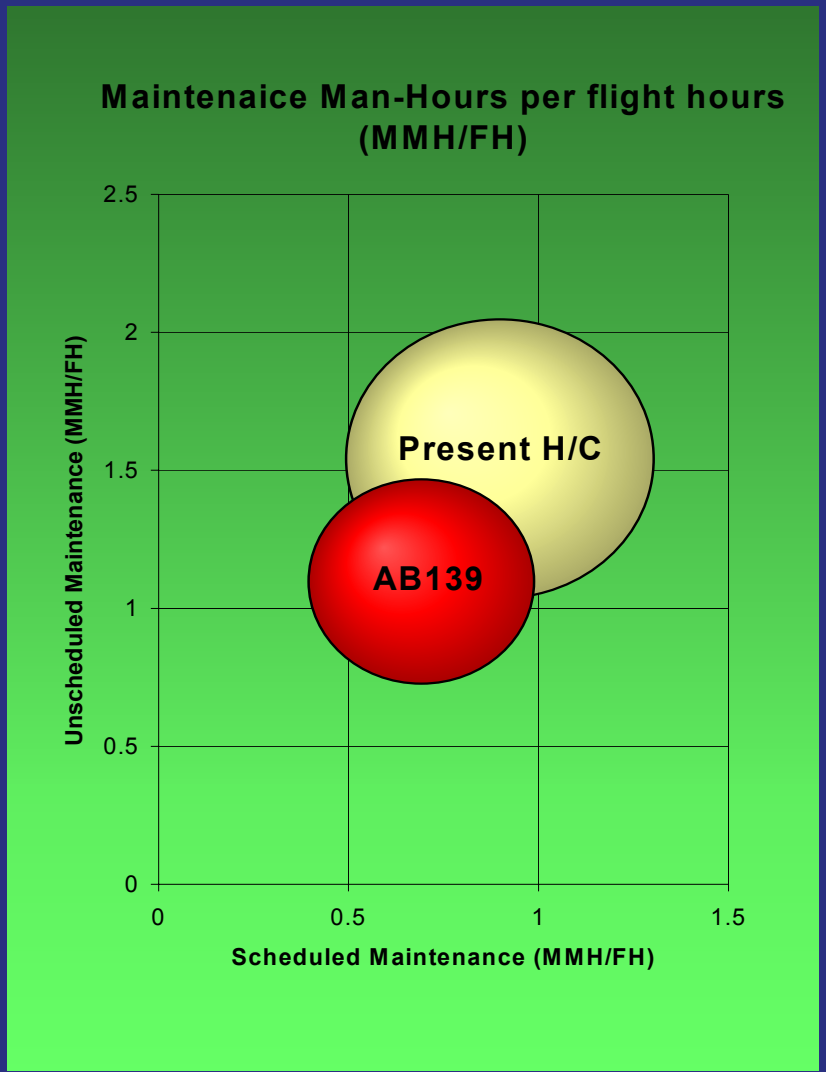
$$\frac{MMH}{FH} = \left(\frac{MMH}{FH}\right)_{SCHED} + \frac{MTTR}{MTBF}$$



