Trainer Aircraft
Upgrades and Modifications

Overview and New Approach

Dror Artzi, Business Development Director
RADOM Aviation Systems Ltd.
ISRAEL
Outline

• Operational Needs of Air Forces

• Installation and Integration of Aircraft Systems

• Aircraft Upgrades: The PC-9M as a Case Study
  - Advanced Avionics
  - Navigation Systems
  - Cockpit Arrangement
  - Stores Adaptation and Management Systems

• Flight Tests

• The Future of Upgrades
Operational Needs of Air Forces

• Air To Air Capability
• Ground Support Capability
• Operation In Dense Threats Environment
• Low Level Penetration Capability
Platform Requirements

• Simulate Modern Fighter Aircraft Characteristics
• Simulate Modern Advanced Fighter Cockpit:
  • Environment
  • Avionics
  • Communication
  • Armament
  • Sensors
  • Workload

To Enable Transfer of Skills
From the Training Environment to the
Front Line Aircraft

• Low Cost Affordable Platform
The Solution

OPERATIONAL REQ. + PLATFORM REQ. =

Fully Aerobatic Aircraft
With Armament Training and Stores Management Capabilities
With Advanced Avionics, Navigation and Communication Systems
With Self Defense System
With Advanced Cockpit Arrangement

For

Less Handling Skills and more Systems and Weapon Operations
All Incorporated on Low Cost Turboprop Aircraft
for both Preliminary and Advanced Training
Installation and Integration of Aircraft Systems
Installation and Integration of Aircraft Systems

Involves:

• Airframe Modification
• Structure Analysis & Tests
• Environmental Analysis & Tests
• Systems Installation & Integration
• Stores Adaptation
• Certification
Airframe Modification

AVIONIC BAY ARRANGEMENT

- A.I.U. - ARMAMENT INTERFACE UNIT
- MFD - ELECTRONIC UNIT (OPTIONAL)
- RA - RADER ALTIMETER KRA-405B
- VHF/UHF - XCVER, BOFORS 345-3 MODE 1
- VHF2 - CCVER KTR 908-02
- TACAN - KTU 709
- DIGITAL/DIGITAL CONV. - KDA689
- EFIS SYMBOL GENER. - SG 465 (TWO UNITS)
- INS/GPS - LN 100 LITTON

- XPNDR - MST67A
- AIR DATA COMP. (ADC) - KDC 481T
- ADF - KDF 806M
- NAV1 - KNR 634-10
- NAV2 - KNR 634-10
- MISSION COMPUTER - FV2000E (FV)
Environmental Analysis & Tests

• ALL THE EQUIPMENT TESTED FOR ENVIRONMENTAL CONDITIONS
  – VIBRATIONS
  – MECHANICAL SHOCK
  – ACCELERATION LOADS
  – TEMPERATURE CONDITIONS
  – HUMIDITY
  – EMI / RFI

• TO COMPLY WITH MIL-STD-810E REQUIREMENTS.
Structural Analysis

- **FINITE ELEMETS MODEL FOR COMPLETE AIRCRAFT**

- **FINITE ELEMENTS ANALYSIS OF ALL CRITICAL ELEMENTS, SUCH AS:**
  - ‘INS/GPS’ INSTALLATION
  - CHAFF AND FLARE INST.
  - TRAINING MISSILE INST
Stress Analysis.

AFT FUSELAGE – AVIONICS BAY
FINITE ELEMENT MODEL PRESENTATION.

F.E.MODEL : BEFORE MODIFICATION
F.E.MODEL : MODIFIED STRUCTURE
Stores Adaptation
Aircraft Upgrades: The PC-9M

- as a Case Study
Advanced Avionics

- Head Up Display (HUD)
- Up Front Control Panel (UFCP)
- Electronic Engine Display
- Air Data Computer
- Mission & Display Computer
- Hands on Throttle and Stick (HOTAS)
- Flight Data Recorder (FDR)
- Video Tape Recorder (VCR)
- INS / GPS Navigation System
- VOR / ILS / DME
- Stores Management System (SMS)
- UHF / VHF Communication System
- Radar Altimeter
- Intercom
Mission & Display Computer

