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National Defense University
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MUNITIONS

ABSTRACT: Like other defense industries, the munitions industry has undergone significant change during the past two decades. Three major factors, the end of the Cold War, the subsequent revolution in military affairs, and the increasing reluctance of the American public to accept loss of life and collateral damage in war, have dramatically affected the industry. The munitions industry is vital to US national security. To maintain its viability, a comprehensive and integrated focus on jointness, supplier health, information technology, and acquisition reform is imperative.

Lt Col Thomas Arko, USAF
COL Thomas Boyle, USA
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Ms. Frances Dwyer, Dept. of Navy
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LTC Clint Haynie, USA
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CDR Brett Reissener, USN
Mr. John Wiegand, Dept. of Transportation

CAPT Susan Maybaumwisniewski, USN, faculty
CAPT Ros Poplar, USN, faculty
COL Edwin McDermott, USAF, faculty
Dr. Thomas Hone, faculty
Dr. B.F. Cooling, faculty

PLACES VISITED:

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Executive Munitions Summit Sponsored by National Defense Industrial Assoc. (NDIA)
Joint Chiefs of Staff, Pentagon
Lockheed Martin, Bethesda, MD
OSD AT&L, Pentagon
USAF PEO for Munitions
Munitions Industrial Base Task Force, Arlington, VA

Domestic:

Air Armament Center, Eglin AFB, FL
Acquisition Center of Excellence, Eglin AFB, FL
Air Force Air Combat Command , Langley AFB, VA
Air Force Research Laboratory, Eglin AFB, FL
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Naval School Explosive Ordnance Disposal, Eglin AFB, FL
Deputy Chief of Naval Operations, Pentagon.
Raytheon Missile Systems, Tucson, AZ
Rockwell Collins - Government Systems, Cedar Rapids, IA

International:

BAE Systems, United Kingdom
Bofors Defence, Sweden
Ministry of Defence, United Kingdom
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Swedish Defense Materiel Administration (FMV), Sweden
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INTRODUCTION

In 1993, in a plush Washington DC restaurant, Secretary of Defense Les Aspin dined with key defense industry leaders. The main menu included more than fine cuisine. The dinner, dubbed the *Last Supper*, included as the main course a mandate to restructure the post-Cold-War defense industry. As Norman Augustine, former Chief Executive Officer of Martin Marietta, declared, "We could liquidate, evaporate, or consolidate."

The effect of the consolidation within the Department of Defense (DoD) and the defense industry was enormous. The overall defense industry consolidated from fifty-one to four prime contractors with the munitions sector decreasing from thirteen to three prime contractors. Over the last two decades, the munitions industry has been transforming from one dominated by conventional munitions (artillery, bullets, mortar, etc.) to an industry dominated by precision-guided munitions; from an industry reliant on massive stockpiles to an industry dependent on smaller, but more lethal precision-guided munitions.

THE INDUSTRY DEFINED

The munitions industry is directly dependent on the level of DoD investment. Total munitions research, development, test, and evaluation (RDT&E) and procurement funding is approximately $10B or 7% of the total FY 04 DoD budget.[1] While this represents a relatively small portion of the overall budget, munitions are often at the nexus of many other DoD investments in platforms, combat systems and Command, Control, Communications, Computers, Intelligence, Surveillance, and Reconnaissance (C4ISR) systems integration. Munitions are critical to United States (US) national security and military capabilities. This industry study focused on the emerging precision-guided munitions sector and will only reference tactical missiles and unguided conventional munitions. Unlike unguided conventional munitions, PGMs are produced in the private sector. Since consolidation, the three prime contractors who produce PGMs in the US are Raytheon, Lockheed-Martin, and Boeing. These companies are increasingly transforming themselves to lead systems integrators and sub-contracting with second and third-tier suppliers for component part manufacturing. Today, the sub-contracting component of the PGM sector consists of approximately 100 critical suppliers many of whom are sole-source manufacturers.

DRIVERS

Three events during the last two decades drastically transformed the US munitions industrial base. First, a Revolution in Military Affairs (RMA) that combined stealth, information superiority, and precision and influenced the DoD munitions requirement. Secondly, the end of the Cold War and the elimination of the Soviet Union as a peer competitor drastically reduced required force structure and defense budgets requiring the US to get more "bang for the military bucks." Finally, a cultural shift demanding significant reduction of casualties and minimal collateral damage shifted emphasis from unguided munitions to precision munitions.

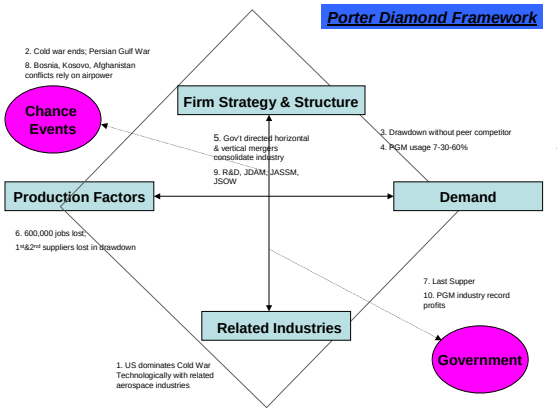
Prior to The Vietnam Conflict, the US fought wars utilizing massive firepower delivered on a target. This method required enormous amounts of munitions and numerous platforms to accomplish the mission. Although primarily a *dumb* war, laser-guided bombs were introduced during Vietnam. These new weapons enabled the US to

destroy a bridge in four sorties that previously had required 870. Although this was not the first time precision weapons were used, it did provide a glimpse of the potential effectiveness of PGMs. That picture was clearly displayed in 1991. Operation DESERT STORM combined stealth technology and precision weapons in an unprecedented display of firepower. Approximately 8% of the munitions expended were PGMs; and they redefined massed firepower on the battlefield as a single precision weapon delivered the effectiveness of thousands of unguided bombs. This 8% total represented 84% of the total cost of munitions used in Operation DESERT STORM. As of June 2003, over 60% of the munitions used in Operation IRAQI FREEDOM were precision guided, displaying an accuracy of three meters on a continual basis.

Just as weapon capabilities and accuracy continue to increase, the costs of these weapons also increased. For example, air-launched PGM procurement skyrocketed from $200 million in 1985 to $1.2 billion today.[2] Today's weapons of choice, the Joint Direct Attack Munitions (JDAM) and laser-guided bombs cost less than $35,000, whereas the Joint Stand-Off Weapon (JSOW) costs over $280,000 and the new Joint Air-to-Surface Standoff Missile (JASSM) costs around $360,000. Although more expensive per unit, a use of such weapons results in an overall cost savings when factors such as the number of weapons needed to destroy a target, the platforms needed to support the mission, and more importantly, the number of personnel placed in harms way were considered. Moreover, improved weaponry significantly reduces the possibility of collateral damage, which is something the public demands, as well as making post-conflict reconstruction dramatically easier.

CURRENT ASSESSMENT

Dr. Michael Porter's Competitive Advantage model[3] is a useful framework for assessing the precision munitions industrial base. The four determinants: production factors; demand changes; industry's strategy, structure and rivalries; and relationships with associated industries are pertinent to the precision-guided munitions industry. The chance event variable, discussed here as the confluence of the end of the Cold War, the revolution in military affairs, and the demand for reduced casualties and collateral damage, was a powerful factor affecting US National Security Strategy and a significant influence on the precision munitions industry's competitive edge.



