

Report Documentation Page				Form Approved OMB No. 0704-0188	
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1. REPORT DATE SEP 2005		2. REPORT TYPE		3. DATES COVERED 00-00-2005 to 00-00-2005	
4. TITLE AND SUBTITLE Lightweight Handheld Mortar Ballistic Computer				5a. CONTRACT NUMBER	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER	
6. AUTHOR(S)				5d. PROJECT NUMBER	
				5e. TASK NUMBER	
				5f. WORK UNIT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Army Armament Research Development and Engineering Center,SFAE-AMO-CAS-MS,BLDG 162 South,Picatinny Arsenal,NJ,07806-5000				8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)				10. SPONSOR/MONITOR'S ACRONYM(S)	
				11. SPONSOR/MONITOR'S REPORT NUMBER(S)	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES CROSSTALK The Journal of Defense Software Engineering, September 2005					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 2	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			

Lightweight Handheld Mortar Ballistic Computer

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While supporting Operation Iraqi Freedom, the enhanced functionality of the Lightweight Handheld Mortar Ballistic Computer (LHMBC) in providing updated ballistic solutions to fire missions for infantry mortar combat units has proven to be a great success. With the LHMBC, mortar fire direction centers are computing faster, more accurate ballistic solutions to fire missions for 60mm, 81mm and 120mm mortar systems.

Today's fast-paced battlefield requires responsive and accurate weapon platforms to stay ahead of enemy forces. The XM 32 Lightweight Handheld Mortar Ballistic Computer (LHMBC) incorporates advances in digital electronics and software capabilities that make it a superior fire control system. Jointly, the product manager for Mortar Systems (PM Mortars) and the U.S. Army Research and Development Center (ARDEC) located at Picatinny, N.J., have developed and are fielding the LHMBC.

The LHMBC provides the soldier, for the first time, a lightweight handheld fire control system with an integrated Global Positioning System (GPS) to determine his/her location, and a modem that allows for digital communication within the fire support network. The system calculates ballistic solutions to fire missions and provides fire support coordination measures with functionality, including digital missions (Grid, Polar, Shift, Adjust Fire, Fire For Effect, Immediate Suppression, Immediate Smoke, Precision Registration) with methods of control (At My Command, When Ready), six simultaneous missions, three final protective fires, priority targets, fratricide checks, check fire, single safety fan with multiple segments, digital meteorological data, and digital variable message format messages to/from the Advanced Field Artillery Tactical Data System and the Forward Observer System.

This software-intensive LHMBC program makes use of corporate software and system engineering methodologies and processes that have led to the successful accomplishment of several key milestones, including urgent materiel release and fielding of 36 LHMBC systems. The Urgent Materiel Release of

LHMBC Vers. 1.1 to 3/2 Stryker Brigade Combat Team was approved in August 2004 to satisfy an urgent U.S. Army requirement in support of Operation Iraqi Freedom.

The LHMBC urgent fielding effort was particularly unique. To meet accelerated fielding, PM Mortars used ARDEC as

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a central location to load software onto a host computer, assemble all hardware components into kits, and stage all fire control equipment for delivery. The program strategy calls for fielding incremental functionality improvements with two additional releases scheduled for fielding in the third quarter of 2005 and fiscal year 2006. Incremental development continues

through fiscal year 2006 with planned fielding through fiscal year 2008.

This incremental fielding strategy best meets the user's urgent requirement. The Incremental Development Life-Cycle Model dovetails with this strategy, thus it was the model of choice for the LHMBC software development team. During the planning phase functionality was prioritized by the user. This input was used by the PM to determine the functionality of each software version.

LHMBC Development

LHMBC is one of several spin-offs of the Mortar Fire Control System (MFCS), also developed in a joint effort between PM Mortars and ARDEC. Initially fielded in fiscal year 2003, the MFCS program was selected for an Army's research and development award in 2003; its architecture is covered by a government patent (pending). Leveraging the flexible MFCS architecture and reusing approximately 80,000 lines of MFCS code (40 percent of the total LHMBC code) resulted in an estimated cost savings of \$2.4 million and a schedule savings of 18 months for the LHMBC program. The system also uses the Mortar Ballistic Kernel that is common to both MFCS and LHMBC (an additional 40,000 lines of reused code).

