

Spring 2017 Industry Study

Final Report Weapons

The Future of the Weapons Industry: 2018 and Beyond



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Weapons 2017

ABSTRACT: The United States (US) Weapons Industry remains robust, with sufficient support from the private sector to underpin current U.S. National Security missions. Although we continue in an era of constrained budgets, demand for weapons will not diminish. The industrial base (private and public sectors) is able to balance maintaining basic infrastructure, providing direct support to ongoing conflicts, and developing competitive strategies to ensure the United States' technical and deployable primacy in the world. The competing demands amongst the Executive Branch, the Legislative Branch, and armed services add extra tension to budget constraints. Substantial efforts by both Congress and the defense establishment to reduce waste associated with defense acquisition do not focus enough on ensuring the health of the defense weapons industrial base. The USG should conduct an assessment on current Research, Development, Test and Evaluation (RDT&E) funding, focus strategies to improve collaboration between defense and industry laboratories, continue revisions of export controls and regulations to support greater opportunities to increase competition, and ensure improvement of the acquisition processes. Without a comprehensive assessment and focused improvement efforts, the United States' Defense Industrial Base can expect diminution of its capacity, innovation, and technological advantage to resource National Security missions.

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PLACES VISITED

Domestic:

Shooting, Hunting, Outdoor Trade (S.H.O.T.) Show, Las Vegas, Nevada
Army Research Lab, Aberdeen Proving Ground; Aberdeen, Maryland
Lehigh Defense; Quakertown, Pennsylvania
FNH America; Columbia, South Carolina
Geissele Automatics, North Wales, Pennsylvania
Holston Army Ammunition Plant, Kingsport, Tennessee
Radford Army Ammunition Plan; Radford, Virginia
Trijicon; Fredericksburg, Virginia
Raytheon Missile Systems; Tucson, Arizona
Orbital ATK Armaments Systems; Mesa, Arizona
Sturm, Ruger & Company, Inc.; Prescott, Arizona
Dillon Aero; Scottsdale, Arizona
Lake City Army Ammunition Plant; Independence, Missouri

International:

Bulgarian Ministry of Defense; Sofia, Bulgaria
Arcus; Layskovets, Bulgaria
Arsenal; Kazanluk, Bulgaria
VMZ; Sopot, Bulgaria
TEREM; Sofia, Bulgaria
G.S. Rakovski National Defense Academy, Sofia Bulgaria

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INTRODUCTION

The Weapons Industry and Markets are important to National Security Resourcing because the federal government relies on both domestic and global markets to supply the goods and services the Department of Defense (DoD) uses in performing national security missions. While some weapons needed for national security are directly available from commercial markets, others are not and the government must undertake extensive measures to create and maintain markets or in-house organizations capable of supplying goods and services unique to national security needs. The Department of Defense related weapons industry requires *security of information* and *security of the supply chain*. The Weapons Industry Seminar used the following methodologies to evaluate the status of the Weapons Industry:

Evaluated

- Structure, conduct, and performance of select sectors in the weapons industry
- Strengths, vulnerabilities, and capabilities of select industries (U.S. and global) to contribute to the nation's economic welfare and national security requirements
- How select U.S. and global firms and organizations interact with governments to influence laws, policies, and regulations
- Government-business relations in support of, and their effect on, the management of the DoD resource allocation process and the resulting ability of select industries (U.S. and global) to satisfy national security capability requirements
- How geostrategic context (to include a nation's history, geography, natural resources, cultural identity, governance, macro-economic policy, security interests) and the government-business environment shape the U.S. and other select countries' defense industrial bases (DIB), and the resulting approaches to integrating strategy and resources to satisfy national security capability requirements

Analyzed

- Political and economic interactions and trade-offs in developing trade, logistics, and acquisition policies and processes and the related impact on shaping, developing and regulating the capacity of industry to contribute to economic welfare and satisfy national security capability requirements

Developed

- Politically and resource-informed policy recommendations to improve U.S. national security requirements and economic interests

Domestic Studies

Lobbying. The Weapons Seminar studied the purpose and value of lobbying as a political and economic activity in support of the arms manufacturing industry. An examination of issues associated with global conventional and non-conventional arms proliferation and control and their impacts on U.S. national security revealed political, economic, and industry issues that have great implications for the Department of Defense and industry. The lobbyists help the U.S.

and global weapons industry firms and organizations interact with government to affect changes to laws, policies, and regulations as well as with respect to how companies solicit government business and produce goods and services for the government or at its behest. This includes the incentives for doing so.

Shooting, Hunting, Outdoor Trade (S.H.O.T.)¹ Show. The Weapons Seminar attended the SHOT show to gain broad based exposure to the size, marketing practices, and direction of the commercial industries related to small arms, ammunition, and optics. This field study also allowed the seminar to gain a better understanding of the methods and strategies companies use compete in a broad-based commercial market. Examples of this were:

- Methods firms use to compete
- Customer demographics
- General customer base
- Marketing strategies of groups/firms

DoD Lab Role. Department of Defense Lab's role in the research and development of ammunition and energetics is critical. Labs enjoy a special relationship in how they interact with industry, and how laboratory R&D advances the lethality of ammunition and energetics. An examination of current and future issues associated with ammunition and energetics development for the range of combat systems in the DoD, the relationship to the commercial market, and implications for non-defense applications influenced recommendations by this group. Nowhere is the role of DoD labs in maintaining the defense munitions industrial base as critical as it is as it is in the primary explosives sector. As a subset of the larger weapons industry R&D laboratories addresses: 1) the research and development of ammunition and energetics in the defense munitions industrial base, and 2) the role DoD Labs in maintaining the R&D sector of the defense munitions industrial base.

Weapons Industry Site Visits. Visiting commercial small arms ammunition manufacturers such as Lehigh Defense not only highlighted innovative manufacturing methods to produce new types of ammunition, but also provided the seminar an understanding of how new technologies can change R&D along with production methods. Focus on the innovative techniques small-scale manufacturers utilize as compared to the large scale, mass production capability and manufactured ammunition processes found at the Lake City Army Ammunition Plant furthered the seminar's assessments. Other weapons industry site visits included Trijicon, FNH (USA), Raytheon Missile Systems, Orbital ATK, Sturm, Ruger & Co. Inc., Geissele, Dillon Aero, and BAE.

Energetics. Understanding the production of energetics in the USG Defense Industrial Base (DIB) involved a look at energetics production and development for the range of combat systems in the DoD, the relationship to the commercial market, and implications for non-defense applications. The role of government and industry in maintaining the energetics industrial base cannot be over emphasized. Government Owned Contractor Operated (GOCO) facilities highlight a better understanding of; 1) the production of energetics in the DIB and, 2) the role of government and contractors in maintaining the DIB. Site visits to Holston Army Ammunition Plant, Radford Army Ammunition Plant, and Lake City Ammunition Plant identified tensions in

the role/mission of DoD prime contractors in development and production, as well as their relationship to requirements development in the Military Services.