The determinants' interrelationships are significant because they are pervasive throughout the industry. The conclusion drawn from an evaluation of precision munitions is that this industry has achieved a national competitive advantage through the fusion of the four determinants.

Large budgets sustained a vigorous research and development infrastructure, active production lines, and multiple suppliers. Advanced and highly specialized factors of production existed at the end of the Cold War in 1989.[4] Through a strategic shift in US

defense priorities and resource allocation, the US defense industrial base has achieved a distinct competitive advantage of the precision munitions industry sector. Clearly today, the US dominates the precision munitions market.

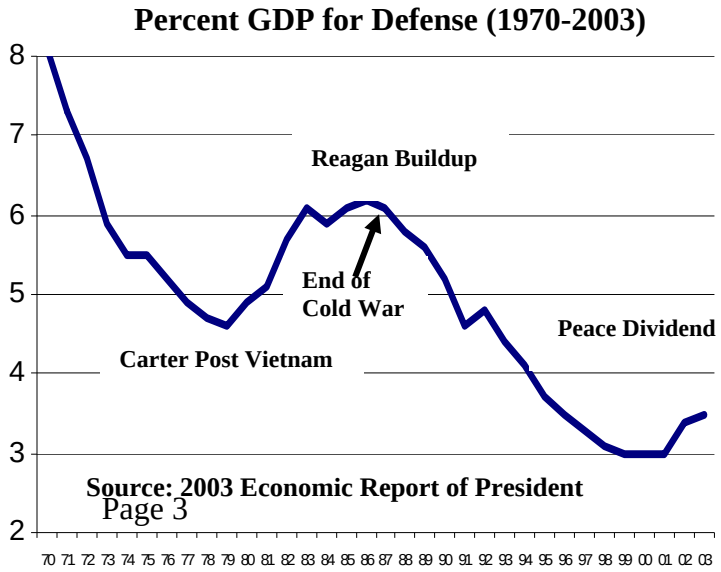
Production Factors. The four production factors contributing to US precision munitions competitive advantage are: infrastructure, capital resources, human resources and knowledge resources. The US possesses an abundance of these features that contribute to the industry's viability. The infrastructure consists of a professional military force, an advanced manufacturing base, and a supportive aerospace industry. The US enjoys capital reserves in both private industry and through large defense budgets that can fund precision munitions developmental programs. Moreover, the precision munitions industry maintains a skilled workforce of trained technicians, engineers and scientists. Finally, the US leads the world in research universities, research institutions and other knowledge assets. The condition of the precision munitions industry, as viewed exclusively through the production factors' lens, explains its dominant position.

Demand Changes. Demand is a critical determinant when seeking competitive advantage. Precision munitions are not a typical market as DoD (the sole customer) is not driven by pricing mechanisms or competition. The monopsonistic DoD also destabilizes the market through its unpredictable purchasing patterns. Precision engagement successes in post Cold War conflicts drove the market shift from dumb bombs to precision munitions. To illustrate, the US Air Force contracted for 128,000 dumb weapons and only 4,000 precision-guided munitions in FY85. Conversely, the Air Force ordered 40,000 precision-guided munitions and only 9,000 dumb weapons for FY 04.[5]

Prime contractors have demonstrated *surge* capabilities to meet the recent large increase in demand. The original JDAM contract called for production of 500 JDAM kits per month. As a result of recent conflicts in Afghanistan and Iraq, the manufacturer is currently producing almost 2,800 kits per month with an eventual goal of 3,000 kits per month.[6]

Demand analysis shows few international orders. The fact that many countries train with our systems increases their desire to purchase similar systems, which in turn increases demand for our weapons. However, to maintain its military superiority, retain its technological advantage, as well as satisfy international non-proliferation and arms control obligations and agreements; the US government limits potential foreign sales through export controls.

Industry Strategy, Structure and Rivalries. Strategy, structure and rivalry are also determinants of national competitive advantage. The precision munitions industry strategy is fundamentally different from most other industries, which are driven by economies of scale, pricing, and percent of market share.[7] In the precision-guided munitions industry, technology that provides warfighters the edge



to win in combat is the paramount strategy. Consequently, research infrastructure is critical. Nevertheless, both research and overall procurement budgets declined in the 1990s. With budget reductions, the military services tended to invest more in sustainment than in future capabilities. Given the downward spiral of research and technology investment during the last decade, additional funding should be allocated to maintain US military superiority and ensure technology advantage in the long term.

The munitions industry structure changed dramatically upon the end of the Cold War. Munitions procurement funding then clearly indicated that the market could only sustain a limited number of companies. The current structure of three prime contractors is characterized by an 89.2% concentration factor driven by horizontal and vertical mergers, which was a result of a drastic cut in defense spending.[8] This concentration amplifies the impact of the munitions demand vagaries and their impact upon production.

With high labor and developmental research costs, mergers were a method of survival as government *influence* created a major drop in demand. Although restructuring of the precision munitions industry was a necessary response, an industry consolidation to only three firms presents some drawbacks. The Porter framework posits that increased competition and rivalry enhances innovation, pricing, and production efficiencies; hence, competition reduced to this oligopoly of three prime contractors may have a dampening effect on the market. Conversely, the viability of companies dependent on defense is immediately affected by both DoD's erratic demand patterns and Congressional funding anomalies. Long-term aggressive competition cannot be sustained in this environment.[9].

Suppliers. The precision munitions industry has a serious structural flaw below the prime level. The defense drawdown and industry consolidations decimated the first and second tier vendor support system, which in turn affects the national competitive advantage. Many munitions production shortfalls link directly to suppliers' production capabilities. For example, industry leaders identified three leading subcomponent shortfalls in the manufacture of one preferred PGM used during Operation IRAQI FREEDOM. Single suppliers largely produced these components.[10]

Supplier vulnerability is linked to profit and risk. With pressure from prime contractors for smaller profit margins, sole source niche suppliers have little flexibility. Suppliers naturally tend to be smaller companies with limited production capacity, so they are more vulnerable to volatile DoD demand swings. They also routinely support multiple primes, which causes prioritization challenges.

Environmental and encroachment concerns also affect the precision-guided munitions industry. The larger a company is, the greater its susceptibility to financial liability associated with these issues; in fact, some firms have been forced into bankruptcy due to environmental based litigation. As another specific example, perchlorate is a major ingredient of TNT and propellants. The Environmental Protection Agency has major concerns about drinking water contamination. Possible water table contamination by perchlorate production byproducts may force DoD to invent a new product to produce the same effect as TNT, an expensive and difficult option. Further, encroachment at test sites like Eglin AFB restricts testing and training with live munitions. This becomes increasingly significant as the range of PGMs increases and the locations allowing required long distance testing continue to shrink or disappear.

Foreign Suppliers. Many PGM subcomponents are supplied from around the world. Although some overseas suppliers operate in a more stable manufacturing

environment as a result of their government's parliamentarian approach to budgeting that allows multi-year program funding, they are also confronted with significantly reduced demand. As the European Union has evolved to a substantial market force, the European defense industry has attempted to capitalize on these market forces. European defense industry has seen its own share of large consolidations hoping to reap horizontal and vertical efficiencies and be more competitive in this reduced munitions market.

