



# **HADA** PROGRAMME

(**HELICOPTER** **ADAPTIVE** **AIRCRAFT**)

**ICAS WORKSHOP**  
**24 September 2007. Sevilla**  
**Manuel Mulero Valenzuela (INTA)**  
**Rafael Pax (Aries Complex)**



INTERNATIONAL CONGRESS ON:

## INNOVATION IN UNMANNED AIR VEHICLES SYSTEMS



### Deadlines:

Requests to attend/present a paper:

**BEFORE 31 st OCTOBER**

Notification of Acceptance of papers to Authors:

**BEFORE 1st NOVEMBER**

[lauras@imaneventos.com](mailto:lauras@imaneventos.com)

### Call for papers

Venue: ETSII (UPM) Madrid

Dates: 14, 15, 16 November 2007

**Under the frame of PLATINO Programme**  
(Programme financed by the Spanish Ministry of Education  
and Science & the Spanish Ministry of Defence)



Organised by:



**PROGRAMME PLATINO**  
(Light Aerial Platform for Innovative Tecnologies)

**PROGRAMME PLATINO**





# HADA

## BRIEF DESCRIPTION

### CONCEPT

HADA stands for “Helicopter Adaptive Aircraft”. The aim of this original design focusses on improving, by combining, the capabilities of both **Helicopter and Fixed-Wing aircrafts**

Though this aim has been tried to be achieved for some nearly 40 years now, sometimes with sound designs, we believe HADA can contribute in a significant manner to produce an effective operational aircraft, based on the actual “state of the art” in light composite materials, microelectronics and Flight Control Systems (FCS) together with light and reliable mechanisms and optimized CFD tools for optimized aerodynamic design



# HADA

## BRIEF DESCRIPTION

### TECHNICAL CLUES

**HADA is a new solution for VTOL operations providing also high efficiency flight in cruise modes (Patent applied)**

**This design could well be dubbed “Morphing Aircraft” in the sense that it looks as a “standard Helicopter” in Hover and Take-off and Landing modes and as a “standard Aircraft” in Cruise modes.**

**The basic architecture responds to a conventional Helicopter with all its inherent capabilities (i.e: cyclic, collective modes..)**

### The Innovations:

**Two half span wings are attached to the belly of the fuselage:  
They are retracted beneath the fuselage when HADA flies in Helicopter Mode (HC) and are deployed to full span when in Aircraft Mode (AC)**

**A pusher propeller is attached to the rear end of the fuselage:  
Power is transferred to it from the engine when in AC Mode, disengaging Rotor and anti-torque**



# HADA

## BRIEF DESCRIPTION

### TECHNICAL CLUES

#### Operational process:

**HADA takes-off as a conventional HC, climbs to operational altitude, achieves horizontal speed up to the “Transition Speed, (TS)” and then deploys the wings, transfers power to the propeller and acquires the cruise speed of the AC configuration**

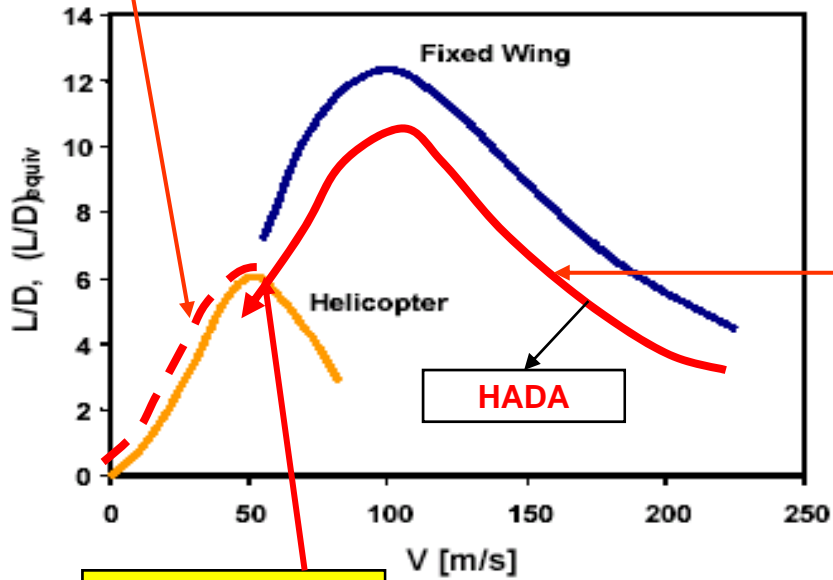
**At any time during the mission, HADA can revert to HC Mode transferring power from the propeller to the main rotor and anti-torque and folding the wings under the fuselage. This process can be executed as many times in flight as required**

