Future Combat Systems (FCS) Creates Cannon and Mortar Synergy

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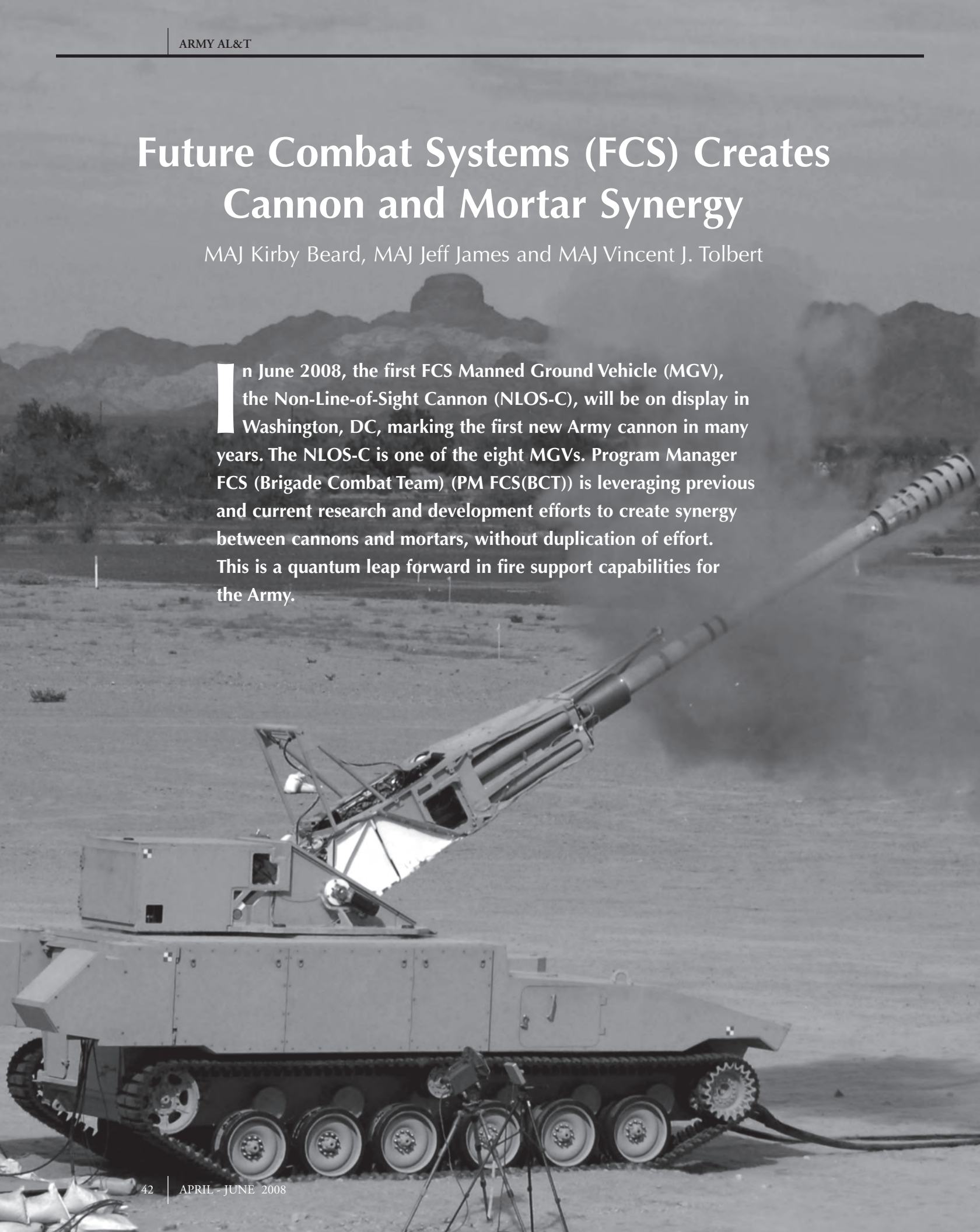

In June 2008, the first FCS Manned Ground Vehicle (MGV), the Non-Line-of-Sight Cannon (NLOS-C), will be on display in Washington, DC, marking the first new Army cannon in many years. The NLOS-C is one of the eight MGVs. Program Manager FCS (Brigade Combat Team) (PM FCS(BCT)) is leveraging previous and current research and development efforts to create synergy between cannons and mortars, without duplication of effort. This is a quantum leap forward in fire support capabilities for the Army.