Nuclear Enterprise. The US nuclear weapons enterprise faces challenges in the areas of nuclear weapons stockpile stewardship, infrastructure revitalization, and workforce sustainment. Additionally, the relationship between DoD and the Department of Energy in the management and maintenance of the Nuclear Weapons Enterprise/Nuclear Security Enterprise must be clearly understood. The US nuclear weapons enterprise (Industrial Base) is a self-contained subset of the broader weapons defense industrial base. However, while the nuclear weapons enterprise faces many of the same issues facing the DIB, the nuclear enterprise also faces its own unique challenges. Addressing these challenges will likely become a near-term focus: “President Donald Trump has made modernizing the nation’s nuclear arsenal a top priority.”² Prime contractors such as Lockheed Martin, Northrop Grumman, Boeing, Raytheon, and General Dynamics should begin to posture their supply chains on key components of systems and prepare to respond to request for proposals for both missile defense as well as nuclear delivery systems. Because the U.S. defense industrial base has not developed new warheads or delivery systems since 1989, a majority of the nuclear weapons production sites will likely need to be modernized and the national security laboratories will need to recruit new talent.

International Studies

Bulgaria Weapons Industry Site Visits. Visiting comparable private and state-owned weapons manufacturers such as Terem, Vazovski Mashinostroitelni Zavodi Co., Arsenal, and Arcus, not only highlighted differences in private and state-owned firms but also gave us an understanding of how industries based on refurbishing Soviet facilities could be profitable. R&D and production methods were less innovative compared to companies in the United States. While we were allowed to visit some parts of sites, we were unable to observe mass production capability and manufacturing processes. The seminar was able to meet with the Ministry of Defense and visit with G.S. Rakovski National Defense Academy.

Bulgaria’s current industry for small arms production relates to its complicated past, a well-positioned present, and, without modernization, a potentially dire future. Bulgaria seemed to be positioned well for two reasons: 1) Soviet-era industrialization with the entire country essentially run as a state-owned enterprise (SOE) now positioned as a dependable supplier for Western powers to provide arms for non-traditional partners. While Bulgaria currently benefits from a world that has a high demand for RPGs & anti-tank rounds, a threat of an emerging competition of suppliers coming online with either a modernization edge or at better cost margins (for example, cheaper labor) might present a problem. 2) This market of Soviet-era weapons currently contains minimal competition but one can see this changing in the coming years.

VMZ highlighted their efforts to modernize their production with the extensive purchase of CNC machines, which confirmed recent press reporting that “VMZ recently expanded its premises and has gone on a massive recruitment drive for the first time in three decades”³ With the exception of Arsenal, most firms were maintaining, but not improving, their facilities. Reinforcing the current status quo appeared the theme but does little to set-up future prospects or

channel innovation properly. The employment structure of Bulgarian firms appears feudalistic in nature, with one being hired for a particular job with little hope of climbing up the corporate ladder.

DEFINITION OF WEAPONS INDUSTRY

The Weapons Industry is a global industry responsible for the manufacturing and sales of weapons and military technology. It typically includes the commercial industry involved in the R&D, engineering, production and servicing of military material, equipment, and facilities. Using this construct and Black's Law Dictionary that defines a weapon as "an instrument used in fighting; an instrument of offensive or defensive combat." The term is chiefly used, in law, in the statutes prohibiting the carrying of "concealed" or "deadly" weapons. The definition of a deadly weapon is: "Such weapons or instruments as are made and designed for offensive or defensive purposes or for the destruction of life or the infliction of injury" (Com. v. Branham, S Bush (IC.v.) 387). "A deadly weapon is one likely to produce death or great bodily harm" (People v. Fuqua, 58 Cal. 2d 245). "A deadly weapon is one which the manner used is capable of producing death, or of inflicting great bodily injury, or seriously wounding" (McReynolds v. State, 4 Tex. App. 327). However, the UN's Convention on prohibitions or restrictions on the use of certain conventional weapons was deemed to be excessively injurious. Alternatively, to have indiscriminate effects was aimed at prohibiting those conventional weapons that could violate the common protocols and Geneva Conventions on unnecessary suffering and indiscriminate attack.

For the purpose of this paper, a weapon is any instrument that can cause a person to be "seized." The definition of "seized" is defined as the loss of freedom of movement. Therefore, the aforementioned definition would include things that you would commonly refer to as lethal and nonlethal. This definition also covers items that can cause death or injury, including firearms, explosives, chemicals, and nuclear material. We can also include the supplemental medical definition of "A man-made or modified artifice designed to kill or maim."

The following sectors are included and part of this industry survey:

- Small Arms: Includes handguns, rifles, shotguns, grenades and grenade launchers, and crew-served weapons
- Less-than-lethal Weapons: Includes systems designed to produce an incapacitating effect such as directed energy (including, but not limited to, focused microwaves, lasers, or high-voltage electricity) or non-lethal projectiles
- Munitions: Includes ballistic projectiles for weapons ranging from small arms to kinetic-effect missiles
- Energetics and Propellants: Includes all types of gunpowder; solid and liquid chemical propellants for systems such as rockets, missiles, and torpedoes along with explosives
- Nuclear Weapons: Includes all weapons, which generate an explosive effect because of a fission reaction between radioactive isotopes
- Sensors and Optics: While not independently considered weapons, this equipment supports the employment or enhances the accuracy of weapons. For the purposes of this paper, sensors and optics were included in this study because of information related to export controls on this sector.

The following items were not considered as part of the study of the weapons industry:

- Aircraft, ships, submarines, tanks, or other mobile manned and unmanned platforms.
Each of these typically serves as a platform for various weapon systems
- Cyber: The weapons industry was bounded with a focus on kinetic or physical effects. Although offensive cyber capabilities exist which may result in a kinetic effect, these capabilities were not evaluated in this study. In addition, The Eisenhower School has industry studies that dive deeply into the platforms such as aircraft, shipbuilding, and land systems.

HEALTH OF THE WEAPONS INDUSTRY

The United States weapons companies, as a whole, constitute a very diverse and profitable industry. The sector includes producers of many small and large weapons who must continue to reinvest in their capacity and innovation while differentiating themselves from other manufacturers. In 2016, industry revenue was expected to reach over \$16 billion with over \$1.3 billion in profit and an annual growth of 1% between 2016-2021. Of the \$16 billion accrued in revenue, approximately 46.3% was specifically small arms manufacturing. Though the majority of the revenue was generated by companies such as Freedom Group Inc., General Dynamics Corp., Orbital ATK Inc., and Vista Outdoor Operations LLC, there are many smaller companies such as Dixie Gun Works, Diamond Back Firearms, and DRD Tactical that have overcome the “medium” barriers to entry into the industry, turned a profit, and have a following by a niche group of people who may want a gun that can be differentiated from other handguns or rifles. However, external events (e.g., tragedies involving firearms) and the political landscape can cause the gun market to fluctuate in either revenue or direction in which some political elites attempt to control the gun manufacturing industry.

