

Spring 2011
Industry Study

Final Report
Land Combat Systems Industry



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National Defense University
Fort McNair, Washington, D.C. 20319-5062



LAND COMBAT SYSTEMS 2011

ABSTRACT: The LCS industry features a monopsonist buyer and is both highly competitive and monopolistic. The industry is healthy, but there is significant excess capacity and pressure to consolidate due to declining demand. Critical risk areas are the loss of combat vehicle manufacturing capabilities and the military unique supply chain. The government must choose either a risk-taking or risk-averse approach to consolidation, and must ensure strategic management of its own facilities. The recent acquisition reform focus on competition is beneficial; however competition must not be mandated as a blanket policy – particularly when critical defense industrial base concerns must be managed.

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PLACES VISITED

Domestic:

Aberdeen Test Center (Aberdeen Proving Grounds, MD)
Allison Transmissions (Indianapolis, IN)
AM General (Mishawaka, IN)
Anniston Army Depot (Anniston, AL)
BAE U.S Combat Systems (York, PA)
General Dynamics Land Systems Hqs (Sterling Heights, MI)
General Dynamics Land Systems Anniston Operations – Stryker assembly plant (Anniston, AL)
Joint Services Manufacturing Center – Lima Tank Plant (Lima, OH)
MTU Detroit Diesel (Detroit, MI)
Oshkosh Corporation (Oshkosh, WI)
U.S. Army Ground Combat Vehicle Office (USATACOM, Warren, MI)
U.S. Army Heavy Brigade Combat Team Program Office (USATACOM, Warren, MI)
USMC Expeditionary Fighting Vehicle Program Office (Woodbridge, VA)
USMC Joint Light Tactical Vehicle (JLTV) Program Office (Quantico, VA)
USMC Mine Resistant Ambush Protected (MRAP) Program Office (Quantico, VA)
USMC Marine Corps Combat Development Command (Quantico, VA)

International:

Finmeccanica Headquarters (Rome, Italy)
Iveco Defense Vehicles (Fiat Consortium) (Bolzano, Italy)
General Dynamics European Land Systems Steyr-Daimler-Puch (Vienna, Austria)
Krauss-Maffei-Wegmann (Munich, Germany)
MAN Nutzfahrzeuge, Commercial Trucks (Munich, Germany)
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Renk Transmissions (Augsburg, Germany)
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OVERVIEW: ANALYSIS OF THE LCS MARKET AND GOVERNMENT ROLES

The U.S. Land Combat Systems (LCS) industry is highly complex, defying simple economic classification. It encompasses many market behaviors, from competition to monopoly to monopsony to bilateral monopoly. The customer has specialized needs and imposes peculiar constraints on meeting those needs. Demand swings in wide, largely unpredictable movements, but the industry is driven by political forces as much as by economic forces.

Land Combat Systems Defined

Combat vehicles (CVs) are heavily armored and used for direct and indirect fire support, as well as field support activities under combat conditions. CVs are larger, heavier, and more weaponized than tactical wheeled vehicles, and most CVs are tracked. The CV class includes the M1 Abrams Main Battle Tank, M2/M3 Bradley Fighting Vehicle, Stryker armored fighting vehicle, M113 armored personnel carrier, Amphibious Assault Vehicle (AAV-7), M109A6 Paladin self-propelled howitzer, and M88 armored recovery vehicle. Recently, some CVs have incorporated “urban survival kits” with reactive, belly, and slat armor to deal with ever-evolving explosive/penetrating threats that can come from any direction around and under the vehicle.

Tactical wheeled vehicles (TWVs) are typically used for general purpose mobility and cargo transport missions. The TWV class includes the well known high mobility multipurpose wheeled vehicle (HMMWV), the Family of Medium Tactical Vehicles (FMTV), Medium Tactical Vehicle Replacement (MTVR), Palletized Load System (PLS), Logistics Vehicle System (LVS), Heavy Expanded Mobility Tactical Truck (HEMTT), Heavy Equipment Transporter (HET), and linehaul tractors.

The nature of the fighting in Iraq and Afghanistan has blurred the distinction between CVs and TWVs. Improvised explosive devices (IEDs) eliminated traditional battle lines, bringing combat to routine military functions occurring outside the wire. Thus, the “protected vehicle” (PV) was born to satisfy more stringent survivability requirements. PVs are armored TWVs designed for robust anti-mine protection. Many PVs feature monocoque hulls welded in blast-deflecting shapes (i.e., “V” or “double-V”). PVs are typically very heavy and have limited to no off-road capabilities. This class includes the family of mine resistant ambush protected (MRAP) vehicles, the Expanded Capability Vehicle (ECV) HMMWV variant, the Armored Security Vehicle (ASV), and other PVs. In response to the IED threat, LCS firms quickly built and fielded thousands of MRAPs, while firms and depots added armor to many other platforms. New vehicle programs must now contend with rigorous protection requirements that add significant weight and cost.

LCS platforms are becoming complex “systems of systems” with high-technology weaponry, electronics and C4ISR¹ functions. Gone are the days of the simple Willys Jeep or the basic M113. LCS platforms today are treated less like high-volume commodity “trucks” and more like aerospace or naval systems that require significant integration and testing. Since this level of technological complexity comes at a steep price, the military is compensating by buying its systems in lower quantities.

LCS platforms incorporate a mix of military-unique and commercially available parts and technologies purchased from two substantially different supply chains. TWVs draw extensively from the commercial automotive industry in which the military is a relatively small customer. Larger, heavier CVs are less commercially sourced, with tracked CVs using a great deal of military-unique parts from a supply chain that looks to the military as its exclusive customer.

The Monopsonist Customer

The U.S. Department of Defense (DoD) is a monopsonist buyer of LCS products, with one major (Army) and one minor (Marine Corps) customer. Thus, DoD faces the monopsonist's dilemma: Its strategies, priorities and policies drive the structure and conduct of the U.S. LCS industry – whether as intended or not. LCS firms face a pattern of large, infrequent orders from DoD, plus occasional foreign sales – unlike the steady sales to numerous customers that could be expected of commercial markets. Consequently, each major DoD program decision (new product development, off-the-shelf purchase, or upgrade) significantly shapes the industry.

The government wants to wield its monopsonistic power to drive competition, get better pricing, and reduce cost and schedule overruns. However, DoD's demand for LCS products follows the boom/bust cycle characteristic of defense spending, and during prolonged periods of low demand the government wants an insurance policy to preserve minimum industrial capabilities that are deemed critical to national security. Therefore, in a bust cycle DoD cannot rely solely on pure competition, which would drive firms to ruthlessly eliminate excess capacity. In such cycles, DoD has historically managed the defense industrial base (DIB) either indirectly through acquisition sourcing decisions or directly through ownership of facilities and tooling or operation of industrial enterprises.

LCS firms must deal with many constraining factors in selling to DoD. Significant knowledge and experience are needed to navigate the complex Federal Acquisition Regulations (FAR) and the Defense Acquisition System (DAS). Strict export controls require U.S. firms to get the government's permission to sell their LCS technologies to foreign markets. Furthermore, DoD can only make short-term commitments with its procurement money. The Constitution states that "Congress shall have the power to...raise and support armies, but no appropriation of money to that use shall be for a longer term than two years."² Congress adds to this constraint with an annual budget resolution with specific rules, and DoD responds with its portion of the annual President's Budget. As one report noted, "Defense acquisition revolves around 15-year programs, 5-year plans, 3-year management, 2-year Congresses, ...1-year budgets and thousands of pages of regulations."³ Finally there is the maze of national politics. It is not enough to produce the best systems; defense firms and programs must be "politically efficient" or risk losing vital Congressional support. Whereas commercial firms use marketing to influence consumer decisions, defense firms must exercise their constituent rights to engage their elected officials in order to influence the political decision-making process.

In seeking to meet its needs, DoD must often provide capital and infrastructure. Firms may not make their own long-term investments in product-specific facilities and tools, especially when faced with unstable DoD funding and the lack of commercial sales to help amortize the investment. Additionally, the use of government capital is a historical legacy, kept in play by politically efficient rent-seeking stakeholders.⁴ Thus, government capital is found throughout the industry, in government-owned government-operated (GOGO) facilities, government-owned contractor-operated (GOCO) facilities, and even within contractor-owned contractor-operated (COCO) manufacturing plants.

DoD is also an LCS competitor, primarily for sustaining systems. GOGO depots have legally mandated "core capability requirements" and guaranteed workshare (up to 50 percent for depot-level maintenance work)⁵ that must be fulfilled, in addition to strong political support due to the economic benefits that accrue from significant levels of employment. Thus, public-private partnerships (P3) have been created to leverage industry expertise while satisfying depot

requirements and “political efficiency” considerations. In addition, the Defense Logistics Agency (DLA) is transitioning from its legacy role as the supplier of depot maintenance consumable parts to its new designation as the DoD-designated supply chain manager (SCM) for depot sustainment operations – in direct competition with original equipment manufacturers (OEMs) that wish to manage their own chains. DoD even competes against itself. The overall excess capacity of the depots is a byproduct of political efficiency; today the depots strive to remain “BRAC-proof”⁶ by competing for direct labor hours (DLH) and designation by the DoD as the Center for Industrial and Technical Excellence (CITE) for specific systems.