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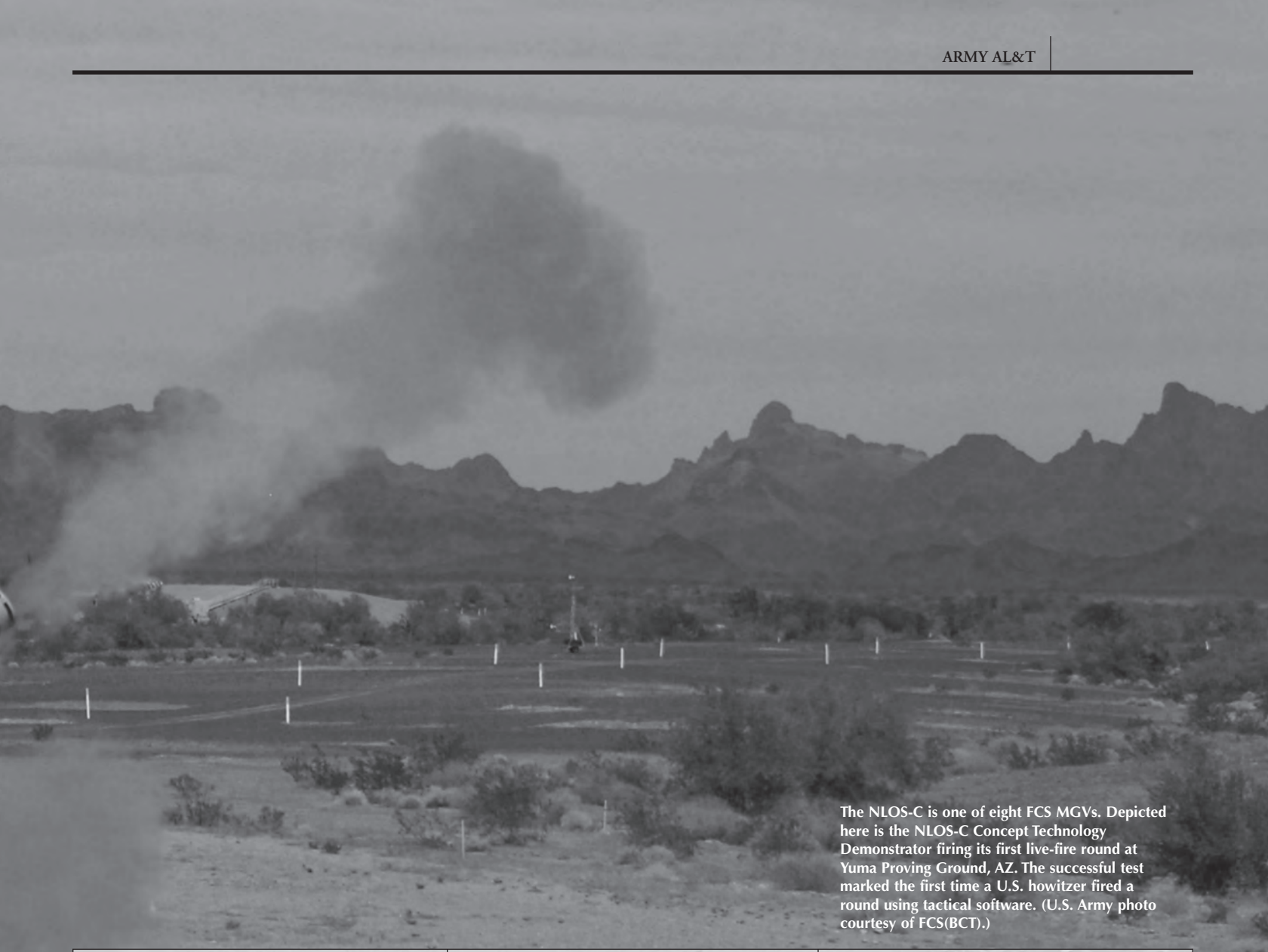