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SUMMARY

The BA609

AGUSTA: THE FUTURE HAS BEGUN - BA609

Capacities

Crew	1-2
Passengers seats	6-9
Baggage comp. Volume	1.42 m^3

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

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Missions

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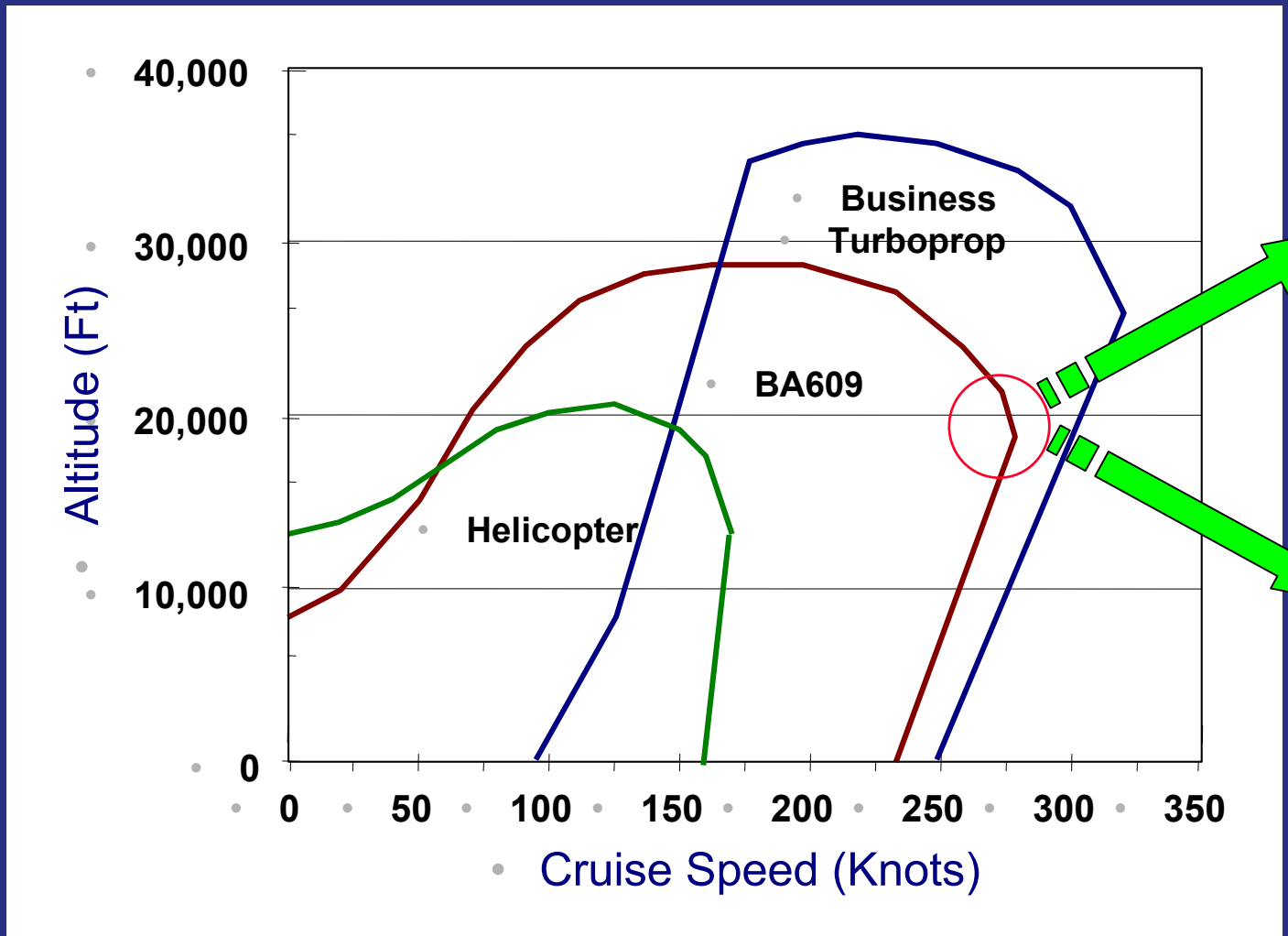