Small Arms Sector

Potential Adversaries. Potential adversaries such as Russia, Iran, North Korea, China, and Violent Extremist Organizations (VEOs) identified in the 2015 National Military Strategy (NMS) will undoubtedly seek to mitigate current advantages of the United States.⁴ While the United States is pursuing a third-offset strategy to develop long-term capabilities for the future, small arms engagements will remain an inherent part of armed conflict.⁵ The United States must focus resources to develop small arms precision, accuracy, and ammunition effects to maintain an advantage for 2035 and beyond. To bring the NMS to life and develop small arms applications consistent with the third offset strategy, the United States Army Maneuver Center of Excellence (MCOE) is pursuing a comprehensive effort to develop a squad overmatch capability.⁶

Small Arms Industry and the Defense Industrial Base. The United States relies on privatized companies instead of state-sponsored manufacturers to produce small arms. Fabrique Nationale (FN) Herstal, Colt, Berretta, BAE Systems, and General Dynamics have all been major contributors while the industry has experienced aggressive revenue growth over the past five years. Despite slower growth projected for the next five years, the relatively large number of

companies and the size of the global market will continue to sustain an adequate capacity to support the necessary strategic acquisition initiatives to maintain a small arms advantage.⁷

Small Arms Innovation. The Department of Defense (DoD) must continue to spark innovation and increase competition by increasing Research, Development, Test, and Evaluation (RDT&E) funding while utilizing the Defense Acquisition System (DAS) process. Developing and fielding a reliable small arms integrated fire control system to increase small arms precision is the most significant priority.⁸ Another priority is increasing target acquisition in low light environments, and Program Executive Office (PEO) Soldier is pursuing a Family of Weapons Sights Individual (FWS-I) program to integrate a thermal maneuver sensor and next-generation Enhanced Night Vision Goggle III (ENVG III). The next step will be integrating the precision of future integrated fire control systems while reducing the cumulative size and weight of the systems so they can be utilized in tandem. Adding advanced triggers while also experimenting with the barrel materials and the barrel forging process can achieve some evolutionary improvements in accuracy as well. Investing in technology development to increase ammunition capabilities will be critical in developing ammunition which will then be more effective for the warfighter.

Recommendations. DoD must continue to prioritize the MCOE driven strategy to develop a squad overmatch capability to improve squad lethality and specifically small arms precision and ammunition effects. DoD should also increase programmed and budgeted funding for developing and maintaining future small arms integrated fire control systems, advanced optics, and improved ammunition effects. Finally, DoD must continue to partner with industry to maintain a healthy small arms industrial base. Providing incentives such as commercial use authorizations, clear production forecasts, and effective communication of strategic requirements will demonstrate government commitment to the industry health.

Summary. DoD must deliberately focus resources to develop small arms precision and ammunition effects to maintain an advantage for 2035 and beyond. While the global small arms market is driven by both defense and commercial applications, DoD must continue to partner with industry to maintain a healthy small arms industrial base. By maintaining a healthy industrial base, the United States will have a strong foundation to develop future small arms integrated fire control systems, advanced optics, and improved ammunition effects to achieve squad overmatch and win future conflicts on increasingly complex battlefields.

Precision Guided Munition Sector

Aircraft delivered precision-guided munitions (PGMs) are the foundation of the second offset. Today, that technological advantage is increasingly at risk as PGMs have proliferated around the planet. To maintain an edge in PGM technology in 2035, the U.S. must deal with three primary issues. First, the PGM industry suffers from a lack of new programs, caused in part by a focus on platforms over weapons. Second, the PGM industry has significant risk within its supply chain, which could cause a disruption in production, which would obviously have severe negative impacts to national security. Finally, the PGM industry is artificially constrained by policy and programming decisions.

PGMs and the Defense Industrial Base. The firms competing in the PGM market include almost all of the major defense companies (“BAE Systems,” “Boeing,” “Lockheed-Martin,” “Northrop-Grumman,” and “Raytheon” all compete) as well as medium-sized firms and smaller defense start-ups. One advantage to this relatively slim sector of the weapons industry is that PGMs account for only a small portion of the overall defense portfolios for the large defense firms. In the case of Boeing, defense business only consumes 27% of their total revenue stream. In this regard, big defense contractors have sufficient financial resources to research, develop, and sustain PGM programs without inducing a significant amount of risk into their business.

Domestic weapons development obviously follows the demand signal from DoD, and there are three primary trends in current PGM programs. Although these trends are specific to the US DoD market, they are broadly reflected across international PGM programs as both US and foreign manufacturers are trying to develop weapons to solve similar tactical problems. Weapons with extended range and stealth are in increasing demand as air defense assets such as surface-to-air missiles (SAMs) also increase their reach. Multi-mode seekers are another trend that seeks to provide all-weather and moving target capability to weapons, while concurrently decreasing the requirement to carry multiple types of weapons with different seeker options. Finally, the UAV revolution, combined with the operational demand for low collateral damage (CD) weapons, has driven the development of small PGMs.

Recommendations. Several policies and processes within the executive and legislative branches impose costs and challenges on the defense industrial base. Inconsistent/rapidly slashed funding by Congress and DoD and laborious export restrictions hamper the defense industrial base. DoD can shore up the PGM industrial base by taking a holistic approach to PGM procurement, focusing not just on operational requirements but industrial base considerations as well. First, DoD must look to develop new start PGMs. DoD must also work with industry to ensure supply chains for PGM programs are secure. ITAR reform remains a critical effort. Finally, DoD planners need to consider the impact to the industrial base when building the defense program. “Sprint and Stop” programming needs to be replaced by an annual minimum acquisition level that keeps production at a sustainable level and allows industry to constrain prices by providing stability to the industry.

Summary. DoD needs to enact policies to ensure the industrial base is not only healthy, but that the U.S. does not lose the technological edge in PGMs. As aerial defenses become more complex, the U.S. must have the ability to strike any target on earth and achieve the desired weapons effect on the first pass. Mitigating fragility in this important sector must address the dearth in new starts, challenges with funding and programming, and the challenges with existing export controls. Meeting these challenges will assure the U.S. remains dominant on the battlefield in 2035 and beyond.

Counter UAS/UAV Sector

Unmanned aircraft systems (UAS), also known as UAVs (unmanned aerial vehicles) have become ubiquitous due to their capability and affordability. Today, small, inexpensive UAS have become the poor man’s ISR platform and potential miniaturized cruise missile. The danger is not far-fetched; UAS are not tomorrow’s near-peer “5th gen” threat, they are already employed by ISIS terrorists⁹ and rogue nations like North Korea. The proliferation of threat-

capable small UAS is an immediate and growing threat from terrorists and nation-state adversaries. A clear vision and urgent collaborative effort—leveraging the industrial base, interagency, and multinational partners—should seek affordable solutions (COTS when available) to rapidly field, evolve, and sustain Counter-small Unmanned Aircraft Systems (C-sUAS)¹⁰ weapons with reliable “hard kill” capability.

Defense Industrial Base. For mid-term procurement, seeking out large system integrators within the industrial base can augment non-traditional producer innovations. Procurement and fielding of C-sUAS at the tactical level appears to be lagging, but fortunately, shortfalls and requirements have been recognized and innovative solutions are being posed and implemented.