Finally, DoD’s difficulty in fielding new LCS platforms must be acknowledged. According to a recent Army-sponsored study, “Army acquisition has proved ineffective and inefficient, as demonstrated by the 22 major acquisition programs terminated since the end of the Cold War,” with 15 terminations since 2001 and over \$1 billion spent annually since 1996 on programs that ended up being cancelled. The study concludes: “This track record of too many cancellations, schedule slippages, cost over-runs and failures to deliver timely solutions to the warfighters’ requirements is unacceptable. The Army cannot afford to continue acquiring materiel the way it has in the last two decades.”⁷ Recently the Marines felt the sting of failure as well with the cancellation of the Expeditionary Fighting Vehicle (EFV) program. DoD has not successfully executed a full-scale development program for a new ground CV program since the end of the Cold War. Critics are quick to point to a slow requirements process, poor acquisition execution, and instability in funding, priorities and requirements, but even these issues are symptoms of deeper causes that are inherent to the acquisition process.⁸ Since the end of the Cold War, the lack of a clearly defined strategic threat picture has prompted the military to shift from threat-based requirements to a somewhat vague “capabilities-based” analysis. This result, combined with the frequent transition of national political and military leadership, has created a vague environment wherein the prerogatives of individual leaders weigh heavier than any long-term consensus on when and how DoD should commit its procurement funds.

Regardless of the causes, the study cited above concludes that “Army leadership, OSD, Capitol Hill and industry have lost trust in the Army’s acquisition processes and capability to effectively provide warfighters the equipment and services they require in a timely manner.”⁹ Thus the troubled investment record both reflects and contributes to the “principal-agent” problem inherent in defense acquisitions: the challenge of ensuring that program managers (PMs) and their hired contractors are faithfully pursuing the warfighters’ needs and acting as good stewards of the taxpayers’ dollars.¹⁰

Describing the Land Combat Systems Industry

The LCS market is highly concentrated, as shown by an analysis of 2000-2010 government contract data.¹¹ For tracked CVs, General Dynamics Land Systems (GDLS) and BAE form a two-party oligopoly, winning 96% of the market combined. The Herfindahl-Hirschman Index (HHI)¹² is 0.47, indicating a fairly balanced split between the two firms. Over 64% of CV contracts were sole source, owing to significant upgrade and recapitalization work on the legacy Abrams (GDLS) and Bradley (BAE) vehicles. Fixed price (FP) contracts were used 60% of the time, as opposed to 33% use of cost reimbursable contracts.¹³ For TWVs (including MRAPs), the top 4 firms won 78% of the market share. The HHI for TWVs is 0.16, a moderate number that reveals competitive balance between the players – indeed, the government competed 72% of TWV efforts. The vast majority of TWV contracts are fixed price (93%), owing to the commercial non-developmental nature of utility truck production.

Before the recent conflicts, there were two major CV firms (GDLS and United Defense); three major TWV firms (Oshkosh and Stewart & Stevenson for medium and heavy trucks, AM General for light trucks); and two major LCS depots (Anniston Army Depot [ANAD] and Red River Army Depot [RRAD]). Today BAE has acquired United Defense and joins GDLS in the duopoly of CV firms; Oshkosh has cornered the medium and heavy truck market (AM General still has light trucks); and Navistar and Force Protection have joined the industry with the new class of PV systems. In addition, the increasingly complex nature of LCS systems has enticed major defense “system integrator” firms to move in from adjacent markets: Lockheed Martin, Boeing, Northrop Grumman, and SAIC are vying to compete as prime contractors, and have partnered with LCS platform providers that already have a foothold in the market.

The statistics on the structure of the LCS industry do not reveal its paradoxical nature: The degree of competition varies by product lifecycle and it can be both fiercely competitive and highly monopolistic. New product development efforts are very competitive, but once the make and model are determined for a system, the market for its production and support tends to become a “winner take all” bilateral monopoly between one firm and the government.¹⁴

The LCS market has moderate barriers to entry. Firms must have in-depth knowledge of the government customer’s rules for acquiring and supporting systems (e.g., mandatory depot core requirements). Design and production experience are critical, and firms must also either have the infrastructure to produce platforms or the financing to develop that infrastructure. This requirement for “deep pockets” is more acute for the larger, more military-unique CVs and for firms trying to move in from adjacent markets, but it is somewhat easier for existing commercial automotive industry firms to enter the TWV market. The increasing technological complexity of LCS platforms and the desire for product differentiation demand that firms spend significant independent research and development (IR&D) funds to compete.

Nevertheless, when the LCS market is open and government money is on the table, new competitors who have the resources routinely show up. This includes big commercial firms using commercial off the shelf (COTS) based products, as well as large defense “system integrator” firms moving from adjacent markets. In some cases, these firms form partnerships with existing U.S. or foreign LCS firms in order to have access to the requisite products and technologies. In the lifecycle of a program, DoD usually must downselect to one producer, since maintaining multiple producers is not economical for relatively low volume defense product production runs. Should it wish to switch to another make or model, DoD faces the high switching costs of recompeting and funding another iteration of development, production and product support. Similarly, once in the market, firms face potentially high costs to exit the market due to the resulting “stranded capital,” i.e., investments in facilities and tooling.

Government ownership of the technical data package (TDP, i.e., data rights) is key to fostering competition for system production and support, provided that it is cost-effective. TDP ownership facilitates breaking up program lifecycle contract “bundles,” wherein one prime contractor enters into a comfortable long-term, monopolistic and lucrative relationship with the government. For example, when DoD recently used TDP ownership to facilitate recompeting the Family of Medium Tactical Vehicles (FMTV) production contract, Oshkosh beat out the incumbent BAE Systems by offering a 28 percent reduction from the previous unit price.¹⁵

However, recompeting the TDP for a system is often uneconomical, especially when low volume production runs do not justify the expense or effort. Buying the TDP from an entrenched OEM is expensive unless it is competitively priced as part of a downselect process. Absent this condition, firms will set the price of the TDP at the expected present value of future profits. This

negates the savings the government would gain from buying the remaining quantities via competitive procurement. OEMs for state-of-the art systems won't sell their intellectual property cheaply; but even if they are willing to sell, other firms may not be capable of producing and/or supporting the systems. OEMs with COTS products won't sell their intellectual property rights to DoD customers that typically represent a small fraction of their commercial customer base. By pressing forward despite these issues, the government could create another market barrier for those firms unwilling to sell the rights to their designs.¹⁶ Finally, even if the TDP is successfully purchased, this places the system integration and support burden squarely on the government program office – a task for which it may not be sufficiently resourced. Thus, DoD is usually unwilling and/or unable to use competition to secure cost-effective product support. This problem is compounded by the lack of long-term, stable funding and requirements for system lifecycle management. Additionally, incumbent OEMs, depots and suppliers are constituents with political support, which impedes any attempt to alter the arrangement.¹⁷

LCS firms adopt a variety of strategies to compete for CV and TWV programs and create growth (return on capital) for their investors. They compete on price and product differentiation, vying to offer cost-effective manufacturing and must-have innovations to their customer. Firms also compete to enter into lucrative lifecycle support relationships, trading on their brand-name reputations and extensive support networks. Political efficiency is a major factor, as savvy firms realize they must spread their work out over multiple Congressional districts and maintain a strong lobbying presence on Capitol Hill. In this regard, LCS firms see P3 relationships with depots as a necessary compromise to ensure market share by allowing the customer (the Services as buyers) to fulfill depot core requirements. Some P3s offer firms the advantage of using government facilities and tooling in order to minimize the risk of stranded capital.

Parts and components suppliers have varying degrees of power over buyers – low for commercially available automotive parts, but higher for military-unique parts such as high-performance diesel engines and cross-drive transmissions. Buyers pay a premium for military unique parts produced in small, economically inefficient order quantities. In addition, prices are high for COTS parts that have become commercially obsolete but must continue to be produced for aging platform configurations that DoD sometimes maintains for decades. Some primes mitigate availability and price issues by vertically integrating elements of their supply chain. Whether using commercial or military parts, primes have more flexibility and power early in the lifecycle when the system specification and configuration are still “putty.” Once a configuration enters production, that putty turns to “clay” and switching costs escalate considerably.

As buyers, the power of LCS firms depends on whether they are buying COTS or military-unique equipment.¹⁸ For COTS parts, vendors have many customers so no single LCS buyer has much power. When the buyer owns the data rights to a military-unique part or has detailed interface and performance requirements, it can purchase from any qualified vendor. When some complex parts, such as engines or transmissions, are only supplied by a single source, the result is a bilateral monopoly where the part vendor holds the advantage.

In the LCS market, the threat of substitution is low: DoD will continue to need LCS platforms for forward presence, mobility and protection. Nevertheless, substitute forms of military power (i.e., air or naval power) and doctrine do exert some competitive pressure on the market. If LCS affordability becomes an acute issue, DoD may economize on land vehicles in favor of other platforms. Thus for the foreseeable future the LCS market will endure, with its multi-faceted, paradoxical nature and behaviors that defy simple classification.

CURRENT CONDITIONS

In recent years, the LCS industry benefited from the post-9/11 boom in wartime defense spending. High demand brought substantial revenues and enabled investment despite the onset of the “Great Recession.” The effects of the recession still linger, and unemployment is still high while U.S. industry attempts to regain a strong position in a globalized economy. Unfortunately for the LCS industry, the boom cycle is coming to an end, as the U.S. has drawn down from Iraq and looks to do the same in Afghanistan. Congress and the public are tiring of steep wartime support bills, and the federal budget is now being squeezed tight as national leaders try to reduce the annual deficit and stave off a catastrophic debt crisis. Consequently, there is significant political pressure to eliminate overseas contingency operations (OCO) funding and lay significant cuts into DoD’s base budget – although there have still been no official decisions to cut service force structure.

With the demand curve shifting left, LCS firms and their supply chain vendors are deciding whether to stay and fight it out or exit an increasingly tough market; indeed, some vendors have already left. As part of this calculation, firms are eagerly trying to predict DoD’s requirements. The prospect for lucrative procurement decisions for new or upgraded systems is mixed, with infrequent but possibly large orders on the horizon. One thing is clear: DoD is strongly emphasizing affordability for any new systems. Any other specifics are hard to discern. As discussed earlier, DoD itself faces a vague threat environment, and uncertainty in long-range military needs is simply a fact of life in dealing with the U.S. government.

