

**Spring 2012
Industry Study**

**Final Report
*Land Combat Systems Industry***



The Industrial College of the Armed Forces

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LAND COMBAT SYSTEMS 2012

ABSTRACT: The United States is the leading producer and consumer of advanced Land Combat Systems. The industry has two major segments, tactical-wheeled vehicles (TWV) and combat vehicles (CV). The TWV market is comparable to the commercial truck market, while the CV market is completely government reliant. A decade of war-driven funding has produced healthy, recapitalized vehicle fleets. This growth, followed by major defense budget cuts, left an extreme of excess capacity. As industry scales down from production highs, normal market forces will resolve the TWV segment. For CVs, the Government must intervene to retain critical skills, flexible capacity, and continued innovation.

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AM General (Mishawaka, IN)
Anniston Army Depot (Anniston, AL)
BAE Systems (York, PA)
General Dynamics Land Systems Headquarters (Sterling Heights, MI)
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Joint Systems Manufacturing Center – Lima Tank Plant (Lima, OH)
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USMC Joint Light Tactical Vehicle Program Office (Quantico, VA)
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International:

MAN Truck & Bus (Munich, Germany)
Rheinmetall-MAN Military Vehicles Headquarters (Munich, Germany)
Renk Transmissions (Augsburg, Germany)
Krauss-Maffei Wegmann (Munich, Germany)
EADS Cassidian (Unterschleissheim, Germany)
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INTRODUCTION

The Land Combat Systems (LCS) industry is a telling example of the world the United States (U.S.) military finds itself in today. After a decade of force buildup and momentous spending, including a large portion allocated to ground forces and LCS programs, the military faces significant budget reductions. The nation completed force withdrawal in Iraq and is completing major military ground forces action in Afghanistan, marking the beginning of a major force drawdown. The U.S. national debt has driven Congress and the President to usher in an era of austerity when the defense budget will shrink by \$487B over the next ten years and by an additional \$600B over ten years if sequestration takes effect on January 2, 2013.¹ On January 5, 2012, in response to the changing fiscal and security environment, the President released a new strategic direction that shifts U.S. focus toward the Pacific.² This announcement was followed by the fiscal year (FY) 2013 President's budget, reflecting the resources needed to execute the new strategy. Today, military ground vehicle inventories and equipment readiness are at healthy levels, shifting the focus to sustainment planning. Robust inventory and readiness levels offer the Department of Defense (DoD) an opportunity to reduce budgets originally allocated to land combat systems without sacrificing warfighting capabilities.

Based on extensive discussions with government and industry officials, the 2012 LCS industry study seminar has: 1) assessed the current LCS industry's ability to adapt to its monopsonist buyer's changing requirements, policies, and budgets; 2) observed how the Government uses guidance, policy, and law to shape this behavior; and 3) identified opportunities to adjust these approaches to better meet the future needs of the ground forces. Today's challenge is balancing how to scale back capacity, maintain a competitive and innovative market, assure a resilient industrial base, and support the ground forces' mission, while continuing to outfit ground forces with world class land combat systems.

DEFINE THE INDUSTRY

The LCS industry is a collection of firms that supply a broad spectrum of vehicles and systems, including tanks, infantry fighting vehicles, armored carriers, artillery and missile systems, protected vehicles, tactical trucks and command and control vehicles. For the purposes of this analysis, the seminar aggregated the vehicles on this list into the Combat Vehicle (CV) and the Tactical Wheeled Vehicle (TWV) markets (see Appendix 1). The size of the industry varies considerably depending on the national security environment. At the beginning of the last decade, industry revenue was about \$10 billion annually and grew steadily during the war years, peaking in 2008-2010 with annual sales in the range of \$30-45 billion. Revenues have declined sharply since 2010 and are presently at about \$15 billion annually and falling.

TWVs are trucks specifically designed for military purposes. Compared to commercial trucks, military trucks have greater off-road capabilities, are often armored for crew protection, and may be equipped with weapons. However, their primary purpose is combat support and combat service support, including transporting supplies and troop movement in lower threat areas. TWVs include the High Mobility Multipurpose Wheeled Vehicle (HMMWV), the Family of Medium Tactical Vehicles (FMTV), the Medium Tactical Vehicle Replacement (MTVR), and heavy trucks such as the Heavy Expanded Mobility Tactical Truck (HEMTT), Palletized Load System (PLS), Heavy Equipment Transporter System (HETS), and the Logistical Vehicle System Replacement (LVS).

CVs are military unique, built specifically for defense with little or no commercial or civil applications. Heavy tracked or wheeled CVs have extensive armor protection, large

weapon systems, and are often used in support roles by both the Army and Marine Corps. The current CV fleet includes the M88 Armored Recovery Vehicle, the M992 Field Artillery Ammunition Supply Vehicle (FAASV), the M113 Armored Personnel Carrier (APC), the Light Armored Vehicle (LAV), the Multiple Launch Rocket System (MLRS), the M9 Armored Combat Earthmover (ACE), the M1 Abrams tank, the M109 self-propelled artillery, the Amphibious Assault Vehicle (AAV), Bradley M2 Infantry and Cavalry Fighting vehicles, and the Stryker family of wheeled combat vehicles.

The Protected Vehicle (PV) class of platforms emerged in response to the threat posed by Improvised Explosive Devices (IED) to U.S. and coalition troops in Iraq. These vehicles protect personnel engaged in counter-insurgency warfare, primarily for use in an urban environment. The primary example of a PV is the Mine Resistant Ambush Protected (MRAP) vehicle, which combines the armored survivability technology found in CVs with the commercial truck features found in TWVs. The MRAP, with its excellent survivability record, has influenced the requirements development process by emphasizing protection as a key performance parameter for all future TWV and CV platforms. While increased protection is always desirable, the added weight and underbody shaping are burdens that negatively affect mobility performance. Trading protection, performance, and payload with weight and cost remains very challenging for vehicle design engineers as they attempt to address platform threshold and objective requirements. Seven different manufacturers, most representing the commercial trucking industry, produced approximately 27,000 MRAPs between 2007 and 2009.³ For the purpose of this analysis and brevity, the LCS Seminar did not address PVs separately, but instead determined that it functions in a manner consistent with the TWV market.

Market Structure

Within the TWV and CV markets, the Government is a monopsony buyer and wields considerable buyer power during the competitive phases of an acquisition program. As a sovereign, the Government exerts extensive influence on defense firms to develop needed technology, to exact only reasonable profits, and to protect the intellectual property within these systems. Buyer power is prolonged if the Government owns the technical data package (TDP). In addition, the Government has ultimate control over export sales and technology transfer, thereby dictating to suppliers the size and scope of the market in which they may operate. The Army and Marine Corps each have unique ground vehicle requirements, but collaborate when feasible. Foreign governments are customers as well. Despite only being one of many, and with no nation making procurements on the same scale as the U.S., foreign governments wield considerable buying power due to their freedom to shop among multiple producer nations.

The TWV and CV markets, like most classic capitalist markets, are driven by consumer spending and profit. The companies involved respond based on when and how much money is available. The overall market structure is reshaped with each new program competition and award depending upon who wins, production volume and schedule, and whether the TDP is included in the award price. During the two most recent conflicts in Iraq and Afghanistan, the funding for LCS programs was liberally allocated to both the upgrade of existing systems, as well as the acquisition of new systems. The size and behavior of the market expanded and shifted to create space for new entrants and infrequent participants, particularly as the vehicles became increasingly complex and the deep-pocketed system integrators grew more critical to the design and production process. For new LCS programs, the market is more open to new partnerships and supplier relationships. However, once a make-model is selected, particularly if

the original equipment manufacturer (OEM) maintains ownership of the TDP, the market can close to outside players and transitions to a long-term bi-lateral monopoly market.

As in most heavy manufacturing environments, firms within the LCS industry rely on production and process improvement philosophies such as Lean Manufacturing and Six Sigma to achieve higher quality products, greater production velocity, more transparent supply chain visibility, and reduced overhead costs. These two philosophies have been widely adopted across multiple industries, and the DoD. This broad acceptance and application offers numerous advantages to user communities, including standardized training modules, on-the-job training, and knowledge acquisition. The methodologies provide a relatively common set of terminology, tools and techniques, and the ability to extend the application of these proven methodologies across the production system quickly to generate enterprise-level cost and performance improvement benefits. Major TWV companies like Oshkosh and AM General have incorporated moving production lines, takt times, job rotation, ergonomics improvements, as well as the ability to produce numerous military vehicle variants on commercial production lines.