Innovation. Like cyber concerns that narrowly preceded UAS, we know the threat is evolving, and likely to increase in both volume and complexity. Also like cybersecurity initiatives, the urgency to react must create both “thrust” and “vector” in methodical strategies for fielding options. Realizing that DoD and governmental procurement tends to be time consuming, JEONS/JUONS must be leveraged. However, immediate initiatives should include small unit training for UAS engagement. Many military installations have available ranges that would be suitable for training C-sUAS “Designated Marksmen.” Firearms simulators can be upgraded with UAS threat profiles to teach service members on how to engage flying moving targets and make ranging and beaten zone assessments. Investing in guided projectiles (e.g., 25mm) holds promise for C-sUAS in defeating UAS while diminishing collateral risks. Pairing weapons with optics, UAS, and remotely operated weapon stations or Counter-Rocket, Artillery, Mortar (C-RAM) systems for area and point defense also bears consideration.

Recommendation. Instruction on legalities and Rule of Engagement (ROE)s for C-sUAS should be conducted along with procurement for specialized C-sUAS prototype weapons. Leveraging all available options to “build the plane while flying it” is necessary, as empirical data will shape how C-sUAS weapons and tactics will evolve. It is unwise to “go it alone” on technologies. The proliferation of tech is a necessary trade-off, given the value in using COTS to keep costs down, especially since methods will not likely involve advanced technologies¹¹. Acquisition efforts can be modest in expense but still have great effect if whole-of-government, joint, and coalition/foreign partnerships in an evolving unity of effort.

Summary. Evolution and iteration of C-sUAS technologies can make use of COTS solutions and integrate the similar needs and collaborative synergies of intergovernmental, foreign, and industry partners. Gaps do exist in clear rules of engagement, threat detection, and in weapon capability seams. Like VBIED threats before it, the urgency for fielding C-sUAS capability is being catalyzed by the destructive actions of our adversaries. The DoD seems to be adapting and building momentum in fielding this needed capability; to avoid significant loss of life or mission degradation, focus must be maintained.

Directed Energy Weapons Sector

Potential Adversaries. Anti-access / area denial threats of actors such as China, Iran, Russia and the low technology threats of non-state actors have made our current technology too

expensive and unpredictable to employ efficiently. Directed Energy Weapons (DEW) are finally becoming more viable as the technology to support them comes to fruition. However, as the technology behind DEWs matures there are still key issues that need to be addressed to make them available and prevalent as weapons systems in our modern military.

DEW Industry and the Defense Industrial Base. Since 1960, the DoD has invested more than \$6B in DEW R&D. In the 1980s, research and development (R&D) expenditures were at their height, with defensive missile systems reaching \$1B per year and, at the time, expected investment in space laser systems increased to \$500M in 1988. Some others say, “US spending on laser-weapons research peaked at U\$2.4 billion in 1989 during the Reagan administration for Strategic Defense Initiative (SDI), but declined in the following decade.” Soon thereafter, the United States key threat disappeared from the world stage. The worldwide market for directed-energy weapons will rise to \$24.3 billion over the next five years at a combined annual growth rate of nearly 24 percent. As of now, the research and development of DEWs has been solely in the propriety of governments and their research labs. The capabilities of current DEW systems are ones that are being executed by conventional munitions. This causes tension amongst the manufacturers of traditional propellants and explosives and gives pause to the policy makers on the value of research and development of these “new” systems. They are seen by some as redundant and in some cases as substitute products that will make the current weapons systems obsolete. Currently, the US is vested in the development and production of propulsion and energetic explosives in the defense industrial base with the facilities of Holsten and Radford Army Ammunition Plants. These facilities provide jobs to key constituents that would not be easy to sacrifice for the development of DEWs.

DEW Innovation. DEWs are a group of multiple breakthrough technologies that include:
 laser weapons that provide for speed
 significant engagements at tactically
 resulting in savings realized by minimizing the use of defensive missiles and projectiles;
 electromagnetic launch of projectiles that will significantly increase firing ranges imposing
 greater cost to adversaries of ballistic and air defense missile engagements; enhance the land
 attack mission; and fielding of high power radio frequency systems for non
 -kinetic electronic
 attack and active denial technology allowing for non
 -lethal determination
 beyond small arms fire ranges.

Summary. Overall, the capabilities that DEWs provide are ones that can greatly supplement the current arsenal of the US, but there are several obstacles to overcome. As DEW technology progresses, most of these issues will begin to diminish. The Third Offset should include DEW technology and propel the US forward in remaining on the cutting edge of technology, far ahead of our allies and adversaries as it has been since the end of World War II.

The current design of DEWs can act as a complement to conventional munitions and reinforce our existing systems, especially in taking account of the limits of current magazine sizes in the case of ballistic missile defense. Initially, the US should take a position where DEWs are perceived as a complementary technology that will supplement current conventional weapons until there comes a time when the political environment is more accepting of newer technology.

Non-Lethal Weapons Sector

The use of non-lethal weapons has grown within the Department of Defense since the late 1990's. The investment in non-lethal weapons was launched in recognition of the asymmetric capabilities required to enable U.S. forces to work in urban areas, control crowds, and deny access through counter-personnel and counter-material tasks. Challenges to using non-lethal weapons persist within the Department of Defense due to a lack of policy directing or guiding the use of non-lethal weapons. Additionally, a majority of the non-lethal weapons used in the military today are commercial 'off-the-shelf' products designed for law enforcement and repurposed for military use. For future weapons capabilities such as non-lethal directed energy weapons there remain several unknowns about the long-term effects on humans, which raises ethical concerns. While the Department of Defense Joint Non-Lethal Weapons Program (JNLWP) has created a strategic vision through 2025, the current non-lethal requirements are over 8 years old and based on requirements that are over 20 years old. Thus, the Department of Defense should revisit the non-lethal weapons requirements of today and consider the future needs in alignment with the third offset strategy. Mandatory non-lethal weapons training for all service members should be required. Today's global challenges could influence the market growth in the NLW industry outside of North America as the U.S. partners with our allies to support missions where the limited use of force is paramount to mission success. The defense industry should focus on the growth area of non-lethal directed energy weapons to support extending the range of non-lethal weapons. This would increase the versatility and use of NLWs across the military.

Non-Lethal Weapons Industry and Defense Industrial Base. Non-lethal weapons (NLW), also known as less-lethal weapons, have gained increased interest from the global market. NLW are primarily employed by law enforcement and military customers. A majority of the weapons currently employed globally include explosives, gasses and sprays, projectiles, conducted energy weapons (TASER), and weapons that distribute light and sound (optical and acoustic). Directed energy weapons represent the future growth area for both lethal and non-lethal weapons. Key vendors identified across several different market sites include AARDVARK Tactical, BAE Systems, General Dynamics, Kratos Defense & Security Solutions, Lamperd Less Lethal, Condor Non-Lethal Technologies, NonLethal Technologies, Raytheon, Safariland, LRAD Corporation, Pepperball Technologies, and TASER International (which recently changed its name to Axon in April 2017). While many of these companies are well-recognized defense industry companies, others have a long history in working with federal, state, and local law enforcement.