Vcruise

275 Kts

High cruise altitude

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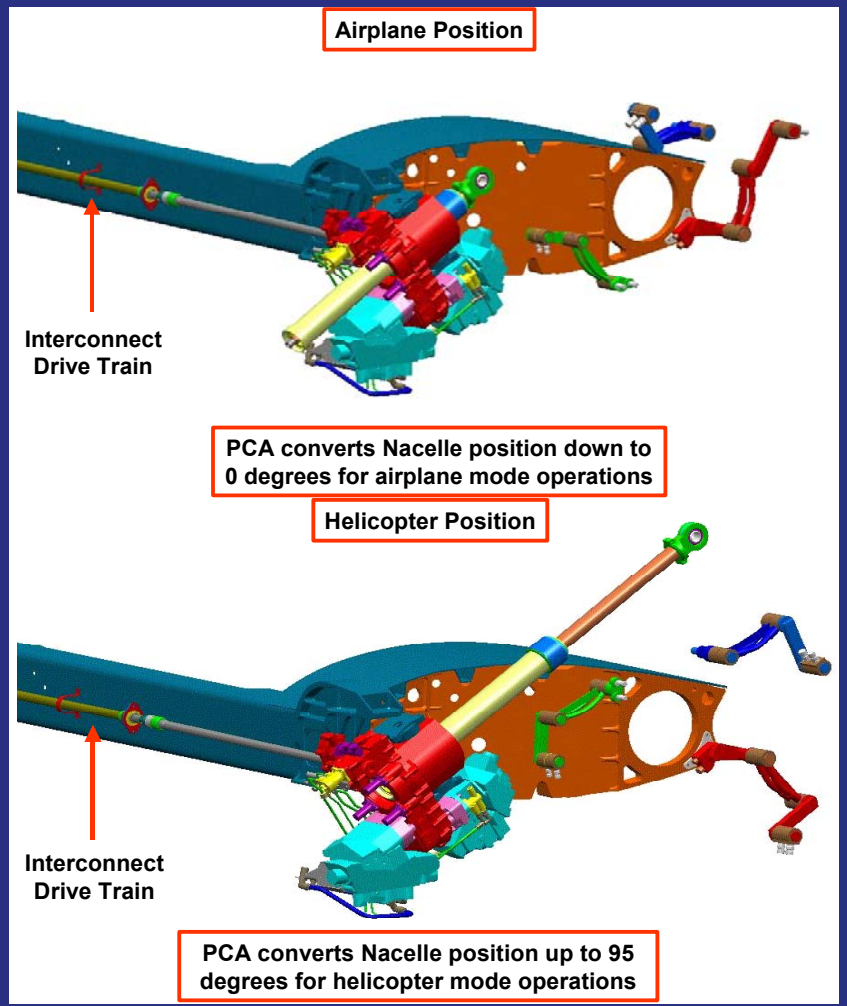
AGUSTA: THE FUTURE HAS BEGUN - BA609