The NLOS-C is one of eight FCS MGVs. Depicted here is the NLOS-C Concept Technology Demonstrator firing its first live-fire round at Yuma Proving Ground, AZ. The successful test marked the first time a U.S. howitzer fired a round using tactical software. (U.S. Army photo courtesy of FCS(BCT).)

The NLOS-C is the organic indirect fire support component of the FCS(BCT) System-of-Systems (SoS), with a high level of commonality with other MGV variants. NLOS-C provides networked, extended-range, responsive and sustained precision attack of point and area targets. It has a fully automated armament system firing a suite of conventional and special purpose munitions to provide a variety of effects on demand. The NLOS-C will be able to move rapidly, stop quickly and deliver lethal first round effects on target in record time.

The NLOS-Mortar (NLOS-M) is the organic indirect fire support component of the FCS(BCT) SoS, also with a high level of commonality with other MGV variants. Like the NLOS-C, the NLOS-M will transform mortars' traditional role on the battlefield by providing deadly, accurate and responsive short- to mid-range fire support critical to Soldiers in the close fight. Very similar to NLOS-C, NLOS-M uses automation to index, present and fire rounds with minimal manual touching or adjusting by the crew. Above all, the crew performs its fire mission under the protection of armored vehicles.

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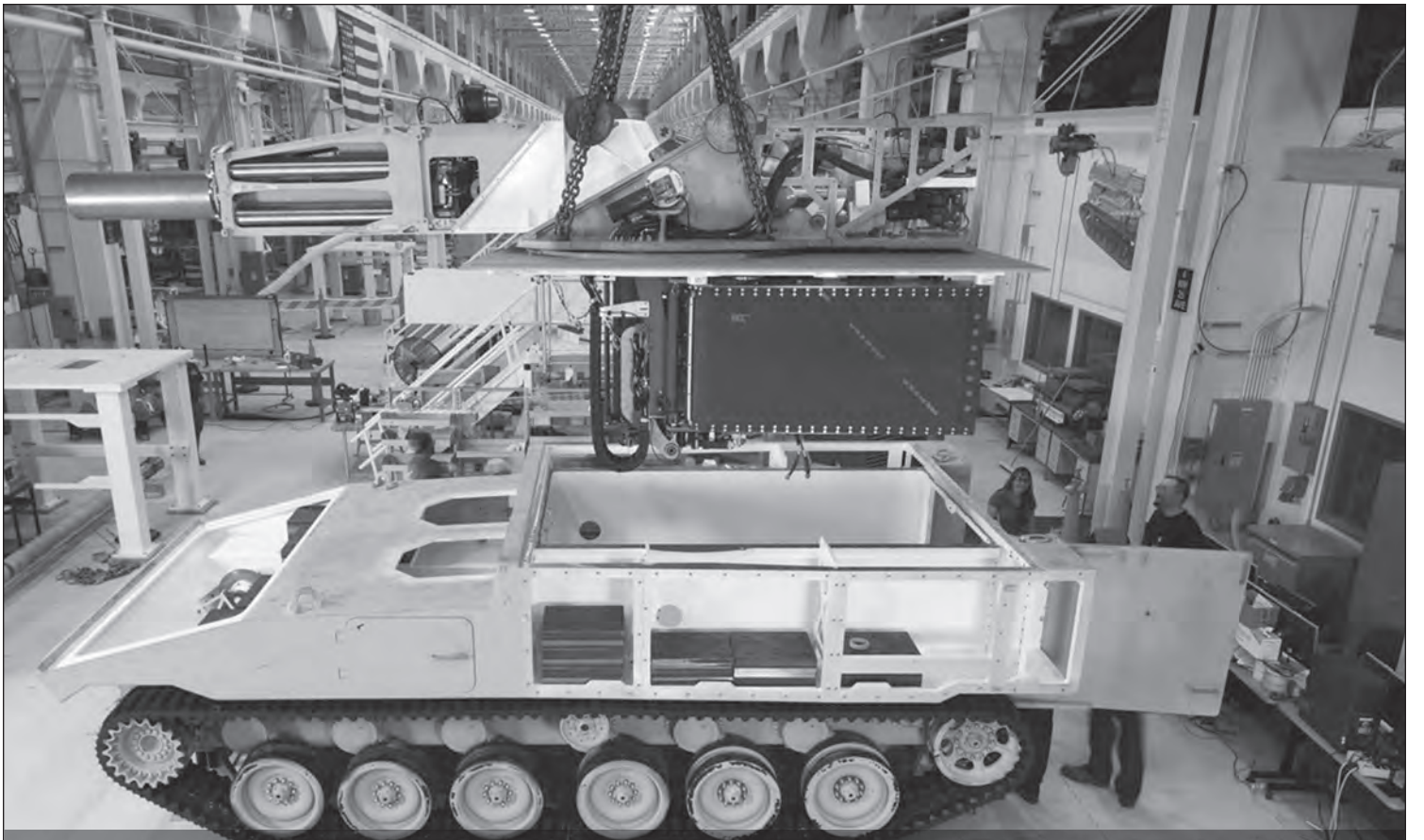
Improved Lethality Through Automation