**On landing (any time during the mission or at the end of it), HADA adopts the HC configuration, allowing the aircraft to land in any unprepared site**

# HADA

## FLIGHT MODES

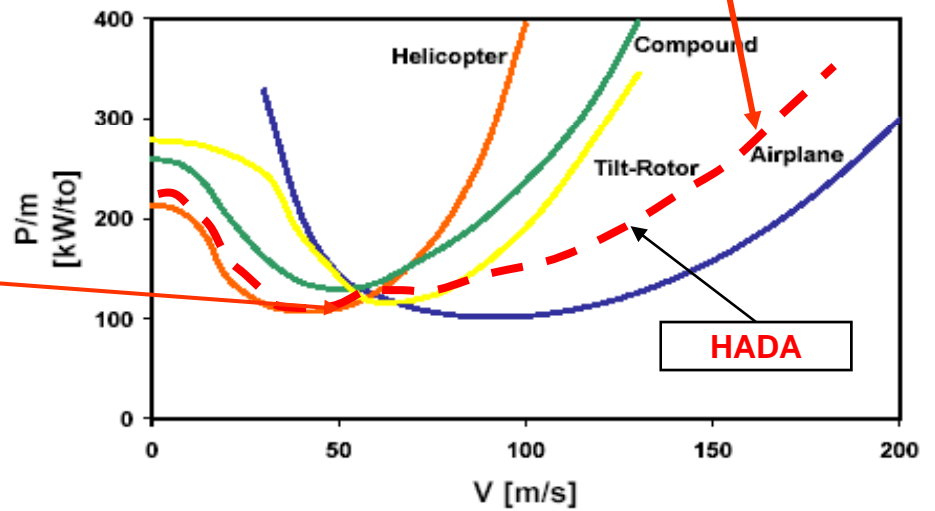
HOVERING  
AND LOW SPEED FLIGHT



CRUISE FLIGHT

POWER/WEIGHT

TRANSITION



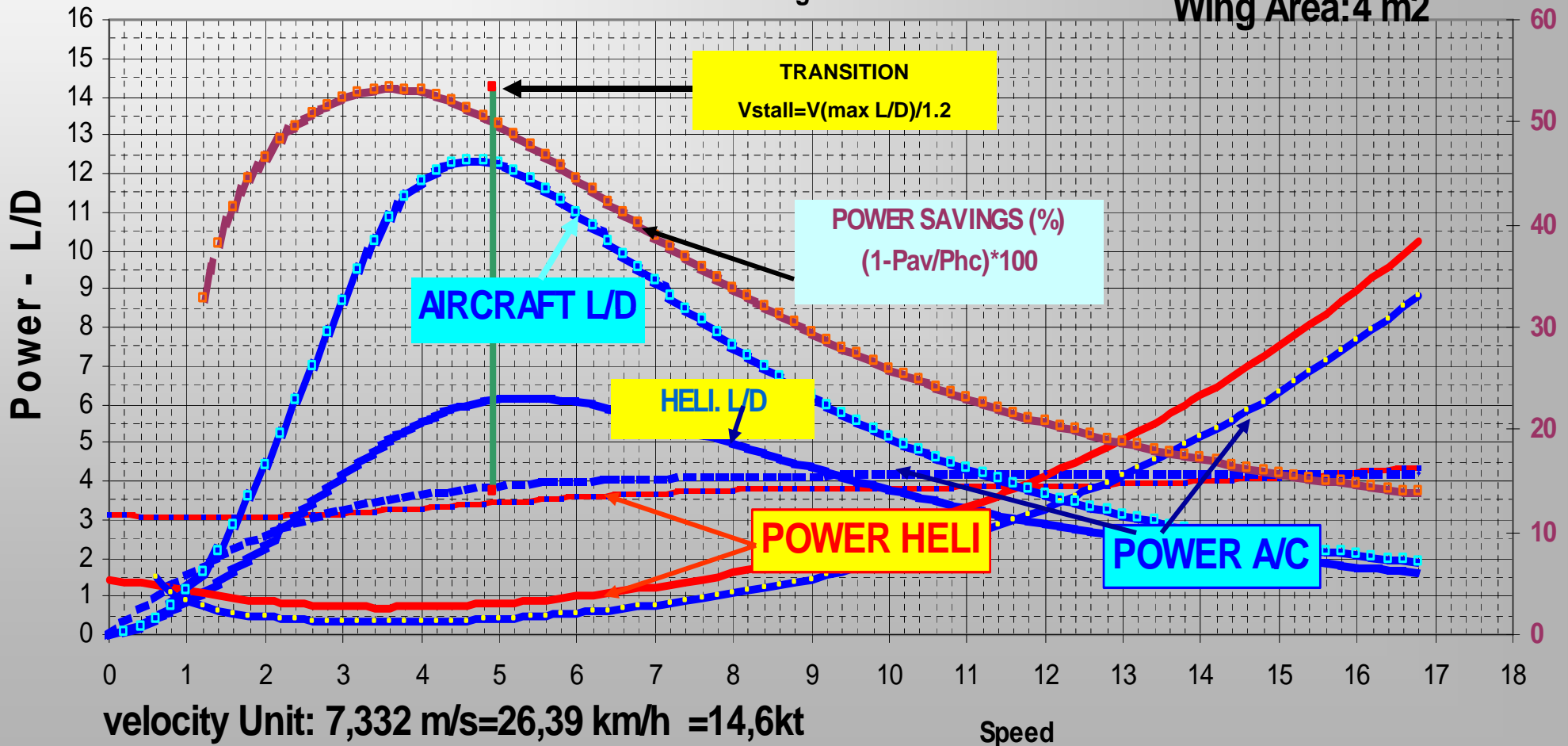
# PERFORMANCES OF HADA SYSTEM

## PRELIMINARY DESIGN FOR UAV SYSTEM

Mass: 380 kg  
Power: 130 kw

Required and available Power  
L/D helicopter and Aircraft  
Power gain

Main rotor Diameter: 6m  
Wing span: 6m  
Wing Area: 4 m<sup>2</sup>



velocity Unit: 7,332 m/s=26,39 km/h =14,6kt

Power unit: 27,3 kW= 37 hp



# WORLD WIDE ONGOING PROGRAMMES

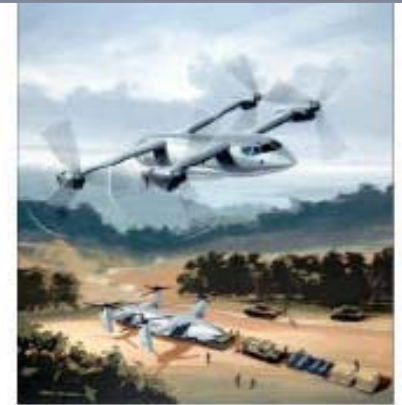
## MANNED SYSTEMS



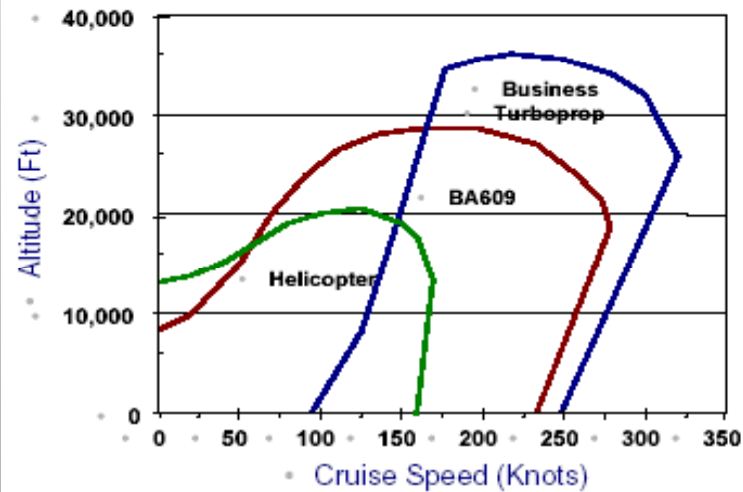
**BA-609**



**V-22 OSPREY**



**QTR HEAVY LIFT**



**FLIGHT ENVELOPES**

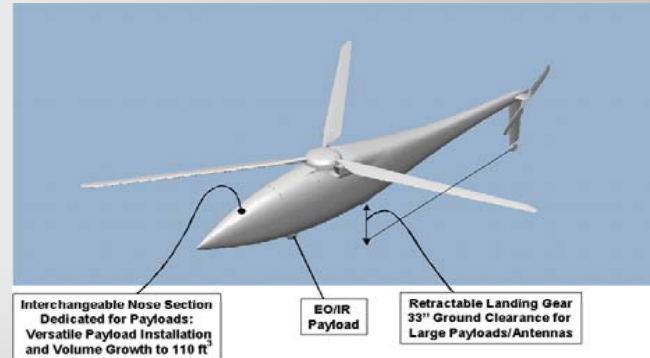