Non-Lethal Weapons Innovation. When reviewing the list of NLW currently employed within the services the majority of the NLW available are for counter-personnel tasks with an emphasis on force protection, checkpoints, crowd control, and security as primary mission areas. While the current NLW are kinetic in nature, the developing and future NLW are primarily non-kinetic. As the DoD develops and researches future NLW, directed energy will play a key role in meeting the 2025 strategic drivers for the JNLWP: megacities, engagement and special operations, emphasis on non-kinetic FIRES, dispersed/non-linear battlefields, and unmanned systems. Policy, military-specific NLW, and ethical considerations in regards to human effects

will still hinder any advancements in this segment of the weapons industry unless the DoD prioritizes the NLW research & development to create NLW with extended ranges.

Recommendations. Industry should remain poised to develop non-lethal technological capabilities that use directed energy, conducted energy, as well as optical and acoustic technology. There are several companies that are able to provide the NLW of today, but future NLW capabilities will be found in the labs, universities, or perhaps someone's garage (like TASER). As NLW advance technologically, the DoD should continue to invest in basic and applied research to further our technological superiority. The DoD needs to revisit the NLW initial capabilities document and validate the requirements. Additionally, while DoD develops new NLW and associated systems, it still needs to determine the proper way to use them. One recommendation is the JNLWP non-lethal weapon training become mandatory for all service members rather than being an elective as it is today.

Summary. With the growing instability across the globe, the unprecedented movement of refugees since World War II and the increased reliance on military forces to quell violence with minimal use of force, the NLW market is poised to see significant growth in demand in the near future. The DoD JNLWP is preparing for the future of NLW in its Strategic Plan for 2025, which projects the future of NLW just two years shy of the 30-year anniversary for the program. Non-lethal weapons capabilities are needed with extended ranges, which would have more versatility for our military. There exists an opportunity within the DoD to work with industry and academia to mold the future of the NLW market in-line with our National values and interests.

Energetics (Primary Explosives) Sector

The United States Defense Industrial Base (DIB) relies heavily on producing primary explosive materials defined here as; chemical explosives, secondary explosives, propellants, and military explosives. Currently, one of the most important chemicals necessary for an explosion function is wetted nitrocellulose. The first useful explosive stronger than black powder was nitroglycerin (developed in 1847) which was highly unstable, and quickly replaced by nitrocellulose and TNT (in 1863). Although more powerful explosives such as C-4 and PETN exist, the reaction to metal and the highly flammable nature typically make them unsuitable in military arms. After more than 50 years of sustained operations, the facilities producing nitrocellulose are slowly being retrofitted (meaning fitted with technologies and systems not available during their construction). Although weapons have become more sophisticated, the chemicals, energetics, and explosives still necessary to produce weapons have changed relatively little.

Primary Explosives DIB. The market for primary military explosives is a unique oligopoly. Like many defense-oriented markets, the products delivered in this market are highly regulated by performance specifications by the Department of Defense. There are high barriers to entry in the market due to GOCO arrangements, safety measures, and policy requirements. The DoD has decided primary explosives utilized in DoD weapons will not utilize foreign suppliers, thus the need for GOCO facilities. Currently, there are approximately 11 facilities that manufacture weapons-related ammunition, rockets, and propellants.

Primary explosive materials are now produced in one GOCO facility and are transported to prime contractors such as; ATK, General Dynamics, BAE Systems, NAVCSEA, NAMMO Talley, American Ordinance, Esterline, SMP, AEROJET, EAB&D, L3, Raytheon, and Lockheed Martin. The contracts then produce such items such as the 120mm round, Hellfire, TOW, .50-Cal, 7.62, 5.56mm, 25 mm, 105 mm, Hydra, MACS, and 40 mm.

Primary explosives are also used in the commercial markets specifically in the area of drilling and demolitions. All firms in the primary explosive markets are required to maintain a technical workforce and lines to produce for increased demands should a “surge” be required in the list of weapons mentioned earlier.

Innovation, Risks, and Trade-offs. Although firms compete in a market, the DIB, and specifically the explosives market fall more into the Porter’s Diamond model, which adds the impact that a nation has on a particular, market especially in the area of a Competitive Advantage as a nation. In the DIB, the government can influence a market in a “pro-active” way. The firm strategy, structure, and rivalry naturally exist evidenced by the innovation from black powder to today’s advanced less sensitive explosives. The area that our government currently greatly influences and impacts competitive advantage is in the area of factor conditions specifically the area of specialized factors. The U.S. DIB ensures the continuance of skilled labor, capital, and infrastructure that is able to surge. The GOCO facilities have had to increase production to meet the demands of the global war on terrorism for example. The ability to do so means a heavy, sustained investment to keep the lines able to operate.

Commercial Explosives Innovation. Commercial use of primary explosives comes in the form of commercial ammunition but also in the area of demolition, drilling & blasting and of course the logistics to ensure the security of the supply chain.

Trade-offs and risks. Investing resources and industrial base capacity to maintain the needed supply of primary explosives for the DIB will undoubtedly have tradeoffs and risks. The first tradeoff is that research and development capacity applied first to safety and the environment will potentially affect other technology development priorities for more efficacy. The second tradeoff (and risk) is accepting that if our sole provider for wetted nitrocellulose were incapacitated, the DoD would be willing to depend on foreign sources of supply for critical materials as some companies in Bulgaria do. If the assumption is that we will maintain these specialized GOCO facilities, then we must find a way to provide alternative sites not just for manufactured threats but threats from natural disasters. Risks to explosive development are also perceived to come from current, stringent environmental protection agency standards that may make new facilities impossible without new technologies or regulations. New state of the art facilities would have to be achieved to provide explosives that would meet all requirements of efficacy, safety, and environment. The U.S. government has a mission of demilling chemical weapons that could be used as a framework to learn from. For example, Blue Grass Army Depot is a facility that neutralizes chemicals followed by supercritical water oxidation breaking down toxic chemical agents into water and salts. Approximately 70% of the water used gets recycled back into the process. The metal from the projectiles is heat-treated and recycled as metal scrap. This is accomplished in a manner that is environmentally sound from a regulatory perspective. The drawbacks are that the process requires large amounts of energy, water, and hazardous

chemicals to operate. This is however, an improvement from the American public's perspective of the traditional incineration method. If the U.S. could do this with a chemical weapons demilitarization facility, it should be able to apply some of the same innovations to making explosives in a state-of-the-art facility that is safer and environmentally responsible. Finally, the risk of continuing to develop safer and easier ways to produce primary explosives may encourage or hasten proliferation of advanced explosives and will undoubtedly lead to increased risk to military-grade weapons to develop enemies.