Employing these production improvement tools within the LCS industry is a product and driver of market behavior. The advantages created through these solutions enable manufacturers and their suppliers to respond quickly and effectively to the ebb and flow of DoD budget fluctuations. They are able to ramp up quickly and scale down efficiently depending on demand levels. This flexibility contributes to the excess capacity that currently exists across the industry as LCS companies, particularly the U.S.-based OEMs, do not require a large footprint or additional manpower to accommodate existing DoD demand. Companies use this capability as market differentiators to drive down costs and pricing to remain viable in a highly competitive industry. Looking deeper into market statistics over the past decade, as shown in Figure 1,⁴ we see that less than 50% of all program spending came from full and open competition.

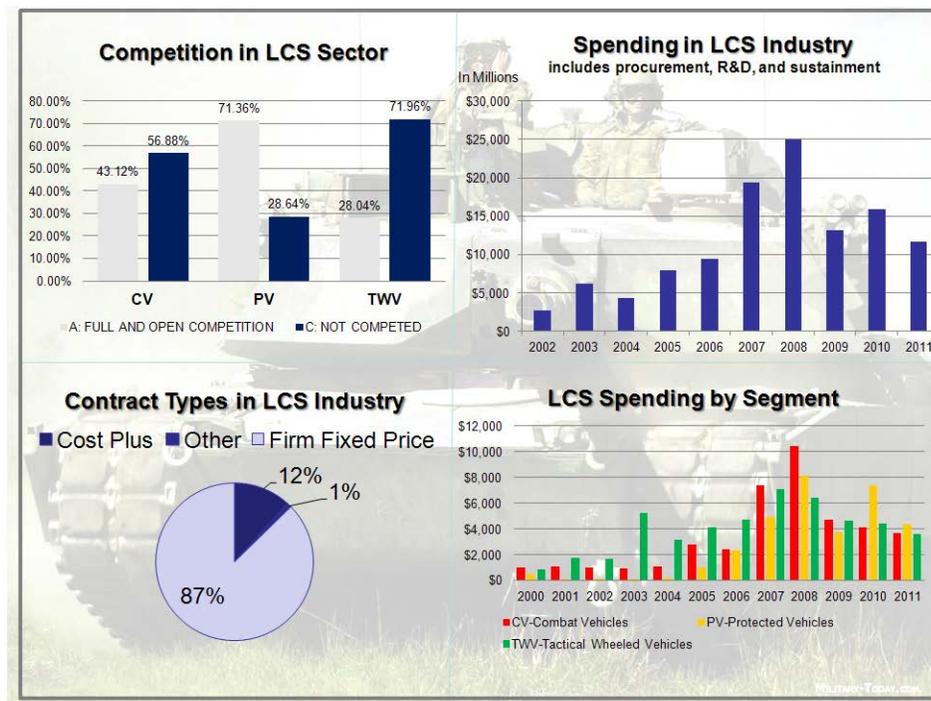


Figure 1: Competition in the LCS Market (source: USAspending.gov)

* USAspending.gov data does not include all TWV and CV related spending, i.e. depot work, repair parts, and Science and Technology activities

These numbers are skewed due to over \$25B spent on the production and modification of MRAP vehicles during this period. Almost 72% of the spending in the TWV market was executed without a full and open competition compared to 57% in the CV market. These figures reveal the nature of the competition within the industry. The initial procurement of a given program is competitive, but follow-on procurement of the make-model, upgrades and logistical support is traditionally sole source. The analysis also reveals that 88% of the money spent in the LCS industry came in the form of fixed price contracts. Because there are low risks in the manufacturing phase of vehicle acquisition, fixed price contracts are the norm. Fixed price contracts give OEMs a powerful incentive to seek efficiency in production. Every dollar of cost reductions results in a dollar more of profit.

Nature of TWV and CV Markets

Within the LCS Industry, competition at various acquisition lifecycle phases can be fierce, especially as the number of new programs fall and the military reduces its force structure. These market conditions force manufacturers to compete for short-term contracts to produce smaller batch sizes and affect the types of vehicles being purchased. To meet the Government's desire for protection, advanced survivability technologies are major considerations for LCS vehicle manufacturers. In addition, some companies rely on government-furnished facilities and tooling to maintain capacity and ensure a minimum level of readiness to respond to planned or unplanned increases in demand. LCS firms also stress the need to manage their labor force and protect specific skills that are necessary to remain competitive and capable of supporting government program requirements.

Firms typically invest their Independent Research and Development (IR&D) dollars to develop new technologies and remain competitive in the market. The current DoD budget and acquisition environment encourages reliance on mature technologies in current and future programs. As a way to protect the revenue stream that feeds IR&D investment, industry may increase their focus on export opportunities, as well as upgrade and modification workload on programs such as Abrams, Stryker, and Bradley.

Supplier power in the TWV and CV markets is mixed but is greater for components that have directed sources or where the prime OEMs do not own the TDP for a particular part. Low-density, unique small parts manufacturers pose significant risk to the supply chain, and live a feast or famine existence. Once their component is selected for a new LCS vehicle program, they can count on that business for decades.

Manufacturing Infrastructure and Labor Workforce

There are three models for producing military vehicles:

1. **Government Owned Government Operated (GOGO):** Facilities are both owned and operated by the Government. Deeming depots as national assets, Congress enacted laws to ensure timely support of large-scale national mobilization and emergency defense contingencies. Anniston Army Depot (ANAD) and Red River Army Depot (RRAD) are the LCS GOGOs responsible for maintaining, recapitalizing, and resetting CV and TWV platforms.
2. **Government Owned Contractor Operated (GOCO):** Government facilities or manufacturing plants are operated by contracted OEMs. GOCOs place the burden for capital investment on the Government, while firms ensure employees are highly skilled and cross-

trained to support different program requirements. The Joint Systems Manufacturing Center (JSMC) in Lima, OH is operated by GDLS as a GOCO. The equipment in Plant 14 at Allison Transmissions is Government owned and functions similarly to a GOCO.

3. **Contractor Owned Contractor Operated (COCO):** Traditional commercial business operated by a for-profit company. Within the LCS industry, BAE, Oshkosh, and AM General are all examples of COCOs.

A major component of the LCS industry is the labor workforce, which expands and contracts with the erratic swings typical in LCS budgets. Based on discussions with industry stakeholders, the critical skills at GOGO, GOCO, and COCO sites include ballistic welders, job setters for military unique tools, and quality and manufacturing troubleshooters and testers. These skill sets are specific to CV fabrication and manufacturing and not easily transferable with commercial industry. Across the industry, the art and science of CV design and engineering is resident at the OEMs. This expertise accrued over decades and is highly difficult to regenerate.

GOVERNMENT GOALS AND ROLES

U.S. defense markets, especially those that develop military unique equipment, differ significantly from the commercial markets. The Government, a monopsonist buyer, seeks to replicate market forces to elicit both best prices for individual acquisitions and long-term innovation capacity in an effort to provide national defense, a public good that is often taken for granted by U.S. citizens.⁵ The three components of the iron triangle (DoD, Congress, and Industry) exert pressures against each other; the military by responding to current and predicted future threats, the industry by determining how best to posture their comparative advantage to capture future business, and the elected politicians representing constituent interests and working to provide for the common defense. Thus, the goal of equipping the Armed Forces with land combat capabilities becomes increasingly difficult in an extremely politically charged environment that does not lend itself to efficiencies.

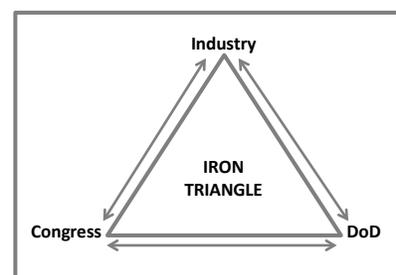


Figure 2: Iron Triangle

Further complicating this difficult task, the Government is in the midst of responding to the congressionally mandated reductions to procurement and personnel budgets. These forces reduce the Government's buying power in the market, while at the same time making it more difficult to ensure a robust and fully capable Defense Industrial Base (DIB). Force structure and force mix decisions will influence the types and volumes of vehicles required and the long-term direction taken by the LCS industry.

A key and essential Government goal is to manage the DIB. The DoD primarily relies on market forces to sustain the broader industrial base yet has the authority to take action in exceptional cases where a vital industrial capability, necessary to meet national defense security requirements, is genuinely endangered.⁶ Within the LCS industry, the DoD has determined the need to sustain the Combat Vehicle Industrial Base (CVIB), and has done so at great cost for much of the past few decades. In recognizing the value of the CVIB, the DoD has assumed responsibility for developing the capability and capacity it needs to support the U.S. national security interests. A look back at the LCS industry in 1995 provides an illuminating lens on today's environment.