The LHMBC software application program is hosted on a Ruggedized Personal Digital Assistant (R-PDA) that replaces the aging M23 Mortar Ballistic Computer. The R-PDA hardware is basically a commercial off-the-shelf device acquired through the PM Common Hardware and Software (CHS) located at Ft. Monmouth, N.J. Choosing available hardware saved development time, maintained commonality of fielded hardware, and reduced cost by utilizing economies of scale in quantities purchased through PM CHS. The hardware is produced by Tallahassee Technology Incorporation of

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Florida and provided through the PM CHS contract.

The LHMBC incorporates an innovative fire control software application that provides enhanced capability to the mortar operator by reducing response times; providing enhanced accuracy; and allowing the mortar to be more mobile, responsive, and lethal. This advanced fire control system provides effective means to rapidly disseminate relevant data among weapon and command-and-control systems. The LHMBC provides unique capabilities available for the first time ever on a R-PDA, with a significant weight reduction from eight pounds to three pounds at one-eighth the size of previously fielded lightweight fire control systems.

The ability to quickly react to an urgent need and the continuing success of this program is due to the well-defined proven practices and processes used to develop, manage, and integrate the software into a state-of-the-art R-PDA computer. The in-house software development and system integration team used tools such as Lean Six Sigma processes and procedures, earned value management, and the Software Engineering Institute's (SEI) Capability Maturity Model® Integration (CMMI®) Level 3 software development process to enhance overall efficiencies and quality of the software.

The Build Team and Processes

The LHMBC integrated product team (IPT) consisted of in-house members along with members from the test and user communities, including actual soldiers who operate the system. The test and user communities were involved early during system development to address any concerns or issues and reduce the number of potential changes and rework required.

The user provided valuable feedback on screen layouts, content, and sequencing of messages to process missions. To ensure the soldiers have a reliable product, intensive qualification testing was performed in the Systems Integration Lab, including formal qualification testing and an initial operational test. Furthermore, an independent validation and verification (IV&V) process was also employed prior to the product baseline. During the IV&V process, physical and functional configuration audits were done on the software.

The industry- and government-sponsored CMMI process improvement model provides a set of best practices that address product quality, productivity, performance, cost, and stakeholder satisfaction. CMMI Level 3 compliance ensures



The U.S. Army's XM 32 Lightweight Handheld Mortar Ballistic Computer is a significant improvement over the M23 Mortar Ballistic Computer – its predecessor – because it is lighter, provides digital connectivity to the fire support network, processes ballistic solutions faster, and provides system location through an integrated Global Positioning System.

that all CMMI-defined process areas at Levels 2 and 3 are implemented. CMMI Level 3 processes are addressed in the following areas: requirements development, technical solutions, product integration, verification, validation, integrated project management, risk management, decision analysis and resolution, and integrated supplier management. The ARDEC effectively implemented these process improvement efforts in the development of the LHMBC.

The ARDEC Armament Software Engineering Center (SEC) has experienced success in implementing CMMI Level 3-compliant processes for software-intensive system projects such as the LHMBC. This success has led to the current process improvement initiative that resulted in upgrading the ARDEC Armament SEC's Organizational Standard Process to CMMI Level 5 compliance. The LHMBC and other current software-intensive system developments undertaken at ARDEC Armament SEC now implement the CMMI Level 5-compliant Organizational Standard Process.

LHMBC and the other Level 5-compliant development efforts are scheduled to be appraised in the fall of 2005 by SEI approved appraisers. Software development and process tools such as Embedded Visual Studio for C++, Visual SourceSafe, and processMax were utilized for the LHMBC software development process. These tools assisted the developers and the IPT members with data man-

agement, configuration management, and process management.

The LHMBC is a significant improvement over the M23 Mortar Ballistic Computer because it is lighter, provides digital connectivity to the fire support network, processes ballistic solutions faster, and provides system location through GPS. The combined efforts of the PM Mortars and ARDEC teams, along with support from our test and user community, has led to the successful development of the infantry's first fully digitized lightweight mortar fire control system, thus making the infantry mortarman an integral part of the digitized battlefield. ♦

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