For many years, the artillery and infantry fire support communities have worked toward automating the fire support chain links to improve fire support by increasing both speed and accuracy to deliver fires when and where the maneuver commander desires.



NLOS-C firing platform initial assembly at BAE Systems in Minneapolis, MN. The NLOS-C will have a high level of common parts with the other FCS MGVs. This will be a long-term benefit in the NLOS-C's sustainability. (Photo courtesy of BAE Systems.)

Automation increases fire support responsiveness by decreasing the time required for computing technical firing solutions, and emplacing and displacing firing platforms. Most importantly, automation decreases manpower requirements to facilitate smaller crews or allows crew members to focus on other Soldier tasks. Lastly, automation makes multiple-round, simultaneous-impact missions possible, allowing a single firing platform to create effects on target that previously required several platforms firing in coordinated unison.

During the late 1990s, the Crusader program was envisioned as the greatest leap forward in completing the process of automating the fire support chain. When the program was terminated in mid-2002, a short-term bridge contract was put in place to migrate the technological developments and workforce into the FCS program, which was approaching Milestone B in mid-2003. This proved valuable as the NLOS-C has remained the leader in terms of FCS MGV variant development.

NLOS-C Features

The NLOS-C contains several automated components that improve its battlefield effectiveness when compared to manual systems prevalent today in the Current Force. These automated features allow the NLOS-C to achieve an accurate and unprecedented sustained rate of fire of up to six rounds per minute, including a 4-round multiple-round, simultaneous-impact capability, while also reducing the self-propelled howitzer crew from four to two.

When the NLOS-C receives a fire order, the Automated Fire Control System (AFCS) onboard computer permits the real-time automated calculation of accurate firing data, and the refinement of firing data to hone accuracy on subsequent rounds and subsequent missions. The Projectile Tracking System is a phased array radar that measures the muzzle velocity and ballistic trajectory of each round as it departs the cannon, then feeds the information back into the AFCS, allowing the NLOS-C to adjust firing data to obtain greater round-to-round and mission-to-mission accuracy based on the minute ammunition differences and the battlefield conditions experienced.