The downturn in the budget in 1995 was based on both the post-Cold War and post-Desert Storm eras, and perceived as a time of reduced global threat. In this timeframe, the

Government used Base Realignment and Closure (BRAC) actions and forums such as the “Last Supper”⁷ to consolidate the broader DIB. The CV budget was \$6.2 billion in the mid-1980s and significantly reduced during the FY 1996 Defense Program, where it ranged from \$1.1 to \$1.6 billion. The fleet was generally healthy following force reductions, excess war reserves, excess material from Desert Storm and streamlined business practices.⁸ Following 1995, two CV programs, the M1 Abrams, produced by General Dynamic Land Systems (GDLS), and the M2 Bradley, produced by British Aerospace Engineering Systems Land and Armaments (BAE), were funded for major upgrade developments on existing vehicles. At this time, CV firms went from three to two firms after United Defense Limited Partnership (now BAE) combined the defense portions of the Food Machinery Corporation (FMC) and Bowen McLaughlin York (BMY). On the government side, this era saw the depots reduce from three to the two, ANAD and RRAD. Over fifteen years later, the same two major firms and depots continue operations, increasing output to cover the surge requirements of the past decade. With competing demands of reduced force structure, shrinking budget and an enduring CV sustainment tail through 2050, slimming down the post-Cold War CVIB while retaining resiliency is in order.

WSARA/BBP

In 2009, Congress enacted the Weapon Systems Acquisition Reform Act (WSARA). The following year DoD implemented Better Buying Power (BBP) guidance. These measures use competition to generate greater efficiency, affordability, and productivity from the nation’s defense budget.⁹ Now in full force, LCS acquisition professionals have used WSARA and BBP to shape new major defense acquisition programs such as Ground Combat Vehicle (GCV) and Joint Light Tactical Vehicle (JLTV). As each acquisition strategy proceeds, the effects on the conduct and performance of the LCS industry stemming from these structural changes are evident.

TDPs remain a key competition lever for DoD and the LCS market. In line with WSARA and BBP, LCS acquisition professionals are developing acquisition strategies that include competitive pricing of TDPs to allow for future Government procurement of TDPs. TDP ownership can sustain DoD’s buying power throughout the lifecycle of a program. As LCS vehicles grow in complexity, various key subcontractors may refuse to release their intellectual property rights represented within a given TDP. This poses unique challenges for Program Managers (PMs) as they unbundle the technical packages.

Since the enactment of WSARA and BBP, the LCS industry has yet to see a program proceed through all acquisition milestones, leaving the overall benefits of these initiatives not yet fully realized. Essay #1 in this paper provides a more detailed review of WSARA and BBP using the JLTV program as a short case study.

TACTICAL WHEELED VEHICLE MARKET

Current Conditions

The TWV market falls between competitive and oligopolistic with a fluctuating, but still single digit, number of firms competing for any given program. Once contracts are awarded, winners have the potential to become a monopoly supplier of DoD selected make-models for decades. Competitors include commercial truck companies that also produce military TWVs, some defense-heavy firms such as military truck manufacturer AM General and to a lesser extent, Oshkosh, as well as foreign-based truck firms. Companies compete across the board on

price, reputation, performance, life cycle support, innovation, and manufacturing/assembly capability. For defense-heavy firms, each competition is viewed as a must-win because opportunities to compete for large-scale programs are infrequent. Even when large programs are anticipated and seemingly underway, they remain fragile. Firms must invest considerable resources just to compete in the market. For commercial firms, an unsuccessful bid on a new program may be enough to exit the defense market altogether, at least until a new opportunity emerges. Barriers to entry are not as great as in the CV market, though highly specialized design and manufacturing expertise is important to incorporating survivability and armoring into newer product models. While capital investment can be significant, the main barriers to overcome for new entrants are knowledge and experience competing for military programs and the customer switching costs. The high switching costs associated with introducing new vehicles into the LCS fleets drives DOD to minimize the number of make-models thereby limiting opportunities for new entrants. These are surmountable by well-capitalized, politically connected commercial truck firms willing to make the long-term investment to be competitive. Substitutes are a higher threat for TWVs than CVs with Commercial Off the Shelf (COTS) alternatives, unmanned vehicles, and new doctrinal approaches as potential alternatives.

There is less concern for the future TWV DIB than for the CVIB. TWVs are typically comprised of commercially available and applicable parts and components. Over the course of this industry assessment, the mantra of "...it's just a truck" was repeated by military and industry representatives. This may be an over-statement considering the demanding acquisition process and performance requirements for these vehicles. The Government enjoys its single-buyer role that drives vendors to distinguish themselves based on reputation, performance and price.

The TWV marketplace is robust. The industry experienced dramatic growth over the past decade due to the wars in Iraq and Afghanistan. However, the current budget conditions indicate that demand will drop precipitously in the future. Political support to develop and acquire a large fleet of MRAP vehicles expanded the revenues for companies like Oshkosh, BAE, Force Protection, and Navistar when commercial sales were low (2007-2010). Oshkosh is maintaining a strong position with its medium and heavy truck contract awards. A presentation at the 2010 Aerospace & Defense Conference predicted that AM General, Navistar, and Plasan may be forced out of the TWV market if they are not members of the winning JLTV team.¹⁰

The Army and Marine Corps' TWV fleets are healthy. A majority of vehicles have been "reset" or "recapitalized" and are in serviceable condition. The active TWV programs, such as the Army FMTV procurement and HMWWV production, will conclude by FY 2014,¹¹ while the funding for the HEMTT and PLS will continue at the rate of \$100M per year.¹² This represents a reduction in funding from the FY 2012 procurement funding of approximately \$950M.¹³ The Marine Corps is reducing all ongoing TWV program buys by 25 percent.¹⁴ Taken together, these budget projections comprise part of the "bathtub" for LCS procurement spending over the next decade (see Appendix 2).

Outlook

Future funding projections for procurement and upgrades to Army and Marine Corps TWV fleets are greatly reduced from FY 2012 levels. This is driven by DoD budget forecasts combined with the heavy Army and Marine Corps investments in their fleets over the past ten years. As an example, the average age of the Army's medium TWV fleet will be eight years in 2018, with less than 2000 vehicles being over ten years old.¹⁵ The Marine Corps has no new TWV procurements programmed until JLTV Low Rate Initial Production (LRIP) in FY 2015.¹⁶

This vehicle will provide mobility to the reinforced rifle squad and fire teams across the range of military operations with heavy weapons, forward command and control, and cargo.

The TWV industrial base pulls from suppliers of components that are commercially available. TWV customization requirements, erratic demand over time (driven by war and peace), lags in environmental regulation compliance, competition policy that hinders fleet standardization, favored status for American manufacturers, and International Traffic in Arms Regulations (ITAR) challenges to foreign military sales are factors that set the DoD apart from commercial consumers. Companies like Peterbilt focus efforts elsewhere because of these additional burdens. The scale and scope of the commercial market is different from the DoD market. The key is that large commercial companies have the capital necessary to enter the TWV market. A company such as Navistar could quickly learn how to work with the Government. Consequently, the need for the Government to preserve or support the TWV DIB during periods of budget cuts is not a dire requirement. To stay competitive in the commercial market the truck manufacturers will produce high quality, competitively priced trucks whether or not DoD buys TWVs. TWV capacity and expertise will not atrophy. DoD may merely need to accept less customization of TWVs that are in production if a surge is needed to support an emerging requirement. Non-commercial, off-road capability and protection should be the focus of improvements in technology and could be sourced overseas. An example occurred with the original FMTV acquisition, based on an Austrian vehicle design. Survivability will remain a driving factor and is discussed in Essay #2. Even if the JLTV competition forces some of the current TWV firms to exit the market, the ability to support a new surge requirement presents low risk to the Government. The commercial industry will continue producing economical, powerful, and reliable trucks for commercial applications that can be leveraged for military use in the future.

COMBAT VEHICLE MARKET

Current Conditions

The CV market is a highly competitive oligopoly dominated GDLS and BAE. Because the M1 Abrams and M2 Bradley are 30-year-old systems and represent the most current programs in the U.S. inventory, few other manufacturers have the equipment or expertise to enter the market. Neither company maintains a commercial equivalent or means to augment production and sustainment other than with limited FMS contracts.