Foreign manufacturers also often receive host government funding for research and low rate development. Despite subsidies, the shrinkage of the global munitions market increasingly attracts international suppliers to the comparatively more robust US defense market. In response, the Strom Thurmond National Defense Authorization Act for FY 99 requires that the Army, as the Single Manager for Conventional Ammunition (SMCA) "limit a specific procurement of ammunition to sources within the *national* technology and industrial base if required to preserve the nation's industrial base"[11]. This act addresses the Services' procurement of conventional ammunition, and is designed to ensure the availability of ammunition in a national emergency or industrial mobilization. The law effectively prohibits overseas companies from competing as prime contractors. Some international munitions suppliers are lobbying the U.S. Congress to rescind the law. Despite this protectionist legislation, US prime contractors continue to seek partnerships with international suppliers to acquire high quality and low cost PGM parts, though with more difficulty. Clearly, this issue is complex and fraught with risks and potentially significant industry consequences.

The prognosis for US suppliers is not totally bleak. Since September 11th some critical node second and third-tier suppliers have received federal production line expansion subsidies to facilitate surge. Moreover, prime contractors practiced in manufacturing efficiency initiatives (e.g. Six Sigma, Lean Manufacturing, and analytical decision support tools) are mentoring some suppliers. In total, these efforts are designed to improve efficiency, reduce costs, increase profits, and maintain a viable domestic industrial base.

Relationships with Associated Industries: The relationships among industries are also a factor for national competitive advantage. Clearly, the precision munitions industry partners with world-class related industries. The aircraft aerospace industry provides a variety of technologies, technical workforce, communication and manufacturing advantages. Electronic component systems are dual-use for both defense and consumer industries. Advanced manufacturing industries include state-of-art composite materials whereas the space industry complements the precision munitions industry through GPS guidance satellites and the C4ISR infrastructure. Generally, the related factors that enhance the support of the precision munitions industry are: the largest defense budget in the world supporting advanced technologies; the higher education/university system providing technical engineers and scientists, as well as an outstanding university research infrastructure; and the world's most modern military consistently seeking technological breakthroughs. The Porter framework implies that having related industries capable of supporting a national industry improves communication, innovation and economy-of-scale.[12]

Current Assessment Conclusions. With the Cold War drawdown and the replacing of dumb bombs with precision-guided munitions, the structure of the industry shifted away from massive stockpiles of unguided munitions. The conclusion drawn

from the Porter model analysis is that the precision munitions industry possesses a definite national competitive advantage. However, the variables of government intervention and confluence of chance events strongly influence this competitive advantage. From a National Military Strategy perspective, the precision munitions industry is fragile. It is able to deliver sustained replenishment, but it is less capable to surge. The precision-guided munitions industry is largely unable to mobilize to meet unremitting increases in demand. Since military preparedness requires surge capability, then the requirement must be identified, the capability planned, and the acquisition executed before future conflicts further accentuate these weaknesses.

CHALLENGES:

The precision munitions industry faces challenges that are varied in their scope and far-reaching throughout and external to the industry. One such challenge involves the precision-guided munitions supply chain. Globalization, sole-source suppliers, consolidation, profitability, and second and third-tier supplier related issues are some of the major concerns that face an industry laden with complex relationships and increasing interdependence among the industry, the military, and Congress.

Another significant challenge deals with information technology, a widely recognized key enabler and force multiplier. As the benefits of information technology continue to be leveraged, the probability of achieving a truly integrated C4ISR architecture increases. Also, across the munitions industry the business and production processes are very diverse, and effective utilization of information technology can be a critical component to support these processes.

Planning the munitions of the future is another challenge. As we transform for the future, what capabilities will new technology afford us? There are many areas where technology trends may provide new and unique solutions. We need to stay informed and involved in that technology progression to gain maximum benefit.

Determining joint requirements is a challenge as well. Valid, stable requirements, which are based upon the National Security Strategy and National Military Strategy, are needed to formulate a plan of how we intend to fight. This in turn generates a requirement for a plan with industry to maintain a viable production base. The process of determining requirements needs to be efficient and effective in order to successfully provide warfighters with adequate capabilities.

Another challenge that goes hand-in-hand with requirements is the acquisition process itself. Today's acquisition workforce can provide warfighters the systems they need faster, better, and cheaper. Recent acquisition reform changes should provide an acquisition system that is an enhancement to achieving successful results rather than an impediment. This focus on acquisition reform needs to continue to ensure the requirements are met quickly and in the most cost effectivemanner.

Each of these challenges is of critical significance to the munitions industry, and is discussed in greater detail in the essays of this paper.

OUTLOOK:

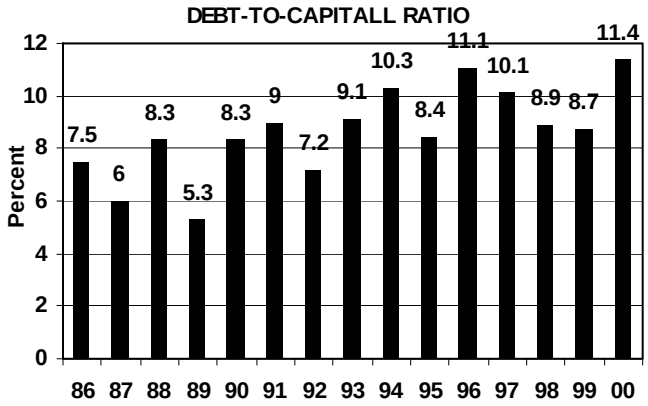
The future of the munitions industrial base is uncertain. Although government and industry actions since September 11th enhanced the industry's productivity, several

constraints loom on the horizon that could be major stumbling blocks for continued industry competitiveness.

Enhancement: Production Capability. PGM industrial base production capabilities have improved since September 11, 2001. With DoD financial support, upgrades in plant and equipment capacity and additional suppliers dramatically improved the PGM industry's capabilities. For example, prior to September 11th, the industry was producing about 500 JDAM kits and 400 laser-guided bomb kits per month. Following September 11th, the industry increased production to almost 3,000 JDAMs and 1,700 laser-guided bomb kits per month. One company added a new production line (and deactivated the old line), increasing their production floor space from 15,000 square feet to 35,000 square feet. In another instance, DoD added an additional company as a second source for laser-guided bombs.

Enhancement: Reduced Risk from Diversification. Reduced defense funding in the 1990s drove consolidation within the defense industry. These consolidations caused diversification among the remaining companies across multiple product lines enabling them to better withstand fluctuations in program funding. For example, Boeing purchased McDonnell Douglas, gaining a large share in the tactical missile industry while maintaining its large commercial business. Their diversification strategy soon paid dividends. When the commercial airline industry began its decline in the third quarter of 2001 and was later affected by the events of September 11th, Boeing's increased defense sales yielded increased profits that helped offset the decline in commercial airline sales.

Barrier: High Debt to Capital Ratio. A major effect from the consolidations was increased debt as firms spent capital to acquire other firms. This is relevant in the precision munitions sector where three firms (Raytheon, Lockheed-Martin and Boeing) acquired ten other competitors. The graph reveals the high debt ratio after the infamous *Last Supper* in 1993.