**ERICA CONCEPT**

## MAIN UAV – VTOL PROGRAMMES WORLDWIDE



**FIRE SCOUT MODELO 379  
NORTHROP GRUMMAN**



**A-160 HUMMINGBIRD  
BOEING**



**DRAGON FLY CANARD  
ROTORWING  
BOEING**



**ORKA  
EADS**



**EAGLE EYE  
BELL TEXTRON**



**GOLDEN EYE-50  
AURORA FLIGHT  
SCIENCES**



# HADA - UAV VERSION

## HADA UAV VERSION

**As a first step, a UAV- VTOL aircraft is proposed: The short term aim is to fulfil the requirements of Navies and Civil Agencies of different Countries all over the World.**

**Basically all users require VTOL operation on board small to medium size ships (patrol boats, frigates,..) or easily deployable systems “on the spot”**

**They also require around 5 hours endurance; 40 to 90 Kilograms payload and ranges around 100-200 miles from the Operational Base**

**We believe HADA can fulfill these requirements advantageously over conventional Helicopters or Tilt Rotors, thanks to its unique high performance design**

**HADA**

## STATE OF THE PROJECT

### HADA PROJECT PLANNING

- PHASE - A: “**COLIBRÍ**”: 2007
- PHASE - B: “**LIBÉLULA**”: FULL SCALE UAV:  
2008-2010

Project Funded by:



MINISTERIO  
DE EDUCACIÓN  
Y CIENCIA

# PHASE A: "COLIBRÍ"

- THE PROJECT HAS STARTED WITH A FEASIBILITY PHASE LASTING 18 MONTHS
- TWO ACTIVITIES ARE CARRIED OUT IN PARALELL:
  - FEASIBILITY STUDIES FOR THE FULL SCALE "HADA"
  - PROOF OF CONCEPT: REDUCED SCALE ("COLIBRÍ")



# PHASE A: "COLIBRÍ"

## CONSORTIUM



R&D LEADER

INTA

ac aries COMPLEX, S. A.

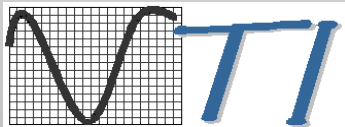
INDUSTRIAL LEADER



PÍGMYLY



Isdefe  
Ingeniería de Sistemas



UPC  
Departament d'Enginyeria de Sistemes,  
Automàtica i Informàtica Industrial  
UNIVERSITAT POLITÈCNICA DE CATALUNYA



IIIA  
INSTITUT D'INFORMÀTICA  
I APLICACIONS



# Aries Strategy in UAV



Aries is a Group of companies specialized in designing & manufacturing High Technology Composite Aerostructures.