The NLOS-C uses a Global Positioning System and an Inertial Navigation System to remain constantly informed of its own location, permitting rapid and precise emplacements and eliminating the need for external aiming reference points such as a collimator or aiming poles. The lack of external aiming references and the ability to move and rapidly

reemplace also facilitates frequent survivability or tactical movement displacements.

The NLOS-C ammunition handling system is fully automated and comprised of several subcomponents that enable firing without manual handling. The propellant and projectile storage magazines make all onboard ammunition combinations available on any fire mission. When the fire mission data is calculated, the propellant and projectile shuttles transfer the fuzed projectile and propellant to the loader/rammer assembly. Along the way, the Enhanced Portable Inductive Artillery Fuze Setter automatically sets the electronic fuze to the desired setting. If a rocket assisted projectile (RAP) is selected, the fuse is set and the RAP plug removed automatically prior to loading.

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The loader/rammer assembly loads the projectile into the breach, uniformly and consistently rams the projectile and loads the propelling change. The breech closes and the laser ignition system ignites the propellant on cue. Following firing, the breech opens and the Automated Cooling and Cleaning System (ACCS) sprays a water/glycol mixture to extinguish residual propellant embers, clean the laser window, wet the breech seal and cool the propellant chamber.

The NLOS-C system demonstrator began firing in August 2003 and has fired more than 2,200 rounds, testing and validating that a 155mm cannon could be fired from a lightweight platform. It also demonstrated the concept of a hybrid electric drive propulsion system. (See Page 36 of the October-December 2007 edition of *Army AL&T* Magazine for a related story.) This propulsion system will be used in all FCS vehicles. The system demonstrator was also used to mature the ammunition handling system, the laser ignition, the optimized muzzle break and the ACCS. The NLOS-C firing platform fired its first round in October 2006 and has fired more than 1,200 rounds, testing and validating the objective ammunition handling system, platform stability, ammunition compatibility testing and sustained rate of fire.

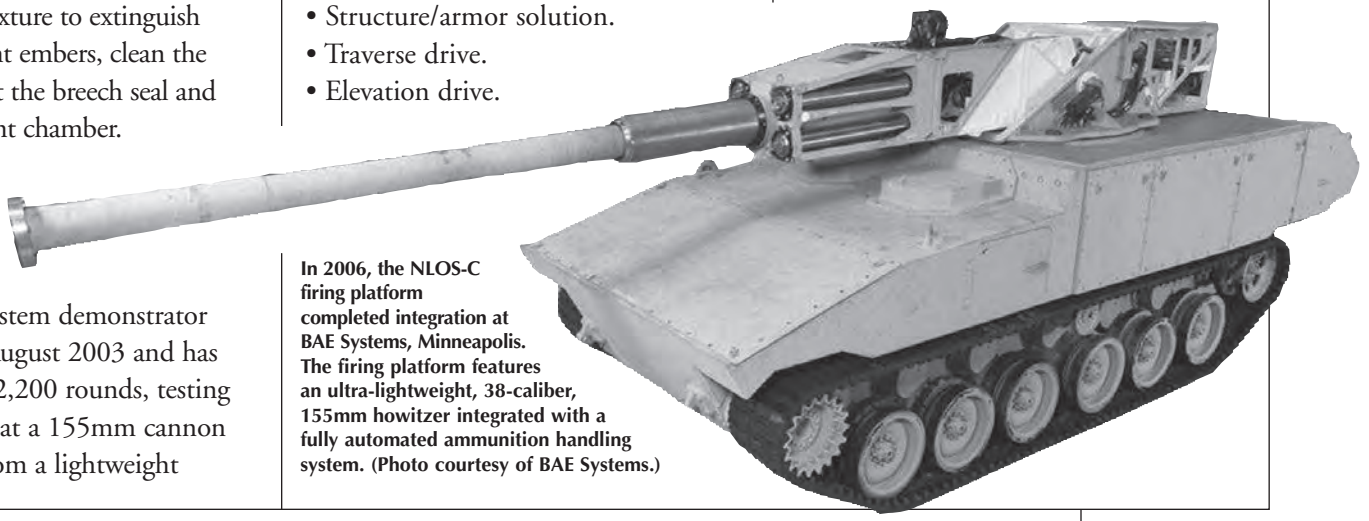
In the leader/follower concept, when a work product is common to NLOS-C and NLOS-M, NLOS-C provides the personnel to provide the product for both variants. However, if the common work requires a modification for NLOS-M specific needs, personnel are shared between variants to improve efficiencies. The leader (NLOS-C) provides:

- Common turret.
- Common traverse bearing.
- Structure/armor solution.
- Traverse drive.
- Elevation drive.
- Common recoil components.
- Automated Mortar Cooling System/ Automated Cannon Cooling System.
- Common components.
- Electrical architecture.
- Common installations (although most are a result of the FCS commonality requirements).
- Kitted approach.

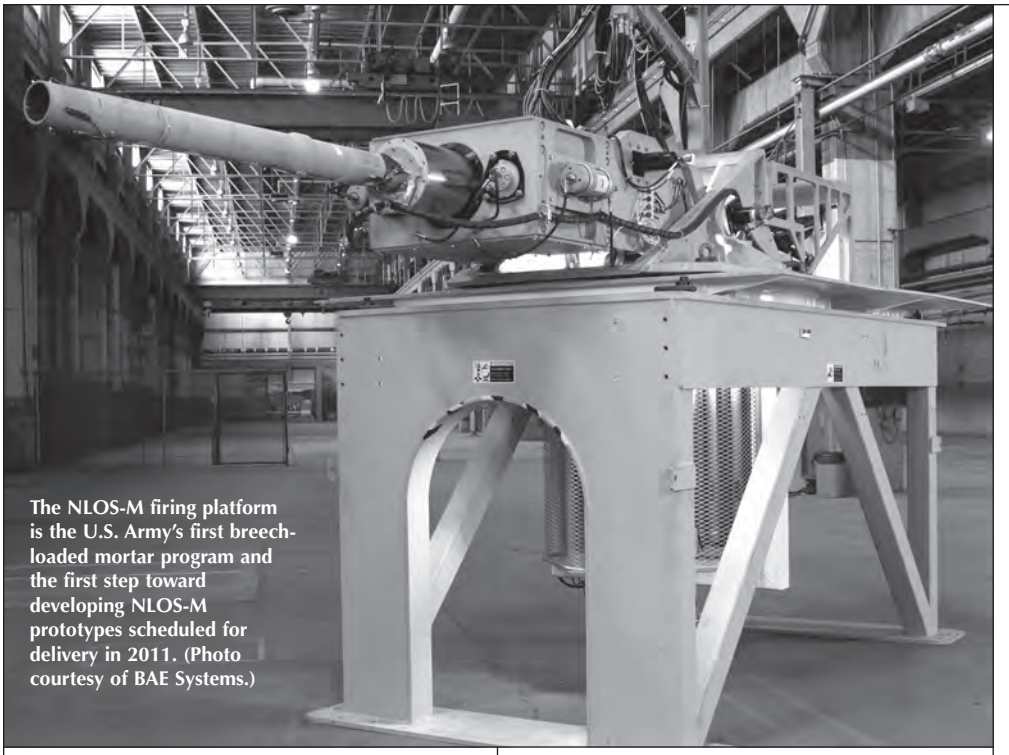
As noted above, common design groups and common analysis groups are staffed by the same personnel by NLOS-C and NLOS-M to leverage learning and design work that can be used by both vehicles. The follower (NLOS-M) modifies:

- Turret for NLOS-M-specific gun mount.
- Recoil elements for recoil length and quantities.
- Structure/armor solution (possibly).
- NLOS-M-unique requirements for kitted approach.