HUD

UFCP

AAP
System Architecture

- HUD Repeater
- VTR
- Warning System
- WCP
- MC
- UFCP
- HOTAS
- LRF
- AIU
- RAD. ALT
- VOR/ILS
- DME
- ADC
- INS/GPS
- STBY GPS
- AOA
- ADF
- EFIS
- RADOM Aviation Systems

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Navigation Systems

- INS / GPS Navigation System
- VOR / ILS / DME / TACAN
- Back-Up GPS
Navigation System

GSP KLN 900

- Aircraft Power
- Altitude, way points insertion (MC)
- Fuel Management System

INS-GPS LN 100

- Aircraft Power
- Air Data from MC (Optional)
- ARINC 429

Connections:
- RS-422
- RS-232
- ARINC 429
- Mowing Map Data (MC)
Cockpit Arrangement

Before Upgrading
After Upgrading

- Up Front Control Panel
- Store Management System
- Hands On Throttle and Stick
- Head Up Display
- EFIS
- C&F Control Unit
- AAP

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Integrated Cockpit Management

- A Single Button Operation
- HOTAS Control
- Weapons and Display pre-sets
- RADAR/RWR Simulation (OPTIONAL)
Stores Adaptation and Management Systems
Stores Management System – Main Components

- Weapon Control Panel (WCP).
- Aft Weapon Display Panel (AWDP).
- Armament Interface Unit (AIU).

**WCP**

**BLOCK DIAGRAM**

- Stores Management System
  - Stores Management System
  - Weapon Control Panel (WCP)
  - Aft Weapon Display Panel (AWDP)
  - Armament Interface Unit (AIU)

**NOTES:**
- ACS Status =
  a. Weapon Select (Off, Gun, Bomb, Rkt)
  b. QTY and INT selection
  c. Cool and Uncage command.
SMS MAIN TASKS

- Weapon Delivery.
- Weapon select: armament station select, weapon type select, quantity of stores to release etc.
- Air to Air missile control: power supply, cool and uncage command.
- Gun control: fire signal, automatic and manual recocking, burst limit etc.
- Display and indication: presence of stores, station READY, guns’ remaining rounds etc.

- Armament safety provisions:
  - W.O.W. and W.U, M/A switches, SAFE mode etc.
- Emergency jettison of loaded weapon on stores.
Weapon System Training

• Emulated and actual weapon delivery capabilities
• Six wing stores allowing large variety of carriage and delivery capabilities:
  – Single and triple stores carriage on wing stations
  – All bombs delivery modes: CCIP, delayed CCIP, CCRP, DTOS
  – Guns and rockets carriage and delivery modes
  – Pods carriage (LRF, CFD, emulated A/A missile)
• Store Management System (SMS) allowing stores recognition and handling
## EXTERNAL STORES

### TRAINING CONFIGURATION

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>SYMBOLS</th>
<th>WEIGHT [KG]</th>
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<tbody>
<tr>
<td>BOMB RACK TYPE P65 (INCLUDING 3 BL-5 BOMBS)</td>
<td>![Icon]</td>
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<tr>
<td>0.5&quot; GUNPOD</td>
<td>![Icon]</td>
<td>116</td>
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<td>ROCKET LAUNCHERS LAU-7A</td>
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<td>LASER RANGEFINDER</td>
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<tr>
<td>TRAINING MISSILE / DUMMY MISSILE</td>
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<tr>
<td>FUEL (160 LITTERT)</td>
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NOTE: STATION LOADING 1 & 6 CAN CARRY TRAINING MISSILE (TM) OR DUMMY MISSILE (DM) OR LASER RANGEFINDER (LF) WITH ALL CONFIGURATION.
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<Diagram of a plane with various symbols and numbers>

June 21st 2001

RADOM Aviation Systems
EXTERNAL STORES
ADVANCED TRAINING/COMBAT
CONFIGURATION

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>SYMBOLS</th>
<th>WEIGHT [KG]</th>
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<tr>
<td>ROCKET LAUNCHERS LAU-19A</td>
<td><img src="image1" alt="Symbol" /></td>
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<td>CLUSTER BOMBS ATAP-300</td>
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<td>BOMBS MK 82 (250 Kg)</td>
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<tr>
<td>BOMBS MK 81 (125 KG)</td>
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<td>LASER RANGEFINDER</td>
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<td>TRAINING MISSILE / DUMMY MISSILE</td>
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<td>FUEL (160 LITTERT)</td>
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June 21th 2001
COMBAT CONFIGURATION