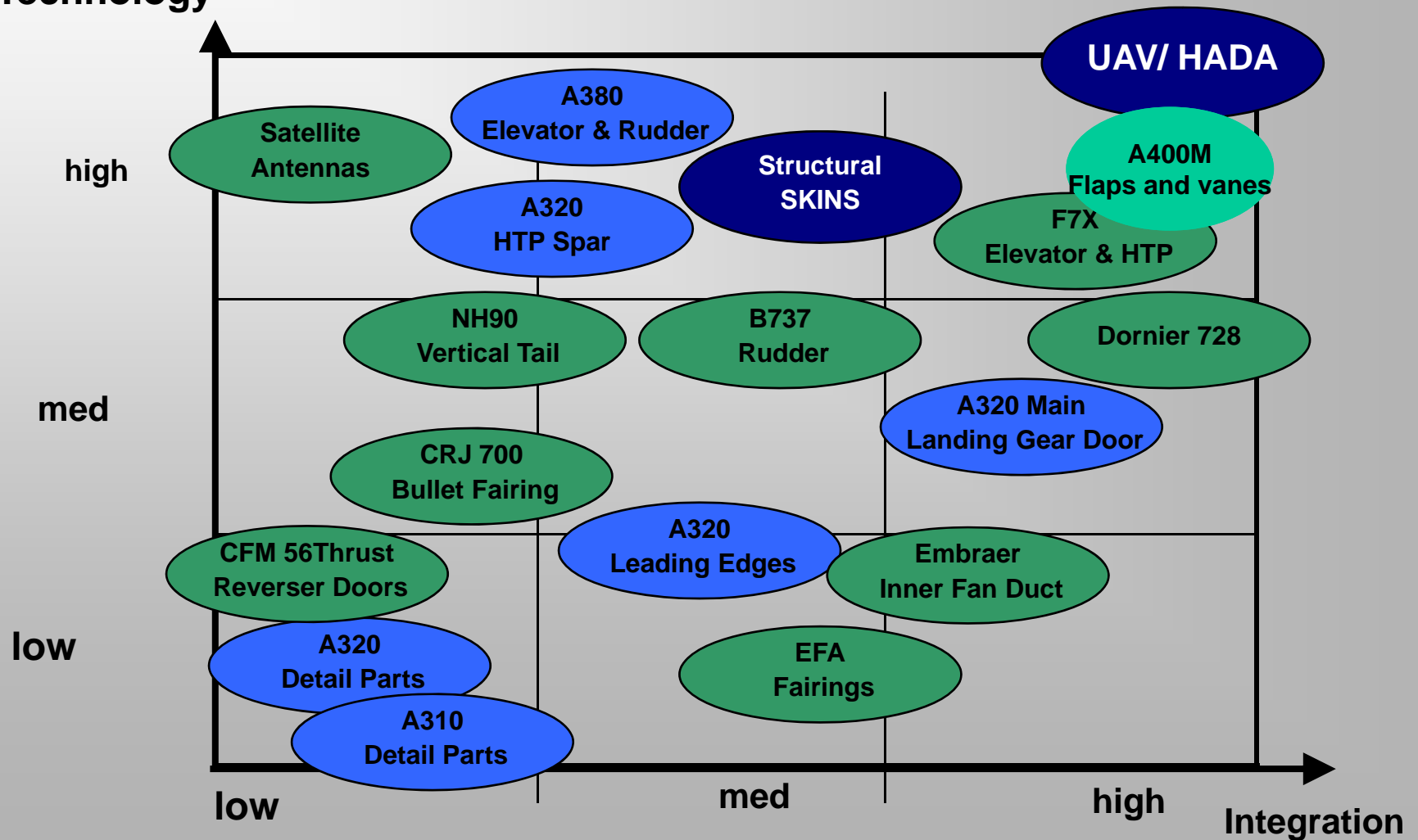
- Establish in 1965.
- Participating in aerospace projects since 1986
- Manufacturing Plants at Madrid & Valladolid
- 450 employees
- \$ 50 million revenues 2006



# Aries Strategy in UAV

Aries participation in UAV projects allow us to apply all our experience in aerospace

Technology







## **Aries Strategy in UAV**

### **Aerospace Projects Management**

- **Aerospace Specialist**
- **Wide Experience in Aerospace Projects**
- **Industrialization Capabilities**
- **High Technology Products.**

### **Industrial Capacity**

- **Industrial Organization**
- **Assembly & Manufacturing plants**
- **Capacity**
- **Competitive Costs.**

### **Technological Capacity:**

- **Strong R& D Commitment**
- **Engineering Capabilities**
- **Flexibility**
- **Large investment in equipment and technology.**