Despite substantial production and repair activity over the last decade due to the wartime surge, there is still significant excess capacity across the spectrum of private and government LCS industrial capabilities.¹⁹ Most facilities have some unique capabilities, but there appears to be ample opportunity for consolidation. For example, the Joint Systems Manufacturing Center (JSMC) and BAE’s York facilities are both geared for heavy CV fabrication but are now struggling to maintain minimum economic workloads due to declining demand. Similarly, the depots are experiencing sharply declining direct labor hours, and neither RRAD nor ANAD was near capacity at the height of the last decade’s surge. As workload at each facility declines, the overhead cost of operations must be allocated at higher rates to a smaller customer base.

Status of the LCS Fleet

During the last decade of high LCS demand the military was well-funded to support a high operational tempo, with significant spending on CVs and TWVs. As a result, Active and Reserve LCS assets are presently well capitalized.²⁰ Most high-end CVs were rebuilt or underwent extensive reset, while older trucks were replaced and a large portion of reserve component shortages were filled. However, there are some major LCS issues to deal with as the conflicts wind down. The fleet is now a large, stratified mix of systems at various ages, usage levels, and states of upgrade. MRAPs present a particularly thorny problem. They were bought in large numbers, in a variety of models, for a specific purpose and under urgent circumstances. The deliberate decisions to prioritize the MRAP fielding schedule over life-cycle sustainment considerations will likely result in significant cost liability if they are retained in service.

The Services have recognized these issues and are now building post-war vehicle strategies. Over the last decade, they changed their force structure (e.g., fewer Heavy Brigade Combat Teams (HBCTs) but more Infantry and Stryker BCTs). In re-examining this force structure for the future, the services must balance their requirements with the looming budget

cuts and the resulting inevitable emphasis on affordability. While DoD is starting from a state of well-capitalized rolling stock, it is now beginning to divest of vehicles that are no longer seen as needed – despite the fact that there are currently no plans to reduce the overall force structure. In one major example, the Army has already decided to reduce its TWV fleet by 10%.²¹ In short, DoD is shifting its LCS demand curve to the left and industry must respond accordingly.

Status of Commercial and Government Industry: Healthy but Preparing for a Tough Market

The LCS commercial industry survived the recession in relatively good shape, flush with revenues from the wartime boom cycle of defense spending. In the last several years, the industry has been characterized by active market entry, high profits, and strong levels of investment in capital and facilities, from which they are still seeing solid returns. It is apparent from visiting numerous facilities that firms continue to invest in lean manufacturing and quality-enhancing techniques, in order to remain competitive in an increasingly tough market. In addition, innovation and IR&D are emphasized as essential to product differentiation, in order to be well-positioned to win the few remaining program competitions. Similarly, there was an influx of capital to the government depots over the last decade to support the surge. With some new facilities, updated processes, and an entrepreneurial spirit driven by competition for relevance, the depots are in significantly better condition than they were 10-15 years ago.²²

Nevertheless, the government side of the industry is characterized by the “rented car syndrome,” i.e., the lack of continuous investment and enterprise-level management – despite the strategic importance of these industrial capabilities. GOCO facilities such as JSMC or Allison Plant 14 (tank transmissions) generally use less modern equipment and processes than their private counterparts. Management of these national assets, including allocation of overhead costs, is typically delegated to a program office that has neither the incentive nor the funding to make improvements beyond immediate programmatic need. JSMC is advertised as being willing and able to handle multiple joint manufacturing needs, but facility costs and strategic management responsibilities are borne by the Army’s HBCT program office. HBCT has, in turn, contracted the daily operation of the plant to GDLS, which happens to be the largest HBCT contractor. This situation hinders the possibility of non-Abrams work being performed at JSMC. Special arrangements are required to share overhead costs, and the presence of GDLS in its plant management role requires firewalls and other assurances to avoid conflict of interest issues.

GOGO depots are still government bureaucracies that struggle to operate as efficiently as the private sector due to several factors, including the lack of existential competition (i.e., the prospect of going out of business or having the management team replaced); no profit-loss implications or shareholder feedback on stock prices; a strong preference for the use of labor over capital; the uncompetitive pricing nature of working capital funds (whereby overhead and capital depreciation costs are liberally charged to the customers); vague operational objectives; and “due process” government business rules that frustrate the achievement of cost-efficiency.²³

Since depots have strong political support and workshare requirements, both government and private industry are proactively engaging in P3 relationships as the best available (if not the most efficient) way to sustain and upgrade the LCS fleet. In a typical P3 arrangement, the depot performs the touch labor for disassembly, parts reclamation, and rebuild of major components such as engines and transmissions, thereby netting prized direct labor hours while gaining access to the technical information on the systems. The OEM retains the high-profit work of engineering, technology insertion and final reassembly, thereby sharing its core strengths with the government. Another P3 benefit for private industry is that it allows the OEM to remain the

supply chain manager for its products, as opposed to the Defense Logistics Agency (DLA, see below). By joining in a P3, the OEM and the depot can each offset their overhead costs with more workload. As one successful example of a P3, Honeywell works with government employees at ANAD to rebuild Abrams tank engines.

Status of the Supply Chain: Healthy but at Risk Due to Declining Demand

The constraining factor in the LCS industry's ability to surge is neither depot nor OEM capacity but the supply chain (SC). While the automotive SC survived the recession more or less intact, the military-unique SC is at risk due to the forecasted decline in demand. Increasingly uneconomic order quantities are resulting in higher prices, and some vendors are choosing to exit the market altogether. For example, elements of the Abrams supply chain for long-lead items have already disappeared in anticipation of a production shutdown in 2013 (discussed further in Outlook), and this is expected to happen for the Bradley as well. In fact, the window of opportunity for the government to have prevented this SC situation (2009-10) has already passed.²⁴ OEMs are either vertically integrating to ensure cost-effective access to unique parts and subassemblies, or competing to lock in qualified vendors.

Elsewhere in the supply chain arena, DLA is attempting to fulfill its newly assigned role as the designated SCM to the depots for all parts and subassemblies. However, both government and private entities are complaining that this arrangement has resulted in parts that fail to conform to technical specifications, slow requisitioning, and uncompetitive pricing. Indeed, DLA has major obstacles to overcome. Supply chain management is not its core competency (as opposed to supplying consumable parts), and it often doesn't have full data rights to systems. As a public bureaucracy, DLA must comply with the Federal Acquisition Regulations (FAR) which require due process in selecting vendors and acquiring parts. As a government monopoly for depot supply support DLA is not subject to the disciplining forces of competition, their efforts to be responsive notwithstanding. Working capital pricing, with "cost recovery rates" amortized over large and small customers, cannot compete with free market pricing. In response, OEMs have entered into teaming agreements with the depots to offer parts "kits," a practice that allows them to circumvent DLA's supply chain.

Status of Acquisition Policy: A Sea-state Change for the LCS Industry

The Weapon System Acquisition Reform Act (WSARA) of 2009 and DoD's Better Buying Power (BBP) initiative have triggered a major sea-state change, with mixed results for the LCS industry. The expected payoff is better performance, lower prices, and reduction of technological risk and lifecycle cost, but these reforms have drawn-out the acquisition process by mandating additive events and measures prior to major program decisions.

OUSD/AT&L²⁵ now mandates that PMs for major acquisition programs present competitive strategies at each program milestone.²⁶ Competition is expected for each acquisition phase, and even within each phase if cost-effective. For example, competitive prototyping during the Technology Development (TD) phase is expected for most programs and is heavily emphasized by DoD. However, since the government assumes the burden of simultaneously funding multiple firms, maintaining competition into the production and support phases may be impractical or prohibitively expensive. At each milestone, the strategy can either be to downselect from the current slate of competitors or to have full and open competition. By using full and open competition at subsequent program phases, DoD discourages monopolistic behavior and hopes to incentivize more firms to remain in competition for a given system – even

if they lose out on a previous phase.²⁷ More competition may or may not inspire firms to invest in capital and innovation. On one hand, firms want to invest enough to be in a strong position to win a future competition. On the other hand, firms may not push leading edge technologies or make significant investments if the program is recompeted at each milestone.

For the Joint Light Tactical Vehicle Program (JLTV), AT&L directed a strategy with at least three competitors with prototyping in the TD phase; at least two competitors in the Engineering, Manufacturing and Development (EMD) phase; full and open competition for EMD (not a downselect from TD); and an attempt to purchase the TDP in order to compete production and support. The prospect of open EMD competition is keeping at least one firm in the game that didn't earn one of the JLTV TD contracts. Competitive prototyping in JLTV appears to be incentivizing better performance, risk reduction, and cost control. TD vendors are hustling to prove the value of their prototypes and be in position to win an EMD contract. On the other hand, knowledge gained from TD has caused the government to substantially modify the requirements. While this result is in fact a successful example of the "knowledge-based" approach encouraged by DoD to reduce risk, TD competitors are loath to see their efforts scrapped. One industry executive lamented that his company had spent tens of millions of IR&D dollars developing its prototype only to see the investment nullified.²⁸

In order to fulfill its goal of lifecycle competition, AT&L is pushing for the purchase of system TDPs. As discussed previously, this is often not a prudent course of action. An executive from the commercial supply chain stated that his company would not move up to become an LCS prime, despite the ability to do so, due to government pressure to sell the TDP.²⁹

Beyond the TDP issue, the recent strict emphasis on competition limits the discretion of LCS PMs to tailor optimal strategies. Since even moderate upgrades are currently viewed as "new programs" potentially subject to open competition, PMs and OEMs are prevented from otherwise healthy collaboration on the lifecycle management of systems. While this may reduce unsolicited change proposals from the contractors, it may also delay getting necessary capabilities to the warfighter. In addition, sole source justification and authorization (J&A) requests are heavily scrutinized and seldom approved.