CV production requires extensive capital investment, specialized equipment, and manufacturing skills that limit entry into this unique market. Possible aids to overcoming these barriers include firm teaming (including foreign competitors), and possible complementary production in adjacent markets. Public-Private-Partnerships (P3) are enabled by the designation of certain depot facilities as Centers of Industrial and Technical Excellence (CITEs). This designation authorizes and encourages P3 agreements and permits performance of work related to core depot competencies. These partnerships provide a lucrative mechanism for prime contractors and/or other firms to enter at the margin. The CVIB footprint is extensive, dispersed across the U.S. to include ANAD in Anniston, Alabama; RRAD in Texarkana, Texas; JSMC in Lima, Ohio; government-owned real property at Allison Transmissions Plant 14 in Indianapolis, Indiana; and BAE-owned facilities in York, Pennsylvania.

In terms of workflow, extensive Overseas Contingency Operations (OCO) funding gave the Army and Marine Corps the opportunity to upgrade all active duty M1s to A2 System

Enhancement Package configuration and reset both M1 and M2 fleets to “zero-zero.” This effort is responsible for a spike in CVIB demand over the last several years. However, work is declining rapidly. The USMC Expeditionary Fighting Vehicle (EFV) was cancelled and the GCV program time lines extended by several years.

The JSMC facility remains sized and managed under a Cold War era construct. During the full rate M1 Abrams run in the 1980s and 1990s, up to four tanks were completed daily. At the height of support to the wars of the last decade, upgrade work peaked at 1250 annual units in 2009. Today, JSMC production is down to 1.1 tank equivalents per day, with plans to reconfigure to support a rate of 0.6 units per day.¹⁷ While GDLS has attempted to offset reduced tank production with Stryker upgrades and FMS contracts, these programs do not nearly utilize the capacity of JSMC. On the management side, as “Home of the Abrams Tank”, PM Abrams has responsibility for the plant. With the reduced M1 workload, a number of issues exist stemming from the combination of no enterprise-wide Government owner and the GDLS facility management contract. These issues include capital investment that lags industry norms, lack of vision for shared facility use, no cost allocation model to extract appropriate usage fees, and potentially unfair advantage to GDLS in competing for future CV procurements.

The Government, as the monopsonist customer, seldom initiates new CV contracts. However, competition ensues between the dominant companies and several smaller OEMs for upgrade or sustainment contracts for current systems. While GDLS and BAE might survive the loss of smaller contracts, they generally must win large contracts to sustain critical manufacturing skills and supply chains. While the CVIB appears thoroughly tenuous, both GDLS and BAE benefit from a low threat of substitutes in the market. The CV has been a mainstay of every powerful army for the last century, and current conflicts have reinforced their role far into the future.

Outlook

DoD and Army budgets will continue to decline in the future and will likely revert to historic peacetime levels. The fact that the CV fleets were reset to “zero-zero” bodes well for the Services but not the CVIB. All active Army Abrams have been upgraded to the latest M1 configurations, creating a production gap from FY 2014 - 2017.¹⁸ As well, the M2 Bradley program will experience the same production gap from FY 2014 -2017.¹⁹ The Stryker fleet is currently being “reset” at ANAD as part of a P3 with GDLS, and the final planned production of the double-V hull (DVH) variant will end in FY 2012.²⁰ While some opportunities may exist for GDLS and BAE in terms of vertical integration, long-term material contracts and systems integration, there is little available on the horizon to carry the CVIB through the looming critical period called the “FY 2014-2017 production bathtub” (see Appendix 2).

The CVIB remains a critical part of U.S. national security strategy. Recent conflicts have reaffirmed the CV as an essential battlefield element and as a result, the Army has extended the M1 program through 2050. While Army and Marine Corps fleets are currently healthy, the CVIB will enter a serious lull in 2014. At that time and with current projections, the CVIB will have little capacity to maintain critical skills until projected upgrades/resets begin in 2017. The DoD must reduce excess capacity, resolve the production bathtub, and maintain special manufacturing capabilities required for the CVIB if it wants to restart production in 2017 and maintain this critical industrial base through 2050. In the end, loss of either GDLS or BAE will seriously impair U.S. CV production in the future.

CHALLENGES

Overcapacity

The majority of the CVIB facilities in use today were originally designed to mass-produce goods in support of high quantity Cold War production requirements. Although the wars in Afghanistan and Iraq provided the LCS industry with an opportunity to exercise some of the excess capacity with production of up-armored HMMWVs, MRAPs, and Strykers, the current capacity the Government sustains is much larger than demand necessitates. However, even during the high demand period during the past ten years of combat operations, the full LCS market capacity was only operating at a small fraction of its full potential. This leads to inefficiencies, causing prices to increase for lower quantities. The Government exacerbates this problem by allocating portions of production, assembly, and overhaul workload to its arsenals and depots. On the GOGO side, following the high production and labor hours generated by wartime demand, ANAD is planning to lay off almost 600 term employees by mid-2012 and anticipates reaching a steady state by the end of the year.²¹ Many of these term employees have 10+ years of depot experience coming out of this peak period. As recently as three years ago, ANAD, while reducing their workforce by eliminating temporary employee positions, built a new \$85 million engine maintenance facility in 2009.²² Today this state of the art facility is operating at approximately 5% utilization.²³ In 2012, ANAD opened a \$54 million transmission overhaul facility to accommodate a limited projected workload.²⁴

This excess production and sustainment capacity offers the Government and industry the opportunity to make significant size and structure changes that could generate immediate benefits through P3 agreements, infrastructure, and manpower optimization efforts. However, major award decisions on future programs like the GCV and JLTV are expected to heavily influence the future structure of the LCS industry. These decisions may limit the options for consolidation and significant capacity-targeting initiatives if Government and industry waits to act.

Supply Chain Management

The current government-directed supply chain structure is creating undesirable results in the LCS industry. The Defense Logistics Agency (DLA) role in providing consumable parts for depot-repairable components and production lines is driving evasion measures by OEMs and depots alike. Based on discussions with industry and government, an expansion of DLA's role from supply chain management (SCM) for generic commodities to providing SCM as an integral function of producing a complex weapon system has led to a number of challenges. The difficulty of managing a military-unique supply chain has led to the provision and delivery of some parts that do not conform to technical specifications. Part of this is tied to OEM reluctance to provide the mandated component-level TDP requirement for parts not commercially available. Additionally, DLA has challenges supporting a time-phased production line, as this is also quite different from supplying units with repair parts on an as-requested basis. These problems prompt depot customers and Services to evade DLA using a variety of methods, such as the P3 agreements between OEMs and depots for SCM, depots buying "kitted" parts directly from OEM, and Services maintaining parts drawing in "design not stable" category, resulting in direct procurement from OEMs.

Science and Technology

The U.S. currently enjoys a technological advantage over its adversaries due, in large part, to substantial prior Science and Technology (S&T) investments and successful transition of advanced technologies to acquisition programs of record. The DoD S&T budget increased steadily for many years and peaked between 2010 and 2011. At its zenith, the S&T budget amounted to approximately \$11.8 billion spread between the Services and DARPA.²⁵ These basic research (6.1), applied research (6.2), and advanced technology development (6.3) resources were distributed to many entities throughout the community, including academia, government labs, and industry. Ground vehicle S&T includes advanced lightweight appliqué armor for ballistic protection, underbody mine and IED blast mitigation, and advanced drive train research for reduced fuel consumption and improved mobility. While firm fixed price (FFP) contracts are the DoD's preferred contract type for all program phases, industry prefers "cost plus" for S&T/technology development contracts. Several acquisition program Nunn-McCurdy breaches over the last decade have brought attention to system complexity and technology maturity levels. Additional maturation of technologies in the concept and technology development phase may reduce risk in latter phases and may lead to more streamlined acquisition processes. In fact, the WSARA and BBP initiatives suggest incorporating increasingly mature technologies into acquisition programs to mitigate risks. This means S&T must assume greater responsibility to develop technologies to a higher technology readiness level (TRL) prior to the Milestone B transition hand-off. With DoD budgets on the decline, technology development and transition of military equipment will be more challenging and result in an increased emphasis on affordability on a per unit basis and during the system life cycle. Utilizing the Joint Center for Ground Vehicles to promote joint service commonality will also help to address cost savings and affordability. Although austere budget cuts will likely impact all facets of the defense acquisition system, maintaining robust S&T funding levels is critical to developing and maturing state of the art technologies that serve as the seed corn for future warfighting capabilities.