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</table>
Laser Range Finder Pod

Chaff & Flare Pod
PC-9M
FLIGHT TEST
PROGRAM
Preceding Activities

• Avionics system functional testing
• Ground tests:
  – geometrical and mechanical compatibility
  – weight and balance
  – system functionality
  – electromagnetic compatibility
Flight Test Sequence

i. Flight envelope expansion of the PC-9M in a clean loading
ii. PC-9M existing systems functional integrity and accuracy
iii. PC-9M new system validation
iv. Flight envelope expansion of new loadings:
   iv.a. Captive envelope
   iv.b. Release envelope
   iv.c. Weapon delivery accuracy
v. Operational test and evaluation
## Tests Envelope

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Limit Value</th>
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<tr>
<td>Weight</td>
<td>Clean</td>
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<td>External stores</td>
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<tr>
<td>Altitude</td>
<td>0-25,000</td>
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<td>0-25,000</td>
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<td>Airspeed</td>
<td>0-320K</td>
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<td>0-320K</td>
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<tr>
<td>Load Factor</td>
<td>-3 / +7</td>
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<td>-2.5 / +4.5</td>
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</table>
Instrumentation & Data Recording

FDR

Continuous Recording on 1.6GB PCMCIA

- A/C GPS (3D position).
- A/C data (pitch, roll, yaw, engine, etc....)
- Engine data (Enabling HUMS)
- Student actions.
- Synchronized VCR and Flight data
- Enables future Digital Video Recording (DVR) and the need for a VCR in the cockpit
- Dedicated PCMCIA cassette recording BIT results and system faults for technician usage
Video photography

- HUD camera
- 2 External CCD Cameras
- 3 VCRs (HUD, L-wing, R-wing)
- Portable Cam Walkman
- Playback between passes
- Video synchronized to Data
Flight Envelope Evaluation
Stall Speed Test
Methods of Test- Avionics System

- INS/GPS LN-100G system testing
  - static accuracy (ground)
  - ground taxi
  - in-flight accuracy tests
- Navigation display and control functions
  - En route
  - Landing
- Air to Ground modes
  - WCP function evaluation
  - designation and pointing accuracy
  - A/G modes and functions
- Air to Air modes
- Laser Range Finder Testing
- Training missile tests
Store Certification Test method

Pre-Flight engineering analysis

• Structure analysis
• Aerodynamic analysis
• Store drag effects
• Separation analysis

Captive carriage tests
  – flying qualities tests
  – performance and drag tests
  – loads and structural integrity
Store Certification Test method

• Employment tests
  – bomb release tests
  – data reduction method
  – gun fire and rockets launch tests
  – jettison tests

• Weapon delivery accuracy tests
Bomb Release Test
Mid Point
Bomb Release Test

Inner Point
Gun Pod Fire Test
Gun Pod Fire Test
Gun Pod Fire Test
HUD Display
Rockets Fire Test
Chaff & Flares Fire Test
The Future of Upgrades
Existing Trainers Fleet

• Quantities and costs

Piston engine trainers - More than 15,000 existing aircraft, with Purchase cost around 100KUSD. Operating cost around 150 USD per Hour.

Turbo-prop trainers - More than 6,000 existing aircraft. Purchase cost between 2-5MUSD. Operating cost 400-1000 USD per Hour

Jet trainers - More than 4,000 existing aircraft. Purchase cost between 2-15MUSD. Operating cost 1000-4000 USD per Hour
Shrinking Budget + Extended Operational Requirements

More Opportunities For Trainer Aircraft Upgrades
Enhanced Capabilities

- RADAR Emulation on MFD, HUD and HOTAS
- RWR Emulation on MFD
- Simulated A/A maneuvering targets (single, many, aggressive)
- Pre-set Scenarios controlled from the aft cockpit
- The limited flight envelop will be compensated by target speed.
Enhanced Cockpit

FCR Displays
HOTAS controls
HUD realistic presentation
Simulated A/A missiles
RWR simulated warnings

Instructor’s input:
• Simulated Targets
• Pre-defined maneuvers
• Target initial conditions
• RWR threats
• Simulated malfunctions
Just a Matter of Perspective:

The Dawn of The Era of Powered Flight

Wright Brothers Flyer – December 17 1903 At 10:35