ENABLING TECHNOLOGIES FOR MISSILES AND ROCKETS

Presented to
The 2nd Annual Missiles and Rockets Symposium

Presented by
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15 May 2001
### Report Documentation Page

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<th>Report Date</th>
<th>Report Type</th>
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<td>Approved for public release, distribution unlimited</td>
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### Supplementary Notes
Proceedings from Armaments for the 2nd Annual Missiles & Rockets Symposium & Exhibition, 14-16 May 2001 sponsored by NDIA. The original document contains color images.

### Abstract

### Subject Terms

### Report Classification
- unclassified

### Classification of Abstract
- unclassified

### Limitation of Abstract
- UU

### Number of Pages
- 19
Hardware in the Loop Simulation
A Powerful Tool for Simulation Based Acquisition

AMRDEC Provides
“World Class” HWIL Simulation to DoD / Industry / UK

Missile Development Cost

Test-Fix-Test

Model-Test-Model

Performance

Cost ($ Millions)

Live Test

Live Test

With Simulation

Without Simulation

Simulation Based Acquisition Reduces Development Cost
AGING MISSILE INVENTORY
**EVOLUTION OF MANEUVER & AVIATION MISSILES**

**NEAR-TERM**
(FY00 - 07)
- TOW 2A
- TOW 2B
- TOW F&F (INTERIM LIGHT FORCE SOLUTION)
- BASIC HELLFIRE
- INTERIM HELLFIRE
- HELLFIRE II
- LONGBOW HELLFIRE

**MID-TERM**
(FY08 - 16)
- MOD. H.F.

**FAR-TERM**
(FY17 – 25)
- COMMON CE MISSILE (Phase I)
- COMMON CE MISSILE (Phase II)

**TECHNOLOGY INSERTION THROUGH EVOLUTIONARY ACQUISITION**

- LONGBOW HELLFIRE

* Will be executed as part of CM Program.
COMMON MISSILE ENABLERS/LEVERAGING TECHNOLOGY

Platform Integration
- AMRDEC Common Launcher
- AMRDEC Common Fire Control
- Future Combat System (FCS)
- Legacy Platforms

Propulsion
- DARPA NETFIRES-Pintle, Dual Pulse
- AMRDEC FMTI-Gel
- NAVY- Pintle
- NASA - Non-Carcinogenic Fuel

Seeker
- AMRDEC FMTI (FPA)
- DARPA NETFIRES (SAL/FPA)
- ARDEC TERM (SAL/MMW/FPA)
- USAF - IR CM Hardening

Warhead
- ARDEC
  - Short Stand-off Warhead
  - ADV Warhead
  - GEN2 EFP

Aggressively Seeking All Technical Opportunities Across Government / Industry Spectrum
COMMON MISSILE PERFORMANCE PAYOFFS

Multimode Seeker Technology
- Selectable multi-spectrum sensors provide:
  - expanded operational effectiveness.
  - improved countermeasure performance.
  - greater adverse weather capability.
  - increased detection & acquisition.
- Enables sensor fusion technology (leap-ahead).

Controllable Thrust Propulsion
- Enables programmable mission profiling through fuel management.
  - scenario specific (range, target…).
  - tailorable flight profile (TOF).
  - extendable maximum range.
  - accommodates multi-launcher requirements (horizontal & vertical).
NetFires
System Concept

New Military Capability
• Immediate firepower
• 5x-10x kills per ton vs current ordnance
• Large zone of influence
• Multimode seekers
• In-flight targeting
• Duration weapon

Family of Missiles
• Loitering Attack Missile (LAM)
• Precision Attack Missile (PAM)
  (Others possible)

Designed for Deployability
• Logistic efficiency through containerization
• No platform or crew required

Low Cost
• Reduced personnel and vehicles
  - LCC reduced > 50%
• CAIV design process
• Commonality of components and assembly

Modular Vertical Launch
• Self locating / orienting
• Unmanned operation
• Not platform specific
• Can be vehicle appliqué