Source: Merrill Lynch 2001 Defense

Increased debt created a major barrier to industry competitiveness in the form of decreased capital. Reduced capital provided less company funding for research and development, and maintaining a technical advantage via research and development is vital for sensor-seeker technology in precision weapons. DoD further exacerbated the research and development shortfall when they reduced their government sponsored research during the budget decisions of the 1990's to utilize the *peace dividend* for other programs.

Barrier: Three Critical Component Suppliers. Experts identified three second-tier suppliers that represent critical nodes in the PGM manufacturing sector: Eagle Picher, producer of almost all thermal battery units; Honeywell, producer of Inertial Measurement Units (IMU); and Rockwell Collins, producer of Global Positioning System (GPS) receivers. All three independent firms are the primes' sole-source

suppliers.[13] Prime contractors contend these three vendors are the likely sources of production limitations. There are signs of improving production among the three critical suppliers. The primes in concert with these suppliers have implemented strategic sourcing plans, which are improving supplier production rates. The prime contractors have worked diligently with capacity constrained suppliers. One of the primes reported during the 2002 surge that their suppliers were on time 95.5%. Likewise, second-tier suppliers have stated that strategic partnerships with prime contractors yielded positive results.

Barrier: Vertical Integration. Although the precision munitions industry successfully realigned horizontally among primes, the vertical integration between the primes and the suppliers has failed to materialize. Experts contend that the suppliers and primes must align in this direction for improved US competitiveness. A prominent defense industry analyst argues a vertical alignment will provide enhanced competitiveness using the prime's horizontal mergers of the 1990s as a model.[14] Analysts further argue that an aggressive alignment of suppliers, especially in the third-tier subcomponent vendors, is long overdue. Supplier vendors, not prime contractors, make up the bulk of the industrial base comprising 50-85% of the defense industrial base. The prime contractors must move away from a *zero-sum mentality* with their suppliers, namely thinking that if the supplier is making money then it was at the prime's expense.

The Office of the Deputy Under Secretary of Defense for Industrial Policy agrees with this view, and has created an industrial transformation task force that reviewed the health of the defense industrial base. The task force identified improved competitiveness among small business suppliers as a means to improve the defense industrial base.[15]

GOVERNMENT: GOALS AND ROLES:

The precision munitions industry provides a unique case study of seemingly irreconcilable government roles and goals. Primary government roles include traditional oversight functions and demanding customer perspective. These government roles result in an industry at the mercy of its monopsonistic customer's unique budget, requirements, and acquisition processes, subject to often uncoordinated multi-agency proscriptions.

Government Oversight Role. The munitions industry is subjected to conflicting goals addressing US arms export controls, technology transfer policy and strategic international economic promotion. The US defense industry, Congress, and DoD appear to work in concert in support of the National Security Strategy's aim of *unparalleled military strength,* but the triad may be at odds in the pursuit of other strategic objectives related to "great economic and political influence."[16]

Current arms export controls and technology transfer policy architecture is largely an outdated legacy from the Cold War arms control framework established in 1949 through the post-WWII Coordinating Committee on Multilateral Export Controls (COCOM)[17]. Some historians credit COCOM with contributing to the eventual collapse of the Soviet Union by starving the Soviet military and defense industrial base, and economy, over the course of four decades while preventing access to critical military technology. Today, US arms export control and technology transfer policy attempts to strike the delicate balance between providing sufficient safeguards for national security, while simultaneously not burdening the defense industry by diminishing international

competitiveness or inhibiting opportunities for international trade in the rapidly developing global market.

However, no less than four Executive Departments provide administration and oversight of arms export controls and technology transfer policy, directly correlated to laws enacted by Congress. The Arms Export Control Act,[18] administered by the Department of State with the implementing International Traffic in Arms Regulations,[19] delineates items designated as defense articles on the United States Munitions List (USML). The Department of Commerce administers the Export Administration Act (as amended) and corresponding Export Administration Regulations that govern the Commerce Control List of dual-use items and technologies. DoD maintains the Militarily Critical Technologies List and provides consultation and concurrence on the State Department's USML. The US Customs Service, in the Department of Homeland Security, provides primary oversight of the physical import and export of controlled items. US strategic objectives of national security, extension of foreign policy, and the promotion of international trade and economic prosperity are not mutually supportive of each other and occasionally find themselves in competitions resulting in radically different application of arms export controls and technology transfer policy. Numerous agencies involved in oversight result in overlaps and, more importantly, inconsistent approaches to export controls and technology transfers.

The Commerce and State Departments provide primary oversight in fulfilling US commitments to informal and voluntary non-proliferation agreements. The Missile Technology Control Regime was established in 1987 to control the proliferation of missile technology and WMD delivery system capability, while the 1996 Wassenaar Arrangement governs export controls for conventional arms and dual-use goods and technologies. Consideration should be given to enacting legislation directing the consolidation of oversight responsibilities into a single agency, with a mandate emphasizing *zero tolerance* for bureaucratic "*turf wars*" and "*rice bowl*" preservation.

All visits with the industry, both domestic and international, revealed intense frustration with dealing with US arms export controls and technology transfer policy. US export controls regarding technology and arms transfers are frequently vilified as barriers to international defense trade and impediments to US defense industry competitiveness abroad. *Every* domestic and foreign defense corporation visited depicted the export control licensing process as too lengthy and burdensome. The process was described as an impediment to US stated goals of trans-Atlantic defense industrial cooperation, increase Allied interoperability, and promotion of economic interests in the global marketplace. One US defense company CEO expressed his frustration with the export licensing process as "the slow bureaucrats with their dusty paper and quill pens."

The State Department processes an average of 45,000 arms export license applications each year.[20] This largely paper based system can be transformed by leveraging available information technology. The State Department can implement an e-licensing system, which could dramatically reduce application cycle time from initial submission through final adjudication. It would also provide immediate transparency and visibility into the interagency review process.

<u>Government as Primary Customer</u>. DoD is the primary customer of US-made precision-guided munitions and exerts great influence over any sales abroad. Unfortunately for industry, DoD is an unpredictable customer. Strategically, the National

Military Strategy and Defense Planning Guidance provide clarity to DoD's needs. DoD's subsequent analysis generally falls within either of two frameworks: short term views or long term perspectives, both necessary for the successful prosecution of the US National Security Strategy. Unlike most supply items purchased by DoD, precision munitions are not susceptible to traditional demand regression modeling, because military planning does not presume that the way the last war was fought will be the way the next war will be fought. The result is poor material requirements and poor industrial capacity planning.[21]

Prior to September 11th, the dominant inclination had been to invest in technology research to the detriment of precision munitions stockpile replenishment. The dramatic decrease in stockpile investment was considered less risky because of the perceived lack of a competing superpower and the implied assurance that Congress would fund precision munitions in targeted supplemental appropriations to support contingency operations.

American forces expended an incredible number of precision-guided munitions in Afghanistan and Iraq. Congressional supplemental funding for munitions provided vital support. However, the precision munitions industry grows increasingly vulnerable as surge capacity is taxed or if sustaining manufacturing orders do not materialize. Military leaders must undertake serious industrial preparedness planning for critical items and use flexible contracting approaches to ensure that limited munitions industry capabilities thrive. The DoD monopsony must use its requirements, acquisition, and budget processes to forecast and fund a steady rate of production sufficient to maintain a robust precision munitions industrial base.