Both systems have two fully automated carousel-type magazines. The NLOS-C has one magazine to hold 155mm fused projectiles and another to hold Modular Artillery Charge System (MACS) increments. During firing, the handling system retrieves one projectile from the projectile magazine and the appropriate number of MACS increments from the charge magazine. The projectile is automatically uploaded



In 2006, the NLOS-C firing platform completed integration at BAE Systems, Minneapolis. The firing platform features an ultra-lightweight, 38-caliber, 155mm howitzer integrated with a fully automated ammunition handling system. (Photo courtesy of BAE Systems.)



The NLOS-M firing platform is the U.S. Army's first breech-loaded mortar program and the first step toward developing NLOS-M prototypes scheduled for delivery in 2011. (Photo courtesy of BAE Systems.)

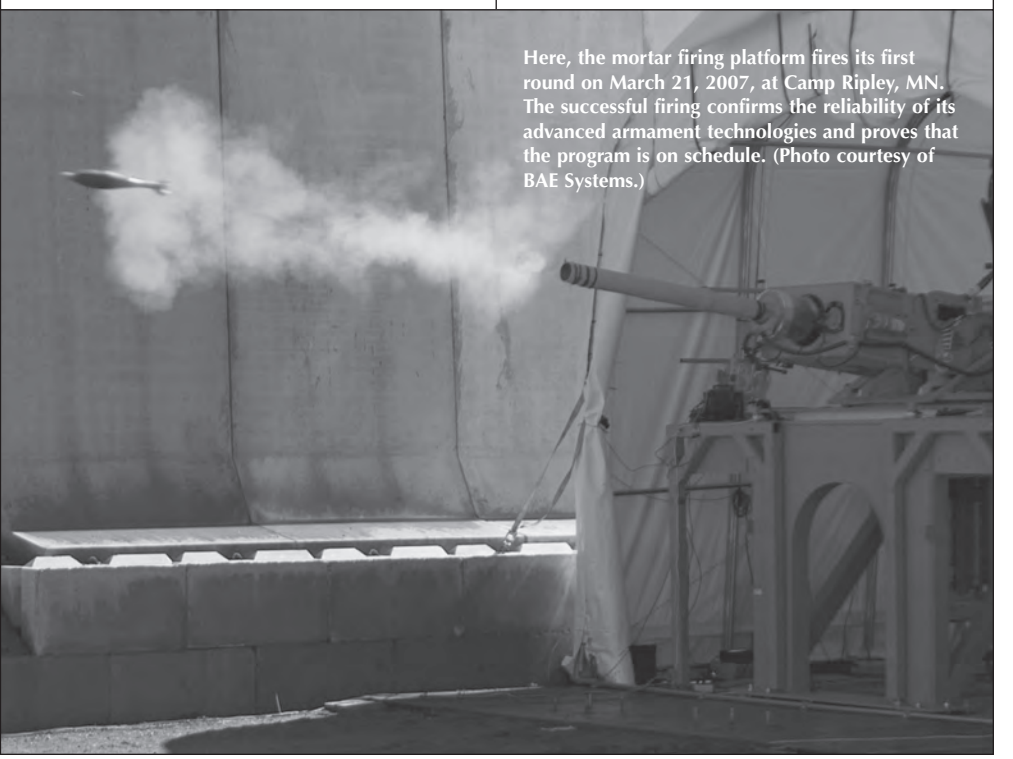
and rammed into the breech, followed by the MACS increments. The NLOS-M loading process is nearly identical to the cannon, except for an additional step requiring the Soldier to set the fuse and charge on the mortar round before it is automatically loaded into the breech. The two NLOS-M magazines are very similar to the NLOS-C in how they operate and, in many cases, the components are scaled versions of the cannon design. No modifications to the 120mm mortar rounds are required to fire from an NLOS-M. The magazine is taller to accommodate future precision-guided munitions currently under development. The automation has made fire missions more efficient, faster and less labor-intensive. Eliminating the physical handling of ammunition enables high rates of fire delivering ordnance at 16 rounds per minute for planned missions with minimal physical effort by the crew.

