ISRAEL AEROSPACE INDUSTRIES LTD

UAS AIRWORTHINESS CERTIFICATION
Ongoing Israel Aerospace Industries Experience

Military Airworthiness Workshop, Olomouc 5 June 2009

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MALAT DIVISION
Military Aircraft Group
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Presentation Topics

- Introduction
- IAI/MALAT Background Experience
  - Overall Flight Safety Trend
  - Israeli Flight Approval / Airspace Operations
  - IAI-MALAT UAS Worldwide Flight Approval Status
  - Heron Flight Approval Typical Processes
  - Heron$^{TP:}$ Towards full Type Certification
- Reflections & Perspectives based upon IAI/Malat Experience

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INTRODUCTION

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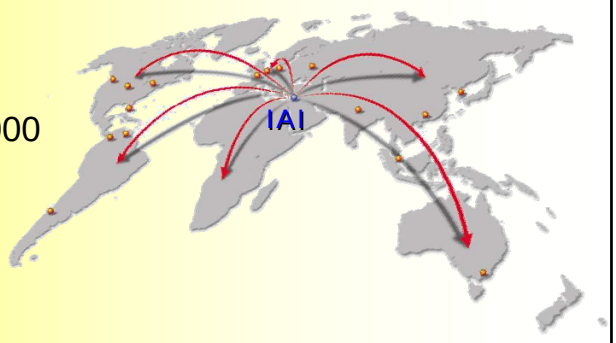
IAI at a glance

- Active on land, at sea, in the air and in space
- Current work force - 16,000
- 6 Groups & 15 plants in Israel
- Subsidiaries and offices around the world



IAI Groups

Military A/C Group	Commercial A/C Group	Bedek Aviation Group	Elta Systems Group Ltd.	Systems Missiles & Space Group	Engineering Group

IAI is in a period of accelerated growth

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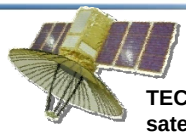
IAI's comprehensive technology base

Air & missile defense

Heron TP



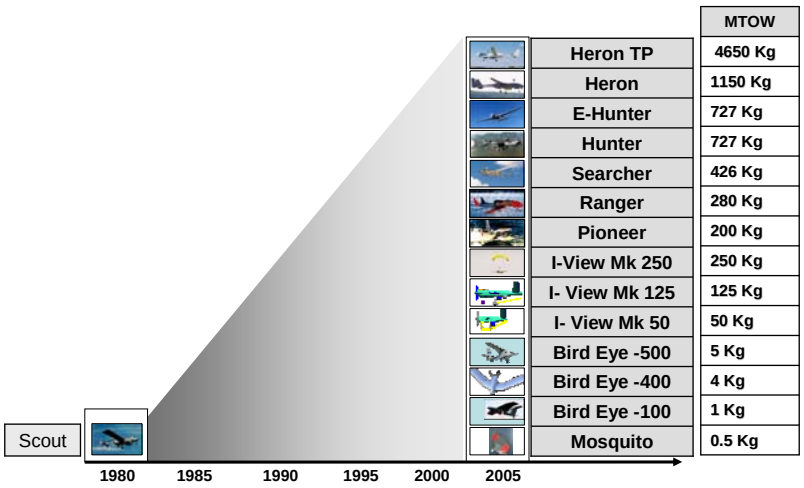
TECSAR satellite

- **Aircraft design and development**
- **Intelligence systems –**
  satellites, ELINT, COMINT, SAR
- **Sensors and seekers –**
  radar, SAR, electrooptical payloads, inertial components and systems for aircraft, ships, UAVs
- **ATBM/C³I, NCO/NCW –**
  anti-ballistic missiles; Command, Control, Computing and Interoperability; Net-Centric Operations / Net-Centric Warfare
- **Rockets and missiles –**
  satellite launch vehicles, precision-strike guided by radar, laser, optics and inertial sensors

- Composite aerostructures
- Unmanned systems –
  ground and maritime vehicles, robotics
- Space systems –
  LEO lightweight imaging and SAR satellites, GEO communication satellites