ESSAY ONE: THE PRECISION-GUIDED MUNITIONS SUPPLY CHAIN

The capitalist economy creates interesting dynamics in the precision munitions industry. As companies increasingly benefit from the advantages of globalization, they accrue efficiencies, as less expensive labor and raw material sources are found overseas. This supply-demand function drives out American sources that, in turn, may result in political and military vulnerability for the security of the United States.[22] An international supplier, which disagrees with American foreign policy, may withhold critical items. A recent example of this exposure occurred during Operation Iraqi Freedom when a European accelerometer manufacturer failed to ship required precision munitions components solely because of opposition to the war. Subsequent intense diplomacy resulted in a convoluted plan for asset release. Ultimately, the manufacturer withdrew this item from its product line, and the precision munitions prime is cultivating an alternative source.

This example does not imply that "*Buy American*" is the panacea.[23] Prime contractors are also vulnerable with domestic suppliers simply because of the supply-demand phenomenon. Precision munitions manufacturers have significantly reduced plant, production lines, and skilled workforce in response to the "*peace dividend*". Limited capacity suppliers may be less able to surge during military conflicts. Suppliers producing parts common to multiple precision munitions may be challenged in sorting shipment priorities among competing primes as well. The shipment prioritization default may end up being the loudest customer rather than a measured overall DoD precision munitions capability requirement.

Sole source suppliers have no compelling incentive to innovate, sustain on-time deliveries, or streamline production processes that could improve surge capability. However, prime munitions manufacturers have been working with the Services and the Defense Contract Management Agency since the September 11th attacks to evaluate major capacity and process issues. Identification and correction of single point failures is pivotal to protecting the integrity of precision munitions manufacturing. These examples suggest that the precision munitions market can benefit from both careful evaluation and long range planning. Evaluation and planning implies thoughtful utilization of supply chain management techniques and improved requirements identification methodology. Generally, industry consolidation in domestic munitions manufacturers has caused the industry to lag behind other commercial sectors in capitalizing on improved strategic supply chain practices. Consolidation created reduced capacity. However, capacity utilization would be less problematic if the DoD customer contracted for quantities consistent with steady production rates. DoD manifests unpredictable demand patterns. Moreover, the Services divert munitions funding regularly to fund platforms, leaving the munitions industry with production planning anomalies. In time of conflict, precision munitions orders increase dramatically. Unfortunately, the industry may be unable to respond. DoD must ensure at least low rate production lines and fund surge capacity.

Likewise, Congressional funding anomalies introduce perturbations into this market. While Congress appropriates supplemental funding to ensure stockpile buy-back after military conflicts, these appropriations may have little relationship with production capacity constraints. Congress and DoD should minimize the penchant for defining the precision munitions in terms of the latest conflict.

Despite these customer incongruities, munitions primes and their suppliers are moving towards the 21st century private sector trend of supply chain management. Supply chain practices normally result in both efficiency and effectiveness. "A supply chain comprises the flow of a company's products, the information about them, and the money which exchanges hands between the company and its suppliers and customers."[24] Prime munitions contractor interactions with their suppliers generally fall into three categories: strategic partnerships, vertical integration, and traditional competitive sourcing.

Strategic partnerships encompass establishing objectives, continuous process improvement, and shared information through various computer/web-enabling solutions. Partners are treated as though they are inside the company. Process integration through timely shared data, objectives and metrics underpins these relationships. Supply chain information technology also facilitates *virtual* integration, as some primes are pursuing Enterprise Resource Planning (ERP) software solutions to link with their suppliers.[25] Continuous improvement is facilitated through strategies such as Six Sigma, quality vendor certification, ISO 9000 standards, and Lean business practices. Strategic partnerships appear to work well when the principals follow a core competency focus and employ a combination of fixed and cost commitment curve contracting.

Vertical integration, on the other hand, offers the opportunity for full spectrum process control through ownership of significant or complete raw material and production processes. Vertical integration reduces vulnerability caused by limited suppliers by ensuring that a prime is not forced to compete for resources. However, the prime may

inadvertently increase overall costs and reduce efficiency, when required to manage multiple processes, including some not considered to be core competencies.

Where multiple sources and varied supplier relationships exist, competition appears to be the effective contracting arrangement. The prime is able to select a best value among vendors. Ordinarily, price and delivery considerations drive the competitive arrangements. Qualifying sources that meet munitions specifications is a challenge in this acquisition arrangement. The prime manufacturers in the precision munitions industry employ all these corporate strategy arrangements.

Second and third-tier suppliers identified additional supply chain concerns. Research and technology, for instance, is an expensive, risky investment especially for small companies. Exacerbating this problem, DoD tends to fund small business research external to the supply chain. DoD or the prime manufacturers ought to share the financial burden for research with existing suppliers. DoD has also created facilities for new competitive sources directly or through the provision of incentives to prime contractors. This practice seems to demoralize some vendors and appears antithetical to strategic partnership.

DoD must encourage best supply chain business practices in the precision munitions industry. Supplier relationships are important to the success of the industry. The continuum of supply chain strategies varies with the cultural maturity of corporate relationships. Domestic sourcing does not inherently guarantee uninterrupted component flows. Yet, overseas sourcing invokes a trade off. Strategic American alliances and the acquisition of quality parts versus political uncertainties add yet another complexity to the precision munitions market.

Munitions suppliers typify the complex relationships and increasing interdependencies among the industry, the military, and Congress. The precision munitions industry requires long-term sustainment; it cannot be resuscitated on the eve of a military conflict. The military services must undertake serious industrial preparedness planning for critical items and use flexible contracting approaches to ensure that limited industry capabilities thrive. Therefore, the Services must use the requirements, acquisition, and budget processes to better forecast and fund a rate of demand sufficient to maintain profitable supplier production lines.

Written by Ms. Frances Dwyer, Dept. of Navy; and Lt Col Dennis Daley, USAF.

ESSAY TWO: INFORMATION TECHNOLOGY APPLIED TO MUNITIONS

The US military has benefited immensely from the cross-fertilization of military and civilian innovations in the field of information technology. Yet this blend of information and communication capability has yet to achieve its full potential. Information technology (IT) embedded in weapons systems platforms, munitions, and C4ISR systems dramatically increases the combat capability of our forces. In particular, targeting accuracy has drastically improved during the last decade resulting in fewer munitions expended to achieve the desired effects that translates into fewer combat sorties, and ultimately, reduced exposure to hostile forces. Operation Iraqi Freedom provided a glimpse of how even a partially integrated C4ISR architecture can increase survivability, lethality, and combat capability. By continuing to leverage advances in information technology, US forces will realize higher combat effectiveness and efficiency.

Continued intra-service C4ISR and munitions integration affect many aspects of how the US and its allies will conduct future warfare. One major consideration will be the decision-making process due to time compression of the sensor-to-shooter loop. With a mature net-centric architecture, decisions are made that have the potential to be executed across all dimensions of battlefield operations. With the confidence of precision delivery and the destructive assurance afforded by the speed of execution comes the need to act decisively and with full confidence in the outcome of any engagement. Therefore precision engagement situational awareness, planning, execution, and assessment become skills required by all combatants and Combat Commanders staffs.

