

Land Combat Systems

ABSTRACT

The focus of the 2004 academic year Land Combat Systems (LCS) Industry Study was strictly on the armored combat vehicle portion of LCS, and was conducted within the framework of the United States Army Future Combat Systems (FCS) and United States Marine Corps Expeditionary Fighting Vehicle (EFV) programs. These programs call for the development, fielding, and sustainment of new, complex platforms and systems with quantum improvements over existing platforms that place significant new demands on the LCS industrial base. This report focuses on the current condition, challenges, and outlook of the remaining two armored combat vehicle companies, General Dynamics and United Defense Industries.

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PLACES VISITED

DOMESTIC:

Aberdeen Proving Ground, Aberdeen, MD
Allison Transmissions, Indianapolis, IN
Anniston Army Depot, Anniston, AL
Detroit Diesel, Detroit, MI
General Dynamics Land Systems, Anniston, AL
General Dynamics Land Systems, Lima, OH
General Dynamics Land Systems, London, Ontario, Canada
General Dynamics Land Systems, Sterling Heights, MI
Joint Manufacturing Systems Center, Lima, OH
United Defense D Ground Systems Division, Santa Clara, CA
United Defense D Ground Systems Division, York, PA

INTERNATIONAL:

Santa Barbara Sistemas, Seville, Spain
MOTORWAGENFABRIK AG, Kreuzlingen, Switzerland
Motorien and Turbinen Union, Friedrichshafen, Germany
Krauss-Maffei Wegmann, Munich, Germany
Steyr-Daimler-Puch Spezialfahrzeug AG, Vienna, Austria
Patria, Helsinki, Finland

INTRODUCTION

Defense consolidation in the 1990s dealt with scarcity; now the newly emerged mega-primes are asked to play the role of lead systems integrators (LSIs) or system-of-systems managers to deliver capability to DoD for transformed operations.

Dr. Robbin F. Laird

A major element in the Industrial College of the Armed Forces (ICAF) curriculum is the study of the resources component of national security, including an Industry Studies Program. The program establishes a framework to apply analytical techniques in assessing the state of a selected industrial sector. The objectives of the program are: (1) development of a strategic perspective of selected industries and their role in supporting the materiel requirements of national defense in normal and crisis conditions, (2) comparative analyses of United States (US) and international members of selected industries in both defense and non-defense environments, and (3) preparation of specific policy options to enhance industrial preparedness. Visits to domestic and international firms directly support the research. The international field study allows the comparative analysis, and permits a realistic assessment of the long-term health of the US industrial sector in the competitive world arena.

For the 2004 academic year, the Land Combat Systems (LCS) Industry Study was conducted within the framework of the United States Army Future Combat Systems (FCS) and United States Marine Corps Expeditionary Fighting Vehicle (EFV) programs. The FCS is the centerpiece of the Army's transformation. The FCS is a system-of-systems (SoS), network-centric approach to transform the Army from the Cold War era to the future. The FCS represents the first instantiation of Army Objective Force (OF) capabilities. The FCS is made up of 18 advanced, networked air and ground based maneuver, maneuver support, and sustainment systems that will include manned and unmanned platforms, the network, and the Soldier, as shown in Figure 1.

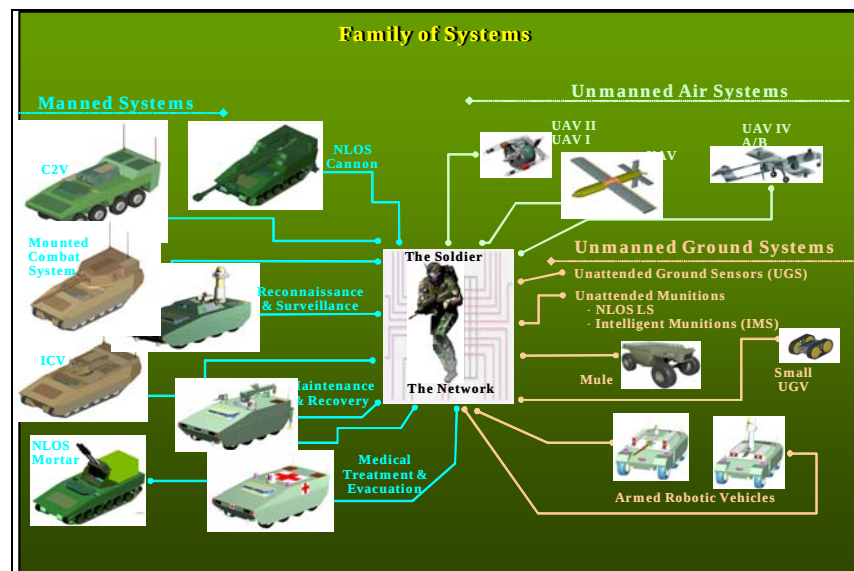


Figure 1. Future Combat Systems Concept

Expeditionary Maneuver Warfare (EMW) is the capstone concept for Marine Corps employment in the 21st Century, given 75 percent of the world's population will live within 300 miles of an ocean.ⁱ The EMW concept unifies the expeditionary heritage and culture of the Corps with the doctrine and philosophy of combined arms maneuver warfare and supported by new innovative equipment across the MAGTF. These innovations include the expeditionary fighting vehicle (EFV), replacing the amphibious assault vehicle and enabling beyond the horizon ship to objective maneuver.