A secondary emphasis of the acquisition reforms is the reduction of cost and schedule risk. DoD is signaling that it is willing to trade off cutting-edge innovation for cheaper and faster acquisitions. Fixed price development contracts are now preferred over cost reimbursable efforts in order to manage cost as an independent variable (CAIV) and keep schedule under control. Without the guarantee of reimbursement of all costs, industry is expected to manage its risk by offering mature technologies. Cash flow from progress payments becomes particularly important on a FP effort, but early development program by their nature involve few deliveries and/or events on which to gauge "progress." Thus, if the government mismanages the payments, it either pays for work that hasn't been done or starves the contractor of much-needed cash. This latter possibility may keep smaller competitors, i.e., those with "shallower pockets," away from FP development efforts, since they must be able to forward-finance their own effort and possibly do the same for their suppliers. Yet the use of FP contracts in a competitive development phase may not even be necessary, since competition between multiple firms should be sufficient to incentivize cost control. This story is set to play out for the new Ground Combat Vehicle (GCV) program, where three firms will be awarded fixed price contracts to participate in a competitive technology development phase. More than one of the bidders expressed concern about the progress payment arrangement.

OUTLOOK AND CHALLENGES

The Security Environment

Our assessment of the future security environment is consistent with the 18 February 2010 Joint Forces Command Joint Operational Environment (JOE): An operational and political environment characterized by persistent conflict among state, non-state, and individual actors that will use violence to further their ideologies. The coming decades of this century will likely be characterized by a sentient enemy that evolves effective tactics, techniques and procedures to counter current DoD war-fighting strengths. Frequent, continuous, and prolonged ground conflicts that vary markedly in intensity, scope of operations, and susceptibility to traditional means of conflict resolution will be a given. The immediate future will challenge American world dominance, counter many vital interests both at home and abroad but, absent the use of weapons of mass destruction, should not endanger the continued existence of the United States.

In contrast with the era of persistent conflict, senior leaders during the Cold War had a clear and existential threat—the Soviets. The capabilities employed on both sides were industrial based and the decisions for resourcing and countering the Soviet industrial might was based on a national strategy of parity and consensus; unlike today’s threat which is ill defined and employs simple and crude weapons—to which no strategy of national parity or consensus exists. In today’s fight, senior leaders must choose from an almost infinite range of less than optimal, often very expensive and divergent options to enable our forces fight this shadowy threat.

Resources

During the past decade, our nation’s wealth and ability to borrow provided senior leaders with the resources to exercise those options in multiple wars, support a myriad of humanitarian operations around the world, and maintain a robust domestic agenda. As a result our national debt has grown significantly and is now a liability in its own right to our nation. Given this environment of budgetary constraint, the options and decisions facing senior leaders to protect our nation in this era of persistent conflict must be, as President Eisenhower said in his farewell address to the nation in January of 1961, “weighed in light of a broader consideration; the need to maintain balance in and among national programs...and the national welfare of the future.”³⁰

Politics

Senior national leaders face a number of strategic choices without an overriding national consensus to guide the path forward. The sense of the political winds suggests the following assumptions regarding the future: While at war and faced with this era of persistent conflict, there will be drastic spending cuts to reduce the deficit; domestic issues will carry a higher priority than the ambiguous threats to national security; Congress will move to return DoD to a pre-conflict funding levels despite the Army and Marine Corps’ requests to obtain two to three years of additional OCO funding to reset the force after the cessation of hostilities; Congressional oversight of DoD programs will increase due to limited funds;³¹ political efficiency will trump economic efficiency as members of Congress support industrial constituents (government facilities and incumbent defense firms) over competitive market forces; DoD’s acquisition priority will be on cost and schedule over performance; and the demand curve for LCS vehicles will shift more to the left as the Services buy a fewer new systems in lower numbers, which will have a significant impact on the structure of the LCS industry.

Technology

The current financial pressures may require senior leaders to choose between that which is possible and that which is affordable despite rapid advances in LCS technology. Government and industry will need to place much greater management focus on systems integration of C4ISR, electronic warfare equipment, weapons, armor, power trains (including hybrid technology), active suspensions, robotics and autonomous capability for new starts as well as updated legacy platforms.³² LCS firms will increasingly view the main effort of a program to be systems engineering and integration with fabrication and manufacturing the vehicle as a secondary, possibly subcontracted, effort.

LCS firms will need to continue to reinvest significant portions of their earnings on IR&D to remain competitive. Major focus areas will include increasing protection and mobility, as well as cost-effective integration and modernization of software-intensive C4ISR capabilities. In addition to system technologies, new processes and technologies for design and manufacturing are being explored that could change the face of the industry in years to come. For example, DARPA is exploring open source design and rapid fabrication concepts with the goal of dramatically improving the systems engineering, integration, and testing process for defense systems through model-based design methods for cyber-physical systems.³³ These initiatives have the potential to radically change the LCS industry over the long-term, but for the time being LCS firms and customers are skeptical about their feasibility.

Acquisitions

OUSD/AT&L policy will continue to emphasize competition and better pricing throughout the acquisition lifecycle, but increasing budgetary pressures may lead to an overemphasis on affordability over performance. DoD faces a strategic choice to either enforce lifecycle competition as a blanket policy or adopt a selective approach. As discussed earlier, the extent of competition in an acquisition strategy should be based on a solid business case.

Given increasingly tight budgets and more focus on affordability, another strategic choice for DoD is whether to continue to pay significant upfront costs to maintain lifecycle competition or forgo these early costs and revert to the traditional model of an early downselect to a bilateral monopoly relationship with one prime contractor. This choice depends on whether DoD can realize quantifiable value (return on its upfront investment) in the decades to come in terms of better pricing and lifecycle cost, and how well DoD can sell this upfront investment to Congress.

The ability to make these strategic choices will continue to rely on a robust requirements process. While our assessment did not formally address the science and art of requirements determination or the Joint Capabilities Integration and Development System (JCIDS), it did capture the concerns and challenges of the LCS industry which indicated that requirements, in general, lacked the necessary fidelity from which to build a program. In some cases, DoD has diverging requirements. For example, the Army and Marines emphasize different elements of the “performance triangle” (protection, payload (which affects weight and mobility), and performance) based on unique mission requirements.³⁴

Major Programs

The strategic choice facing DoD major programs in LCS is whether to extend the service lives of existing LCS platforms or seek new (replacement) capabilities. This choice is not binary and many options exist throughout the fleet. In the coming years, DoD must plan and execute a complex program to sustain, reset, recapitalize, dispose, upgrade, modernize or replace the

M113, HMMWV, MRAP variants, Abrams, Bradley, Stryker, M109, AAV and several other systems. The outcomes of these decisions will determine the fate of potential new programs such as JLTV, GCV, Marine Personnel Carrier (MPC), and the Amphibious Combat Vehicle (ACV), as well as major CV modernization efforts. It should be noted that since the future security environment suggests that there is no definable technologically advanced threat, it will be increasingly difficult to justify the development and purchase of new systems.

In order to make these complex programmatic decisions, senior leaders will need robust analysis and test and evaluation (T&E) capabilities. The outlook for these capabilities is currently not good, since their resources have already been reduced and are expected to shrink even more in the years to come. In addition, it appears that some gaps are not being fully assessed during the analysis of alternatives (AoA) and leaders are quickly defaulting to new programs rather than fully considering alternative options.

Defense Industrial Base

The LCS industry is carrying forward a significant amount of excess capacity. However, despite the endurance of persistent conflict, there will be a significant decrease in LCS demand that will create intense pressure toward consolidation. For the commercial industry, the government faces a strategic choice of whether to adopt a risk-taking *laissez faire* approach to industry consolidation or a risk-averse hands-on approach to prevent excessive consolidation and ensure that industry can surge for a national crisis. For the government side of the industry, the strategic choice is whether to maintain excess capacity or allow consolidation in government facilities. Put another way, these decisions are choices between maintaining surge capability and political efficiency on the one hand, or allowing economic efficiency to win out.

Private industry consolidation will largely depend on whether DoD retains and upgrades the current fleet of LCS programs or shelves them for new capabilities. In addition, the LCS industry will be significantly shaped by the government's management of the three year gap in CV production (Abrams and Bradley) slated for 2013-2016. This production "bathtub" will drastically impact operations at JSMC (Abrams) and the BAE plant in York (Bradley). Moreover, there is a serious risk of losing critical and unique CV industrial capabilities. JSMC and the BAE York plant are currently the only two U.S. facilities capable of heavy combat vehicle fabrication and assembly, and it would be a monumental task to ramp them back up after a shutdown or mothball scenario. Design and manufacturing expertise for CVs is irreplaceable as well, particularly for specialized skill sets such as ballistic welding of vehicle hulls.

JSMC's plan to mitigate the Abrams gap was nullified with the cancellation of the EFV program. Elements of the U.S. government are at odds on how to manage this situation. The Army is willing to incur the risk of a *laissez faire* approach, especially since there is no Service-level funding to keep the CV industrial base "warm" when there is no demand. Army Lt. Gen. Robert Lennox (G-8) testified to the Senate, "It was something that we had to address in prioritization about whether or not you could afford to buy more of something that we already have enough of, or put our scarce resources against something else. And that was the logic that led us to stop the production at this time."³⁵

Congress is taking a more risk-averse, hands-on approach regarding the planned JSMC shutdown, due to strategic industrial considerations as well as the interests of constituents. The campaign to keep JSMC open has grown increasingly intense, and the House Armed Services Committee (HASC) is supporting continued Abrams production in its version of the FY12 Authorization bill with an increase of \$272 million over the President's Budget: "The committee

believes that the most prudent course of action is to bridge the planned production gap with production of the most capable version of the M1 tank ... at the most economical rate possible. The committee also believes that the cost of shutting down and then restarting the Abrams production line would be significant.”³⁶

As discussed earlier, the strict emphasis on competition and cost control resulting from recent acquisition reforms is limiting the government’s ability to ensure the retention of vital manufacturing capabilities via selective, non-competitive acquisition decisions. This is a major change from the 1990s, when DoD took strategic action to manage the LCS DIB by putting firms together in joint partnerships for both the Crusader and Future Combat Systems Manned Ground Vehicle programs. Absent this latitude, DoD’s hands will be tied if and when the free LCS market can no longer support multiple CV competitors.