Foreign Military Sales

With the imminent downturn in LCS procurements, firms are looking to FMS to balance their military equipment revenues and traverse the lean times. This is challenging on a few fronts. First, a significant portion of FMS funding comes from the U.S. Treasury. These funds are allocated by the State Department, in line with U.S. foreign policy, as foreign aid to other countries to purchase U.S. equipment. Since this funding comes from the U.S. budget, it will be affected by the budget reductions as well. Second, FMS (as well as Direct Commercial Sales) are dependent on foreign demand for U.S. products. In the global military truck market, as in the U.S., the barriers to entry are not overwhelming. As this market is easier to enter, there is a nationalist tendency for foreign governments to look to their domestic manufacturers instead of the U.S. This will limit the ability for U.S. military truck firms to sell in foreign markets. For CV manufacturers, export controls will delay or negate some foreign sales opportunities. Conversely, foreign firms can take advantage of our export controls to exploit markets that may otherwise procure U.S. systems. Third, foreign competitors are looking to the international market to offset reductions in their national markets, as well. Because of this, U.S. domestic companies face a greater competitive environment on the international market, where more expensive, technically advanced vehicles, like those produced for the U.S. military, may not compete as well. Finally, demands for offsets and local work-share will detract from potential

gains to the U.S. DIB, as well as create intellectual property challenges. Foreign sales are an unpredictable opportunity for balancing the upcoming dip in LCS revenues and will not be the savior for all, or even most, companies.

INDUSTRIAL BASE STRATEGIC OPTIONS

Three critical conditions have created the situation that the Defense Department and the LCS industry are currently experiencing: volatile global economic conditions, increased U.S. focus on Asia-Pacific region security issues, and rapid globalization. Economically, the world has suffered a massive economic crisis and the West has survived by leveraging enormous debt and trade imbalances. Now tens of trillions of dollars in debt, the West may have difficulty in their ability to purchase large arsenals of new weapons on borrowed funds. Traditionally, to pay for the nation's war machine, the U.S. has raised taxes and/or paid down the debt between wars, however; this successful pattern has recently been altered by the American public being unwilling to exchange "entitlements for guns." As a result, the U.S. finds itself in historically uncharted territory. Within the LCS industry, the U.S. no longer has the latitude to spend enough money to assume a resilient industrial base. In addition to the need to respond to significant budgetary constraints projected to impact LCS spending for next decade or more, DoD leaders must build and equip a fleet that properly reflects its force size and structure, and be able to react to the global threat environment that exists today and into the future. In addition, modern production techniques and global supply chains have reduced the pressure on DoD and industry planners to maintain a large, physical industrial base as a source of "surge capacity." As such, overt actions must be undertaken by the DoD to assure resiliency, flexible capacity, and critically skilled workforce through the projected "investment bathtub." However, barring any changes to the security environment that would require a large increase in land forces, the "bathtub" may turn into a relatively permanent operating reality for the LCS industry. We have determined that our U.S. industrial base is currently robust enough, and in some cases, exceeds requirements to meet the design, development, production, and distribution tasks required to field the world's most effective vehicles for military operations.

As the sole customer for CV products, the DoD has ultimate control of the CVIB. Essentially, the Government will have the CVIB that it is willing, or able, to fund. This is a fairly unique market factor that requires active management to maintain the appropriate balance of capacity and cost. The Government must constantly evaluate and prioritize ways to generate the greatest value from the CVIB. Risks to the nation's ability to design, develop, produce, and sustain combat vehicles with unique armor and weapon systems have a potentially detrimental impact on its capacity to assure tactical superiority and promote national interests globally. In the LCS market these risks emerge as products of the prohibitive costs of inefficient industry capacity, specialized low-density workforce, and the engineering/designing of military-unique production equipment and tooling. The Government's ability to support the LCS industry and mitigate these risks through a variety of market and national security mechanisms will provide the national advantage required to maintain the U.S. position as world leader.

The CVIB clearly faces challenges in the medium term, specifically the "investment bathtub," that necessitates government intervention to achieve multiple goals of controlling costs, managing capacity, assuring the availability of critical labor skills, and maintaining a competitive, innovative edge in producing systems that are more capable than those of our potential adversaries. There are a few broad, overt approaches to achieving these goals in the

context of economic and political factors. Each approach supports meeting warfighter requirements but uses different risk approaches in terms of the CVIB.

Free Market: The first approach depicts the current state of affairs. With the changes and priorities brought about by WSARA and BBP, competition is king. Each acquisition program exists unto itself, but is still subject to the vagaries of government laws, policies, and procedures. The Government exerts limited explicit maneuvering in selecting the winners, but relies on the emergence of the best competitor according to the pre-determined source selection factors. Program Executive Officers and Program Managers work within the “Iron Triangle” to meet warfighter requirements for specific acquisition programs while following the WSARA and BBP requirements. The current policy could result in one of the two dominant CV firms capturing all of the upcoming CV programs, with the subsequent result that the second CV firm exits the industry in the long-run.

The Free Market approach emphasizes competition to achieve best value for a specific program, but not necessarily for the CVIB as a national security resource, and results in a semblance of laissez-faire capitalism, marked by limited government strategic planning in awarding contracts. This is consistent with the intent of WSARA and BBP initiatives. This “survival of the fittest” approach allows for the best bid to emerge, with the Government reaping cost, schedule, and performance benefits of competition in acquiring a given system, such as GCV. In a narrow industry like CV design and manufacturing, this policy may result in one of two outcomes. The first possibility is that the market may end up being dominated by a single firm. This might result in less surge capacity. More importantly, the absence of vigorous competitive pressures might result in a serious degradation in innovation and product development capabilities. If one firm dominates the market it may not invest aggressively in technology and innovation as a way to achieve competitive advantage. Second, new programs such as MPC could be won by new entrants. This could result in more excess capacity as the current incumbents strenuously lobby DoD and Congress for continued production of their products. Based on the seminar’s overview of the industry stakeholders, we have determined that the Government cannot tolerate the prospect of a single major CV manufacturing firm.

If high market concentration makes reliance on market forces a risky and undesirable means for shaping the CVIB, the next approach folds more government intervention into the acquisition process, and moves away from the quasi-laissez faire approach.

Controlled Market The second approach is to manage the CVIB as a “regulated utility”. This approach is based on the proposition that unfettered competition is incompatible with Government interest in maintaining DIB capabilities in excess of peacetime needs. Firms will ruthlessly eliminate DIB capabilities that are in excess of peacetime demand even though they may be needed by the Government for national defense contingencies. In order to maintain necessary surge capabilities during peacetime, DoD must effectively regulate the industry using various tools at its disposal such as tailored acquisition strategies and government ownership of facilities and tooling. In this case the capability and capacity of the CVIB is a public good, supported by deliberate government intervention to assure a level of continued availability. This approach was used to some extent in the 1990s across the broader DIB. Following Defense Secretary Aspin’s Last Supper direction to industry to consolidate, the DoD directly or indirectly allocated work to various contractors to ensure the desired amount of firms remained in business to maintain a minimum amount of capabilities, surge capacity, and competition in the areas of



innovation and product design. The overriding objective of this approach is preservation of critical industrial capacity unique to defense products and maintenance of product design competition.

Multiple market and policy mechanisms are available to the Government to regulate the CVIB, including acquisition, political, and production levers. This could take the form of smaller contract awards to keep multiple lines warm or multi-year procurement to give assurance to CV firms while also spreading out workload over multiple years. Some contracts could be awarded sole source while others are awarded competitively, depending on how the DoD best determines to level out the work in the interest of preserving essential defense industry capabilities. More forceful methods could also be used, to include directed OEM teaming as seen in the United Launch Alliance, as well as work-share arrangements similar to those used in the Joint Strike Fighter program. In the extreme form, the DoD would develop a comprehensive CVIB strategy to deliberately award acquisition contracts to preserve the desired distribution, size, and scope, of production capability and capacity. For instance, if Firm A has upgrade work on an existing combat vehicle, the Government may choose to award the next program to Firm B.

This approach for managing the CVIB is a return to the old arsenal system with the exception that large portions remain under private rather than public ownership. It provides the Government with flexibility in maintaining a smaller, but effective CVIB while still accommodating political and stakeholder interests. However, it pivots from current competition-focused laws and policies and will require the use of exemptions and waivers for the maintenance of critical DIB capabilities. This approach also relies upon the Government to correctly anticipate industry reaction to a given acquisition approach. This approach will bring higher costs to pay for the retention of capabilities that exceed peacetime demand.