As Dr. Robbin Laird stated, "Transformation represents a shift in the demand side of the defense industrial business to provide for these new capabilities."ⁱⁱ The FCS and EFV programs call for the development, fielding, and sustainment of new, complex land combat platforms and systems with quantum improvements over existing platforms that place new demands on the suppliers—the LCS industrial base.

THE INDUSTRY DEFINED

Land Combat Systems can be divided into four major elements, which include mobility and counter mobility platforms; network centric operations and warfare systems; soldier and marine systems; and combat vehicles. Mobility and counter mobility platforms include nuclear, biological and chemical warfare systems; bridging, transport and mine systems; and engineer and construction equipment. Network centric operations and warfare systems include the Joint Tactical Radio System (JTRS), Blue force tracking; and global information grid. Soldier systems include clothing, rations, small arms and mortars. Combat vehicles include heavy and light armored vehicles and tactical wheeled vehicles. Development of systems within each of these elements is designed to support the Soldier or Marine in the field (See Figure 2).

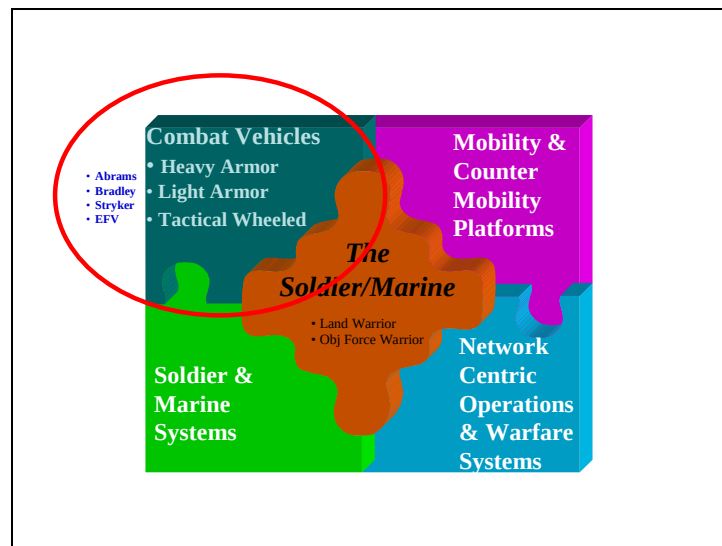


Figure 2. The LCS Elements

The LCS Industry Study for 2004 focused solely on armored combat vehicles within the combat vehicle element, and its supporting industrial base. Like the rest of the defense industry, the LCS industrial base experienced numerous changes as a result of the end of the Cold War and resulting peace dividend. Government pressure for

consolidation coupled with decreases in defense spending drove the consolidation of nine companies into two companies—GD and United Defense Industries (UDI).ⁱⁱⁱ Despite these changes, this sector of the defense industry remains unique, focusing on supporting domestic and international defense. Unlike other defense industries, the LCS industrial base does not produce commercial or civilian applications of their products. The remainder of this report will focus on the current condition, challenges, and outlook of these two firms, beginning with the current condition of GD.

CURRENT CONDITION

In the business world, the rearview mirror is always clearer than the windshield.

Warren Buffett

The ICAF coursework and field trips presented the study team with ample historic data for assessing the current condition of the LCS firms. The annual revenue of GD, spread evenly among its four business units, has grown 85 percent over the past 5 years to \$16.6 billion in 2003.^{iv} Although the US defense portion of its customer base is 63 percent, the customer base remains diverse with 18 percent of sales to US commercial customers, 14 percent to foreign governments through defense products, and 5 percent to international commercial customers.^v

General Dynamics, with a market capitalization of \$18 billion and over 68,000 employees, has realized an average annual revenue growth of 16.7 percent over the past 5 years.^{vi} However, its profitability ratios—return on investment (ROI), return on assets (ROA), and return on equity (ROE)—although still respectable, have consistently declined over the past 5 years.^{vii} Furthermore, their operating margin has declined from 13.4 percent in 1999 to 8.8 percent in 2003.^{viii} The liquidity indicators—quick ratio and current ratio for 2003, which were 0.85 and 1.14 respectively—have marginally, but consistently, improved over the past 5 years.^{ix}

General Dynamics has done a good job of managing its debt over the past 5 years while selectively growing the company through acquisition. The total debt-to-equity ratio of GD grew significantly from 0.14 in 2002 to 0.56 in 2003 as the company financed growth through acquisition; however, a debt ratio below one is considered acceptable.^x In 2003, the cash flow from operating activities for GD increased 53 percent to \$1.7 billion, in large part due to revenues from its new acquisitions, and negative cash flow from investing activities was \$3.2 billion due to the purchases of those companies.^{xi} Cash flow from financing activities increased 344 percent in 2003 to \$2.0 billion from an issuance of fixed rate notes. General Dynamics appears to be in good shape with \$850 million cash equivalent on-hand at the end of 2003, an increase of 162 percent.

