Role of the Government Laboratory in Shaping Weapon System Developments; An ARDEC Perspective

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Mr. Anthony J. Sebasto
U.S. Army ARDEC
Picatinny Arsenal, NJ
anthony.j.sebasto@us.army.mil
974-724-6198
• DoD Perspective on Government Laboratories
• ARDEC at a Glance
• Selected ARDEC Examples:
  – Technology
  – New Concepts
  – Manufacturing Processes
  – R&D Experimentation Facilities
  – Partnering with Industry and Academia
• Update on DoD Specialty Site for Guns and Ammo
• Summary
The DoD view of Defense Laboratories

**Functions**

- Infuse the art of the possible into military planning
- Act as principal agents in maintaining the technology base
- Avoid technological surprise and ensure technological innovation
- Support the acquisition process
- Provide special purpose facilities not practical for the private sector
- Respond rapidly in time of urgent need or national crisis
- Be a constructive advisor for Department directions and programs based on technical expertise (honest broker)
- Support the user in the application of emerging technology and introduction of new systems
- Translate user needs into technology requirements for industry
- Serve as an S&T training ground for civilian and military acquisition personnel
**Mission:**
Plan and execute integrated life-cycle engineering for the research, development, production, field support and demilitarization of munitions, weapons, fire control and associated items.

**By:**
- Maintaining strong working partnerships with our customers, other government agencies, industry, and academia
- Advancing our workforce core competencies
- Investing in state-of-the-art equipment and facilities
- Continuously improving our engineering and business processes

**To:**
- Conduct higher payoff technology research
- Demonstrate novel concepts shaping User requirements
- Develop/resolve manufacturing processes ensuring a robust industrial base
- Support our customers as a “Smart Buyer” addressing technical issues across the life-cycle
- Transition Government Intellectual Property to industry as required

One of the Major Players Shaping Weapon System Developments
Problem:
- Multiple contractors unable to meet requirements for M54A1
- Impacted urgent deliveries of 155mm M110A2 WP Projectile

ARDEC Solution:
- New manufacturing process to maximize production yield
  - Controlled flow with staged cooling process
- Transition equipment/process to industry (Note: Industry declined)
- Provided ~24,000 M54A1s to fulfill need with ~92% production yield

Current Status:
- ARDEC equipment and process successfully transitioned to Crane Army Ammunition Activity (CAAA)
- ARDEC & CAAA collaborated on continuous process improvement
- CAAA has now produced over 29,000 M54A1’s now with ~98% yield

Transition of a New Manufacturing Process to the Industrial Base
Solving Manufacturing Issues
Lead Azide (LA)

Problem:
- US stockpile only qualified source of LA used in all fuze detonators
- Stockpile 30-40 years old with serious quality issues
- Traditional production process inefficient and start-up unaffordable

ARDEC Solution:
- New low cost “On-Demand” continuous manufacturing process
  - Smaller/safer quantities (flexible, up to 1Kg/day per set-up)
  - Eliminates long-term storage and transportation safety concerns
  - Enables multiple production sites, limiting a single point failure

Current Status:
- Energetic Material Qualification expected Sept 2011
- Material successfully tested in various detonator products
- Transition agreements with Industry on-going

Revolutionizing Industrial Base Processes to Mitigate Single Point Failures
ARDEC Prototype Integration Facility (PIF)

PIF Process
- Requirements Identification and Validation with User
- Design
  - concurrent with Manufacturing Engineering
- Hardware Prototyping
- Qualification
- LRIP

Rapid Fielding
Technology Transfer

Field
Industrial Base

Materials & Manufacturing Science
- ASTM Titanium Welding Standard
- Pilots with Industry
- Lean Mfg Cell
- Meeting Urgent User Needs

Model-Based Design & Manufacturing
- Production Process Development
- Concept Development & LRIP

Meeting Customer Demands and Shaping Industrial Base Processes
Automated Direct/Indirect Fire Mortar (ADIM)

**Objective:** Develop a lightweight, remotely operated automated 81mm mortar expeditionary weapon system for multi-service, multi-mission use

**Russian Vasilek 82mm Mortar Weapon**
- Rate of fire: 180 rounds/minute
- 4-round “clips”
- Soft recoil (momentum cancellation)

**ADIM**
- US Gov’t system design
- Rate of fire: 30 rounds/min
- 20-round continuous feed
- Early weapon demonstrator successfully fired 400 rounds (hard stand and HMMWV)