CVIB Concentration The existing CVIB is scaled to support a volume of activity that no longer reflects the realities of the national security environment. As a result, the Government continues to invest in maintaining a capacity that it no longer requires, including a robust portfolio of GOGO and GOCO facilities, and highly specialized production equipment and tooling. Multiple DoD and private facilities like JSMC, Allison's Plant 14, and BAE's production operations are all carrying excessive manufacturing capacity. As a monopsonist customer, it is incumbent on the Government to manage and concentrate its resources to more efficiently operate under its current budget constraints, while continuing to sustain an effective CVIB. One solution to this challenge would be to concentrate CV manufacturing capabilities at government-controlled locations, such as the depot(s) and/or JSMC. This would allow the DoD to maintain more control over the management and utilization of facilities, tooling, and critical labor skills required to support the existing CV fleet and maintain a desired level of surge capacity. In addition, it would allow competitors to concentrate on maintaining innovative design and engineering expertise, while leveraging existing government facilities for production purposes. Concentrating manufacturing at the JSMC and/or the depot(s) would drive down production costs over the long run by facilitating improved manufacturing processes, higher utilization rates for facilities and equipment, and reducing overhead costs. By taking more control over the resources involved in production and sustainment of the CVIB the government would be able to optimize its capacity and maximize the return on taxpayer investment in the industry without sacrificing readiness or effectiveness. By concentrating the industry around government-owned infrastructure, depot and CV manufacturers will have more incentive to enter

into P3 relationships. These arrangements allow both Government and industry participants to more accurately focus their investment and effort according to expertise, core competencies, and respective value propositions.

To concentrate the CV industry, the JSMC facility must expand operations to include firms and products other than GDLS and the M1A2 Abrams Tank Upgrade, with facilities management support being provided by an independent third-party property manager that is properly incentivized to run JSMC as a multi-product enterprise. Opening this facility to additional firms would increase management complexity, but would lower the initial capital investment required to compete in the CV market. This minimizes a major barrier to entry and increases overall market competition. As a result, the Government would be able to select from a wider range of innovative product designs while leveling out the demand signal for critical manufacturing skills.

The depots will also have a critical role in concentrating the CV industry in government facilities. Using a model similar to JSMC, the depot(s) would vertically and horizontally expand their business models to accommodate a diverse portfolio of production, maintenance, and repair workload across a wide range of LCS vehicles, components, and vendor tenants. This expansion would provide the Government with more options for how it chooses to optimize industry capacity and achieve cost savings without losing operational effectiveness. Concentrating more work in the depot(s) would stabilize the size and skills of the depot workforce. During the surge period from 2005-2010 depot leaders relied heavily on a sizeable temporary workforce to scale up and down to accommodate demand fluctuation. Both the depots and OEMs would be able to collaborate to build and draw upon a robust, local labor pool. Expanding the pool of OEMs and supplier in the depot will improve production efficiency, maintenance capacity, human resource management, and infrastructure utilization. This solution would require initial capital investment by the government. However, in recent years the Government has invested significant amounts of money to build up depot capacity, including new transmission and engine facilities, which could be used to meet the requirements of a more concentrated industry approach.

Both portions of the industry concentration approach place the capital investment burden on the Government and reduces some of the risk facing potential new competitors. Prime contractor tenants would still retain responsibility for maintaining their own supply chains and doing the fabrication and assembly work, but would use government facilities and tooling and draw upon the same labor pools. This would open up the field for defense-capable firms who may have a nascent presence in the CVIB. By separating the issue of managing the facilities and tooling needed to produce and maintain CVs, the Government will be able to increase the size and depth of its design and innovation pool, even as defense budgets are reduced.

RECOMMENDATIONS

In dealing with the upcoming challenges in the CVIB, the seminar recommends the DoD take the following actions:

- 1) JSMC Management Restructure. There is strong Congressional support for keeping JSMC open during the FY14-17 CV procurement pause. If JSMC is going to stay open, it must change from its current single program, single OEM business model. First, designate an organization as facility owner with a clear responsibility for operating JSMC as a combat vehicle manufacturing enterprise. This will improve accountability of facility utilization and assign responsibility for capital improvements. Second, replace GDLS with an independent

third party as facility manager. This will remove organizational conflict of interests and allow multiple OEMs to compete for work at this facility. In addition, the DoD should consider directing future CV production and upgrade work to JSMC as a part of contract award, to preclude creation of new and unnecessary manufacturing capacity and maintain critical labor skills. This recommendation will maximize JSMC's value, lower barriers to entry into the CV market, and has potential to consolidate industrial capacity. Implementation will require more complex government-industry coordination on facility usage and proper handling of the intellectual property of multiple OEMs using the facility.

- 2) Maximize Flexibility for Sustainment. Current depot laws drive inefficient and wasteful work-share arrangements between Depot and OEMs. By strict adherence to the 50/50 law, division of labor between Depots and OEMs at times defies logic. By taking advantage of the existing CITE designations at both depots, the Army can maximize use of P3 agreements. Because CITE P3 agreements fall outside the 50/50 calculation, this gives the Army flexibility in allocating sustainment work to the best-suited facility.
- 3) Drive Towards Single CV Depot. Excess capacity at the CV Depots, in both facility and labor, is expensive and increasingly unaffordable amidst today's fiscal environment. Even at the height of the surge in support of the two wars from the past decade, a single depot would have adequately handled the additional work volume. We recommend that the DoD revisit the 2005 BRAC recommendation and consolidate all CV work at either ANAD or RRAD. The congressional "Depot Caucus" and labor union resistance to this recommendation loom large, but with diminishing budgets, the gains from reducing capacity and centralizing a skilled workforce are worth taking on this effort.
- 4) Redefine DLA's Supply Chain Management Role. Depot-level repairable SCM is not in DLA's wheelhouse. They have struggled with technical conformance of critical parts, product knowledge expertise, and time-phased production support. This drives multiple forms of DLA evasion by depot and Service customers. Instead of continuing to force DLA into the depot-level repairable SCM role for CV unique parts, we recommend two actions. First, implement more P3 arrangements similar to the ongoing HMWWV agreement, where DLA leverages AM General's expertise and has them manage the supply chain. This takes advantage of a traditional OEM capability. Second, have DLA serve in an "Amazon.com" role by linking up customers and OEMs for specific requisitions. This would extend Class VIII medical supply practices already used by DLA, and takes them out of the inventory management and transportation business. These actions will ensure better parts conformance, reduce DLA overhead, and put SCM back with the component developers.
- 5) Optimize Science and Technology Spending. One objective of the WSARA and BBP initiatives is to incorporate increasingly mature technologies into acquisition programs to reduce program risk. This means that S&T will have to assume greater responsibility to develop technologies to a higher TRL at the transition hand-off point. The result will be more technology development occurring prior to Milestone A. This places a larger burden on the S&T enterprise to focus technology development, bridge the S&T funding "valley of death", and make tougher go/no-go decisions to make real capability gains. We recommend two actions. First, use the Joint Center for Ground Vehicles to bring together Army and

Marine Corps acquisition and S&T leaders to coordinate and synchronize the military vehicle S&T portfolio. This existing governance body has the appropriate membership to promote wiser, more focused S&T investments geared toward better aligning S&T products to future capability needs and programs. Second, resist reducing the S&T budget amidst larger defense budget reductions and look to keep it constant, or slightly increase, to ensure we continue to cultivate new, innovative ideas that lead to warfighter capability gains.

Essay #1 WSARA/BBP through the JLTV Lens

Today's CV and TWV acquisition programs are impacted by WSARA and BBP initiatives, lessons learned from a decade of conflict, and changes in budgets, weight, and survivability priorities. No LCS program more accurately captures these factors than the JLTV program. The JTLV program embodies the pressures of the performance triad of military vehicles in terms of protection, payload, and mobility. Its acquisition strategy incorporates key WSARA and BBP principles to include ensuring competition is maintained throughout the life cycle, competitive prototyping occurs earlier in the program, the acquisition of TDPs to allow continued competition throughout the program's lifecycle, and the use of Fixed Price contracts for the Technology Development (TD) and Engineering Manufacturing Development (EMD) phases.

While it is too early to fully evaluate the impact of WSARA and BBP on the JLTV program, there are a few areas to monitor throughout the acquisition. These include benefits achieved through best value and source selection strategies, increased competition over the lifecycle, procurement and life cycle costs, and the cost-benefit impact of TDP pricing. Competitive prototyping during the TD phase informed the Services on survivability, capability, available technology, and cost trade-offs. EMD source selection is ongoing, and will award up to three firm-fixed price \$65 million contracts based on performance of Request for Proposal (RFP) requirements, design maturity, schedule, and production cost estimates. During the actual EMD phase, the Government will evaluate "production ready mature designs." The EMD RFP requires each bidder to price their TDPs, but does not commit the Government to purchase any of the TDPs. While the ability to purchase a TDP may result in better lifecycle costs through government ownership of the TDP, it does not appear that TDP price is a heavily weighted factor for program. Without this weighting, industry is not incentivized to competitively price their TDPs. After EMD, LRIP selection will hinge on demonstrated performance with credit given for beyond-threshold performance on parameters.

