Stryker Modernization—Systems Development and Systems Engineering (SE) Requirements Versus Reality

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The Stryker modernization program will upgrade the Stryker Family of Vehicles (FOV). To produce a more capable and effective Stryker, Project Manager Stryker Brigade Combat Team (SBCT) is using the DOD SE process. This article discusses the SE process in Stryker modernization and highlights some of the challenges associated with upgrading a Non-Developmental Item (NDI) system within the current DOD acquisition framework.

The Infantry Carrier Vehicle (ICV), part of the Stryker FOV, moves along an off-road test track in Afghanistan. The Stryker FOV is the primary combat and combat support platform of the SBCT. (U.S. Army photo by MAJ Misty Martin.)

History

In response to the changing operational environment facing the Nation and the Army, the Army Chief of Staff announced a new Army vision in October 1999 to build a land-power force capable of strategic dominance across the full spectrum of operations. The vision established an explicit requirement for the Army to become more strategically responsive. The SBCT was the lead element of the Army's transformation to a lighter, more agile force. The Stryker FOV, formerly known as the Family of Interim Armored Vehicles, includes 10 vehicles built on a common chassis. The vehicles are the primary combat and combat support platform of the SBCT.

The initial acquisition encompassed all 10 Stryker variants and their life-cycle acquisition requirements. Commonality was the centerpiece of the Stryker program. The Stryker acquisition strategy was structured around the objective of rapidly acquiring the best-value solution for integration, production, fielding, and support while providing warfighters with a safe, reliable, supportable, and effective system. To accomplish this objective quickly, an NDI acquisition strategy was followed. This approach favored the acquisition of assemblies and components already in production as opposed to initiating a new developmental program. General Motors (GM) General Dynamics Land System (GDLS) Defense Group LLC was competitively selected to produce the Stryker. The joint venture combined the resources of GM Defense of Canada and GDLS to meet the accelerated program's requirements. (Since the award of the vehicle contract in 2000, GDLS has acquired GM Defense.)

The GDLS platform is based on the Light Armored Vehicle Generation III chassis. GDLS delivered the first Strykers just 15 months after contract award. In the fall of 2003, only 19 months after the first vehicle was delivered, the first Stryker Brigade was deployed to Iraq. Strykers have been in theater for 12 SBCT rotations since November 2003. The vehicles have been driven more than 25 million total miles supporting *Operation Iraqi Freedom*, and Strykers first deployed to Afghanistan in the summer of 2009. Operational readiness rates remain consistently high despite the high operational tempo and hostile operating environment.

The Stryker FOV must evolve to meet existing lessons learned over the last 8 years of warfare, as well as new threats and evolving conflicts. Here, a Stryker ICV is test driven in Afghanistan. (U.S. Army photo by MAJ Misty Martin.)

The Need to Modernize

The Stryker FOV must now evolve to meet existing lessons learned over the last 8 years of warfare, as well as new threats and evolving conflicts. The vehicles were lightweight and highly transportable to provide superior light-infantry support. Heavy armor and firepower were traded for speed and maneuverability. While the mission has not changed, the threats have. Scalable, add-on-armor kits to counter improvised explosive devices, snipers, and rocket-propelled grenade attacks can increase vehicle weights by as much as 30 percent. New communication systems and high-powered frequency jammers are demanding ever-increasing electrical energy. The increase in weight and electrical load impacts vehicle performance and reliability.

Stryker modernization is employing the DOD SE process to update and enable Strykers to face current and future threats around the world. The SE process defines requirements early in the development phase and integrates engineering and nonengineering activities by unifying DOD's product vision with applicable resources. SE enables optimization of the development process to overcome cost, schedule, and performance constraints in producing a highly effective system.

Requirements Versus Reality

To produce a more capable Stryker, several challenges exist, including cost, space, weight, power, and cooling. Using SE, the Stryker modernization team has completed the process of decomposing user needs into clear technical requirements and is conducting trades to develop the preliminary design. The Stryker vehicle is an interconnected system in which each subsystem affects and is affected by the others.

To face the evolving threats, new survivability requirements have been levied on Stryker modernization. At the same time, fuel efficiency requirements limit vehicle weight growth. With the increased weight of the survivability improvements, structural reinforcements are necessary to ensure the integrity of the hull. These reinforcements displace stowage areas and impinge on other vehicle systems. A rigorous SE methodology optimizes the vehicle's structure while taking into account competing space claims of other vehicle subsystems. While the Stryker modernization team is undertaking an

intensive look at the impacts of design changes on various vehicle subsystems, they are simultaneously constrained by the existing hull envelope.

SE is best applied at the initial stages of program formulation. The NDI strategy and the accelerated pace of the original program precluded the rigors of the SE processes, as the SE documentation was not developed for the first Strykers. The Stryker modernization team is now retroactively characterizing the baseline vehicle. The process is not only long and difficult, but also expensive. Traditional, but lengthy, developmental programs designed from the ground up provide information and documentation that facilitates follow-on modernization efforts. In the case of Stryker modernization, adding layers of SE processes retrospectively, while complicated, will result in much better documentation and analysis for further growth.

Long-term planning based on stable requirements is crucial for successful SE implementation. If a piece of the design or requirements puzzle is removed or changed, the whole design has to be re-evaluated or the system may not be optimized. Consequently, SE does not respond well to incremental requirements changes, evolving capabilities, or schedule and funding uncertainties. In Stryker modernization, the user's needs, while challenging, have remained fairly stable; program execution has been less certain. The Stryker modernization project schedule has had to be adjusted to align with available funding. This has resulted in a series of changes to the requirements baseline and several modifications to the contract. Altering vehicle capabilities because of schedule and funding impacts has caused Stryker modernization to rework the system architecture, as well as rebaseline the project, to ensure proper earned-value management system controls are in place.

Stryker modernization is employing the DOD SE process to update and enable Strykers to face current and future threats around the world. (U.S. Army photo by MAJ Misty Martin.)

Program success following a thorough SE process is contingent on stable long-term plans that align the expected production schedule with funding in the out-years. Unfortunately, available funding and priorities cannot be reliably predicted. For Stryker modernization, the research, development, test, and evaluation funding has been in place as needed; however, authorization from leadership to proceed has been uncertain. Changes in law and regulation have also impacted the schedule.

The SE approach does not lend itself to rapid fielding. SE is a structured and meticulous approach to designing a product to meet user needs. As such, SE requires a significant upfront investment in time and money. An aggressive schedule can extend to 9 or 10 years from developing the Initial Capabilities Document to Initial Operational Capability. Recently, mandated competitive prototyping and reliability growth testing, while beneficial, will make the acquisition cycle even longer. Therefore, the extended schedule is exposed to more external factors that can stop or delay projects indefinitely.

The DOD SE process is not easily tailored to address legacy system upgrades. Stryker modernization is starting from a draft Capabilities Development Document requirements baseline. However, upgrading the Stryker through a remanufacture program requires working from an existing hardware baseline. Reconciling this incongruity has been a challenge from the start of Stryker modernization. Maximum reuse from the original Stryker vehicles is necessary to ensure an affordable remanufacture program.

The challenge is in modifying and adapting an existing system to meet a new set of requirements. The SE process has been indispensible in evaluating and trading system capability and performance against the burdens of space, weight, and cost. SE does not respond well to incremental requirements changes, evolving capabilities, or schedule and funding uncertainties.

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