Containerized vertical launch provides immediate heavy firepower for early entry forces
Demonstrate two LOS/NLOS weapons

• Rapid Response PAM (“virtual direct fire”)
  – Short time of flight in “direct fire” mode (100s/20km)
  – Multimode terminal guidance
  – Low cost configuration
  – LOAL to 50 km

• Hunter Killer LAM
  – 3-D LADAR seeker w/ATR
  – Significant loiter
  – Multi-mission including BDA
  – Can update / coordinate PAM/LAM attacks

• Common features
  – GPS/INS guidance
  – Variable propulsion
  – Terminal guidance
  – Midcourse update through networked 2-way data link

• Platform independent launcher
• Container command and control

This fundamentally “reengines close combat.”
NETFIRES TECHNICAL CHALLENGES

• Networked Missile Communications:
  – Line-of-Sight and Range Limitations
  – Performance in Presence of Jamming Environment
  – Bandwidth Sharing
    • In intense communications environment (voice & data)
    • Imagery from Multiple Missiles in Flight

• Distributed automated fire control:
  – Coordination within FCS and Objective Force C3 Architecture
  – Techniques to employ networked NLOS remote robotic fires

• Cooperative engagements and target acquisition:
  – Methods for missile engagements
    • PAM + LAM, PAM/LAM counter air, PAM/LAM + UAV, LAM MTI, LAM counter ECM, AJ, etc
  – Optimization of Missile Sensor Package and ATR./ATA for targets in Clutter

• Command /Launch Unit (C/LU) and platform integration:
  – Techniques for integrating C/LU into the force
    • (Air assault, HMMWV, fighting vehicle, logistics and transportation)
Loitering Attack Munition for Aviation (LAM-A)
(NETFIRES DERIVATIVE)

- Networked RF Datalink for Fast Target Image Updates and BDA
- In-Flight Re-Direct / Target Override / Regret Avoidance
- Increases Helicopter Standoff: 40-60 Km
- Turbojet Engine - Optimized Speeds
  - Search / Combat ID
  - Loiter / Attack / BDA
- Networked RF Datalink for Fast Target Image Updates and BDA
- In-Flight Re-Direct / Target Override / Regret Avoidance
- FY03 Transition to Aviation Hunter-Standoff Killer ACTD
- Surgical Kill at Long Range
  - High Pk – Minimizes Collateral Damage
- Meets Joint Common Missile Block II Objective Loiter and MITL Datalink Requirements

- Joint Program with DARPA Networked-Fires LAM
- Ideal for MOUT Targets

Launchers:
- Apache
- Comanche
- Cobra
- Future Rotary Wing Platforms (Manned or Un-manned)

Gunner’s View
Command Post
Optional UAV with RF Relay
Territory
Terrain Obstacles
Targets of Opportunity

Helicopter-Launched Long-Range Precision Strike Munitions for the Objective Forces

Joint Program with DARPA Networked-Fires LAM

Ideal for MOUT Targets

AIAA 2000_McCorkle
Need for LAM-A based on High Apache Attrition in Wargame Analysis

- **40-60 Km Range** Covers Aviation Operational Area of Responsibility
- **Enhanced Objective Force Crew Survivability** – Greater Standoff Range for Helicopter Launch Platform
- **Non-Direct Flight Paths** for High Target Detection Probability
- **Minimized Timelines** for Targeting to Accelerate Battle Tempo
- **Built-in Loiter Capability** for Fast Targeting / Combat ID / BDA on Targets which may be Fleeting
- **Real-time ATA / ATR Target Cueing** Reduced Gunner Workload
- **Missile Imagery** Transmits to Launcher, Airborne Commander (A2C2S), or Forward Observer over Tactical FCS Network
- **Enhanced Loss Exchange Ratios**

LAM-A Serves as Eyes for Helicopter Forces in Areas Where Low-level Flight is High Risk.
FUTURE COMBAT SYSTEM 
AND THE 
FUTURE TRANSPORT ROTORCRAFT DILEMMA