Another common capability designed into the system that helps the NLOS-C and NLOS-M sustain high rates of fire is the ACCS for the NLOS-C and the Automated Mortar Cooling System for the NLOS-M. The two are practically identical to one another in design and function to keep the tube cool and clean, enabling high rates of fire for long durations. Keeping the tube clean also prolongs the amount of time NLOS-C or NLOS-M can stay in the fight until they have to pull off-line to do a thorough cleaning. With this capability, Soldier workload is reduced and system lethality and responsiveness are increased.

The NLOS-C and NLOS-M structures are comprised of the following:

- Turret structure
- Traverse bearing
- Top plate
- Hull structure
- Crew bulkhead and door
- Rear door
- Side egress door
- Crew hatches
- Turret and chassis armor panels
- Gun cover assembly

With the exception of the differences in the crew bulkhead and door due to the difference in the number of crew, all of the structure components are the same or nearly identical between the two variants. This is because the structure's basic behavior when loaded under gun firing or mobility load cases is fairly consistent between the variants, allowing the turret structure, traverse bearing, top plate and hull structure to use the same structural load paths and interfaces. To ensure structural integrity, collaboration with



Here, the mortar firing platform fires its first round on March 21, 2007, at Camp Ripley, MN. The successful firing confirms the reliability of its advanced armament technologies and proves that the program is on schedule. (Photo courtesy of BAE Systems.)

NLOS-C firing platform being assembled at BAE Systems in Minneapolis. The first NLOS-C prototype will be completed in June 2008. NLOS-C prototypes will enter Army evaluations in 2008 and 2009. (Photo courtesy of BAE Systems.)

external centers of excellence allowed for the development of load-carrying members that efficiently support either the cannon or mortar loads. Further leader/follower benefits have also been pursued in ballistic survivability and compartmentation since the basic requirements and behaviors of the structural components for those functions are so similar. Additionally, since a common structural layout and similar interfaces were achieved, hatches, armor panels and doors are all very similar between the variants, further enhancing leader/follower benefits through consistent accessibility and maintainability approaches.

The NLOS-M firing platform was unveiled in March 2007, just 6 months after the NLOS-C firing platform began testing. To date, the NLOS-M firing platform has fired more than 600 rounds, testing the functionality of the firing platform and collecting engineering data for further NLOS-M prototype development. Current testing will document residue build-up, interior ballistics and tube heating. The testing is also being used to mature the in-bore air regulation system (IBARS) to become a major NLOS-M function. IBARS will allow the NLOS-M to fire rounds at low elevations and allow the crew to eject a misfired round from the tube without having to go through extensive and time-consuming misfire procedures — a unique ability not found on traditional mortar systems.

The NLOS-C and NLOS-M are greater than 80 percent common across the two platforms and with the MGV common chassis. The high level of NLOS-C/NLOS-M hardware and software commonality dramatically reduced the costs and risks of mortar development while meeting schedule and performance goals.

The leader/follower relationship between the NLOS-C and NLOS-M enabled the NLOS-C to define a path for all MGV vehicles. The NLOS-M benefited significantly from early and accelerated NLOS-C development, sharing engineering time, expertise and many common components. Some NLOS-C components were directly incorporated into the NLOS-M and some with only slight modification. The NLOS-C and NLOS-M are greater than 80 percent common across the two platforms and with the MGV common chassis. The high level of NLOS-C/NLOS-M hardware and software commonality dramatically reduced the costs and risks of mortar development while meeting schedule and performance goals. These benefits are significant given the limited resources and other military demands for funding, ensuring the program spends its resources efficiently and effectively.

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