This new way of war will force further changes in tactics, techniques, and procedures that our forces employ as new capabilities are developed and fielded. *Pervasive and persistent precision engagement will eventually result in the need for doctrinal overhaul as services redefine roles and missions regarding how engagements are conducted.* At a minimum, service interoperability issues will be elevated.

The bottom line is that information technology is an enabler. It is a force multiplier. As the benefits of information technology continue to be leveraged, the probability of achieving a truly integrated C4ISR architecture increases. Accordingly, the vision of net-centric warfare will become a reality in our lifetime. It is up to us to embrace that concept and ensure our allies are able to conduct operations at our side.

Today, the U.S. sets the interoperability standards in precision munitions engagements among its allies and partners due to the advanced state of our integrated C4ISR architecture. Transfer of certain smart weapons technologies to select countries increases interoperability to some degree, but in practice is carefully scrutinized to protect our technological advantages. Despite our efforts, those countries that possess advanced weapons but are not capable or willing to integrate with the US's C4ISR architecture often find themselves relegated to supporting roles. With the move toward net-centric warfare, US reliance on precision-guided munitions will increase significantly. Those allies who want to contribute should be able to seamlessly connect into the US's "Plug and Play" C4ISR architecture due to the political risks associated with collateral damage sensitivity caused by targeting or delivery errors.

Although the US's move toward integrated C4ISR / munitions links make it increasingly difficult for allies and coalition partners who do not keep pace with US advancements to operate militarily as an equal, there will still be contributions our partners and allies can make. Even our traditional and industrially advanced allies such as Great Britain, Germany, and France find it hard to keep pace given the US move toward the rapid integration of C4ISR into the battle space. Not only does information impact the battle space, but also within the munitions industry itself.

In another vein, during our five months of analysis we looked at the munitions industry's employment of IT in their respective organizations. Our discussions with company leadership in a wide array of organizations revealed that all leaders were acutely aware of the benefits of employing IT-enabled processes in various aspects of their business. However, not all companies could afford to spend significant resources in the IT arena despite the seemingly direct relationship between profitability and investment in IT systems. Major innovators appear to rely heavily on IT while common production businesses seem to have little or no IT enabled systems; they still depend on human and mechanical processes instead.

Varying levels of IT employment exist and the applications of IT in one company versus another are extremely diverse. At the high end of IT application we observed the entire spectrum from communications to Computer Aided Design and Manufacturing. Conversely, at the low end we observed companies whose IT access was simply the telephone. Amazingly, we even observed a company whose chief engineer used a slide rule for calculations and personally shunned any application of "modern" technology. His processes were automated by another employee once he was satisfied his calculations were correct using the time-proven methods with which he was familiar. Despite this seemingly archaic method of performing calculations, this company is an innovator in the industry and makes high-quality niche products that the government has relied upon for years.

The munitions industry is composed of a variety of businesses that come from an array of industrial segments. Accordingly, it is not surprising that their business processes and models are extremely diverse, and their implementation of information technology appears to be tailored to support these processes in accordance with the dictates of their business and production requirements. Our observations have led us to conclude that each of the businesses has employed information technology to the optimum extent possible given known demand, production schedules, and profitability.

Written by LTC Clint Haynie, USA; and COL Thomas Boyle, USA.

ESSAY THREE: MUNITIONS OF THE FUTURE

Today, as DoD transforms the armed forces from a threat based and platform-centric force to a capabilities-based and net-centric force, one has to ask "What happens to the munitions for the future?" This question applies equally to ammunition used in the soldier's issued firearms, the sailor's missiles, and bombs of an airman. Over the last several decades the munitions industry product has transitioned from an attitude of mass ("more and bigger is better") to one of discrete precision ("fewer and better accuracy is better.")

Bridging the Gap. The industry continues to improve on the sensor technology by combining multiple sensors (GPS, laser, imagery) into a single guidance package for missiles and bombs with the continued aim of ensuring accuracy and reducing collateral damage. As the industry and the military move into the future arena of net-centric warfare, two-way data links between the munitions and the warfighter will allow updating or re-targeting of a weapon after launch, ensuring that the correct target is destroyed.

Advancements in Energetics. Precision guidance in munitions has reached a level of finite return. Present day PGMs have accuracy and precision parameters well within the lethality radius of the conventional warheads used. Further advancements in precision would provide little advantage; placing a 500-pound warhead within two centimeters vice two meters serves no purpose as both are within the blast and fragmentation kill radius. Therefore, technological advancements in the mode of lethality delivered are expected.

Thermobaric Explosives. U.S. development of thermobaric explosives became paramount before operations against the Taliban and al Qaeda in Afghanistan. The need for an improved kill mechanism to be used against personnel in enclosed areas such as caves, bunkers and revetments was realized during Operation Desert Storm, however,

research and development in this area had not been a priority within DoD. The former Soviet Union had previously developed thermobaric warheads because of lessons learned in the Afghanistan war during the 1980s. The U.S. failed to leverage the Soviet lessons learned and did not consider thermobaric advancements a priority until late in the 1990s. Concentrated efforts by both government and munitions industry resulted in the development of thermobaric warheads in various sizes for limited application. Thermobaric technology is not a cure all. The overpressure blast wave produced is effective against enclosed spaces but not particularly effective against targets in open areas.

Next Generation Explosives. The munitions industry has conducted research and development in next generation explosives. The industry gauges explosives in relative explosive power to TNT. For example, composition C4, the U.S. plastic explosive used extensively for years, has a TNT equivalency of 1.6, or about one and a half times as powerful. Technological advancements in this area have failed to make a significant increase in explosive power as compared to cost. A US manufacturer developed an explosive about ten years ago that has a TNT equivalency of approximately 1.8 but at a cost of 20 to 40 times that of conventional explosives used today. The gain in efficiency simply did not justify the increase in cost. During an interview with a government explosive expert they indicated past munitions Program Managers considered the warhead a cost saver while the guidance components were generally expensive with no room for performance compromise.

What's on the Horizon. Breakthrough technological advancements in explosive efficiency could provide the ability to deliver increased lethality in the same sized package or reduce the size of comparably lethal munitions. A revolutionary advancement would be the ability to place the destructive capability of a 2000-pound bunker-busting bomb in a package the size of a hand grenade. Government organizations are presently conducting research into the magnetic fields generated during an explosive event. This research indicates the possibilities of using magnetic energy generated during an explosive event to increase the speed of metal fragments to levels far exceeding velocities presently reached by detonation alone.

<u>High Energy: A Leap into the Future</u>. Though today's munitions represent technology leaps from just a few decades ago, the government generally considers the technology within energetics ("the boom in bombs") and propellants (the means to make missiles go) to be a mature one. The real leap into the future appears to lie in the realm of directed energy systems such as lasers and high-energy microwaves.

Laser Technology. Laser beam technology is the art of focusing light from a specific spectrum of the frequency into a beam of concentrated energy. Today, we apply this technology in art to etch or carve wood and in the medical world to correct eyesight. The laser beam weapons technology can be broken down into three generations of development. They are chemical lasers, solid-state lasers, and, within solid-state lasers, fiber-optic lasers.

Chemical Oxygen-Iodine Lasers (COIL) use liquid chemicals and electricity to generate a laser beam with suitable energy to perform as a weapon. Today, this laser exists as the air-borne laser (ABL) for ballistic missile defense. The ABL uses four laser beams to accomplish the weapon mission. Three of the beams involved provide the target identification, tracking and aiming functions for the main laser beam. The ABL

requires a significant amount of power and a large logistic footprint. It provides a limited number of "shots" on target before the chemical system requires a re-charge.