• Future Combat System weight is determined by the C-130 lift capability (Max 20 tons)
• Critical vertical envelopment operations require the FCS to be transportable by rotorcraft
• Cost of the FTR for 20 ton FCS lift is estimated at $100 Billion
• Improvements to existing heavy lift rotorcraft (CH-47F +) will allow about 10 tons of lift
• Achieving a 10 ton FCS is strongly dependent on minimizing the weight of the main anti-armor weapon system
CKEM Approach

KE Solution for the Transforming Army

Lethality

- Lethal
- Direct Fire
- Small, Light
- Deployable
- Affordable

CKEM (Overwhelming Lethality)

CKEM (Penetrator Only)

LOSAT

Compact Size
- Half the size of LOSAT
- More Stowed Kills Per Platform (2X)

LOSAT
- 9.75 ft
- 177 lbs
- 0.75-4 km

CKEM - Goal
- 4-5 ft
- 85-100 lbs

AIAA 2000_McCorkle
Trade Study Hierarchy

TRADE SPACE

CONFIGURATIONS

UNITARY
- Boost-Coast
- Dual Pulse

STAGED
- Boost-Sustain
- Staged
- Staged-Sustain

INCREASING CONFIGURATION RISK

ENABLING TECHNOLOGIES

Lethality
- Novel Rod
- Component Effects

Propulsion
- Specific Impulse
- Burn Time
- Loading

Aerodynamics
- Diameter
- Control Scheme

G&C
- Navigation
- Mass

 trade space

AIAA 2000_McCorkle
Payload Specific Energy Comparison

P = Motor Propellant Weight Fraction

Ratio Propellant Weight to Payload Weight

Payload Specific Energy (MJ/kg)

0.45 Char Coeff

CKEM P = 0.75

CKEM P = 0.8

CKEM P = 0.85

CKEM P = 0.90

0.45 Char Coefficient
Thermal Efficiency Comparison

Fraction of Propellant Energy Converted To Payload Kinetic Energy

P=Motor Propellant Weight Fraction

Ratio Propellant Weight to Payload Weight

Thermal Efficiency

0.45 Char Coeff

CKEM P=0.75

CKEM P=0.80

CKEM P=0.85

CKEM P=0.90
Conclusions for CKEM vs Cannon for the FCS

• Given:
  – Munition weights per MJ of penetrator energy are approximately equal
  – Missile Launcher and Autoloader are comparable within a few hundred Kg

• Big Difference is:
  – Weight of the Cannon
  – Weight of the Cannon Mounting and Recoil System

• Demand for Robust Overmatch Capability and Transport Capability by C-130 and Heavy Lift Helicopter:
  – Places premium on Lightweight Armament System
  – Requires substantially greater than 120 mm Cannon equivalent performance
The Guided MLRS Role

- GMLRS is fired from C-130 Transportable HIMARS
- Use of FCS Vehicle Optional
- Highly improved accuracy (2.1 meters @ 49Km)
- Order of Magnitude Reduction in Logistics Burden
- Guidance Section is compact, simple, inexpensive

One Example: In Order to Defeat 24 MRL’s

- 88% Reduction in Rockets Required
- 86% Reduction in Launchers Required
- 86% Reduction in Logistics Burden

Cost

- $14.13M
- $2.26M

4 Electro Mechanical Actuators
Thermal Battery
4 Canards
Inertial Measurement Unit
Flight Computer
GPS Receiver

AIAA 2000_McCorkle
Summary

• Transformation is presently focused on reducing logistics burden via the Future Combat System
  – The role of aviation and the FTR is yet to be developed

• Precision Tactical Munitions must play a major role
  – Munition probable kills per logistic ton, plus high favorable Loss Exchange Ratios will be critical metrics
  – Precision Missile Systems are essential to achieve a “Responsive, Deployable, Agile, Versatile, Lethal, Survivable, Sustainable” Transformed Army