From discussions with industry and government representatives, this WSARA/BBP-influenced JLTV acquisition strategy has produced a number of effects. First, firms that were TD non-selects are coming back to compete for EMD with contractor-funded prototypes. Thus, competition is again clearly present in the EMD phase with six teams vying for three contracts. Second, while firms are developing prototypes, we expect these will be modifications of existing products, vice new technologies. Third, some industry representatives remain skeptical whether DoD's BBP initiatives are truly aiming for efficiency gains and not simply targeting profits. This caution, combined with the uncertainty over future contract award may lead firms to take on less IR&D risk to ensure a steady shareholder return. Next, BBP reporting requirements are adding costs against the JLTV contracts, without perceivable commensurate utility. Finally, acquisition and test community tension has increased, with the requirement for 20 test articles in the EMD phase. The magnified cost and logistical test burden is perceived to consume precious program funds and may open the door for government tester-induced requirements creep.

By adhering to the WSARA and BBP initiatives, the JLTV program is designed to bring DoD benefits from ongoing competition. The JTLV program implements best-value contracting and selection strategies and emphasizes reduced production and lifecycle costs to achieve “best product” while decreasing overall schedule and costs throughout the lifecycle. Lessons must be captured and evaluated as this program moves forward.

Essay #2 SURVIVABILITY ESSAY:

U.S. enemies in Iraq and Afghanistan realized that they could not win through force-on-force tactics. This led to the use of improvised explosive devices (IEDs) against minimally protected vehicles. They understood that the physical damage caused by these inexpensive devices may not defeat the U.S., but it would hinder the mission and cause casualties that would deteriorate American public support for continued combat operations. The IED strategy had a profound and lasting effect on the military, resulting in significant changes to how it fights and equips its troops. The most visible example of these changes are the thousands of MRAP vehicles that were purchased between 2007 and 2009 that will be placed in long term storage because they are too large and costly for CONUS units to maintain. The MRAP procurement experience and their success at saving lives have influenced other DoD acquisition efforts. The lack of MRAP-level survivability in the Army’s FCS Manned Ground Vehicle and Marine Corps EFV design was one of the significant issues that led Secretary Gates to cancel these programs in 2009 and 2011 respectively. The Army’s call for increased survivability has led to a major design change to the Stryker, the removal of the Bradley from Iraq in 2008, and the emphasis on survivability requirements for the GCV and JLTV programs. The IED impact is also prevalent in the psyche of the Congress and military planners, driving political decisions that change the focus of the LCS industry.

The LCS industry responded rapidly to the demand for survivability, from MRAP development to the Stryker’s double-V hull design. Across the LCS industry, firms have designed and engineered survivability solutions, making significant changes to vehicle seats, add-on armor packages, and multiple defense systems designed to defeat rocket-propelled grenades. However, one consequence of survivability as the key design factor is the increased weight and cost of TWVs and CVs. Another consequence of incorporating survivability into military vehicles has been cost. Procurement and sustainment costs of the MRAP family were \$47.3 billion through FY12 funding. This 27,000-vehicle fleet from seven different manufacturers with 52 different variants potentially saved thousands of lives.²⁶ The military has seen first-hand the value of this vehicle in the theater of operations, with survivability a critical factor to the mission success in Iraq and Afghanistan. However, the Services have also realized that the MRAP family does not have a mission in CONUS and a majority of these vehicles will have to go into long-range storage. The long-term plan for lifecycle logistics was not sufficient for a program of this magnitude.

The recent requirements struggle between Services on JLTV requirements was eventually resolved under threat of Senate appropriator cancellation,²⁷ but had centered on survivability and price. The Marines valued lower weight and cost, while the Army put a premium on survivability. The increased weight of the earlier JLTV over the HMWWV would impact the Marine Corps amphibious operations (as the ships could not hold the same quantity of vehicles), their airfield recovery mission, various other operational roles, and requirement for air-transportability by heavy lift helicopters, C-130s and the Army CH-47F. The original Marine

Corps JLTV concept had add-on armor kits, which provided the operational flexibility required but added additional storage and transportation requirements and costs.

The success of survivability solutions is continuing to drive up costs for the new LCS fleets. The GCV is targeted to weigh as much as an M1A1 Abrams tank at 70 tons at a cost in the range of \$11-17 million. Even with the lower survivability levels of the re-scoped JLTV, it is targeted at 15,600 lbs at a cost range of \$225K to \$270K. This focus on survivability may be short sighted, as these vehicles are more expensive to manufacture, operate, and maintain in a time of reduced military budgets and changing enemy tactics that may not focus on the IED. The additional weight required to meet the survivability requirement will result in a military unique engine and transmission for GCV, increased fuel consumption requiring more frequent fuel resupply, and increased operational costs. However, as long as Congress is unwilling to accept IED casualties, the funding for survivability will continue.

ESSAY #3 European Market

Since the end of the Cold War, changes in the European economic and political environment have profoundly challenged its LCS industry. Logically, decreased threats of world war led to a reduction in European defense spending. By the late 1980s, the estimated defense budgets of Germany, the UK, and France all fell by approximately 20% compared to earlier in the decade. The majority of the cuts came from military equipment acquisition accounts instead of from massive reductions in troop strength, operational deployment, and training budgets. Requirements for large LCS force structures and “forward basing” measures dropped to almost zero. Consequently, military operations shifted from heavy armored conventional warfare to other secondary missions like humanitarian assistance and “operations other than war.” This evolution increased the requirement for lighter and smaller, yet capable, military units and vehicles. These post-Cold War progressions in doctrine and force structure necessitated changes to the procurement and production methodologies of Europe’s LCS industry. These trends are forecasted to continue and it is not known when LCS spending will stabilize.

With the significant cuts in the European defense budgets and other security priorities following the end of the Cold War, it became clear during the 1990s that European defense industrial consolidation was inevitable. There was inadequate demand, especially in smaller European nations, to sustain their defense industrial base. Yet this consolidation moved very slowly due to the complex mix of political, security, and national DIB concerns inherent in cross-border defense industry consolidation, including considerations of national sovereignty, job security, and “security of supply” fears of relying on foreign suppliers. OEMs began designing more reliable and longer lasting equipment. As an example, a new battle tank is currently designed for an average life span of 25-30 years, further decreasing the need for replacement. As consolidation stagnated and demand decreased, over capacity in Europe’s LCS industry quickly developed. Companies in the industry attempted to mitigate the reduced demand by diversifying into other market segments such as light vehicles. Firms learned that a company does not need vast resources to develop a 4x4 or wheeled armored fighting vehicle. Consequently, the number of European defense firms competing for these “smaller” contracts increased between 1993 and 2003. However, as competition within the European LCS industry increased, so did the risk of being forced out of the market. Each competition became a “must win” situation. Over time, firms that could not compete either left the market, were bought by other firms, or required government intervention to survive. Today, twelve major firms remain from more than thirty in the early 1990s.²⁸

The efforts toward cross-border consolidation and increased collaboration in Europe remain short of the levels required for economic efficiency. The demand for multiple national variants of major combat systems will likely remain inadequate to support more than a handful of firms. Unless the European Commission continues reforms to encourage inter-European competition, and the European Union can achieve consensus to act as one buyer (instead of 27 sovereign buyers), overcapacity and inefficiency will remain in the European LCS industry. Currently, European firms can count on their national government for some business but consolidation may be nearly played out.

CONCLUSION

The U.S. is the world's leading producer and consumer of advanced technology land combat vehicles. Following more than ten years of combat-driven spending, innovation, and production levels, the LCS industry is preparing for an austere and uncertain future. In the TWV sector, these contraction challenges will resolve through normal market mechanisms. However, in the highly specialized CV segment the Government must intervene to ensure an industrial base that reflects its priorities and means. Major OEMs and system integrators are developing business strategies that not only enable them to sustain the existing vehicles in the fleet, but will also ensure that they will be competitive on future program acquisitions. The success of these plans will depend on their ability to efficiently manage respective supply chains. In addition, both Government and industry will need to manage the changing situation across the entire LCS production system, from requirements definition to life-cycle sustainment.

The TWV industry functions in a similar manner to the commercial truck manufacturing market. As government spending for military trucks goes down, the TWV OEMs will shift focus away from the DoD market and increase efforts to win commercial truck business. The production infrastructure, labor force, and supply chain required to design and produce a military truck are not exclusive. A reduced TWV industrial base poses low risk as history has shown that commercial truck manufacturers will later re-enter the military truck market when DoD spending increases. The CVIB operates in an opposite manner. It is sustained almost exclusively through government investment. It is fragile and vulnerable to changes in DOD acquisition plans. Cancellation of a single program can create crisis in the industry and risk retention of essential industrial capabilities. During flush budgets, the market functions with limited government intervention in industrial base management issues. However, DoD's buying power decreases as LCS budgets decrease. Given the pressure to reduce costs while maintaining troop readiness and surge capacity, the Government should optimize its investments into GOGOs and GOCOs. This should reduce the capital investment burden on the OEMs and suppliers, increase competition by lowering barriers to entry, preserve competition in design and innovation, and create an opportunity to improve industry and government cooperation, all with the aim to sustain an industrial base that retains critical labor skills, assures flexible production capacity, and fosters continued innovation.