IAI annual R&D exceeds $900M

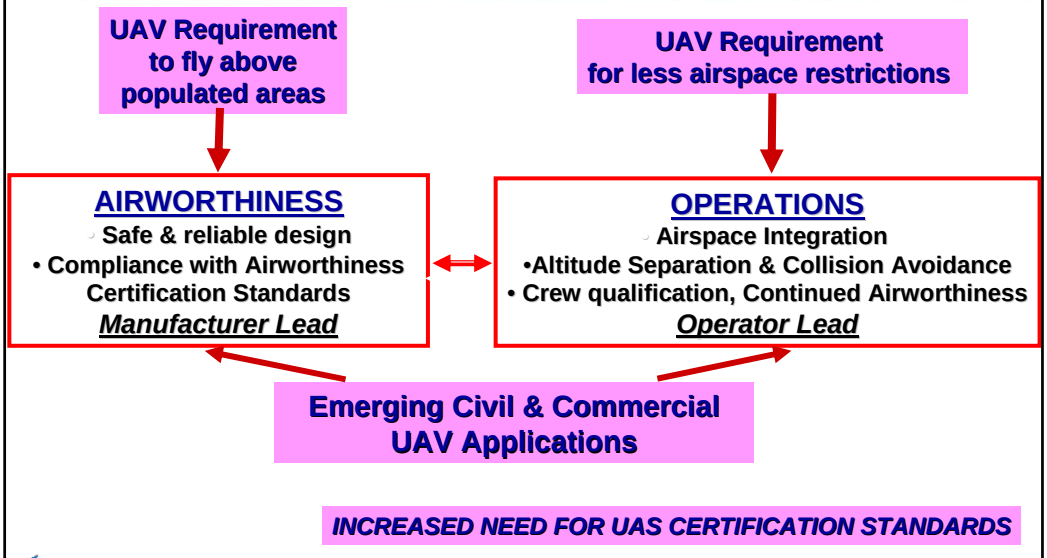
IAI/MALAT Product Range



IAI/MALAT Involvement in UAS Rule-Making Activities

- French DGA "USAR" Working Group on Military UAV Airworthiness Certification (2004)
- Deputy Leader of JAA-Eurocontrol UAV taskforce / Airworthiness Subgroup (2002-2004)
- EC Funded USICO Project (UAV Safety Issues for Civil Operations) 2002-2004, Airworthiness Work Package Leader
- DGA-IMOD Study on UAS Airworthiness & Airspace Integration (2001-2004)
- Israeli CAAI/Industry Working Group (2006-2007)
- Leader of Eurocae UAS WG73 Subgroup 2 – Airworthiness (May 2006-today)

Airworthiness & Operational Interrelated Factors



INCREASED NEED FOR UAS CERTIFICATION STANDARDS

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IAI MALAT BACKGROUND EXPERIENCE

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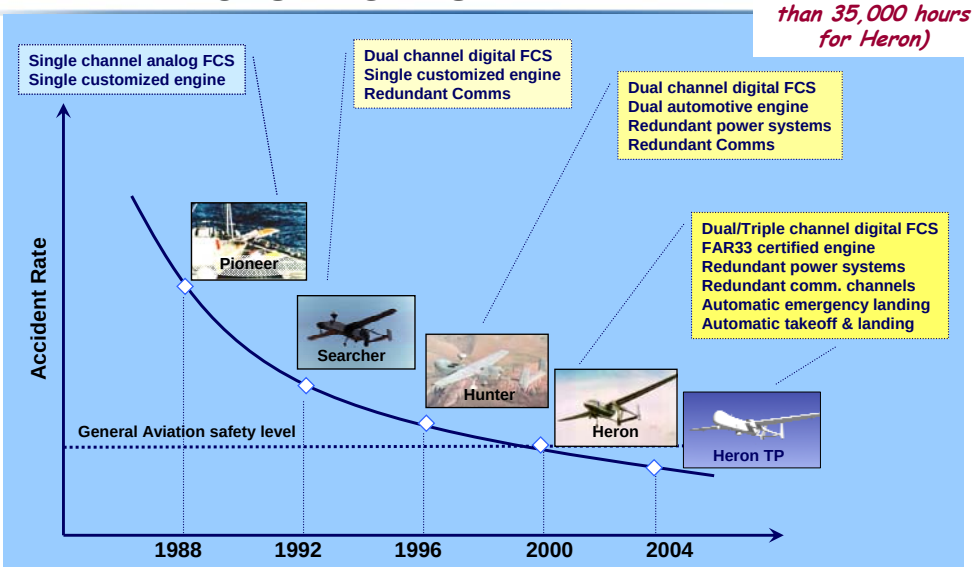
IAI MALAT UAS FLIGHT SAFETY TREND

450,000 flight hours (incl. more than 35,000 hours for Heron)



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ISRAELI UAS FLIGHT APPROVAL & AIRSPACE OPERATIONS

- **Military UAS Operations**
  - UA flights treated as any other manned aircraft flights
  - Military UAV operations under full military ATC control:
    - Flight safety\flight clearance under IDF flight safety board
    - Flight plan coordination
    - Ongoing Communications between UAV Ground Control Station and ATC
    - Altitude separation rules
- **Non military UAV Operations**
  - Special Committee appointed by the Director of CAAI (transition phase)
  - Civil UAV Operations coordinated with civilian ATC
  - Special UAS Type Permits granted to Heron, Searcher