The Combat Systems business unit directs all LCS work. General Dynamics has divided its Combat Systems business unit into four product-oriented divisions, as shown in Figure 3: Land Systems (GDLS), European Combat Land Systems, Ordnance and Tactical Systems, and Armament and Tactical Products. Land Systems, with over 7,400 employees, focuses on the US defense market and provides design, development, production, and field support and sustainment for both light-wheeled and heavy-tracked armored combat vehicles.^{xii}

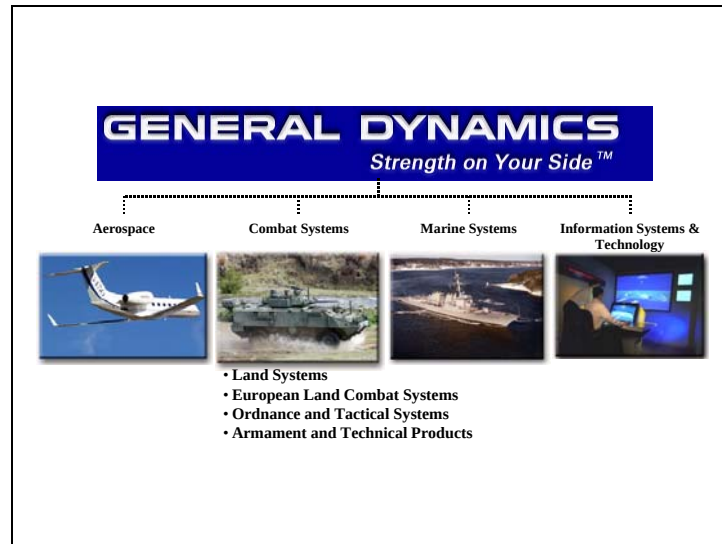


Figure 3. General Dynamics Organization^{xiii}

In 2003, the Combat Systems business unit of GD expanded by 40 percent as a result of organic growth and acquisition.^{xiv} The organic growth was a result of winning several major development programs, including a \$2.2 billion contract for developing several vehicles for the FCS, \$384 million contract for the production of vehicles for the third Stryker Brigade, \$380 million contract increment for the continued development of the EFV, and \$100 million contract for the development of the Future Force Warrior Soldier system.^{xv} The acquisition growth was a result of GD purchasing General Motors Defense (including MOWAG of Switzerland), Intercontinental Manufacturing Company, and Steyr-Daimler-Puch Spezialfahrzeug Aktiengesellschaft & Company KG (Austria). Subsequent to these acquisitions, GD consolidated its new European subsidiaries with previously acquired Santa Barbara Sistemas into a single European Land Combat Systems unit headquartered in Vienna, Austria. General Dynamics expects continued growth of its Combat Systems business unit from its backlog of \$8,467 billion (\$6,029 billion funded) up 77 percent from 2002.^{xvi} General Dynamics has recently announced plans to purchase Alvis PLC, the leading manufacturer of armored vehicles in the United Kingdom and Scandinavia.^{xvii}

United Defense Industries is a global corporation that designs, produces, and provides service support of combat vehicles, artillery, naval guns, missile launchers, precision munitions, and non-nuclear ship repair, modernization, and conversion. United Defense Industries has three major business units depicted in Figure 4: United States Marine Repair (USMR), Bofors Weapons Systems, and United Defense (UD). The UDI combat vehicle competency is located within the Ground Systems Division under the UD business unit. This division focuses on the US market and provides design, development, production, and field support and sustainment for heavy-tracked armored combat and combat support vehicles.