APPENDIX 1. LCS Industry Structure

First Tier Contractors & Government Entities

<p>Combat Vehicle Producers and/or Integrators BAE US Combat Systems General Dynamics Land Systems (GLDS) Attempting to enter LM, Boeing, SAIC</p> <p>Protected Vehicle Textron (ASV) / Force Protection (MRAP) Navistar (MRAP) / Oshkosh (MATV) BAE GTS (MRAP) / GDLS (MRAP)</p> <p>Tactical Wheeled Vehicles AM General / Oshkosh Defense Freightliner / Navistar Defense (Export)</p>	<p>Future Programs JLTV: {GDLS-AM General} {LM-BAE GTS} {AM General} {BAE-Northrop-Ford} {Navistar} {Oshkosh} GCV: {BAE USCS-Northrop} {GDLS-LM-Raytheon} {SAIC-KMW-Rheinmetall}</p> <p>MPC : {BAE-Iveco} {GDLS} {LM-Patria} {SAIC-Singapore Tech} AMPV: {BAE} {GDLS} {Other} ACV: {BAE} {GDLS} {Other} AAV Upgrade: BAE, GDLS, others? HMMWV Recap: AM General, BAE, Textron, Oshkosh Bradley FOV Upgrade ? Abrams Upgrade ?</p>	<p>Depots (GOGO) Anniston AD Red River AD MCLB Albany</p> <hr/> <p>Lima Tank Plant GOCO JSMC [GDLS]</p>
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Second Tier Subcontractors & GFE Providers

- Constraining factor of the supply chain during OIF/OEF occurred at second tier & GFE providers

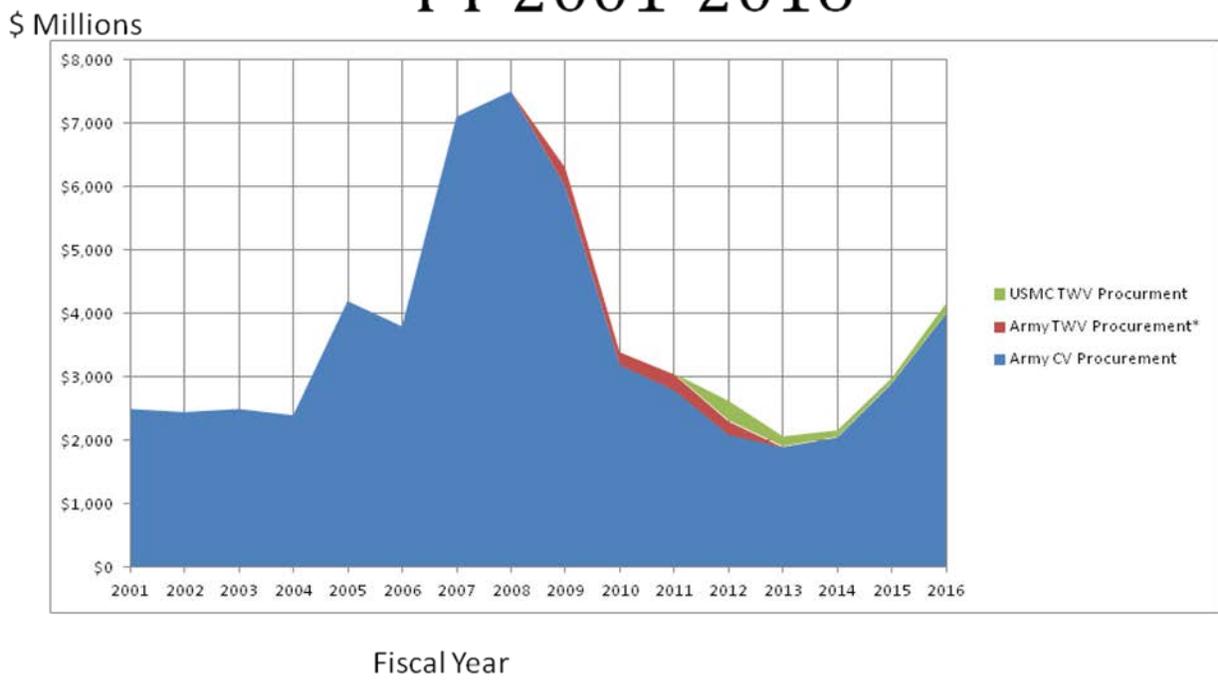
<p>Steel /Alum Alcoa, DOE, Kaiser Arcelor Mittal, Evraz Oregon Algoma Steel Off-Shore</p>	<p>Armor Solutions BAE S&S Ceradyne IBD Oran Plasan Sasa</p>	<p>Engines Caterpillar Cummins Honeywell MTU/ DD</p>	<p>Trans Allison L-3 Twin Disc</p>	<p>Automotive Axletech C E Niehoff Cushman Goodyear, Meritor Michelin, Titan</p>	<p>Sensors/Wpns Boeing, DRS Lockheed Northrop Raytheon Textron</p>	<p>Component Rebuild Anniston AD Red River AD</p>	<p>Arsenals Rock Island, IL Watervliet, NY (M1 gun barrels)</p>	<p>SCM DLA AMC</p>
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Sub-Tier Vendors/Suppliers

- Hundreds of worldwide vendors linked in by OEMs and DLA supply chain managers.
- Heavily influenced by ITAR, Buy American Act, Small Business incentives, etc.

APPENDIX 2. LCS Investment Bathtub

CV and TWV Procurement FY 2001-2016



- * Army TWV Data available for FY 2008 – 2013 only
- Data derived from multiple sources; projections only beyond FY 2014

APPENDIX 3. Acronym List

AAV	Amphibious Assault Vehicle
ACE	Armored Combat Earthmover
ANAD	Anniston Army Depot
BAE	British Aerospace Engineering Systems
BBP	Better Buying Power
BMY	Bowen McLaughlin York
CITE	Center of Industrial and Technical Excellence
COCO	Contractor Owned Contractor Operated
CONUS	Continental United States
COTS	Commercial Off the Shelf
CV	Combat Vehicle
CVIB	Combat Vehicle Industrial Base
DARPA	Defense Advanced Research Projects Agency
DIB	Defense Industrial Base
DoD	Department of Defense
DVH	Double-V Hull
EMD	Engineering Manufacturing Development
EFV	Expeditionary Fighting Vehicle
FAASV	Field Artillery Ammunition Supply Vehicle
FFP	Firm Fixed Price
FMC	Food Machinery Corporation
FMS	Foreign Military Sales
FMTV	Family of Medium Tactical Vehicles
FPIF	Fixed Price Incentive Fee
FY	Fiscal Year
GCV	Ground Combat Vehicle
GDLS	General Dynamics Land Systems
GOCO	Government Owned Contractor Operated
GOGO	Government Owned Government Operated
HEMTT	Heavy Expanded Mobility Tactical Truck
HET	Heavy Equipment Transporter
HMMWV	High Mobility Multipurpose Wheeled Vehicle
IED	Improvised Explosive Device
IR&D	Independent Research and Development
ITAR	International Trade in Arms Regulation
JLTV	Joint Light Tactical Vehicle
JSMC	Joint Systems Manufacturing Center
LAV	Light Armored Vehicles
LCS	Land Combat Systems
LRIP	Low Rate Initial Production
LVSR	Logistical Vehicle System Replacement
MLRS	Multiple Launch Rocket System
MPC	Marine Personnel Carrier

MRAP	Mine Resistant Ambush Protected
MTVR	Medium Tactical Vehicle Replacement
NATO	North Atlantic Treaty Organization
OCO	Overseas Contingency Operations
OEM	Original Equipment Manufacturer
P3	Public-Private Partnership
PLS	Palletized Load System
PM	Program Manager
PV	Protected Vehicle
RFP	Request for Proposal
RRAD	Red River Army Depot
SCM	Supply Chain Management
S&T	Science and Technology
TD	Technology Development
TDP	Technical Data Package
TRL	Technical Readiness Level
TWV	Tactical Wheeled Vehicle
UK	United Kingdom
USMC	United States Marine Corps
WSARA	Weapon Systems Acquisition Reform Act

ENDNOTES

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