Solid-state technology does not rely on chemicals to generate the laser beam. This technology is on the verge of making an emergence as a demonstrator, but still has limited power output, not yet suitable as a weapon. The Air Force is working towards a 25 kilowatt system within the next 24 months, and hopes to step up to 100 kilowatts shortly thereafter.

Fiber Optic lasers work just as the name implies; pushing light energy through fiber-optic cable. The technology involves a different fiber cross-sectional shape than what the telecommunications industry uses. Again, the challenge appears to be power generation in the short term. One of the possible concepts of this system will be the arrangement of a collection of fibers into an array, similar to the radar array system of the AEGIS weapons system. The concept hopes to produce a phased array generating a beam, which can be steered.

High Energy Microwave. High energy or high power microwave represents another type of directed energy system. We, the public, are generally familiar with the household microwave ovens that use this energy to penetrate and cook food. Research is ongoing to develop a system with millions of watts in power, as compared to the 1,500-watt microwave oven. This directed energy becomes suitable as a weapon in two ways. As the world comes to rely more heavily on electronics to support weapons systems, the more susceptible these weapon systems become to the energy of directed microwaves. The second method involves the non-lethal application of high-power microwaves to the human skin. The application stimulates the body's pain sensors without physical damage. The result is an effective means of non-lethally turning away an aggressor.

Rail Gun. Another use of energy deals with the Navy's research and development into an electro-magnetic rail-gun. The theory here uses electro-magnetic power to push an armature linearly between two rails. The armature, in turn pushes a kinetic warhead (large metal bullet). Higher velocities, thus longer distances (range) are safety gained through the absence of gunpowder represent key reasons for pursuing this technology. Though briefly discussed, it appears high energy is the way of the future in munitions. Potentially, it may even do away with energetics and gunpowder or propellants, as we know them today.

Written by CDR Brett Reissener USN; Lt Col John Hunnell, USAF; and Mr. John Wiegand, Dept. of Transportation.

ESSAY FOUR: JOINT REQUIREMENTS PROCESS FOR PRECISION WEAPONS

Requirements are the foundation upon which a sound acquisition program is built. The requirements outline what a system should be capable of doing, who will be using the system, under what conditions the system will be used, and the number of systems needed. The first requisite for any system is an exact definition of the requirement. Without a valid, stable requirement it is impossible to formulate a plan with industry or maintain a viable production base. The vehicle designed to provide the blueprint for establishing the requirements for our military starts with the National Security Strategy that translates into a National Military Strategy. Together these documents are intended to produce conceptual unity for our nation's leaders. Unfortunately, history does not

support our munitions process as stable and is replete with instances where Combatant Commanders find themselves wanting for munitions. One reason for this disconnect is the inherent differences between the Title 10 responsibilities of the Service Chiefs and the Combatant Commanders' responsibilities. Without stable, well-researched requirements, the needs of the Combatant Commander become very difficult for the acquisition community to meet. This essay discusses the findings of the study of the requirements process as it currently stands in the munitions community.

GAO Report. According to an October 2002 GAO report, a fundamental problem not yet addressed is the DoD's munitions requirement process. Specifically, the GAO states there is not adequate linkage between the near-term munitions needs of the Combatant Commands and the purchases made by the military services derived from DoD's munitions requirements determination process. This schism results in the Combatant Commands and Services identifying different munitions needs and results in the Combatant Commanders reporting munitions shortages. GAO believes this disconnect occurs because the department's munitions requirements determination process does not fully consider the Combatant Commanders' preferences for munitions and weapon systems projected for use against targets identified in projected scenarios. There is a basic difference between the Combatant Commanders' near-term focus (generally two years) and the Services' longer-term planning horizon (generally six years). This is the core of the issue.

New Defense Planning Guidance Impact. Along with the requirement process itself, the new DPG requirement replacing the Two Major Regional Conflict scenario is actually more robust in its munitions requirements as it finally formalizes planning for contingency operations that were historically taken out of Operations and Maintenance (O&M) funding. In response to these findings and new strategy, the Joint Chief's of Staff are implementing a DoD Munitions Requirement Process designed to link future requirements based on current doctrine while mitigating the differences between long-term Service needs and near-term Combatant Commander issues.

Recommendation One: Stable, Predictable, Realistic Munitions Procurement Funding. The munitions industry, in partnership with the government must accurately forecast and fund economically sustainable munitions requirements to allow industry to adequately size the industrial base, modernize facilities and stabilize a historically erratic industry. Since 1985, DoD procurement funding has been cut by nearly 70% and research and development funding reduced by 25% over the last ten years. Additionally, munitions procurement has been largely limited to meeting training requirements and has not satisfied all the Service's demands. In 2000, during Congressional hearings, each Service Chief testified to poor readiness due to many factors including the lack of adequate munitions. Although our current ammunition stock appears sufficient, recent operations in Iraq expended this supply at a copious rate. The munitions industry, as a result of downsizing due to reduced requirements and profitability, is less capable to replenish the stocks in a short time period, potentially leaving other theaters of operation at risk. In order to maintain critical munitions capabilities, we must carefully target and encourage the use of multi-year contracts of suitable volume to allow companies to invest in appropriate infrastructure upgrades with the knowledge that program funding is guaranteed for more than a one or two year time span. Recognizing the reluctance of Congress to relinquish the budgetary control they possess requires DoD to ensure careful

and appropriate use of multi-year contracts. However, the end result of this carefully considered action would create a more stable supply of munitions to our troops.

Recommendation Two: Modeling Simulation Fidelity & Commonality. Another weakness discovered in the area of requirements is in modeling and simulation. The Services each use service specific models. As a result, the information derived from those models is significantly different, and there is little common ground for joint discussions. Rather than using a multitude of models, a more common model and set of methodologies used across the Services would serve the requirements modeling and simulation effort more effectively. This would certainly need to be tailorable to provide full functionality and fidelity, but all users would have a common understanding of the process and the foundation of the model as well as parameters and assumptions that are service unique. Until a common, acceptable modeling methodology is chosen, there will always be disagreements and contention between the services on the validity of the modeling upon which the requirements projections are made.

Recommendation Three: Improved Coordination, Communication, and Cooperation via IT The requirements arena is ripe for the benefits that information technology could bring. "Stubby pencils" or Excel spreadsheets seem to be the norm in tracking, coordinating, and consolidating requirements. This is very labor intensive, and prone to error. Communication between the various requirements organizations, when it happens at all, does not seem to be efficient. This is exacerbated by the stovepiped, service-centric approach. Information technology could be used to reduce the labor and error levels, as well as increase awareness and understanding across the Services. It would also provide a faster turnaround to changes, providing a flexible system that could be made readily available to all who require access, regardless of location. A great benefit of information technology to the munitions requirements process could be open communications. Information technology could help remove the barriers that keep information from flowing and keep organizations from working in cooperation – it could be the common thread that traverses (and thus opens up) the stovepipes.

Conclusion. Munitions requirements are still very service-centric. The underlying theme of these recommendations targets this competitive, almost adversarial approach. Until this cultural barrier is broached and munitions requirements are developed more cooperatively and jointly, it will be extremely difficult to manage the munitions requirements effectively, efficiently, and in the best interests of the DoD enterprise.