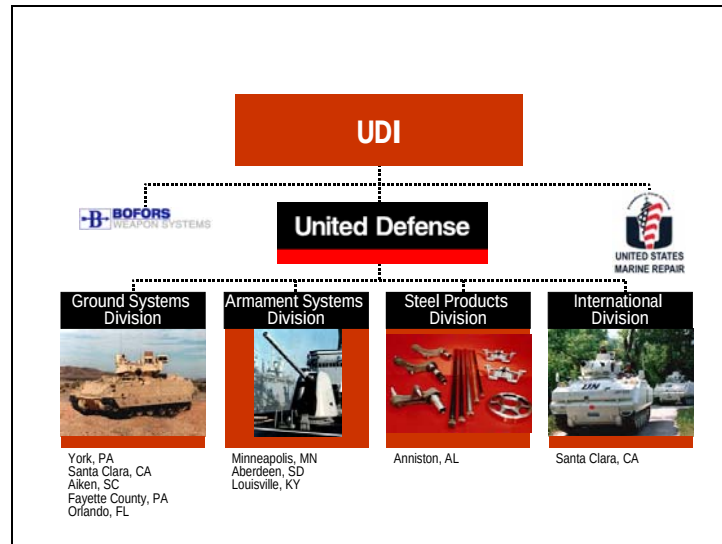


Figure 4. UDI Organization^{xviii}

United Defense Industries has a market capitalization of \$1.5 billion and over 5,300 employees.^{xix} United Defense Industries has realized an average annual revenue growth of 14.7 percent over the past 5 years.^{xx} Its profitability ratios have shown a general improvement since 1999 with their operating margin steadily increasing from 3.42 in 1999 to 10.7 in 2003.^{xxi} The quick ratio and current ratio for 2003 were 0.58 and 1.10. These ratios have shown marginal, but consistent, improvement over the past 5 years.^{xxii} United Defense Industries took on substantial debt in 2001 and 2002 to expand its company through acquisition (Bofors and USMR), and still carries a high total debt-to-equity ratio of 4.54.^{xxiii} In 2003, the cash flow from operating activities increased 24 percent to \$223.8 million, in large part due to new revenue generated from purchasing USMR. Negative cash flow from investing activities was \$43.6 million as a result of capital expenditures and negative cash flow from financing activities was \$10.2 million due to payment on long-term debt.^{xxiv} United Defense Industries appears in good shape, with \$287 million cash equivalent on-hand at the end of 2003, an increase of 170 percent, to continue either growth through acquisition or reduction of long-term debt.

United Defense Industries' primary customers, government defense organizations and their activities, account for 75 percent and 85 percent of total revenues in 2001 and 2002, respectively.^{xxv} The UDI defense customer base is split with 22 percent of its 2003 revenues coming from international customers. The sales of UDI grew 19 percent in 2003 due to the strong performance of its USMR business unit.^{xxvi} In spite of the cancellation of the Crusader program, the performance of the Ground Systems Division continued to contribute to company earnings, as a result of winning a \$2 billion effort for the development of several FCS vehicles and continued work on upgrades for the Bradley Fighting Vehicle, AAV, Hercules vehicle, and Stryker add-on armor kits.

Recently, UD has incorporated armored-wheeled vehicles into its combat vehicle portfolio through its work on the Future Scout and Cavalry System and FCS development programs. United Defense Industries has strengthened its position in FCS vehicle work by acquiring two advanced material suppliers. Kaiser Composithek provides design, development, and manufacturing capabilities for polymeric composite structures.

Cercom provides research, development, and manufacturing capabilities for ceramic structures. United Defense Industries expects to continue its growth with a \$2.1 billion funded backlog for 2004.^{xxvii}

Key corporate summary data for GD and UDI are shown in Table 1. In general, both business units, GDLS and UD Ground Systems Division, are currently in strong financial positions.

	General Dynamics	United Defense Industries
EMPLOYEES	68,400	5,300
MARKET CAP	\$18B	\$1.2B
NET SALES	\$16.6B	\$2.1B
ROI	24.1%	26.8%
ROA	61.6%	8.8%
ROE	16.8%	110.7%
OPERATING MARGIN	8.8%	10.7%
QUICK RATIO	0.85	0.58
CURRENT RATIO	1.14	1.1
TOTAL DEBT-TO-EQUITY RATIO	0.56	4.54
CASH ON-HAND	\$850M	\$287M

Table 1. 2003 End of Year Financial Data for GD and UDI^{xxviii}

Domestic competition is limited to the main suppliers, GDLS and UD Ground Systems Division, along with their associated 3rd tier suppliers. Competition is fierce and each company protects its knowledge base intensively. Several trends were identified during the visits to the domestic industrial base, which span across personnel, manufacturing, and production capabilities.

Personnel. The LCS workforce demonstrates a high level of technical skill throughout the industry. However, the workforce appears to be aging, with an average worker age of about 50 years old. There is not a high level of turbulence among this mature workforce, but it could see a significant level of turnover as workers retire in coming years. Alternately, a workforce on the cusp of retirement could help maintain a “right-sized” labor pool and minimize large-scale layoffs within the LCS industry if low-production trends continue within the sector.

Manufacturing. LCS manufacturers are advertising system integration capabilities over heavy manufacturing capacity, in acknowledgement of the emerging complexity in the SoS design that characterizes new programs such as FCS. There is a drive toward lean manufacturing processes throughout the industry. There is continual investment in emerging fabrication processes, particularly in welding techniques. Most LCS production sites are integrating robotic and friction-based welding to increase quality and efficiency. The ability to weld or join dissimilar materials, such as aluminum, titanium, and composites, will be critical technologies throughout the industry as LCS continue to emphasize lighter, more survivable platforms. The domestic industry did not demonstrate an ability to generate an economy of scale in the assembly, integration, and test processes associated with LCS manufacturing. There appeared to be some efficiencies inherent in some component manufacturing processes, such as large-

scale sheet metal cutting. However, end-item production is largely a manual, stall-built effort throughout the industry.

Capability. There is a tremendous amount of excess production capacity throughout the industry. Although LCS manufacturing is typically a low-volume industry, most facilities are currently operating at a “warm” level, since there are few new LCS programs in production at this time.