Recommendations. Given the conclusion that the United States must invest resources and industrial base capacity to maintain a healthy primary explosives advantage for 2035, there are three resource-informed policy recommendations that should be implemented. First, the Department of Defense must continue to prioritize the technology of primary explosives and develop alternative sites to maintain open lines should a natural disaster or deliberate attack shut down the current one of the kind GOCO facilities. The capability to improvement on lethality, precision, and reliability of primary explosions must not be driven by its location or the environmental/safety regulations. Permitting safety and/or environmental factors drive the innovation will come at a tradeoff of some resources that could benefit other priorities, but there is little doubt that explosives will be critical in the fight to win conflicts. Second, the Department of Defense should increase programmed and budgeted RDT&E and O&M future for developing and maintaining future primary explosives closely with commercial explosives. The specific priorities for the Army in the FY 2017 budget amendment to continue investment of \$7.9 billion in emerging technologies and development to solve future capability gaps do not prioritize the primary explosive facilities and only work to clean up facilities instead of true modernization. Third, the Department of Defense must continue to collaborate with industry to maintain a healthy primary explosives industrial base. Providing incentives such as commercial use authorizations, clear production forecasts, and effective communication of strategic requirements will demonstrate government commitment to the industry health. Implementing these three resource-informed policies will provide more lethal weapons systems capable of winning conflicts in the future.

Summary. The United States Defense Industrial Base's primary explosives market relies on a small number of one-of-a-kind plants to provide the means to produce every piece of ammunition, artillery, missiles, and projectile in its inventory. Currently, the most important chemical necessary for the primary purpose of an explosion function is wetted nitrocellulose that was first discovered in 1863. A visit to the facility would reveal World War II era bunkers and buildings with trees literally growing out of them. After more than 50 years of sustained operations, the facilities are slowly being retrofitted; however, while weapons have become more sophisticated, the chemicals, energetics explosives still necessary to produce weapons have changed relatively little.

Resources must be allocated to ensure a single event does not eliminate the government's ability to produce primary explosives through 2035. The primary explosive capacity must be duplicated in other locations and facilities must continue to improve overall facility production of its basic constituent materials that go into virtually every small-, medium- and large-caliber projectile, and rocket made by the U.S. ammunition base. Every Soldier, Sailor, Marine, and Airman depends on one Government Owned Contractor Operated (GOCO) facilities that

produce the chemicals and explosives necessary to fill all ammunitions and explosives in our inventory.

GOVERNMENT GOALS AND ROLES

Building U.S. Domestic Capability to Provide Foreign Designed Weapons to our Strategic Partners

Since the end of the Gulf War, our Special Operations Forces (SOF) have seen a substantial rise in the number of unconventional warfare (UW) conflicts and missions. That trend will continue for the foreseeable future due to the world's instability and volatility. Because of the enormous cost of putting American "boots on the ground" – we recognize that security cooperation with partners and allies is a critical component to our securing peace, stability, and the pursuit of our National interests. We have demonstrated that our "by, with, and through" missions with our surrogates are a key effort to exercising economy of force.

The USCENTCOM AOR is an "incredibly dynamic, volatile, and tumultuous" operating environment. It "presents a complex convergence of compounding multifaceted security challenges." Because of this and into the immediate future, we will be engaged in "continuous crisis action. Budget constraints and a growing national debt will significantly cut into our discretionary funding packages in the out years and presents as our top national security concerns. Meanwhile, instability in the region and operations in the "grey zone" will increase and intensify. The U.S. will grow more dependent on our surrogates to fight for peace and stability in various regions around the globe while maintaining an extremely high operational tempo (OPTEMPO) of our own. We need to demonstrate our commitment to maintaining high quality and trusting partnerships. It is the key to ensuring and enhancing security cooperation with our partners during a time when we cannot afford to be everywhere.

The most important aspect of demonstrating our commitment is our "mil to mil" cooperation, our foreign military funding (FMF) and foreign military sales (FMS). The success of these relationships and achievement of our strategic objectives is highly dependent on our abilities to rapidly fund and equip our partners with high-quality munitions and weapons so they may achieve operational success. We must have a system in place that can rapidly equip these forces with weapons and ammunition so they may be effective and able to achieve the required success on the battlefield that meets our political ends.

In addition, we should supply our allies with equipment that they are intimately familiar with in order to reduce our training requirement and our own "boots on the ground." Typically, these are Soviet era style weapons, not U.S. style or branded weaponry. To supply our partners with foreign designed weapons accomplishes three things; 1) It reduces the "train the trainer" requirement for U.S. troops because many of these fighters grew up with AK's in their hands, 2) Provides greater access to nonstandard/non-NATO weapons, ammunition, repair parts, and their interchangeability in the global market and, 3) A reduction in the "signature" of our participation in "grey zone" conflicts during our support of proxies.

This paper argues the USG needs to focus this effort by introducing a "whole of government" approach, establishing a clear and coherent "by, with and through" strategy,

acknowledging the number and scope of these missions and how the missions will intensify in the long term. We must drastically reduce the acquisition timeline for international arms and ammunition sales of foreign designed weapons through State Department/and DoD cooperation and unity of effort. We must concurrently stand up our domestic capability in an industrial effort to remove our reliance on the eastern European companies – particularly when they have proven susceptible to foreign influence. Ultimately, we need to consolidate our requirements and maintain a stockpile of critical pieces of nonstandard equipment and ammunition – ready for issue and prepare U.S. and surrogate for forces for flexibility, responsivity, and continuous crisis action.

We will look at some of the challenges associated with meeting the demands for non-standard weapons and ammunition without getting into the sensitivity of types and quantities that are required and are still outstanding. In a classified setting, the data associated coupled with levels of foreign interference by our adversaries and allies would support this recommendation for standing up a U.S. domestic capability to produce high-quality foreign weapons and parts.

To get there will require a policy that acknowledges and clearly communicates the “by, with, and through” efforts will extend beyond the current C-ISIL campaign to affiliate organizations and “start-up” organizations that share the same radical ideologies. Tactically, ISIS will soon be defeated, but the ideology and threat remain while the next generation of ISIS or “ISIS 2.0” prepares to fill the void of its predecessor. Furthermore, policy makers need to see that the demand for weapons and equipment do extend beyond just that of offensive operations for our surrogates. Building Partner Capacity (BPC) is critical to our abilities to achieve our objectives of not only in defeating ISIS type groups but also in securing peace and providing stability and security in regions around the globe. From the operational challenge, we need to orchestrate all this from the operational level and illuminate the linkages between U.S. policy and appropriations to the U.S. industrial base. It is incumbent on operators with a ‘heavy lean’ from military logisticians to illustrate this line of effort and expand the aperture of policy makers so they may communicate to U.S. companies that we are committed to this type of business for the long haul.

Recommendations and Summary. The “Gray Zone” of military conflict - just short of conventional conflict – is primarily comprised of unconventional activities and warfare which include cyber warfare, propaganda, and support to “proxies.” In today's reality this is how the U.S. intends to achieve success on the battlefield. The U.S. should never lose sight of the fact that it will be involved in gray zone wars which will endure for generations to come.

There is a balance of will and necessity to commit U.S. forces unless an existential threat exists. The volatility and instability of our world require us to aggressively pursue national interests through military means, but at the least cost to U.S. blood and treasure. An ‘equip and enable’ strategy is likely how we will pursue our ends of building "strong and supportive partnerships with allies and partners, VEOs degraded, and influence eroded, and lasting and increased regional stability and security." We have to posture our partner forces and ourselves logically or it will degrade the decision space of our civilian and military leaders.