Supply Chain

As the DIB goes, so goes the supply chain, which will be challenged to respond to a national crisis in the years ahead. The SC for military unique LCS parts will continue to consolidate through mergers, acquisitions, or vendors exiting the market. In response, primes will make significant investments to protect and control their manufacturing SCs.

As discussed earlier, DLA has proven ineffective and inefficient in its designated role as the SCM for depot sustainment since, as a government monopoly, it is fundamentally uncompetitive. This problem will only become more acute as DLA transforms from a supporting agency to a large, self-preserving bureaucracy. PMs, in partnership with the depots and OEMs, will continue to seek the most economically efficient path for sustaining their programs – including the circumvention of DLA’s SCM role when possible. Thus, DoD faces the strategic choice of whether to allow DLA to operate as the sustainment SCM monopoly with captive customers or to have DLA compete to provide SCM services in order to ensure efficiency and cost-effectiveness. Essentially this is a choice between centralized and decentralized supply chain management for system sustainment.

STRATEGIC CHOICES AND RECOMMENDATIONS

Strategic Choice #1 (Acquisition Policy): Enforce lifecycle competition as a blanket policy *OR* Adopt a selective approach?

Recommendation: Adopt a selective, yet informed approach to lifecycle competition facilitated by flexible acquisition strategies. Each program should include, as part of its acquisition strategy, a business case for how competition can best be incorporated into the program. A well-trained and stable acquisition workforce that understands the total lifecycle of major programs is key to ensuring the adequate management of cost, schedule, and performance. This includes being able to determine whether competition at a given lifecycle phase is ultimately cost effective for the government, and to what extent TDPs should be purchased and utilized in that competition. TDP purchasing should not be treated as an end in itself or pursued as a blanket policy, but must be correctly understood as a means to competition that should only be pursued after a careful cost-benefit analysis. To be affordable, TDP pricing and purchasing must be integral to a program’s strategy for competition, and must be synchronized appropriately with the acquisition lifecycle. Moreover, the approach must be tailored to selective elements of a system and its supply chain, and only if it is economical and practical and will stimulate competition without compromising industry competitive advantages.

The seminar also learned that acquisition competition rules are being excessively applied to lifecycle enhancement efforts, and therefore are limiting the ability of PMs to effectively manage their programs with their contractors. Competition should be given due consideration in any acquisition strategy, but blanket application of a competitive strategy appears to only limit the flexibility of well trained, discerning PMs.

Strategic Choice #2 (Acquisition Policy): Given the reduction in resources and emphasis on affordability, will the DoD continue to pay upfront cost to maintain lifecycle competition *OR* Forgo these early costs and revert to the traditional model, where by DoD downselects early to a bilateral monopoly relationship with one prime?

Recommendation: Continue to fund programs up front to maintain competition to the extent practicable in each program's acquisition lifecycle. The seminar's assessment is that the value gained by these early investments increases acquisition flexibility over the life of the program. However, the return on this investment must be readily apparent to constituent audiences such as Congress or some members of the Executive. Therefore it is recommend that data be collected showing the cost savings and other benefits realized from these upfront costs, and then proactively presented to strengthen this case so that these initiatives are eliminated due to increasing budget pressures.

Strategic Choice #3 (Major Programs): Extend the service lives of existing LCS platforms *OR* Seek new (replacement) capabilities. (Note: this choice will occur for many LCS capabilities in the next decade).

Recommendation: Improve and maintain objective and robust analysis and test capabilities to enable effective, consensus-oriented program decisions. In light of the increasingly ambiguous threat environment and the length of time it takes to field systems, the Services must be able to make better investment decisions that can maintain widespread consensus through shifting politics and changes of national leadership. Therefore, DoD and the Services must invest in rigorous analysis capabilities that enable robust and objective Analyses of Alternatives, i.e., AoAs that do not automatically favor new "on paper" capabilities.³⁷ In addition, we recommend that DoD protect and augment its test and evaluation (T&E) centers to ensure that program decisions are based on rigorous test results. AoAs and test plans must include lifecycle cost and logistical support considerations, in order to determine the second order effects of an acquisition decision. For example, if a combat vehicle is determined to require extensive logistical support in a hostile environment, the necessary logistical elements must be protected against that environment as well.

Strategic Choice #4 (Commercial DIB): Adopt a risk-taking *laissez faire* approach to industry consolidation *OR* a risk-averse hands-on approach to prevent excessive consolidation and ensure that industry can surge for a national crisis.

Recommendation: The U.S. government should generally take a *laissez faire* approach but should use the defense acquisition process to strategically manage the DIB by exception. After a decade of high demand, there is significant excess LCS industrial capacity that will be increasingly hard to justify in the face of steep budget cuts and lower demand. DoD simply will not have the resources to pay the premiums required to avoid industrial risk. A *laissez faire* approach that allows free market forces to shape the industry is generally warranted and is consistent with the current emphasis on acquisition competition. In assessing the risk inherent in

such a policy, senior leaders are encouraged to expand their understanding of the DIB to include capabilities and capacity found in allied nations.

However, unchecked competition could result in excessive consolidation beyond the point where industry can surge for a large-scale national crisis. For the LCS industry, the loss of unique CV manufacturing, design and labor skills would be unacceptable. In rare cases of critically high industrial risk, DoD must be allowed to make exceptions to the policy on competition. These exceptions must be thoroughly vetted and transparent, and it will be vital for Congress and DoD to send a consistent message regarding the national approach to industry consolidation.

Strategic Choice #5 (Government DIB): Maintain excess capacity (political efficiency and surge capability); *OR* allow consolidation in government facilities (economic efficiency).

Recommendation: Allow consolidation in government facilities, to include the depots and JSMC. The resulting benefits from economic efficiencies will outweigh the political benefits of maintaining excess capacity. In recent history there have already been efforts to consolidate the depots through the BRAC process, but politics intervened. Since neither ANAD nor RRAD came close to approaching full capacity during the height of the recent surge, maintaining both facilities as an industrial insurance policy is difficult to justify. ANAD and RRAD can be consolidated to one GOGO depot that would be well-resourced and still have excess capacity to handle future surges. Despite the risk, it will be more cost-effective to maintain one well-funded depot than two under-funded and under-utilized facilities.

In the manufacturing arena, the JSMC GOCO facility has more than enough capacity to be the single U.S. location for heavy combat vehicle production. Multiple LCS firms could rent JSMC floorspace and finance their own capital to manufacture their systems, but they must be incentivized to set up their operations at JSMC. For this arrangement to be viable, JSMC's management structure must be drastically changed: Rather than have "ownership" delegated to HBCT and plant management contracted to GDLS, JSMC must be strategically managed by DoD as the critical national asset that it is. JSMC should adopt a cost model that would allow multiple programs and firms to "pay to play" and cover a more broadly amortized schedule of overhead costs that would include facility improvements.³⁸ Overall, government LCS facilities need more strategic and coherent resource management at the Service level or higher.

Strategic Choice #6 (Supply Chain): Allow DLA to operate as the sustainment SCM monopoly with captive customers or have DLA compete to provide SCM services in order to foster efficiency and cost-effectiveness.

Recommendation: Have DLA compete to provide SCM services for LCS sustainment. Market competition is the most effective way to ensure that DLA remains an agile organization that provides quality, cost-effective supply chain management for LCS sustainment.

ESSAYS ON MAJOR ISSUES

Competition in the Global Market

The importance of export sales in international markets will grow as the U.S. LCS industry heads into the “bathtub” – several years of flat or declining DoD vehicle procurement budgets – before picking up again in FY17. For most U.S. LCS firms, international sales are only a small portion of revenue, but for the industry leaders they can make up as much as 20 percent. International sales will help LCS firms ride out the bathtub and may keep some firms from exiting the market. However, there is intense competition for international sales, and firms around the globe are pursuing this same survival strategy. Demand will not be sufficient to save all of them. The Israeli contract with GDLS for production of the “Namer” AFV is a good example of how international sales will help an LCS firm through this difficult period.

For many countries, choosing weapons suppliers is more a matter of politics than of economics. For example, Saudi Arabia and other Middle Eastern countries buy a mix of equipment from U.S. and Western European manufacturers to satisfy various political constituencies. For U.S. partners such as Israel and Egypt, purchase of U.S. equipment is a requirement of their U.S. aid packages.³⁹ The Defense Security Cooperation Agency estimates the U.S. Foreign Military Sales program will reach a record \$46.1 billion in sales for 2011.⁴⁰

U.S. export controls, specifically ITAR, shape the behavior of the U.S. LCS export market. Multinational firms with a presence in the U.S. conduct some of their IR&D efforts outside the U.S. to avoid ITAR restrictions on export of their finished products. Multinational firms seek so-called “home markets” in foreign countries in order to expand export sales and to fulfill offset or coproduction requirements. Such arrangements frequently call for joint R&D efforts to take place in the “home markets.”

Export controls also hurt U.S. firms’ attractiveness as suppliers to foreign LCS manufacturers and as partners in joint research and development efforts. European-based firms in the past have admitted to avoiding using U.S. component suppliers, claiming they have difficulty meeting delivery schedules due to ITAR encumbrances. Indeed, some firms seek to develop “ITAR-free” products as part of their marketing strategy. Some also shun joint R&D projects with U.S. firms to avoid having the final product controlled under ITAR.