The defense industry has experienced a shift towards growth in the international market with US firms acquiring foreign companies to strengthen their competitive positions. General Dynamics has emulated this strategy with its international holdings (Santa Barbara Sistemas (SBS), Spain; MotorWagenFabrik AG (MOWAG), Switzerland; and Steyr-Daimler-Puch Spezialfahrzeug AG (Steyr), Austria), and is a large, capable supplier along with Krauss-Maffei Wegmann in Germany and Patria in Finland. The European suppliers are competitive, including competition between SBS, MOWAG, and Steyr. General Dynamics allows, and even appears to promote, competition between its European holdings.

The European LCS industry, despite its smaller stature, shares characteristics of the domestic US industry. Perhaps the most significant distinction among European companies is the high emphasis on quality through manual manufacturing processes. In Europe, the industry is very focused on craftsmanship achieved through hand-built products. While this approach clearly enhances attention to detail and quality, it severely limits the potential output of manufacturing facilities. However, output is not an issue at this time given the current contractual obligations.

The European firms use cash generated from product sales as the fuel for future research and development on the next innovation. This clearly places a premium on cash flow and the desire for these European countries to see their defense monies spent in their own country. In other words, when SBS is contracted to build a system for Germany, there usually is some kind of agreed “offset.” For example, if parts for the final product are provided by Germany, then exchanges are made so that a German company provides some other product to Spain. These offsets can become very complicated and difficult to understand, but it is a way of ensuring equality throughout the European Union (EU). The success of this strategy was evident throughout the visits. The European firms demonstrated many technologies, advanced developments, and significant achievements that offer capabilities worthy of consideration in addressing the FCS and EFV challenges.

CHALLENGES

The marvel of all history is the patience with which men and women submit to burdens unnecessarily laid upon them by their governments.

William H. Borah

The continued, long-term financial strength of the LCS industrial base appears highly dependent on any work that becomes available from Army reset and sustainment requirements of current systems and the viability of the FCS program. General Dynamics Land Systems and UD Ground Systems Division face significant challenges over the next few years. Both are heavily dependent upon the domestic defense marketplace, which poses a significant challenge for them as demand for their current products wanes and the

demand for future systems, although high, cannot be adequately forecasted because those systems are still in development. Both GDLS and UD Ground Systems Division are hindered by the lack of large contracts

Production Gaps. Based on current resourced requirements, the LCS industry faces a gap in production orders, as shown in Figure 5, that may make it difficult to maintain an adequate surge and mobilization capability. By FY08, overall armored vehicle procurement will be down by 85 percent. Current system upgrade programs wind down by FY05 and future system initial production does not get off the ground until FY08. While the delivery schedules for the Army Stryker and Marine Corps EFV programs is in concert with the overall production schedule for GDLS, UD Ground Systems Division faces a complete production shutdown before the FCS program production ramp-up. Current force upgrade programs could be extended to spiral new capabilities while allowing more time for future system technologies to mature and thus lessening the risk of making future system deliveries that perform on schedule and cost.

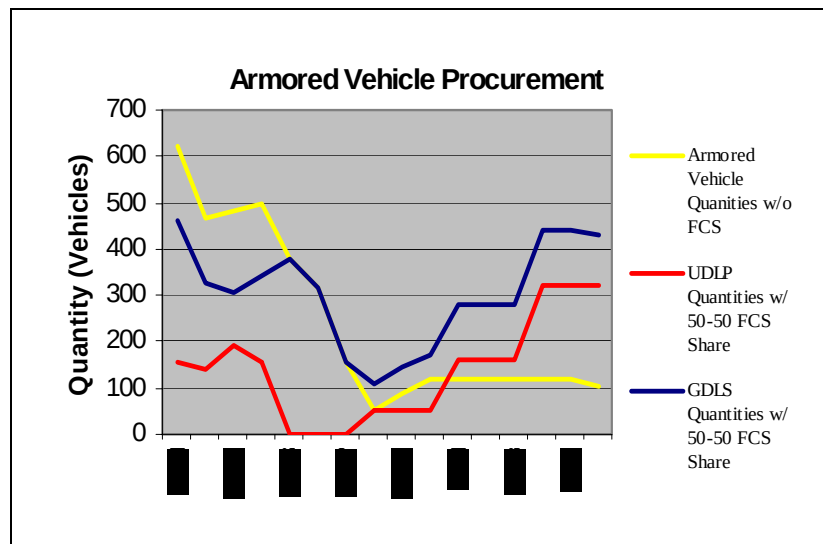


Figure 5. Armored Vehicle Procurement Quantities and Industry Bathtub^{xxix}

Changing Nature of System Development. Meanwhile, they are both protected from new competitors because entry into the market requires substantial financial and intellectual capital. Yet, competition now arises as a result of the changing nature of system development. Today's programs are larger and more complex. In fact, many programs are system-of-systems programs that require multiple skill sets rarely found in any one company. To overcome these obstacles, companies are teaming with their competitors. Prime contractors that specialize in systems integration, as opposed to those that specialize in specific technologies or platforms, lead these teams. Both GDLS and UD Ground Systems Division face this challenge with the advent of the Boeing and SAIC lead systems integrator (LSI) team for FCS, and their subsequent new roles as subcontractors to the LSI. They are both struggling to make the adjustment to system integrators as opposed to their traditional "metal-bending" role.