The process begins and ends with our operators and logisticians on the battlefield – partnered with those that are executing the missions, risking life and limb in pursuit of U.S. national interests. At the operational level, it is the only place where requirements can translate into policies. It is the communication of operational impact that shapes policy, and we need to do a better job of that. The DoD must consolidate our requirements across all combatant commands. We are engaged in small proxy wars in each of them, with each drawing their separate and competing requirements. With the help of the Joint Staff, the U.S. Army and heavy lean from their logisticians – we need achieve a common understanding as to what the total requirement is.

As a USG policy issue, the new administration needs to make the determination whether we will continue President Obama's "by, with, and through" and "equip and enable" policies. Couple that with the operational demand signal created by the USCOCOMs and make it known to Congress that we intend to produce and distribute foreign designed weapons to our partnered forces and why. Congress should establish a set budget for foreign designed weapons and ammunition and establish a single Global 1209 program and get 'Industry's' attention. In addition, if Congress were to put the 1209 appropriations into a single pot, it will provide USCOCOM commanders greater flexibility to shift priorities as required and fulfill requirements as needed. As that money is appropriated, DoD needs to establish the Defense Security Cooperation Agency (DSCA) as the executive agent to execute contracts, exercise ACSA agreements, and create stockpiles of nonstandard/foreign designed (including FSB) weapons and ammunition. The USG would attack this from two angles and work them in simultaneously. Execute a whole of government approach in dealing with international procurement, transportation, and delivery from on U.S. entities while developing a domestic capability to reduce dependence on other countries. Have the USG invest taxpayers dollars into U.S. companies that can provide quality assurance and help the USG enhance its relationships and security cooperation. Lastly, engage with industry partners, provide them with the technical data to get what it is we need and when we need it.

The Changing Priorities for Weapons Interoperability

Merriam-Webster defines "interoperability" as the "ability of a system (as a weapons system) to work with or use the parts or equipment of another system." Interoperability can also mean the ability of different military forces to plan, deploy, communicate, compliment, and fight effectively together: "defense acquisition policy mandates that interoperability shall apply within and among U.S. Forces and U.S. coalition partners." In addition, both the U.S. Departments of State and Commerce include interoperability in their management of official weapons trade. While the concept of interoperability can have wide applications, this paper utilizes the focus of enhancing interoperability of modern weapons systems and how the pursuit of that goal needs to be reconsidered and updated to address new technology opportunities as well as strategic goals for such systems. Pursuing greater technology interoperability requires addressing heightened risks from cyber-attacks and other integrity failures. Despite these risks, the United States, with its dominant influence on defense procurement, is well positioned to direct the evolution of interoperability in the coming years.

Key approaches to modernizing interoperability including greater use of modular components for proven performance across systems, faster acceptance of COTS inputs, and

developing systems that can be customized in the field, including the use of field-programmable gate arrays (FPGA). Such efforts can lead to:

- More rapid modernization of systems
- Flatter supply chains
- Greater flexibility for theater and field commanders
- Scalable technology sharing with allies and partners
- New partnerships with leading technology companies

The Department of Defense, along with traditional and new commercial partners, needs to modernize weapons development to create the necessary innovation for 21st-century weapons interoperability. That requires updating how weapons are acquired, including relooking at how requirements are established, expanding the possibility for COTS inputs, and ensuring that industry has an organic stake in achieving such innovation. Modular systems need to be tested and modified more quickly. Feedback from the field needs to be incorporated more efficiently. Finally, creating the new systems must happen together with innovations to protect their integrity. The outcome of such reform is to guarantee the U.S., and when appropriate, her allies, maintain the most flexible, effective weapons.

Government Controls & Regulations in the Weapons Industry

The weapons industry is at a crossroads. The uncertainty of the defense spending cycle, as major incidents have curtailed, prompts Congress to again look for a peace dividend and a reduction in military spending. The climate seems ripe for a weapons industry downturn. It however does not appear to be the case, if the new administration gets its way, along with the continued reformation of export control for weapons continues in its trajectory. These efforts and additional funding to the industry will provide the industrial base the opportunity to modernize across operational sectors and increase its ability to compete globally. This was evident during the AY 17 seminars travel to the 2017 Shooting Hunting and Outdoor Trade Show (SHOT) in Las Vegas, January 17-20, 2017. While industry representatives we consulted with were honest in their discussions about the current fiscal environment affecting the industry and the prospect it would decline, there was also an underlying enthusiasm born out of the inauguration of a new administration taking office. A “business man” in the white house is believed to be a good thing for all business, and notably the Defense Industrial Base (DIB). This fervor did not end on the first outing of our seminar’s visits; it was also palpable as we visited the diverse weapons industry representatives, each with a growing anticipation for what this new administration would mean for the industry. It did not take long for the administration’s preliminary 2018 budget proposal blueprint to cement the likelihood of an increase in defense spending by approximately \$54 billion. This is in addition to the \$600 + Billion, which is allocated from the discretionary portion of the federal budget and includes Overseas Contingency Operations (OCO) funds. What this preliminary budget actually translates to within the weapons industry and specifically the DIB is yet to be determined, but the industry professionals this seminar has encountered from both private companies and government facilities are beginning to realize the hope for progress that began at SHOT. The weapons industry just may be on the ascendancy, as long as the role of government influence and controls stay on the fringes of economic opportunities. From a business perspective, the preliminary budget will require cuts to multiple

government departments, which in turn will be integral for the DIB and weapons industry to improve its financial position.

Summary. While industry associations continue to call for additional export control removal, or that the government refrains from interfering in U.S. firms' ability to compete with environmental requirements, the record reflects that the U.S. is the world's leader in the export of weapons. The Stockholm Peace Research Institute (SIPRI) annual report of international trade of conventional weapons note the five largest exporters begins with the U.S., followed by Russia, China, Germany, and France and reflects that developing countries are the largest importers. These metrics are not an anomaly, but actually prove U.S. products remain reliable for any warfighter who purchase weapon systems from U.S. firms. The following recommendations are in line with current reforms to eventually add firearms and ammunition to the commerce control list (CCL) and will also keep the industry competitive; 1) Limit the controls on fewer and the more critical or sensitive items on the USML, 2) Adapt multilateral cooperative export controls with allies, 3) Improve transparency in the licensing system to help small businesses, 4) Improve resources and outreach to small and medium business exporters, and 5) Increase the dollar amount for notification to Congress for arms sales. As revealed this semester, weapons are sold as systems and sustainment packages, which far exceed the current \$1 million notification threshold to Congress.

While it is evident, the Weapons industry has controls in place for both small arms and energetics; most are only now investing in equipment upgrades, engaged in lean manufacturing, and enhanced safety requirements in an effort to improve production performance. It is however in the reliability/lethality of each product and their respective mitigation of environmental impact that will keep U.S. products as the primary exporter of weapon systems and life cycle sustainment packages regardless of any regulations imposed. The industry has already made the change across all operational segments including the seminar teams visits with companies who have on staff "teams" of export, import and environmental experts dedicated to assist navigation of the many regulations in place and to defend their products reliability and performance for the warfighter and seem in tune to safeguard the environment in the communities in which they reside. While the industry may have shrunk to a few large producers, it will continue progressing.