Finally, export controls exacerbate the differences between U.S. commercial and defense sector practices for product development and supply chain management. National boundaries are becoming increasingly irrelevant for commercial firms as specialization and division of labor occurs across borders and firms are free to seek advantageous supplier relationships around the world. This is not true for prototypical defense firms, which are able to engage foreign sources only on a selective basis due largely to export controls and other U.S. regulatory policies.

The Obama administration recognizes that the U.S. export control regime is a Cold War relic that harms competitiveness.⁴¹ Proposed reforms, begun in late 2010, will decontrol many items and others to the less-restrictive Commerce Control List. Fortunately for LCS firms, these efforts began with Category VII (Tanks and Military Vehicles) of ITAR’s U.S. Munitions List (USML). Decontrol of many items will reduce LCS firms’ regulatory costs on export sales and thus improve profit margins. In addition, administration proposals for USML export exemptions for U.S. allies will ease the process of exporting to them. Reaction from U.S. industry groups, including the National Association of Manufacturers, has been overwhelmingly positive, and a number of organizations have provided constructive comments on the proposed revisions.⁴²

European Land Combat Systems Market

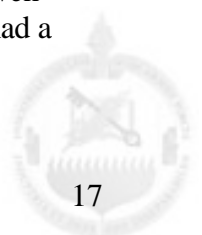
For the European LCS industry, national level restructuring, consolidation, and rationalization have been the norm over the past two decades. The most significant recent event for the ongoing consolidation of the defense industry was the 5 December 2007 passage of the European Commission (EC) Defense Package.⁴³ The goal of that European Union (EU) initiative was to create a stronger defense and security industry, predicated upon market-wide competition through the standardization of policies governing competition and export control.⁴⁴

The European LCS market is currently healthy and has enjoyed a significant surge in demand, investment and advanced R&D initiatives in 6x6 and 8x8 wheeled designs.⁴⁵ Intended for low- to medium-intensity warfare, the predominant type of conflict in which the Europeans currently expect to place troops in the field, these multi-purpose systems are air-transportable, highly maneuverable, and feature the most current C4ISR technologies.⁴⁶ There are no new main battle tank (MBT) programs on the horizon in this market despite recognition of the inherent advantages in firepower, protection and maneuverability in challenging terrains and demanding conflict scenarios.⁴⁷ For these heavy tracked vehicles, continuing work on the extensive number of existing platforms (as a sense of scale, there are over 3000 Leopard 2 tanks in service) is intended to improve capability and protection, reduce fuel consumption, and extend service life.⁴⁸ That having been stated, European LCS technology is recognized as state of the art and could provide significant opportunities for the U.S. to leverage for mutual benefit.⁴⁹

Consolidation of the EU LCS industry, per the fervent wishes of the European Defence Agency (EDA) and EU, is impeded by a challenging mix of direct and indirect state, publicly traded, and private ownership. Germany, with Rheinmetall, Krauss-Maffei Wegmann, and Diehl Stiftung, has a blend of business ownership models. Italy, with Finmeccanica and Iveco, has a mixture of partial state ownership of the former and corporate ownership (with partial state ownership of the holding corporation) for the latter. The UK, after the Thatcher Government divestiture of many state owned businesses two decades ago, retains golden share control of BAE. This difficult blend of direct and indirect state, publicly traded, and private ownership will limit the extent of further consolidation of the European LCS industry.

The major concern raised by those publicly opposed to further consolidation is the importance of preserving national businesses. Consolidation at the European level raises significant concerns regarding effective control of large corporate entities, potential relocation of major elements chasing the advantage of necessary business economies and conditions, and, it must be admitted, continued individual state support to firms with less clear nationalistic connections. By wielding the budgetary hammer, the governments of Europe are currently able to directly impact the progress and direction of national businesses to meet certain social and foreign policy considerations. This power will be significantly attenuated should the LCS industry consolidate across borders and, in direct response, a diminished sense of governmental obligation to protect what were major portions of the national economy could be the end result.

A key force driving the current LCS market is the significant reduction in allocated budget authority during the midst of repetitive deployments to persistent low- to medium-intensity conflicts. The nature of these conflicts has focused acquisition efforts upon wheeled 6x6 and 8x8 vehicles with the necessary intended mobility over difficult terrain for effectiveness and proven survivability in these episodic peacekeeping/peacemaking engagements.⁵⁰ The Europeans had a ready inventory of MBTs but, given the nature of present day conflicts, recognized certain



operational limitations that needed to be corrected. To ensure current and future relevance, they have contracted for continued upgrades to improve survivability against an evolving and determined threat.⁵¹ By focusing new acquisition resources upon the wheeled vehicle assets, the market has shifted the application of research and development monies into improving the effectivity, lethality, survivability, sustainability, and C4ISR capability/capacity of these rapidly evolving systems. These systems are the main focus of the market at this time and European technology is both recognized and appreciated by their global partners and customers.

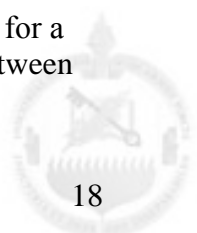
The second key force is the continued dominance of national markets because of dissimilar legacy doctrine; but the commonality of military purpose which has grown from decades of North Atlantic Treaty Organization (NATO) exercises and recent out-of-theater operations has produced close military cooperation and high levels of interoperability that manifests itself in shared doctrine. The resultant tactics, techniques, and procedures effectively determine how the specific LCS system will be used on the field of battle and, hence, the necessary design features/requirements.⁵² A key recommendation from the Jun 3, 2009 European Security and Defence Assembly (ESDA) was for the European partners, through the EDA, to work to harmonize of operational requirements and design standards to facilitate the stable procurement of standardized systems able to support European needs.⁵³

The third key force is the focus on developing and sustaining systems engineers and technicians capable of producing LCSs.⁵⁴ The objective is to maintain a competitive market share and prevail in future competitions with suppliers from the U.S. and Russia through a strong defense industrial and technological base. A key recommendation from the 3 Jun 2009 ESDA was for continued state support for maintaining skills, recruitment, and transmitting knowledge and experience across generations given the expected decline in the European populace.

The fourth key force is the desire by the EDA to reduce European dependence upon external technologies. During a 2011 EU Common Security and Defense Policy (ESDP) conference, the EDA focused attention upon technologies critical to sustaining an independent European capability.⁵⁵ To ensure continued design and production capabilities and to permit an assertive European defense posture, the EDA proposes to further this initiative through advanced R&D of selected technology vectors funded by the EU's structural funds and Framework Program. This will place the European LCS market in the advantaged position of continued development of advanced capabilities necessary for the international market.

The current market remains in transition between national consolidation and a market consolidation that will cross national borders; it is likely to stay in this delicate state given a number of significant tensions. The first tension stems from the drive, principally pushed by the French, to consolidate the industry to produce a supra-national market capable of supporting an "independent and assertive European foreign and defense policy that can act freely of the United States" is in direct tension with the desire to sustain national businesses and jobs.⁵⁶ This internal tension is made more complex when you contrast that larger French desire with the distinctly filial protection the Fifth Republic provides Nexter against external acquisition and potential consolidation.⁵⁷ Understandably cautious given the unexpected impact of acceding to earlier French desires when European Aeronautic Defense and Space Company (EADS) was created, the Germans remain cautious and will move to exert a more proportional balance of benefits to participants. Until that balance of desire for greater European influence with practical economic and political advantage is reached, this transition will remain in stasis.

Earlier assertions that the ESDP is "all process and no results" should remain true for a 10-15 year period until the French and the rest of Europe strike a suitable compromise between



aspirations and reality.⁵⁸ During that extended period of adjustment, several significant decisions will have to be made. A key decision is how to implement the ESDP to consolidate limited parts of the European R&D budgets and then, more significantly, to make centralized investment decisions in the 2014 and beyond EU Framework Program for Research.⁵⁹

A second major tension that is in the process of resolution is the desire to reduce internal trade constraints. EU leaders are calling for a tighter interpretation of Article 346 of the EU Treaty, which allows governments to claim exemptions from EU commercial procurement rules for national security reasons.⁶⁰ This ongoing change is a significant step forward given the supreme comfort with which national governments have historically invoked the exemption.⁶¹ Given that the *DefenseNews 100* rankings include six major European LCS firms, it is clear that there is surplus capacity that could be properly driven from the market in the absence of overriding national interests.⁶² The best option is to eliminate the uncritical use of Article 346 through direct treaty modification or, as the more likely alternative, indirectly through either a galvanizing European Court reinterpretation of the intent of the article or, even more likely, through smaller decisions which chip away at the reflexive invocation of the exemption.⁶³

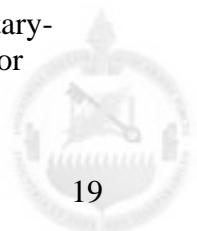
By consolidating production across national borders, the regional land combat market could optimize, from an economic standpoint, how, where, and when the R&D, production, and sustainment occurs for individual programs. Bundling collective purchase orders, a second worthy form of consolidation, could benefit each participant though the inherent advantages of reaching economic order quantities at a lower level of individual financial commitment. These two consolidation options, it must be recognized, are not mutually exclusive; one or both could be implemented consistent with individual and collective state interests.