However, this LSI role requires additional capital and systems engineering and integration staff, forcing the prime to bear more risk. The need for additional capital

stems from increased development cost, integration cost, production capital, and life cycle support cost.^{xxx} In this FCS construct, DoD has less input into and influence over the execution of the program. A primary objective for GDLS and UDLP is cooperative design, development, and manufacture of the various FCS variants.^{xxxi} Yet, two significant challenges are apparent: Boeing is capturing most if not all the value in the FCS program and GDLS and UDLP have little incentive to partner, fostering a winner-take-all approach and stifling innovation.

This lack of teamwork is also evident in the behavior of the GDLS and UDLP parent companies. GD senses the threat from the top-tier suppliers and is emulating the acquisition and integration strategy. They have acquired transatlantic competitors and key suppliers like Cadillac Gage, an industry leader in chassis manufacturing.^{xxxii} Currently, with a Morningstar Financial Health rating of “B,” GD is well positioned. However, the hidden costs generated by such acquisitions and the danger of unfavorable foreign exchange rates may threaten their financial health and positive cash flow.^{xxxiii} Given such a corporate strategy, it’s little wonder that GDLS lacks the motivation to cooperate.

On the other hand, UDI is in poorer financial health primarily due to its large debt burden. Their inability to secure additional capital inhibits them from entering the systems integrator market. Instead UDI is pursuing lean manufacturing to cut costs. Yet, they have had limited progress because of their cash shortfall, which is further exacerbated by their FCS subcontractor position to Boeing. The situation is perhaps so hopeless that UDI shareholders might seek a buyer bailout to recover their initial investment.^{xxxiv} General Dynamics might well be that buyer, which could adversely affect LCS competition. The DoD faces a significant policy dilemma—striking a balance between cooperation and competition—that is not easy to resolve.

General Dynamics faces a different challenge. General Dynamics inherited some significant constraints with its international acquisitions. First, in the case of one of its holdings, consolidation is not permitted in the first couple of years per the contract. Second, it is further constrained by domestic labor legislation throughout the EU. Laws generally constrain the ability of companies to rapidly adjust workforce to market conditions, particularly through layoffs.

Yet, the future of the LCS industrial base is dependent on both the actions of GD and UD and those of the government. The next sections address the potential outlook and the roles of both industry and the government in shaping that outcome.

OUTLOOK

Destiny is not a matter of chance; it is a matter of choice. It is not a thing to be waited for; it is a thing to be achieved.

William Jennings Bryan

The long-term viability of both GDLS and UD Ground Systems Division will be determined by future production decisions by the Army and Marine Corps on the FCS and EFV programs, respectively. Currently, both companies are party to a teaming agreement with the FCS LSI that specifies a 50/50 revenue split between GDLS and UD Ground Systems Division for the system design and development (SDD) and initial production (IP) phases. During SDD, there are two primary contracts for FCS MG

development: the contract between the Lead System Integrator (LSI), Boeing, and GDLS and between the LSI and UD Ground Systems Division.

Under these contracts, GDLS leads the design and development of the common chassis for all FCS MGCV variants. In some cases, there may be differences in chassis configuration for specific variants optimized for selected mission modules; however, the major components (e.g., engine, transmission, suspension, etc.) will be common. During SDD, GDLS will design and deliver to the LSI the Mounted Combat Vehicle (MCV), Command and Control Vehicle (C2V), and Reconnaissance and Surveillance Vehicle (RSV).

Under a separate contract, UD Ground Systems Division will design and deliver to the LSI the Infantry Carrier Vehicle (ICV), Non Line of Sight-Cannon (NLOS-C), Non Line of Sight-Mortar (NLOS-M), and Medical Treatment and Evacuation Vehicle (MTEV). The Army has not funded the Maintenance and Recovery Vehicle (MRV); however, the Army identified the Heavy Equipment Transporter (HEMTT) as a suitable substitute until the MRV is available.

The future position of GDLS is more secure because in addition to participating in the FCS program, GDLS is scheduled to produce over 1300 Stryker wheeled combat vehicles for the Army from FY03 to FY08 and over a 1000 EFVs for the Marine Corps from FY06 through FY16.^{xxxv}

On the other hand, as noted above, UD Ground Systems Division has a significant production gap to fill. Moving future system production orders 2 years to the right may allow industry and the Army to close this gap on mutually beneficial terms. Otherwise, UD survival may depend on the amount of work available from Army reset and sustainment of existing programs, and its ability to successfully bid for that work. For the FCS program to succeed, the continued participation of UD Ground Systems Division is essential, since it has core competencies that enable key FCS capabilities.

Achieving a favorable outcome mutually beneficial to industry and the government demands that industry align with this new systems integrator role vice the more traditional metal-bender role. The government plays a key role in making that outcome a reality.

GOVERNMENT GOALS AND ROLE

Government's view of the economy could be summed up in a few short phrases: If it moves, tax it. If it keeps moving, regulate it. And if it stops moving, subsidize it.

