Research Brief

RAND NATIONAL DEFENSE RESEARCH INSTITUTE

Results from the Congressionally Mandated Study of U.S. Combat and Tactical Wheeled Vehicles

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Corporate Headquarters
1776 Main Street
P.O. Box 2138
Santa Monica, California
90407-2138
TEL 310.393.0411
FAX 310.393.4818

www.rand.org

The process of research, development, and acquisition to procure military vehicles has historically been challenging for a variety of reasons. Sometimes, the difficulty lies in translating the threat (such as an enemy antitank guided missile) into a design criterion (such as a protection requirement of so many inches of armor plating). In other instances, problems have included a mismatch between cost estimates and actual costs, creeping or changing requirements, unrecognized risks from immature technologies, or overly ambitious designs.

In Section 222 of the National Defense Authorization Act for Fiscal Year 2010 (Public Law 111-84), Congress directed the Secretary of Defense to contract with an independent body to assess activities for modernizing the technology of the ground combat vehicle and armored tactical wheeled vehicle fleets. RAND's National Defense Research Institute was asked to conduct the study and, specifically, to provide a detailed discussion of requirements and capability *needs*, identify capability *gaps* for vehicles, identify critical technology elements or integration *risks* associated with particular categories of vehicles and specific missions, and recommend *actions* to address the identified capability gaps.

The research focused on a selected group of ground combat and tactical wheeled vehicles that are representative of different classes of vehicles (e.g., heavy truck, main battle tank) and that were at different stages of development. These include the Army's ground combat vehicle (GCV); the joint light tactical vehicle (JLTV), which is sponsored by the Army, Marine Corps, other services, and foreign partners; the Marine Corps' expeditionary fighting vehicle (EFV) and medium tactical vehicle replacement (MTVR); and the Army's Heavy Expanded Mobility Tactical Truck (HEMTT).

Key findings:

- **The analysis found no fundamental flaws in the requirements development processes. However, choices must be made and risk accepted due to the impossibility of designing vehicles that are optimal for all future threats.**
- **There are four key technical challenges: protection, electrical power generation, fuel cost and availability, and sensors, networking, and complexity.**
- **The study identified several areas in which business practices, processes, and policy changes could enhance the acquisition process, including the cost of vehicle survivability, cost-estimating procedures, and alignment of modeling and simulation tools to support decisionmaking.**

Requirements-Related Issues

The researchers found no fundamental flaws in the requirements development processes for the vehicles considered. However, predicting future threats over the expected life spans of vehicles now in production is very difficult, and choices must be made and risk accepted due to the impossibility of designing vehicles that are optimal for all future threats.

Inevitably, *the U.S. Department of Defense (DoD) will have vehicles in its fleets that were designed and built for requirements that differ somewhat from those it will face in the future.* This fact is driven by the wide spectrum of potential threats and scenarios in the 21st century and the fundamentally different physics and engineering problems presented by these threats. There are constraints on the trade-offs (i.e., power

versus protection versus performance) that can be made in developing vehicle requirements, which means that vehicles are unlikely to deliver 100-percent performance against all desired design criteria.

The "iron triangle" of trade-offs is permanent. In particular, DoD will always want vehicles that provide better protection, have more power (electrical and mechanical), and perform better or are more capable (in terms of weight, mobility, and so on). Investments in these areas will always be beneficial.

Thus, *the vehicles resulting from this process may fail to meet all requirements but may nevertheless be satisfactory.*

Technology-Related Issues

The analysis identified four classes of technical challenges that currently affect—and for the foreseeable future will continue to affect—the ability of the defense research, development, and acquisition communities to field cutting-edge vehicles that meet the operational requirements of fielded forces.

Protection. Improving protection will be a permanent task to which technology and engineering will need to contribute (along with tactics, unit designs, and other factors); protection will never be "good enough."

Electrical Power Generation. The advent of tactical networks, computer-based battle command systems, and expectations of battle command on the move, situational awareness, and various protection devices drive demand for electrical power upward. Vehicles must be able not only to provide the electricity but also to accommodate the space, weight, and cooling requirements associated with additional equipment.

Fuels and Fuel Consumption. Fuel cost and availability are major factors in ongoing and possible future operations. Future conflicts could pose even more challenges with respect to fuel, such as if U.S. forces were unable to secure enough fuel from international supply routes, forcing them to depend on local fuels.

Sensors, Networking, and Complexity. Sensors and networking contribute to vehicle complexity. Complexity adds a greater chance of schedule slippage and cost growth for the vehicles currently under development than was the case with their simpler predecessors. Complexity cannot be done away with, so it must be well managed.

Acquisition Policy and Business Process–Related Issues

The study identified seven areas in which business practices, processes, and policy changes could significantly enhance the military services' ability to field vehicles that are appropriate for the anticipated operating circumstances.

The Funding Implications of the Survivability of Tactical Wheeled Vehicles. As a result of current operations, tactical vehicles are acquiring more situational awareness and protection capabilities; these trends mean more expensive vehicles in most fleets and, due to the large number of tactical wheeled vehicles, much more expensive fleets.

Stable Funding and Vehicle Requirements. Many acquisition officials believe that funding instability and creeping vehicle requirements are among the biggest threats to their programs.

Cost-Estimating Procedures. Among the officials interviewed for this research who commented on cost estimating, most believed that estimating life-cycle costs is superior to estimating unit cost alone. In particular, there was general consensus among the acquisition personnel interviewed that different acquisition decisions would be made and net life-cycle costs reduced if cost estimates included life-cycle cost considerations.