There is a clear business need to consolidate the European LCS industry. It is obvious that the dramatic rationalization that has occurred over the past several years is not over. The movement to consolidate intra-state industry was difficult but necessary after the loss of the galvanizing threat and the sharply diminished national military budgets that victory spawned. Three viable options exist to move forward. The first is to eliminate the national defense exemption found in Article 346 of the EU Charter to mandate unrestricted cross border competition by existing land combat system providers. This would require the Europeans to act upon what their leaders have advocated for a decade. The second is to permit the consolidation of industry across borders, thus enabling supra-national entities the leverage to provide standardized equipment throughout the larger market. The final option is to bundle national orders across the EU to take full advantage of economic order quantities from the intra- or supra-national LCS industry. The most likely outcome, given current trends and reporting of EDA and EU studies, is for option one to come into effect over the next five to ten years and, given the current pace of integration efforts, for option two to kick in over twenty to thirty years.

Engines and Transmissions

The commercial engine and transmission industry is robust and competitive with a fair amount of competition, product differentiation, innovation, and research and development. The outlook of the military-unique engine and transmission industry is not so bright due to dwindling demands for combat vehicles and new tougher emissions standards that will significantly impact future designs of *all* military LCS engines and the continued use and availability of JP-8 fuel.

Military engine and transmission designs can be subdivided into two groups, military-unique used in tracked combat vehicles and COTS found in wheeled vehicles. Demand for



tracked combat vehicle engines and transmissions has been in decline since 1993 as a result of the decline in post-Cold War demand. Since then every producer of military-unique engines and transmissions has exited or is considering exiting the market. Demand for tactical and protected vehicle engines and transmissions has increased over the past decade. Industry easily met this increased military demand because these vehicles use COTS products. However, because the military locks itself into a standard configuration for decades, eventually even these COTS engines and transmissions risk becoming military unique due to commercial obsolescence.

Reduced military demand can impact a company beyond a simple drop in profits. Low demand ultimately results in unproductive infrastructure and a fractured supply chain. While in some markets DoD may be a big customer, DoD is often a small customer in the LCS market for COTS products compared to customers like Ford or General Motors. Thus, DoD must incentivize manufacturers to produce the parts it needs for military-unique components, including engines, transmissions, and final drives. Typical incentives include providing the contractor with state-of-the-art government furnished equipment (GFE) used to make the unique-military parts to lower industry's upfront capital investment. Other incentives include refurbishing factories or making other capital investments in the plant infrastructure in order to minimize the risk industry takes in producing low volumes with annual, unstable DoD funding.

One example of this arrangement is found at Allison Transmission's Plant No. 14. This large plant, occupying nearly 500,000 sq ft, fabricates the Abrams X-1100 transmissions with once state-of-the-art GFE installed in the late-1970s. This plant is capitalized to make 90 new transmissions and 180 final drives per month on a single 8-hour shift working 5 days per week. Today Plant No. 14 operates well below capacity, overhauls as few as 10 transmissions per month, and has not produced a new transmission since 1993. Because of the anticipated small future demand, there is no incentive for the government to upgrade this 1970s era equipment which is now old and has become increasingly inefficient over time, but still meets the government's needs.

Suppliers of combat vehicle engines and transmissions will stay in the market as long as there is enough business for them to make a reasonable profit. Unless GFE is provided (as with Allison's Plant 14) along with incentives to mitigate risk, suppliers will quickly exit a high risk market to pursue other opportunities. So while the government may have the physical plant and equipment to make a military unique item, the components from which to build it may not exist.

The last issue related to reduced demand deals with the intellectual property in fabricating military unique items. It became clear during our numerous visits to manufacturers of combat unique military parts that art and science is required to fabricate an item as sophisticated and large as an Abrams tank transmission. The skill required to build these items is fleeting like the supply chain just discussed. With regard to the planned three year suspension of tank manufacturing, will there still be skilled labor to build these parts once work resumes in 2016? The leadership at Allison could not be certain but did suggest that maintaining minimal production would be prudent rather than shutting down production altogether for three years.

Should DoD require large numbers of CVs, ramp-up time will be slow, supply chains will need to be established, and new workers trained in unique skill sets. Our assessment is that with time and significant resources, our nation could ramp-up to build the parts needed to make combat vehicles, but this risk should be weighed against the costs to update our investments for military unique items and keep production lines warm.

The second area of concern for military engines and transmissions is the changing diesel emissions standards for the U.S. and Europe, which require diesel-powered vehicles to run on

ultra-low sulfur diesel (ULSD). The impact of this change affects the design and power of diesel engines. While CVs and armored TWVs are exempt from this standard, the larger population of non-military commercial trucks are not, which creates several problems the military must eventually address. First, the U.S. military uses a standard fuel, JP-8, for all land vehicles and aircraft. JP-8 is a less refined diesel and as such the engines that run on JP-8 can run on most diesel fuels found around the world. JP-8 is too crude to run in a ULSD engine and would destroy it. The problem for the military is this: converting the current engine to run on ULSD is not cheap and changes the physical size and power performance of the engine. In short, one can convert the engine but it might not all fit back under the hood and there will be a loss of engine power. The second problem is that while the United States and Europe have agreed to switch to ULSD, much of the world has not – Africa, much of the Middle East, and large parts of South America will continue to use lower grades of diesel in their vehicles. Simply, if the U.S. switches its military vehicles over to ULSD it will have plenty of fuel in the U.S. and Europe, but once it deploys to a place that does not use ULSD the U.S. will have to import fuel at huge cost rather than use local sources. Should DoD continue to use JP-8 in its fleet it will be able to use local sources when deployed, but availability in the U.S. will be uncertain given that all commercial diesel trucks will convert to ULSD in time.

The challenges for senior leaders regarding engines and transmission are many but can be solved with time, appropriate analysis, and resources. Senior leaders must be watchful of the risks and consequences of their decisions today in relation to challenges that face our nation in the future in this critical area of land combat systems.

CONCLUSION

The LCS industry is complex and paradoxical. It features a monopsonist government buyer that operates with complex rules, and both highly competitive and monopolistic behaviors, depending on whether the market is for new development or production and support.

The health of the LCS industry is currently good due to significant defense spending in the last decade, but several emerging factors will increase risk. Excess capacity, combined with sharply declining demand, will create intense pressures for consolidation. Some capabilities would be very difficult to restore– particularly the ability to design and manufacture heavy CVs. The supply chain for military unique LCS parts is at risk, and will be a limiting factor in a future surge. The government faces strategic choices about the extent to which it should influence consolidation. Given the excess capacity, competition should be allowed to shape the commercial industry, but with rare exceptions to be managed by the defense acquisition process. The depots can be consolidated to one major facility, and the management of JSMC should be reorganized to allow for consolidation of heavy CV manufacturing at that facility.

The focus of acquisition reform on affordability and competition must be tempered to allow for flexible acquisition strategies that use business cases to determine the best use of competition. TDPs are a means to that end and should be pursued selectively.

As the U.S. military moves forward in an enduring era of persistent conflict and vague threats, LCS platforms will continue to be needed to some extent. However, the lower demand, focus on affordability, and lack of consensus on requirements will put a premium on DoD being able to make informed programmatic decisions in the years ahead.

Endnotes

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- ¹ Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance.
- ² *U.S. Constitution*, Art. I, Sec. 8.
- ³ “Getting To Best: Reforming the Defense Acquisition Enterprise,” Task Force on Defense Acquisition Law and Oversight Report (Washington, DC: Business Executives for National Security, July 2009), 1.
- ⁴ For definitions of “monopoly rents” and “rent-seeking” see http://en.wikipedia.org/wiki/Rent_seeking.
- ⁵ “Limitations on the performance of depot-level maintenance of material,” Title 10 *U.S. Code*, Pts. 2466.
- ⁶ Base Realignment and Closure; periodic rounds of Congressionally-mandated consolidation of DoD installations.
- ⁷ U.S. Department of the Army, *Army Strong: Equipped, Trained and Ready: Final Report of the 2010 Army Acquisition Review* (Washington, DC, January 2011), iv, viii, ix.
- ⁸ Sebastian Sprenger, “Study Paints Bleak Picture of Billions Sunk Into Incomplete Army Programs,” *Inside the Army*, February 14, 2011.
- ⁹ U.S. Department of the Army, *Army Strong*, xi.
- ¹⁰ According to Wikipedia (http://en.wikipedia.org/wiki/Principal-agent_problem), “In political science and economics, the principal–agent problem or agency dilemma treats the difficulties that arise under conditions of incomplete and asymmetric information when a principal hires an agent, such as the problem of potential moral hazard and conflict of interest, in as much as the principal is—presumably—hiring the agent to pursue its, the principal's, interests.” The historically common strategy of downselecting to a single prime contractor on a major cost-reimbursable development contract provides ample opportunity for rent-seeking behavior. DoD attempts to mitigate the lack of incentives for cost efficiency through fixed price contracts and competitive prototyping. It should be noted that the principal-agent problem exists on the government side of the industry as well. While the depots and DLA exist to meet their customers’ needs, they are also bureaucracies that pursue their own interests at the margin. For example, to the extent that depots favor direct labor hours, they will use more labor-intensive production and maintenance methods than would be considered economically efficient. DoD policy makers must decide which approach is preferable: maximizing cost-effectiveness, or maximizing political support through higher employment.
- ¹¹ USASpending.gov, <http://usaspending.gov/> (Prime Award Advanced Search, DoD contracts, 2000-2010 data, Product/Service code 23 (Ground Effect Vehicles, Motor Vehicles, Trailers and Cycles), subcodes 2320 (Trucks and Truck Tractors Wheeled) and 2350 (Combat Assault and Tactical Vehicles Tracked); accessed April 23, 2011).
- ¹² HHI is calculated as the sum of the squares of the market shares. It gives more weight to larger firms and is a better indicator of market competition than the simple concentration ratio.
- ¹³ Definitions for Fixed Price and Cost Reimbursable contracts are given at Defense Acquisition University’s online ACQuipedia resource, under “Contract Types” (<https://acc.dau.mil/CommunityBrowser.aspx?id=272937>).
- ¹⁴ This trend is being challenged by new acquisition policies emphasizing lifecycle competition.
- ¹⁵ Colonel Dave Bassett (Project Manager, U.S. Army Tactical Vehicles), in discussion with the seminar, March 4, 2011.
- ¹⁶ On a positive note, this could create a market for “design-only” firms (e.g., SAIC or Force Protection) who would subcontract the production effort.
- ¹⁷ These non-competitive aspects of defense acquisitions have led to numerous institutions and policies designed to regulate bilateral monopoly contracts, including the Truth in Negotiations Act (TINA), profit guidelines, requirements for competitive subcontractor quotes, and the use of government-owned tooling and equipment. These tools ensure that firms do not make excess profits above their costs, but they do not control the costs themselves. Good prices are ensured only through competition for incentivizing cost control and cost-saving innovations such as lean principles.
- ¹⁸ The government also buys directly from the vendor base and component suppliers for new GFM, depot rebuilds, and repair parts. For COTS purchases, the government is usually a small segment of the vendors’ market so there is little purchasing power.
- ¹⁹ Most facilities are operating with single shifts, with the exception of certain lengthier critical path processes such as painting. Only occasionally during the surge were second shifts used, and no point were facilities running around the clock. The only limiting factor in the surge was the lead time required to get the supply chain up to speed.
- ²⁰ Colonel Lisa Kirkpatrick (staff officer, Office of the Assistant Secretary of the Army for Acquisition, Logistics, and Technology), in discussion with the seminar, February 11, 2011.
- ²¹ U.S. Department of the Army, *The Army Tactical Wheeled Vehicle Strategy* (Washington, DC, January 2011), 5.
- ²² Jack Kline (deputy director, Anniston Army Depot), in discussion with the seminar, February 4, 2011.