Ronald Reagan

Such traditional government approaches to stimulate the economy are clearly inappropriate. The key aspects of a successful transformation strategy is having industry aligned with the vision of capability-based acquisition and having the federal government remove the obstacles—laws, rules, and regulations—that inhibit true partnerships with industry.^{xxxvi} While existing competencies in the LCS industry are crucial to national defense, it's more important that the integration begun by Boeing, GD, and UD under the FCS program continues. The complexity of future platforms and the SoS concept demands that these firms move from a focus on sole source product development and production to mutual participation in capability development. Systems integration

yielding effects greater than the sum of the parts is the direction now required of this industry.

However, GD and UD have had a difficult time breaking away from the old paradigm of sole source development and production because of their fear of “losing all or a fair share” of FCS production and uncertainty with the role of Boeing as the LSI. The opportunity provided by the FCS program is setting the precedence for successful partnerships among industry firms and between industry and the government, easing the transformation to systems integration demanded of the LCS industry.

Given the complexity of systems required this does not mean DoD should desert the full service providers. Quite the contrary, partnerships with a team of suppliers and cooperation are absolute imperatives for success. This means striking properly constructed contracts that provide a win-win outcome for all players concerned.

John Nash, the Nobel laureate, demonstrated through his equilibrium theory that economic problems are solvable under cooperative and competitive conditions.^{xxxvii} The critical role for DoD is to negotiate an affordable price that includes a fair and reasonable profit margin for each supplier. This induces the proper incentive, price-led costing, vice what Peter Drucker terms one of the “five deadly business sins,” cost-driven pricing.^{xxxviii} The Japanese consumer-electronics industry used price-led costing to drive their costs down and under price their American counterparts, eventually driving them out of the market.^{xxxix} Similarly, a price-led strategy will give defense suppliers the proper incentive to cut costs.

Another critical enabler identified during travels abroad is the opportunities that the foreign firms can provide. Yet, the overly restrictive regulations within the International Traffic in Arms Regulations are hampering the ability of negotiating successful partnerships with the EU companies. The US and European governments must work together to develop cooperative agreements to facilitate the mutual development of sustainable, interoperable capabilities for the US and allied forces.

Despite its poor track record in setting incentives in contracts, DoD cannot be irresolute. The DoD must implement this policy, learn, and adapt as necessary to become better price setters. Doing these right things will return value to both industry and DoD in the form of a vibrant defense industrial base.

CONCLUSION

The only good is knowledge and the only evil is ignorance.

Socrates

The knowledge gleaned from this year’s industry study have taught the team that despite the many challenges confronting the nation, the industry and government play an important part in successfully overcoming these challenges. To ignore the evidence is fraught with peril. The imperative for businesses is establishing sound business strategies that provide competitive advantage, profitable earnings, and a return on shareholders’ equity, while fully adopting the new DoD vision of lead systems integrators. The imperative for DoD is setting the right industrial strategy—an effective one that removes the barriers that inhibit partnership with industry and will ultimately deliver timely, affordable, and sustainable capability to the nation’s warfighters.