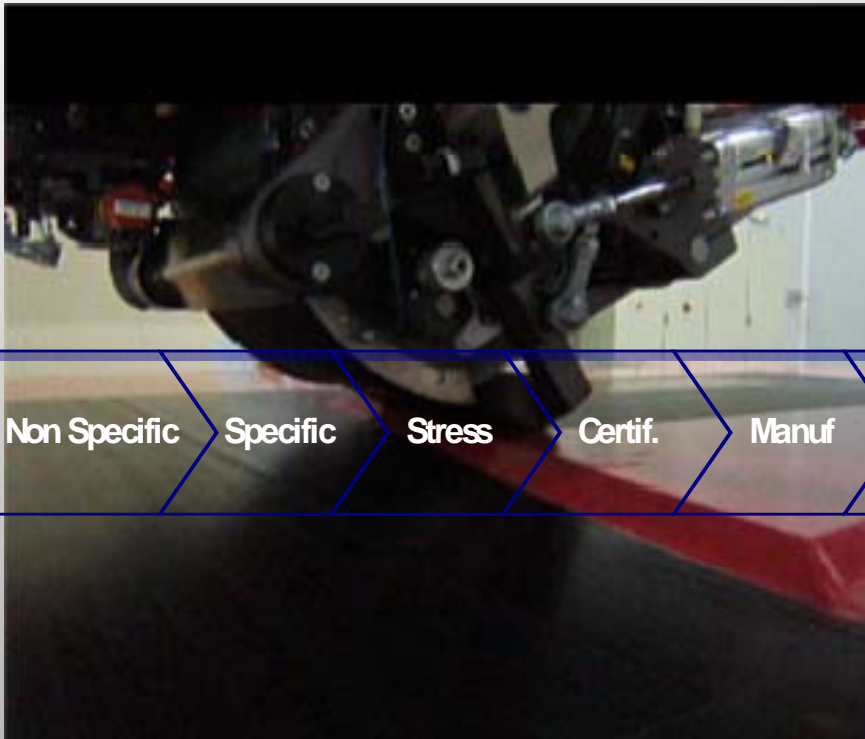
### **Company Strategy:**

- **Technology & Growth**
- **Develop new Products line: UAV Strategic Development**
- **Increase participation on Military Programmes and Collaboration with MoD.**
- **Strategic Agreement with Spanish INTA for UAV development**

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# Aries Strategy in UAV

**HIGH COMPOSITE TECHNOLOGY ALLOWS to OPTIMIZE AEROSTRUCTURES for COMPETITIVE COSTS & EFFICIENCY IMPROVING PERFORMANCES**



# PROGRAM PHASES

## PROJECT PHASE A

- EXTERNAL INPUTS
  - CUSTOMER REQUIREMENTS
  - MARKET ANALYSIS
  - AIRWORTHINESS RULES
- REDUCED SCALE FLIGHT PROTOTYPE (COLIBRI)
  - FLIGHT TESTS
  - TUNNEL TESTS
- FEASIBILITY STUDIES/DEVELOPMENT ANALYSIS
- INDUSTRIAL ORGANIZATION



## PHASE B

P  
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## **Phase A Program WBS**