Full Scale Military UAV Airworthiness Approval & Flight Clearance Processes

UAV System	Approval Authority / Process	Country	Year
Ranger ADS95	Swiss and Finish MOD (Qualification Process) 	Switzerland, Finland	1999-2000
B-Hunter	Belgium MoD (Military Airworthiness Process, Tailored JAR VLA & MIL STD-882C) 	Belgium	2001-2002
Heron	French MoD (DGA) (Technical Flight Clearance Reqts, Towards Type Certification?) 	France	2006-2008
Heron	Canadian MoD (DND) DND Airworthiness Regulation, “SIDM” validation 	Canada	2008

IAI/MALAT UAVs AUTHORIZED TO FLY IN EUROPE

B-Hunter flying over populated areas – Belgian North Sea shore

French Heron over France South

UAV Flight Permits (Military & Civil)

UAV System	Approval Authority	Country	Year
Firebird 2001	FAA CoA (Certificate of Authorization) 	USA Montana	1996
Eagle I / Heron	Swedish MoD & Swedish CAA 	Sweden (Kiruna Civil Airport)	2002
	Canadian MoD 	Canada (Tofino)	2003
	US DOD / FAA CoA UK MoD (JUEP exercise) 	US (Fallon) Canada (Batus)	2003
	Singapore Airshow "Premiere" 	Singapore	2004 & 2006
	Transport Canada/SFOC [MDA] 	Canada (Suffield)	2007-2008
	Australian CASA 	Australia	2008
	Spain Air Force (SpAF) 	Spain (Mixed Civil/Military Airport)	2008

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Typical Flight Approval Processes

French MOD (DGA)
SIDM- Eagle 1 (*)
Flight Clearance -2006

Australian CASA (Civil)
Special Certificate of
Airworthiness -2008

(*) EADS-IAI joint effort based upon Heron

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IAI/MALAT Heron UAS Basic Characteristics

- **Multi-payload system (250 kg)**
- **Basic Physical characteristics**
  - MTOW : 1150 kg
  - Wingspan : 16.6 m
  - Total length: 9.3 m
- **Basic Performance**
  - Max Endurance : 40 hours
  - Max Ceiling : 25000 ft
- **System features**
  - Rotax 914 reciprocating engine (certified)
  - Dual redundancies & back-up
  - LOS & SATCOM capability
  - Automatic Take-Off & Landing
  - State of the art Airspace Integration features
  - Anti-Icing option

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EAGLE 1 - Flight Safety Requirements

SAFETY EQUIPMENT REQUIREMENTS
- IFF equipment
- Anti-collision lights, Navigation lights, ground taxiing & landing light
- VHF/UHF Radio Relay
- Forward Looking (Panoramic) Camera

"FUNCTIONAL" REQUIREMENTS
- Communication failure handling
- Avoidance maneuver control
- Failure monitoring & indication
- Redundancies in critical system
- Flight Termination

FLIGHT SAFETY REQUIREMENTS

FLIGHT SAFETY JUSTIFICATION
- Flight Safety Report (Safety Hazard Analysis)
- Flight Readiness Dossier "DAV" (incl. procedures & limitations)

EAGLE 1 Airworthiness File / Key Elements

- System Hazard Analysis as a central piece
  - System (UA, Data Link, GCS) as a whole
  - Tailored MIL-STD 882C / Hazard Risk Acceptability Criteria
  - Uncontrolled Crash Risk Assessment
  - Single Failure Analysis (FMECA)
  - Potential failure conditions (severity vs. probability)
- Emergency Recovery Procedures (Loss Link, Engine Cut)
- Hardware & Software Qualification
- Propulsion System (based upon FAR 33 certified engine)
- Airframe structural justification
- Flight Manual / Check List
  - Normal & Abnormal Procedures
  - Limitations

Heron Flights in Australia
Civil Aviation Safety Agency (CASA) Approval (1/2)

Heron Flights in Australia
Civil Aviation Safety Agency (CASA) Approval (2/2)

Australian Government
Civil Aviation Safety Authority

SPECIAL CERTIFICATE OF AIRWORTHINESS

1. Nationality & Registration Mark	2. Manufacturer & Manufacturer's Designation of Aircraft	3. Aircraft Serial No.
VH-BJJ	Israel Aerospace Industries Ltd HERON-1 UAV	169

4. Airworthiness Category *Experimental*

4(a) Purpose: CASR 21.191(d) Exhibition

5. This certificate is issued pursuant to the Civil Aviation Regulations of Australia in respect of the above aircraft which is considered to be airworthy when maintained and operated in accordance with the Civil Aviation Regulations of Australia and any prescribed conditions set out as an Annex to this certificate.