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ENDNOTES

- ⁱ This section adapted from USMC Expeditionary Maneuver Warfare: Marine Corps Capstone Concept, November 2001, retrieved 27 May 2004 from World Wide Web at https://www.mccdc.usmc.mil/pdf_files/emw.pdf.
- ⁱⁱ Dr. R. Laird, "Transformation and the Defense Industrial Base: A New Model," *Defense Horizons* (Number 26) (Ft McNair, Washington, DC: Center for Technology and National Security Policy, May 2003), p.1.
- ⁱⁱⁱ ICAF 5300-01, Acquisition II, Lesson 8, "Government-Industry Interaction," Industrial College of the Armed Forces, 27 February 2004.
- ^{iv} Calculated from financial data provided in General Dynamics 2003 Annual Report retrieved 27 May 2004 from World Wide Web at <http://www.generaldynamics.com/ir/AnnualReport2003/PageF14.htm>.
- ^v Retrieved 27 May 2004 from the World Wide Web at <http://www.generaldynamics.com/ir/AnnualReport2003/PageF15.htm>.
- ^{vi} General Dynamics Market Capitalization derived from Mergent Online 19 April 2004 closing price, \$91.06, and 197,966,200 outstanding number of shares as of 31 December 2003, retrieved from the World Wide Web at <http://www.mergentonline.com> and <http://www.generaldynamics.com/ir/AnnualReport2003/PageF14.htm>, respectively; total number of employees from the General Dynamics Company Overview retrieved 27 May 2004 from the World Wide Web at <http://www.generaldynamics.com/>; and annual net sales growth derived from General Dynamics data retrieved 21 April 2004 from the World Wide Web at <http://www.mergentonline.com>.
- ^{vii} Profitability ratio derived from data retrieved 21 April 2004 from the World Wide Web at <http://www.mergentonline.com>.
- ^{viii} Operating margin derived from data retrieved 21 April 2004 from the World Wide Web at <http://www.mergentonline.com>.
- ^{ix} Liquidity ratio derived from data retrieved 21 April 2004 from the World Wide Web at <http://www.mergentonline.com>.
- ^x Debt-to-Equity ratio derived from data retrieved 21 April 2004 from the World Wide Web at <http://www.mergentonline.com>.
- ^{xi} Cash flow derived from data retrieved 21 April 2004 from the World Wide Web at <http://www.mergentonline.com>.
- ^{xii} Retrieved 27 May 2004 from the World Wide Web at <http://www.gdls.com/>.
- ^{xiii} Constructed from General Dynamics corporate organization retrieved 27 May 2004 from the World Wide Web at <http://www.generaldynamics.com/>.
- ^{xiv} Retrieved 27 May 2004 from the World Wide Web at <http://www.generaldynamics.com/ir/AnnualReport2003/Page3.htm>.
- ^{xv} Ibid.
- ^{xvi} Retrieved and calculated 27 May 2004 from the World Wide Web at <http://www.generaldynamics.com/ir/AnnualReport2003/PageF9.htm>.
- ^{xvii} General Dynamics 11 March 2004 News Release, "General Dynamics and Alvis PLC Agree to Terms of Acquisition Offer," retrieved 27 May 2004 from the World Wide Web at <http://www.generaldynamics.com/>.
- ^{xviii} Constructed from United Defense corporate locations retrieved 27 May 2004 from the World Wide Web at <http://www.uniteddefense.com/co/locations.htm>.
- ^{xix} United Defense Market Capitalization derived from Mergent Online 21 April 2004 closing price, \$31.06, and 51,695,114 outstanding number of shares as of 31 December 2003 retrieved from the World Wide Web at <http://www.mergentonline.com>; number of employees retrieved 21 April 2004 from the World Wide Web at <http://www.uniteddefense.com/co/index.htm>.
- ^{xx} Annual net sales growth derived from United Defense data retrieved 21 April 2004 from the World Wide Web at <http://www.mergentonline.com>.
- ^{xxi} Operating margin derived from United Defense data retrieved 21 April 2004 from the World Wide Web at <http://www.mergentonline.com>.
- ^{xxii} Liquidity ratio derived from United Defense data retrieved 21 April 2004 from the World Wide Web at <http://www.mergentonline.com>.

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- ^{xxiii} Debt-to-Equity ratio derived from United Defense data retrieved 21 April 2004 from the World Wide Web at <http://www.mergentonline.com>.
- ^{xxiv} Cash flow derived from United Defense data retrieved 21 April 2004 from the World Wide Web at <http://www.mergentonline.com>.
- ^{xxv} Calculated from United Defense 2002 Annual Report, p. 5, retrieved 27 May 2004 from the World Wide Web at http://media.corporate-ir.net/media_files/irol/13/130499/reports/AR2002.pdf.
- ^{xxvi} United Defense Industries 2003 Annual Report, p. 4, retrieved 27 May 2004 from the World Wide Web at http://media.corporate-ir.net/media_files/irol/13/130499/reports/AR2003.pdf.
- ^{xxvii} Ibid.
- ^{xxviii} Data obtained from General Dynamics 2003 Annual Report and United Defense 2003 Annual Report.
- ^{xxix} Derived from United States Army Budget Material, retrieved 1 June 2004 from the World Wide Web at <http://www.asafm.army.mil/budget/fybm/FY05/pforms/wtcv.pdf>.
- ^{xxx} Retrieved 31 March 2004 from World Wide Web at <http://www.mcaleese.com/papers/csfb-uk.pdf>.
- ^{xxxi} Guest Lecturer, Land Combat Systems Industry Study, Industrial College of the Armed Forces, 28 January 2004.
- ^{xxxii} Information gathered from Land Combat Systems Industry Study site visits, Industrial College of the Armed Forces.
- ^{xxxiii} Financial data obtained during ICAF 5202, Economics of National Security Strategy and Resource Allocation (II), Lesson 6, "Cost Concepts and Analysis II: Financial Costs," Industrial College of Armed Forces, February 2004.
- ^{xxxiv} Information gathered from Land Combat Systems Industry Study site visits, Industrial College of the Armed Forces.
- ^{xxxv} Retrieved 27 May 2004 from the World Wide Web at <http://www.efv.usmc.mil/program/ProgramSchd/Slide1.gif>.
- ^{xxxvi} Dr. R. Laird, "Transformation and the Defense Industrial Base: A New Model," *Defense Horizons* (Number 26) (Ft McNair, Washington, DC: Center for Technology and National Security Policy, May 2003), pp. 7-8.
- ^{xxxvii} E. Nosal and P. Rupert, "A Beautiful Theory," Federal Reserve Bank of Cleveland, Economic Commentary, 15 April 2002.
- ^{xxxviii} P. Drucker, *Managing in a Time of Great Change* (New York, NY: Truman Talley Books/Plume, 1995), pp. 47-48.
- ^{xxxix} P. Drucker, *Managing in a Time of Great Change* (New York, NY: Truman Talley Books/Plume, 1995), p. 48