Enabling Flexible Response Capability for Rapid Deployment Needs

Exceeds current 81mm range
Automated Direct/Indirect Fire Mortar (ADIM)

Recent Testing at YPG
Special Purpose Facilities
Armament Software Engineering Center

- AMC Chartered Life Cycle Software Engineering Center
- 30+year legacy of developing & sustaining SW-intensive systems to our warfighters
- 79,000 sq. ft. including SILs and High Bay
- Technology Innovation Leader – Winner 2004, 2006 & 2007 DoD Top 5 Program of the Year
- State-of-the-Art Facilities, Equipment, Tools
- CMMI Level 5 – 2006 First in DoD
- CMMI Level 5 – 2010 Sole Gov’t Organization to achieve; only Gov Org to successfully re-appraise

Major Goals:
- Reduce software life cycle costs by identifying and fixing defects closer to phase of origin (requirements, design, code, integration, test)
- Maximize software re-use through common requirements, common solution, and enhanced products and capabilities
Armament Software Engineering Center
Example of Re-use

Flexible Architecture Enabled 40-100% S/W Re-Use Across Multiple Applications

D120 Mortar FCS (MFCS)
- $9.59M / 36mo avoided

Paladin/Excalibur FCS
- $2.2M / 12mo avoided

MFCS (H) Heavy SW
- 2003

MFCS for Stryker
- $6M / 35mo avoided

ONR / USMC EFSS Demo
- $5.67M / 30mo avoided

LHMBC
- $2.4M / 18mo avoided

M119 Howitzer
- $6M / 31mo avoided

M777 LtWt 155mm
- $2.4M / 36mo avoided

Note: Does not include O&S cost savings

% Re-Use

Re-use Examples:
- MFCS Software
- MFCS for Stryker
- ONR / USMC EFSS Demo
- LHMBC
- M119 Howitzer
- M777 LtWt 155mm
S&T Investments Driving Transitions to the Field
Some Examples of Recently Fielded Items

90’s  00’s  10’s

March 2011

Precision Guided Mortar Munition (PGMM)
- Demonstrated extended range flight
- Demonstrated terminal accuracy against target

Anti-Personnel Landmine Alternatives (APLA)
- Responded to Presidential Directives
- Replaced hand-emplaced APL

Accelerated Precision Mortar Initiative (APMI)
- 120mm Smart Munition Sys
- 1-6 Km range with < 6m CEP

XM7 SPIDER Munition System
- Anti-personnel area denial munition
- Man-in-the-Loop System

Two New Smart Munitions Fielded Enhancing Warfighter Versatility and Effectiveness
Game Changing Technologies
Very Affordable Projectile Program

Forward Single-axis Canard for Control system

120mm VAPM

- Gov’t deployable flip-back fin design
- Successful Guide-to-Hit Test March 2010
  - 9.8m miss distance from target at 3.8km

155mm VAPP

- Same GnC with modified canards for 155mm
- Successful Guide-to-Hit Test July 2010
  - <10m miss distance at 16.4 km

105mm VAPP

- Gov’t folding fin design
- Preprogrammed maneuver test completed Dec 2008
- Guide-to-Hit test planned FY12

Gov't Owned Common Technology Approach Across Multiple Applications Available to Industry to Reduce Development and Unit Costs
Game Changing Technologies
Gun Launched MEMS Safe & Arm Fuzing

2000
2005
2010

MEMS S&A
MANTECH

MEMS S&A
M762A1 S&A for ARTY
Successful Gun Firing
96% size reduction

40mm MEMS S&A
Tech Transition Initiative
M433 M430

20/25mm Air Burst MEMs S&A

Technology and Manufacturing Development to TRL6 / MRL7

MEMS “G-Switch” Firing Test

MEMS Impact “G-Switch”

• Reduced S&A size/weight
• Higher reliability in graze & soft target impact
• Micro-Scale Firetrain demo’d
• Transitioned to PM 2QFY11

Pushing Emerging Technology for Performance, Reliability, and Affordability Gains
Game Changing Technologies
Scalable Effects Technologies

• More engagement options
  – Improves Weapon Effectiveness
  – Reduces Collateral Damage
• Enables military operations in complex environments
• Demonstrations planned Oct/Nov