Aligning the Proper Modeling and Simulation (M&S) Tools to Support Decisions and Decisionmakers. M&S efforts need to be better aligned with the decisions they are meant to support and the information needs of the officials who will make those decisions. This will require continual adjustment of scenarios and vignettes, greater transparency in the modeling process, and improved decisionmaker understanding of the choice of M&S tools.

Acquisition Category (ACAT) Decisions That Emphasize Risk Rather Than Just Cost. Risk should be the dominant factor in ACAT decisions. Risk is not currently explicitly considered, except to the extent that cost is used as a proxy for risk. As a result, mature, well-understood, but expensive programs contemplating changes and modifications that pose little risk are nevertheless subjected to stringent requirements meant to manage risk.

Adequately Resourcing Programs from the Beginning. The consensus among the experts interviewed in this study emphasized the need to ensure that programs are appropriately resourced from the outset. Doing so is challenging but is also particularly important for large, complex programs.

More Fully Integrated Test and Evaluation. A number of experts interviewed for this research noted that independent tests and evaluations sometimes led to new performance requirements for vehicles at the end of a system's development, potentially causing delays in final certification for the vehicle and adding to program cost and schedule slippage.

Trends

Equipping the armed services with ground combat and tactical wheeled vehicles will remain a challenging endeavor. This research identifies both positive and negative trends.

Positive Trends. The preference among program managers for relatively mature technologies at the beginning of a program's technology development phase is clearly positive. Another positive development is the services' appreciation of systems engineering expertise (e.g., both the Army and the Marine Corps have renewed their efforts to improve management practices and risk management). A third positive sign lies in the responsiveness of the research, development, and acquisition communities, which have shown an improved ability to produce needed vehicles in a hurry and have demonstrated responsiveness to addressing urgent operational needs.

Negative Trends. New vehicles will almost certainly be significantly more expensive than the ones they replace. If necessity continues to drive tactical wheeled vehicle requirements closer to those of their combat vehicle cousins, that will surely afford crews greater protection and situational awareness, but it will also increase complexity and cost growth. Also, there is the persistent vulnerability of the vehicle fleets to adaptive threats. Technology-based solutions to mitigate vulnerability are expensive, whereas the enemy's countermeasures are relatively cheap. It is impossible to protect the vehicle fleets from all threats solely with onboard armor, situational awareness, and active protection systems; solutions will require consideration of how forces cooperate on the battlefield.

Uncertain Trends. The potential of robotics and autonomous systems, on its face, seems significant, but until the services advance these technologies and develop concepts for their application in roles that would reduce the threat to ground combat and tactical wheeled vehicles, their future utility remains unclear. The effects of the network on vehicles are another question mark. The key question is whether on- and off-vehicle capabilities can be integrated so that communication, situational awareness, protection, and power-generation requirements can be reduced without significant increases in complexity and cost.

What Congress Can Do

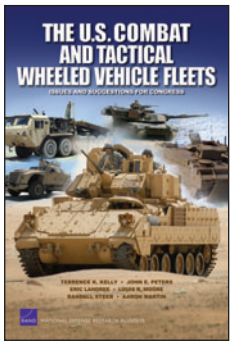
The study identified a number of strategic, technical, and business practice and process considerations that affect DoD's ability to field ground combat and tactical wheeled vehicle fleets that meet the country's needs. Some take the form of things that Congress should pay attention to or do, whereas others frame and in some cases constrain DoD's ability to field these vehicle fleets.

Congress should consider requiring DoD to present the strategic rationale for vehicle fleet development choices fleet wide, as well as explain how each proposed vehicle fits within this rationale. DoD leadership should clearly articulate what rationale it is using in vehicle fleet development (e.g., optimizing vehicles against a specific threat, as in the Cold War, or creating vehicles that are adequate for a spectrum of threats). Given the joint nature of conflict, this rationale should be considered by, if not standard across, each armed service.

In its oversight role, Congress should consider taking steps to ensure that defense programs addressing each of the key technical challenges (i.e., improved protection, power generation, fuel consumption, and sensors and networking) are adequate. These are classes of problems that affect almost every vehicle (and many other systems) that DoD fields. Congress should consider making all four of these areas focal points of its interactions with DoD on research and development, new systems, and modifications to existing systems.

Congress should consider a range of actions to address acquisition policy and business process–related issues. Some of these challenges can be addressed—and may be in the process of being addressed or readdressed—by DoD (e.g., how cost estimation is done; how programs are staffed and supported for success; how modeling, testing, and evaluation are done). Some may require congressional action in the form of guidance, changes to laws, or clarification of congressional intent with a focus on regulations (e.g., adopting ACAT decision practices that more realistically address risk rather than using cost as a proxy for risk). And some, if not all, have cost implications that Congress should factor into the way it oversees vehicle fleet development (e.g., the rising costs of tactical wheeled vehicles). In all seven cases considered in the study, Congress may decide that the changes required to make progress will demand that it play some role. Furthermore, in all seven cases, Congress should consider asking for updates and challenging DoD to make or recommend changes.

Finally, a more comprehensive M&S capability—and leaders who are empowered to use it well—will be essential tools in everything from establishing future requirements to research and development to engineering, program design, and manufacturing. DoD and the services should consider improvements to their already substantial capabilities along the lines presented in the study, which will require support and guidance from Congress. ■



This research brief describes work done for the RAND National Defense Research Institute documented in *The U.S. Combat and Tactical Wheeled Vehicle Fleets: Issues and Suggestions for Congress*, by Terrence K. Kelly, John E. Peters, Eric Landree, Louis R. Moore, Randall Steeb, and Aaron Martin, MG-1093-OSD (available from http://www.rand.org/pubs/monographs/MG1093.html), 2011, 180 pp., $24, ISBN: 978-0-8330-5173-8. This research brief was written by Kristin Leuschner.

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