²³ According to Wikipedia (http://en.wikipedia.org/wiki/Due_process), “Due process is the legal principle that the government must respect all of the legal rights that are owed to a person according to the law. Due process holds the government subservient to the law of the land protecting individual persons from the state. When a government harms a person without following the exact course of the law it constitutes a due process violation which offends against the rule of law.” The same article later clarifies that “The due process clauses apply to “legal persons” (that is, corporate personhood) as well as to individuals.” Thus, in dealing with individuals and firms a government organization is not free to act with the same level of discretion as private concerns. A government entity, for example, cannot refuse to stop doing business with a firm without following a rigorous process to assess the reason for debarment and providing the firm a chance to challenge any incriminating evidence and submit exculpatory evidence. Government business considerations also include mandatory procedures for competition for acquiring goods and services, as well as set-aside requirements for small and disadvantaged businesses.

²⁴ Based on discussions with both government and contractor personnel in the Abrams program, April 2011.

²⁵ Office of the Undersecretary of Defense for Acquisition, Technology and Logistics.

²⁶ Ashton B. Carter, *Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending*, memorandum for acquisition professionals (Washington, DC: Office of the Under Secretary of Defense for Acquisition, Technology and Logistics, September 14, 2010), 9.

²⁷ DoD also wants to facilitate lifecycle competition in the supply chain. But this only makes sense in the earlier “putty” phases of the program, before the configuration has turned to “clay” with high production and logistics switching costs. Furthermore, the government itself frequently requires OEMs to use a significant percentage of directed-source parts. BAE claims that well over half of the Bradley bill of materials is from government directed sources (discussion with BAE executives, March 25, 2011).

²⁸ Lieutenant Colonel Casey Travers (Program Manager, Joint Light Tactical Vehicle), in discussion with the seminar, January 28, 2011.

²⁹ In the commercial arena, the government has far weaker buying power because it accounts for as little as 1 percent of annual sales for some companies (quote from Caterpillar executive). Commercial component pricing is already competitive, and there is little price reduction to be gained. Moreover, it is extremely unlikely that anyone could build the low quantities of the item needed by the government at prices lower than the vendor who can produce them at much higher volumes.

³⁰ Dwight D. Eisenhower, “Farewell Address to the Nation,” <http://mcadams.posc.mu.edu/ike.htm>.

³¹ Congress will hold more decision discretion in the future vice ceding much of it to the Executive as it has in the past decade. Because there is no clear and definable threat, expect Congress to trend to allocate resources in accordance with constituent interests vice program or Service efficiencies.

³² According to BAE, 60-70% of Bradley functionality depends on software; Abrams has 170 LRUs (discussion with BAE executives, March 25, 2011).

³³ DARPA Tactical Technology Office, <http://www.darpa.mil/AVM.aspx>. “The ultimate goal of the META program is to dramatically improve the existing systems engineering, integration, and testing process for defense systems. META is not predicated on one particular alternative approach, metric, technique or tool. Broadly speaking, however, it aims to develop model-based design methods for cyber-physical systems far more complex and heterogeneous than those to which such methods are applied today; to combine these methods with a rigorous deployment of hierarchical abstractions throughout the system architecture; to optimize system design with respect to an observable, quantitative measure of complexity for the entire cyber-physical systems; and to apply probabilistic formal methods to the system verification problem, thereby dramatically reducing the need for expensive real-world testing and design iteration.”

³⁴ Each service will choose where to take risk based on its core missions: the Army prefers to balance payload and mobility with significant levels of protection, whereas the Marines prefer lighter systems for naval/littoral transport and expeditionary mobility.

³⁵ Tony Bertuca, “Planned Break in Army Tank Production Causing Stir on Capital Hill,” *InsideDefense.com*, April 8, 2011.

³⁶ House Committee on Armed Services, *National Defense Authorization Act For Fiscal Year 2012: Report on H.R. 1540*, 112th Cong., 1st sess., 2011, 23.

³⁷ Prior to release of the second RFP for the GCV, the analysis “did not compare the capabilities of the new GCV design concept with the wider range of alternatives in the original assessment — such as the Bradley upgrade and some foreign or current vehicles — but only against the current force Bradley vehicles (without upgrades).” Quote from Michael Sullivan of the Government Accountability Office as reported by Kate Brannen, “GAO questions need for Ground Combat Vehicle,” *Army Times*, March 9, 2011.

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- ³⁸ A similar situation exists at Aberdeen Test Center. The Army Test and Evaluation Center (ATEC) is reimbursed by the Army for overhead costs related directly to Army testing. Many other agencies test their products on site, but ATEC is not funded to improve upon non-Army capabilities. A working capital fund could alleviate this situation.
- ³⁹ Vaughn's Summaries, <http://www.vaughns-1-pagers.com/politics/us-foreign-aid.htm> (U.S. Foreign Aid Top Recipient Countries; accessed April 20, 2011).
- ⁴⁰ Tony Capaccio, "U.S. Projects More Than \$46 Billion in Arms Exports in 2011," *Bloomberg.com*, April 20, 2011.
- ⁴¹ The White House, "President Obama Lays the Foundation for a New Export Control System," press release (Washington, DC: Office of the Press Secretary, August 30, 2010).
- ⁴² Franklin Vargo, "Letter to the Honorable Ellen Tauscher Re: USML-Positive List," National Association of Manufacturers, http://www.nam.org/~media/9D1C9F56DA324B079B0889CACC87CE2F/NAM_Comments_to_Directorate_of_Defense_Trade_Controls_on_United_States_Munitions_List.pdf (accessed March 22, 2011).
- ⁴³ Commission Of The European Communities, *A Strategy For A Stronger And More Competitive European Defence Industry* (Brussels, May 12, 2007).
- ⁴⁴ Ibid.
- ⁴⁵ European Security and Defence Assembly, *European Armoured Vehicles: Current Programmes*, Document A/2034 (Paris, June 3, 2009).
- ⁴⁶ Ibid., 2.
- ⁴⁷ Ibid., 4.
- ⁴⁸ Ibid., 6.
- ⁴⁹ Ibid., 2.
- ⁵⁰ Ibid., 5.
- ⁵¹ Ibid., 8.
- ⁵² James L. Graves, *The Post-Cold War Armored Vehicle Industries in Britain, Germany, and France: A Study in Political Economy and Transition* (Connecticut: Greenwood Press, 2000), 28-29.
- ⁵³ Commission Of The European Communities, *A Strategy For A Stronger And More Competitive European Defence Industry*.
- ⁵⁴ European Security and Defence Assembly, *European Armoured Vehicles*.
- ⁵⁵ Julian Hale, "EDA: Reduce Dependency on Key Technologies," *Defense News*, April 19, 2011.
- ⁵⁶ Jeffrey Bialos, Christine Fisher, and Stuart Koehl. *Fortresses and Icebergs: The Evolution of the Transatlantic Defense Market and the Implications for U.S. National Security* (Washington, DC: Center for Transatlantic Relations, 2009).
- ⁵⁷ J. Lewis, "France Confirms That "Nexter Is Not For Sale"," *Jane's Defence Weekly*, February 11, 2010.
- ⁵⁸ Bialos, Fisher, and Koehl, *Fortresses and Icebergs*.
- ⁵⁹ Hale, "EDA."
- ⁶⁰ European Defence Agency, "European Defence Agency Ministers Call for More Cooperation on New Armoured Fighting Vehicles," press release (Brussels, May 23, 2005).
- ⁶¹ Keri Smith, "Financial Crisis Must Prompt EU Procurement Change, Europe Hears," *Jane's Defence Industry*, November 4, 2008. Describes the difficulty Europe will encounter without a rational mutual cooperation and defined export policy.
- ⁶² We consider BAE, GD, Finmeccanica, Rheinmetall, Krauss-Maffei Wegmann, and Nexter to be a good selection of major global players in this industry.
- ⁶³ Pierre Tran, "Pioneers Needed to Boost European Defense," *Jane's Defence Weekly*, October 31, 2008. Describes the need for senior leaders to step forward and implement.

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