Written by Lt Col Thomas Arko, USAF; and Dr. Myra Gray, Dept. of Army.

ESSAY FIVE: ACQUISITION STRATEGIES FOR PRECISION WEAPONS

Acquisition reform has been around in one form or another since Robert McNamara's first attempt in the 1960s. In 1994, Secretary of Defense William Perry said, "*DoD has been able to develop and acquire the best weapons and support systems in the world. DoD and contractor personnel accomplished this feat not because of the acquisition system, but in spite of it. And they did so at a price…the nation can no longer afford to pay.*" [26] Today's acquisition reform initiatives are proving that we can get warfighters their tools better, faster, and cheaper. The munitions acquisition processes are in many ways a microcosm of the overall munitions industry's transition, where there is a wide disparity between conventional munitions and precision-guided munitions. There is a trend for the precision-guided munitions to embrace acquisition reform

initiatives, while conventional munitions remain entrenched in legacy processes. There are many aspects of acquisition reform that merit discussion, and this essay will use the Advanced Medium Range Air-to-Air Missile (AMRAAM) and JDAM programs to explore the new relationship between government and industry.

The AMRAAM program was established in the late 1970s with two competitive producers, Hughes and Raytheon. The original program planned for a combined Air Force and Navy procurement of 24,000 missiles over ten years. Raytheon and Hughes established their own production facilities and competed annually for the build-to-print production, with the Government controlling more than 370 individual specifications. By 1997, the dynamics of the program were significantly changing with the requirement dropping to 10,000 missiles over a 20-year period and Raytheon buying out Hughes. The Systems Program Office (SPO) saw this as an opportunity to change the acquisition strategy for the AMRAAM program with the intent to *shift more of our appropriated dollars to buying missiles as opposed to buying overhead*. Within a year and a half, they had reduced procurement costs by 30%, reinvested some of the savings into software modernization, and reduced the Government workforce from 325 to just over 100. *The estimated life cycle cost savings for the AMRAAM program are almost $600 million*. The program reached these goals by radically changing the relationship between the SPO and the contractor. The new relationship was a *team business structure and a partnership* between the SPO and Raytheon. In general, *the SPO moved from oversight to insight*. The SPO no longer tracked adherence to the 370 specs, but only ensured the missile met performance specifications.

The JDAM program also showcased a way to change the nature of the government-industry relationship. The government streamlined the normal acquisition processes for efficiency and clearly laid out selection criteria for competition. Average Unit Production Price and adherence to the Key Performance Parameters (KPPs) were the keys to selection. The program office did not require the usual cost data packages and the winning contractor retained control of the Technical Data Package (TDP). This allowed the contractors to modify the TDP as required for cost saving measures without interference from the Government - as long as they still met the KPPs. The overall effect was a *complete change in the relationship between the Government and the contractors to a much more commercial relationship*. As long as the product met the KPPs, the Government would let the contractor do as it pleased. The down-select process was also modified to include periodic feedback to the contractors that is atypical of the normal acquisition selection process. The JDAM down-select process used three report cards over an 18-month period. This process provided an opportunity for the contractors to receive feedback and modify their proposal as necessary to remain competitive.

AMRAAM and JDAM illustrate the changing relationship between the government and industry critical to an acquisition reform mindset. Of course there are many other areas changing such as JDAM's Multi-Year procurement contract that allowed the winning prime to comfortably invest in its infrastructure and establish efficiencies with their second and third-tier suppliers. The new relationship between government and industry coupled with other acquisition reform initiatives such as Cost As an Independent Variable, wooden round concepts, warranties, and Spiral Development have resulted in the 90% solution being fielded much more quickly with significantly reduced life-cycle costs. Results show that acquisition reform is not another

hollow initiative, but is producing real changes to the way the DoD acquires weapons. Moreover, acquisition reform applies to legacy systems (AMRAAM), new systems (JDAM), and complicated and technologically advanced systems (AMRAAM P3I/JASSM) just as much as it does to low cost and low technology systems (JDAM). A significant conclusion is that there is no single template that can be applied to a program to magically make it reap the rewards other acquisition reform programs have achieved. The real onus is on the program manager to analyze their programs and insert acquisition reform if it makes sense.

This highlights one of the key factors in achieving successful acquisition reform, the program manager and key acquisition individuals involved. Acquisition reform requires program managers with a wide breadth of experience; the confidence to try innovative approaches; and, a robust understanding of the cost and design tradeoffs and risk management process in order to structure suitable processes for identifying and mitigating significant risks early in the development process. As the munitions industry is transforming from older legacy ammunition and bombs to greater use of precision-guided munitions and tactical missiles integrated into network centric architectures to achieve overwhelming effects based mission capabilities; the development and selection of managers and leaders for future acquisition programs must also evolve to groom individuals capable of managing large, complex, highly interdependent programs with very diffuse and complicated organizational and technical interfaces focused on joint war fighting and mission capabilities vice a product or service specific orientation.

Written by Lt Col Terrence O'Shaughnessy, USAF; Mr. Jerry LaCamera, Dept. of Navy; and CDR Michael Eaton, USN.

CONCLUSION:

To ensure the continued viability of the munitions industry, DoD must understand their role in the process. By establishing a joint warfighting architecture, the resulting munitions requirements process could drive an effective and more efficient acquisition process. Incorporating continued acquisition reform initiatives would also allow flexibility to ensure each program was optimally managed and the health of the industry maintained while ensuring a common benchmark of continuing to deliver world-class weaponry.

Joint warfighting architecture could also objectively highlight issues such as deconflicting weapons of choice; forecasting accurate life cycle budgets to prevent reliance on supplemental funding; and ultimately lead to a much healthier munitions industry. The new joint warfighting architecture may also provide a clearer picture of the interrelationships among DoD, industry, and Congress. This would allow a basis for legislative reform as the DoD would be able to target the most appropriate use of multi-year contracting and potential environmental, import, and export laws most adversely affecting the unique and sensitive aspects of the industry. As DoD moves to capabilities-based planning, this approach would allow the industry to more appropriately flex to meet unanticipated demands, ensuring we bring the best, most appropriate, and most capable munitions and overall military capabilities to the theater.

[1] Melita: Budget: NP

[2] Supron: 5
[3] Porter: NP
[4] Daley: NP
[5] Supron: NP
[6] Bloomberg: NP
[7] Daley: NP
[8] US Census Bureau: NP
[9] Baumol: 252
[10] DCMA: NP
[11] Aldridge: 1
[12] Daley: NP
[13] DCMA: NP
[14] Chao: NP
[15] Transform IB: 13
[16] NSS: introduction
[17] COCOM was dissolved in 1994 and replaced by the establishment in 1996 of the Wassenaar Arrangement On Export Controls for Conventional Arms and Dual-Use Goods and Technologies.
[18] Title 22 United States Code (USC) 2751
[19] Title 22 Code of Federal Regulations (CFR) Parts 120-130
[20] Directorate of Defense Trade Controls: NP
[21] Dwyer, Transformational: NP
[22] Dwyer, Supply: NP
[23] Aldridge: 1.
[24] Kanakamedala: NP
[25] Munitions Industry Visits, February through April 2003
[26] Frank: 280

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