Current Munitions

Scalable Munitions

Collateral Region
Lethal Region

Control Collateral Region
Enhance Lethal Region

Focused Effect
Large/Small Area Effect

Demonstrations to help User/Developer community shape path forward
Special Purpose Facilities and Equipment
Nanomaterials Manufacturing

**Induction Plasma Reactor**

- $10M in facility investments since 2002 enabling:
  - Material quantities for Applied Research
  - Development and characterization of manufacturing processes for nano and nano-structured materials
- Processing capabilities for both metals and ceramics
- Up to 1Kg/hr yield
- Full characterization capability of nanomaterials
- Multiple Government, Industry, and Academia customers/partners for material supply and applications

**High Energy Milling**

Examples of materials made:
- Aluminum/Al alloys
- Copper/Cu alloys
- Magnesium/Mg alloys
- Silicon
- Tungsten
- Iron
- Boron
- Boron Carbide
- Cerium Oxide

Accelerating R&D of Nanotechnology Applications to Armaments
Special Purpose Facilities and Equipment
Nanomaterials Consolidation

**Sintering Technology**

**Isostatic Pressing**

Enabling:
- Near-Net Shape components
- Lighter and stronger materials
- Functionally Graded Materials
- Improved output performance
- Manufacturing process development

Reduced Manufacturing Times/Costs for the More Complex Components
High Performance M&S
Some Examples

- Product Improvements (e.g. Cluster Munition Replacement)
- Novel Designs (e.g. VAPP)
- Production Flaw Behavior Analysis (M20A1)
- Failure Investigation (M789)
- Failure Investigation (M777)

Setting the Standard on Applications of High Performance M&S
Solving and Preventing Anomalies Across the Life-Cycle
Special Purpose Facilities
ARDEC Soft Catch (SCat) Gun

- Non-destructive, soft catch of gun fired conventional, and smart munitions, sensors, guidance, and fuzes
- Current configuration fires any 155mm projectile
-Eliminates expensive and time consuming iterations of open-range, destructive testing
- Reduces experimentation/testing costs (>80%)
- Over 380 shots to date supporting both Government and Industry customers (IMUs, GPS, Full-up GnC, Variety of Electronic Components, etc.)

Unique Facility Significantly Reducing Development Cycle Times/Costs

- ~$10M investment
- Operational in 2007
Partnerships with Industry and Academia
Key Government-Consortia Relationships

- Promoting strong partnership with industry/academia
- Section 845 Other Transaction Agreements (OTA)
- Includes Traditional and non-traditional industries and academia

**DoD Ordnance Technology Consortium (DOTC)**
- Established 2004
- ~100 members in the National Small Arms Technology Consortium
- “Supplier Push” emphasis on investments
- >$23M awarded since inception

**National Small Arms Center (NSAC)**
- Established 2004
- ~170 members in NWEC
- “Customer Push” emphasis on investments
- >$500M awarded since inception

Increasing Business Efficiency and Effectiveness of Solutions to Meet Warfighter Needs
Update on DoD Specialty Site for Guns and Ammo

- Involves moves from both Navy (240 positions from NSWC and NAWC) and Army (43 positions from ARDEC (Adelphi)); Picatinny Navy element part of NSWC-IHD
- $71M construction on new/renovated facilities nearing completion
- Service Guns and Ammo labs will begin to examine approaches to increase effectiveness and efficiency of weapon system developments in a Joint environment

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<thead>
<tr>
<th>Navy</th>
<th>Army</th>
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<tbody>
<tr>
<td>Auto Gun Test Facility</td>
<td>Fuze Engineering Complex</td>
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<tr>
<td>Turret Facility</td>
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<td>Minor Caliber Weapons Lab</td>
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<td>Packaging, Handling,</td>
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<td>Storage and Transportation Center</td>
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Summary

• Functions of the Service labs driven from the top
• ARDEC is helping shape weapon system developments across our life-cycle engineering mission
  • Game-changing technologies and concepts for performance, reliability, functionality, and affordability
  • New/updated manufacturing processes ensuring a robust industrial base
  • New facilities reducing development and production times and costs
  • Promoting strong partnerships
  • Answering the call of our many acquisition customers!
• DoD Specialty Site for Guns and Ammo provides the setting for more collaborative developments and business process enhancements across DoD
• Gov’t Labs: One of the Major Players Shaping Weapon System Developments