Nacelle tilting mechanism

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

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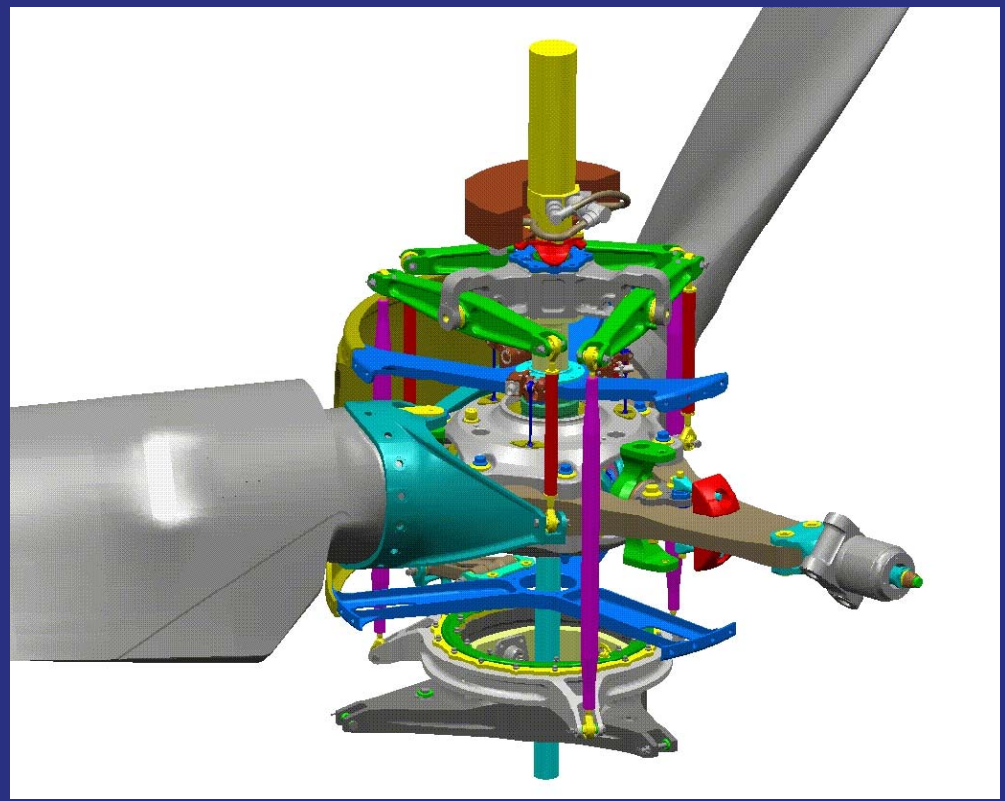
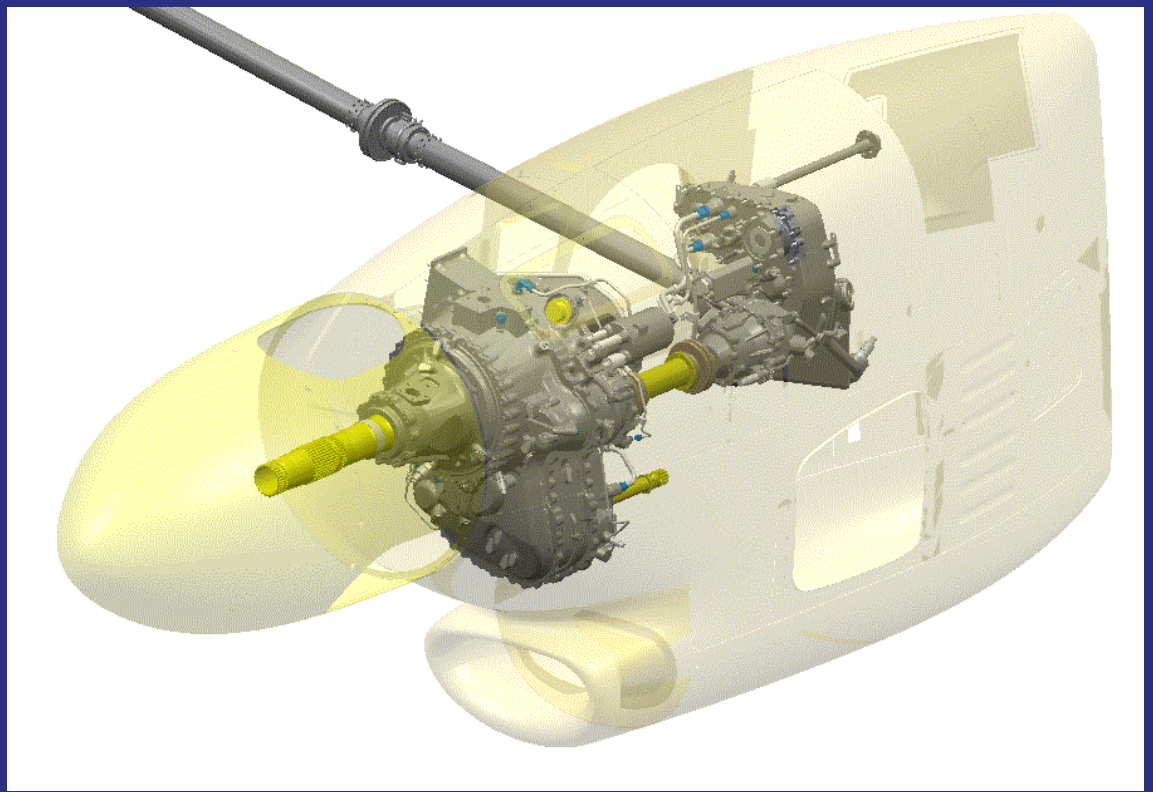
Rotor System

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



Drive System

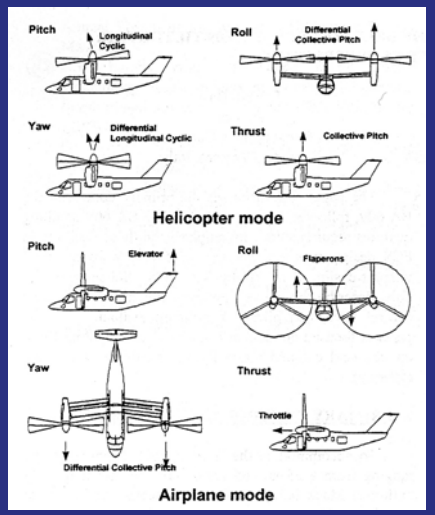
- Interconnecting shaft
- Drive of both rotors in case of engine failure
- No asymmetric flight or controls



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 harware in the loop
- optimised handling qualities of the aircraft
- tested all possible failures and emergency procedures.

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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.

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