**WP#1. Program Management**

**WP# 2. User Requirements Analysis: Actual and Future needs.**

**WP# 3. Alternative systems analysis in the market.**

**WP# 4. Requirements/Specification/Certification Rules.ISDEFE**

4.1 Technical, Logistic and Operative Requirements

4.2 Functional especifications

4.3 Technical especifications

**WP# 5. Preliminary Configuration. ARIES COMPLEX- INTA**



# Phase A Program WBS

## **WP# 6. Basic technologies Flight Segment.**

### 6.1 Mechanisms.

6.1.1 Wing Folding. **ARIES COMPLEX.**

6.1.2 Folding/Alignment Rotor. **CESA**

### 6.2 Powerplant. **INTA / UNIVERSIDAD LEÓN, PIGNALY.**

6.3 Aerodynamics and Flight Mechanics. Loads. **INTA./ARIES, MEDIA, CYO.**

6.4 Performances. Transition mode. **INTA/ ARIES, MEDIA y CYO.**

6.5 Electrical and electronic systems. **CTA/ Aries, INTA.**

6.6 Structural engineering **Aries/MEDIA.**

6.7 Manufacturing Engineering. **Aries/AITIIP, CTA**

6.8 Weights engineering. **Aries.**

## **WP# 7. Onboard Systems Technologies**

7.1 Navigation Guidance and Control. **INTA/UPC, CTA, AICIA.**

7.2 Data link. (9/07-30/11). **INTA/ CTA, INASMET, AICIA.**

7.3 Support to onboard systems.

7.3.1. Ground Control Station. **INTA.**

7.3.2. Automatic Landing/Takeoff. **INTA/ CTA, AICIA, GMV.**

7.3.3. Auxiliary equipment. **INTA/ CTA, VTI, GMV.**



# Phase A Program WBS

## WP# 12. Technological Demonstrator

### 12.1 Modifications

12.1.1 Configurationn

12.1.2 New Mechanisms. **ARIES COMPLEX**

12.1.3 Electrical and Propulsion mechanisms. **INTA**

12.1.4 Design and Manufacturing of Components

**Fenestron. INTA**

**Wing Folding Mechanism. Aries / AITIIP.**

**Wing. Aries / AITIIP**

**Powerplant. INTA**

**Control Surfaces. ARIES**

12.2 Navigation, Guidance and Control system **INTA. AICIA.**

12.3 Aerodynamic Characterisation. **INTA/ARIES, MEDIA, Tech Cons.**

12.4 Flight Test.**INTA.**

12.5 Wind Tunnel Tests. **INTA.**



# ARIES INVOLVEMENT

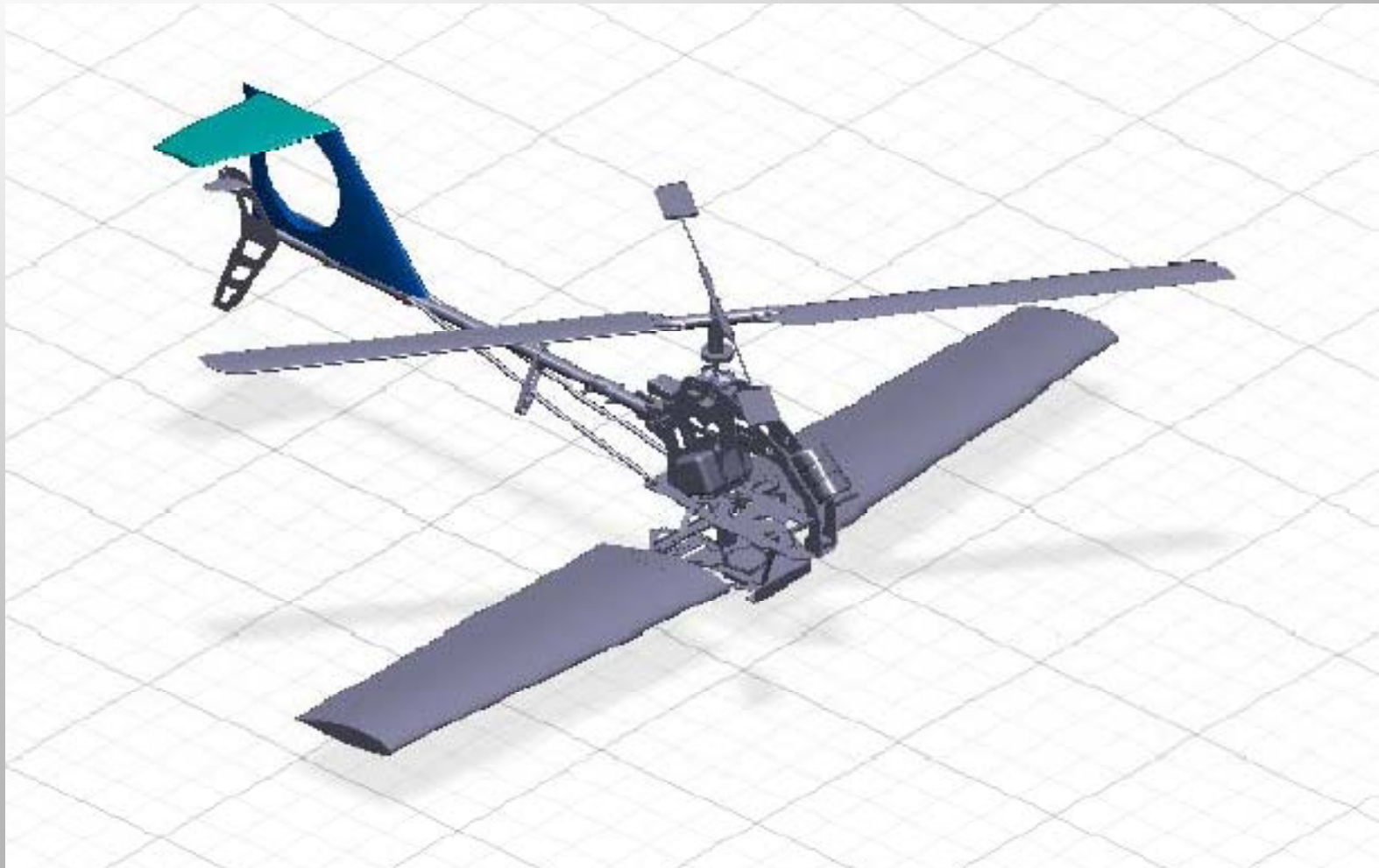
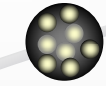
## **ARIES HAS TAKEN THE LEAD IN**

- PROJECT MANAGEMENT**
- STRUCTURAL AND MECHANISMS ENGINEERING AND MANUFACTURING**
- SYSTEM INTEGRATION.**
- RELIABILITY, ACCESIBILITY, MAINTAINABILITY. VEHICLE AIRWORTHINESS**
- **FINAL INTEGRATION AND DELIVERY**
- PRODUCT SUPPORT**