However, the above mentioned aircraft **does not** meet requirements in Annex 8 to the Convention on International Civil Aviation (ICAO) and therefore the aircraft must not be operated in international airspace or over the territory of a foreign country without the special permission of that country.

Certificate issue date 13/05/2008 (day/month/year) — *Delegate of the Authority* ... (Signature) Dinh Nguyen (Printed Name)

6. Subject to suspension or cancellation, pursuant to the Civil Aviation Regulations of Australia, this certificate shall remain in force until the *expiry date below* or the aircraft ceases to be registered on the Civil Aircraft Register of Australia.

Certificate expiry date 20/06/2008 (day/month/year)

Note: • *this certificate is subject to conditions as listed on the annex dated 13/05/2008 attached to this certificate and forms part of this certificate.*

NO ENTRIES MAY BE MADE ON THIS CERTIFICATE EXCEPT BY A DELEGATE OF THE AUTHORITY OR AN APPROPRIATE AUTHORISED PERSON.

Any person finding this certificate should forward it to the Civil Aviation Safety Authority

CASA Approval including
- Heron Special Certificate of Airworthiness, (namely based upon System Safety Risk Assessment)
- IAI UA pilots and maintenance personnel
- Flights in Uncontrolled Airspace (Class G):

Operational Flight Features
- Flight plan to ATC
- ATC transponder / VHF Communications
- MPR (MMR) Air to Air Mode Credit
- Strobe Lights on / Forward Vision Camera
- NOTAM publication

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HERON^{TP} UAS

Towards full Type Certification

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IAI/MALAT Heron^{TP} UAS Basic Characteristics

- **Multi-payload system (1000kg)**
- **Basic Physical characteristics**
  - MTOW : 4650 kg
  - Wingspan : 26 m
  - Total length: 14 m
- **Basic Performance**
  - Max Endurance > 36 hours
  - Max Ceiling : 45000 ft
- **System features**
  - Certified Turboprop Engine
  - Triple redundancies & back-up
  - LOS & SATCOM capability
  - Automatic Take-Off & Landing
  - State of the art Airspace Integration features & Sense and Avoid Provisions
  - Anti-Icing option

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IAI/MALAT Heron^{TP} UAS : towards full Type Certification

- **Heron^{TP} designed toward Military Type Certification** based upon STANAG 4671
- **Initial successful Certification Review** performed by French DGA experts in the framework of recent SDM proposal (Dassault/Thales/IAI)

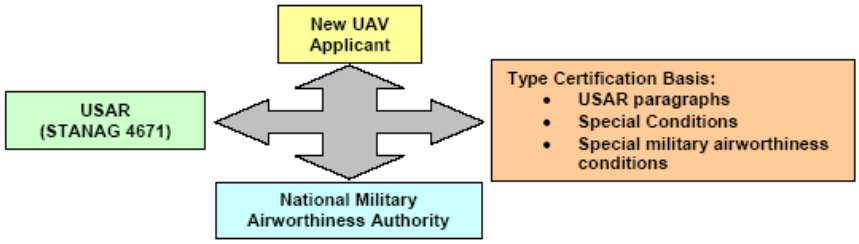

Figure 3: Type Certification Process for a new UAV

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UAS Airworthiness Certification Reflections & Perspectives

Reflections & Perspectives based upon IAI/Malat experience

UAS Rule-Making Process

- All Official Aviation Bodies **(Authorities, Standardization Institutions : FAA, EASA, Eurocontrol, ICAO, NATO, RTCA, Eurocae, WRCC etc…)** have now initiated UAS Rule-Making Activities.
- **UAS Industry** may / should play **an important role**
- **Harmonization process** (military/civil, national civil/national civil) is a **must** not only for **industry** but **also for authorities**

UAS Flight Clearance / Airworthiness Approvals

- **Becoming a reality,** as shown by **IAI/MALAT accumulated experience** from both **civil and military** authorities.
- Both **pragmatic approach** and **building confidence process** is necessary
- Requires **correct understanding** of **similarities and differences** between **manned and unmanned** certification processes.

Reflections & Perspectives based upon IAI/Malat experience

The future may be already today

- **Military UAS** are to be (already being) **used** in more and more for **civil / paramilitary applications,** before emergence of dedicated civil UAVs
- Military UAS to be designed according to airworthiness standards “negotiable” with / acceptable to CAAs
- **Airworthiness Certification Process** based upon
  - **Stepwise UAS Airspace Integration** Process
  - **Reasonable Operating Limitations**

An old Biblical Prophecy ?

“They shall beat their swords into ploughshares…”
“Ils transformeront leurs épées en socs de charrue…”
Isaie II, 4

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THANK YOU !

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