## **ARIES PROVIDES SUPPORT IN**

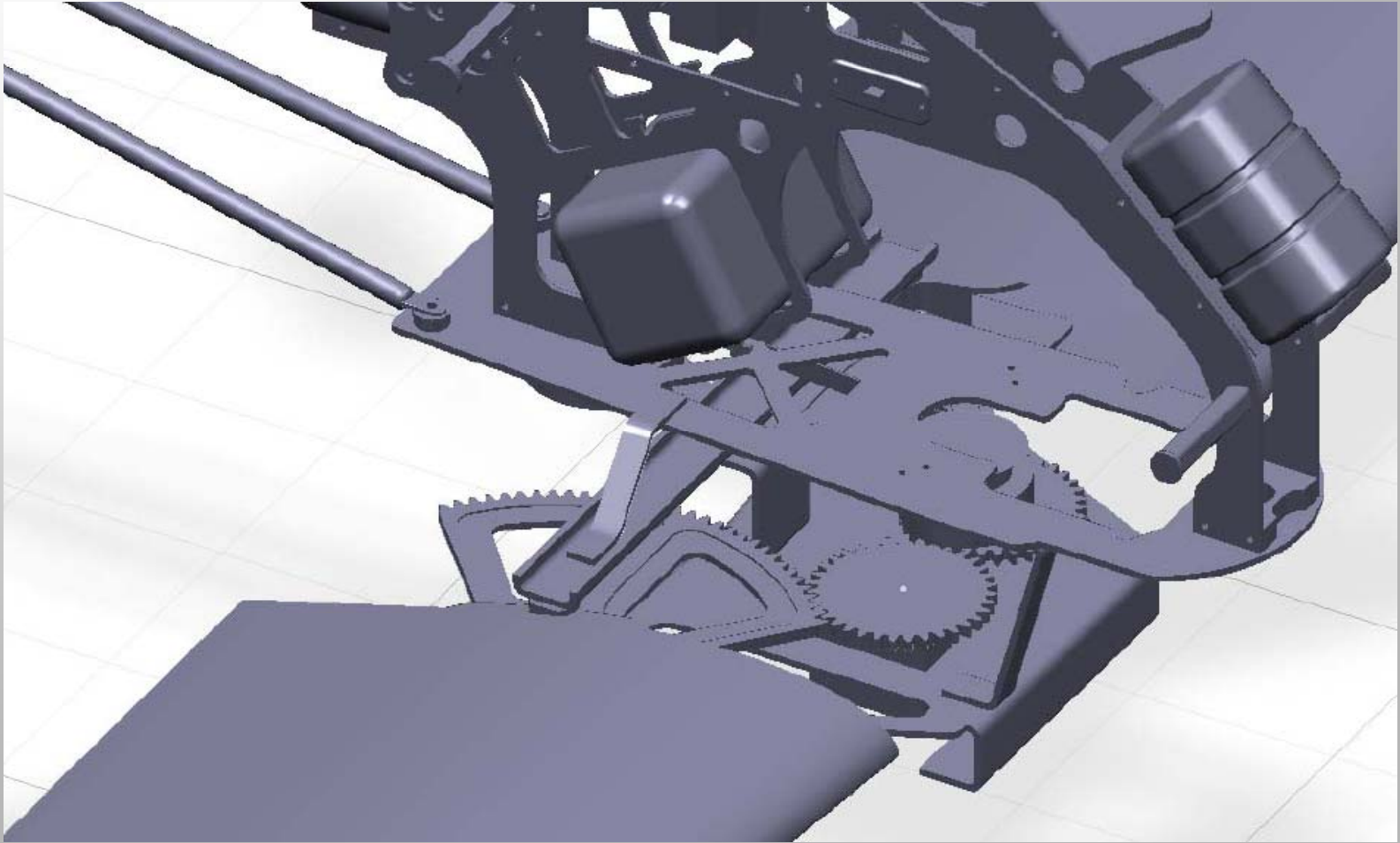
- AERODYNAMICS AND FLIGHT MECHANICS**
- SYSTEMS ENGINEERING**

# REDUCED SCALE FLIGHT MODEL





# DETAIL OF FOLDING WINGS MECHANISM



# CONCLUSIONS FOR HADA

- **HADA PROJECT** HAS BEEN APPROVED BY THE SPANISH MINISTRY OF EDUCATION AND SCIENCE (M.E.C) AND M.O.D AND WILL RECEIVE FUNDING FOR THE DURATION OF THE PROGRAMME
- INTA/AC INVITE INTERNATIONAL PARTNERS TO JOIN **HADA** FROM 2008 AND BEYOND:
  - OPPORTUNITIES: “SECURITY” 7th E.U PROGRAM AND “TRANSPORT INCLUDING AERONAUTICS”
  - BILATERAL AGREEMENTS WILL BE SOUGHT (EREA, EADS, EUROCOPTER, ETC..)