President Eisenhower warned that the military industrial complex has become an important contributor to international political and economic relations and the growth of the U.S. position in the world and remains integral to U.S. national security. While there are unpleasant incidents that have surfaced including price gouging, and a questioning of character of the military industry and its sometimes ruthless race for profit, prompting controls to be initiated, the U.S. does not take its role in weapons production lightly. World events as in October 2000, when then UN Secretary General Kofi Annan drafted a letter announcing that the annual death toll from arms, regularly exceeds the carnage of Hiroshima and Nagasaki. The US has shown efforts to address world arms concerns, promoting regional security to make the world safer, and which contributed to some of the regulatory requirements, which exist today. In addition, while these efforts have mitigated illicit arms trades where terrorists or organized crime are present, there still exists some areas where there may be a competitive disadvantage to US businesses. The key for U.S. firms is the follow up of export reform while continuing to produce reliable products

which will give the U.S. firms an advantage as trusted products. As the pendulum swings, back in favor of business in general, the new administration will likely continue export reform initiatives; curtail regulations and government controls, which will provide the setting for weapons industry growth.

WEAPONS INDUSTRY 2018 AND BEYOND

The USG weapons industry will likely remain in the same position with the same leading contractors and companies in 2018 and beyond. Smaller contractors will work to provide more niche items such as technical services or a refined product but will have to consolidate in some aspects to compete. The danger in this prediction is the lack of competition in the market that will result in *less depth* and innovation. This will push the weapons industry to chase technological advances being pioneered in the commercial sectors as evidenced in the area of electronics. Achieving affordable programs by controlling life cycle costs and improving competition should in theory help, but these efforts must include improving incentives for productivity and research and development. Building exportability early in the arms development process will also help with competition and innovation with global partners.

CONCLUSION

The weapons manufacturing industry is a \$400 billion industry with six of the nine largest weapons companies residing in the United States. Study of domestic and international companies show that foreign weapons industries not only imitate the United States but is also aimed at the United States as a potential customer. Recognizing the vast array of organizations, processes, stakeholders, and material that comprises the weapons industry. It is impossible to address the full range of issues, even with the robust list of recommendations contained in this report. Improving the health of the industry will take dedicated efforts across both the public and private sectors. The key will be to cultivate innovation while keeping a healthy balance of capacity to surge and profit for the companies.

Like many nations working to address their own national security, the U.S. is not alone in addressing perceived challenges. Study of other nations in the weapons industry uncovered similar challenges; limited budgets, competing requirements, lack of technical expertise, and aging infrastructure. There will be more pressure to work on weapons systems with other nations to help reduce cost, which will inherently come with friction points specifically in the area of intellectual property rights sharing and manufacturing rights. Ideally, the United States and its allies should maximize efficiency and effectiveness of each nation's military-industrial complex in order to maintain global stability and support our shared national security goals.

The Weapons Industry Seminar makes the recommendations contained in this report as an attempt to look at current processes, private investments, save taxpayer dollars, and increase capabilities for our warfighters. This requires a competitive strategy to ensure the United States primacy in position as a technologically and global military power.

RECOMMENDATIONS

The following list of recommendations summarizes the body of this paper. They are listed according to which entity within the Iron Triangle has the responsibility to implement each of them. An asterisk (*) indicates shared responsibility among more than one entity. More details about each can be found by referring to the appropriate sections above.

Department of Defense

- Seek industry input early on requirements prior to the Analysis of Alternatives
- Continue to use supply chain security as one of the source selection criteria
- Streamline testing requirements where solutions are COTS or shared across Services
- Level out multi-year procurement to maintain capacity and reduce costs *
- Centralize control of the defense research enterprise
- Ensure GOCO facility capabilities are not in one single location/resource
- Modernize and consolidate laboratory facilities
- Capitalize on existing military and civilian (dual-use) technologies
- Establish a set of common explosive fills for all Services
- Stabilize munitions procurement *
- Standardize testing requirements for energetics formula changes
- Create and maintain an overseas contingency stockpile *
- Limit supplies of non-OEM parts *
- Improve existing nuclear weapons enterprise infrastructure *
- Re-establish government tritium production *
- Develop new uses for nuclear material *

Congress

- Repeal the \$1 million Congressional Notification threshold for arms exports
- Consolidate responsibility for all defense and national security-related items under the

Department of Commerce

- Provide incentives for items imported via ISO 28001 accredited companies *
- Incentivize industry to invest in the repatriation of critical capabilities *
- Repeal Title 10 U.S.C. § 2466 to provide increased flexibility in depot maintenance
- Re-establish REE capabilities within the U.S. *
- Stabilize multi-year procurement funding *
- Improve existing nuclear weapons enterprise infrastructure *
- Re-establish government tritium production *
- Fund development of new uses for nuclear material *

Industry

- Invest as required to obtain ISO 28001 accreditation in supply chain security
- Invest in the repatriation of critical capabilities *
- Exploit existing civilian technologies to fill military requirements *
- Invest in and partner on REE capabilities in Allies nations *
- Clear, traceable labeling of repair parts to facilitate OEM specification verification

LIST OF ACRONYMS

AoA	Analysis of Alternatives
AOR	Area of Responsibility
ATT	Arms Trade Treaty
CAD	Cartridge Actuated Device
COCOM	Combatant Command
COI	Community of Interest
COTS	Commercial Off-the-Shelf
DAS	Defense Acquisition System
DOC	Department of Commerce
DoD	Department of Defense
ECR	Export Control Reform
ExCom	Executive Committee
FAR	Federal Acquisition Regulations
FFRDC	Federally Funded Research and Development Center
GOCO	Government-Owned, Contractor-Operated
HAAP	Holston Army Ammunition Plant
IMX	Insensitive Munitions Explosives
IRAD	Independent Research and Development
ISO	International Organization for Standardization
ITAR	International Traffic in Arms Regulations
JCIDS	Joint Capabilities Integration and Development System
JIMTP	Joint Inensitive Munitions Technology Program
JROC	Joint Requirements Oversight Council
LANL	Los Alamos National Laboratory
MHS	Modular Handgun System
MYP	Multi-Year Procurement
NNSA	National Nuclear Security Administration
NPT	Non-Proliferation Treaty
OCO	Overseas Contingency Operations
OEM	Original Equipment Manufacturer
OSD	Office of the Secretary of Defense
PAD	Propellant Actuated Device
PGM	Precision Guided Munition
POM	Program Objective Memorandum
R&D	Research and Development
RDT&E	Research, Development, Testing and Evaluation
REE	Rare Earth Elements
S&T	Science and Technology
SECDEF	Secretary of Defense
SMPB	Strategic Materials Protection Board
SRS	Savannah River Site
TPBARs	Tritium-Producing Burnable Absorber Rods
TPP	Trans-Pacific Partnership
TVA	Tennessee Valley Authority
USML	United States Munitions List

End Notes

¹ The SHOT (Shooting, Hunting, Outdoor Trade) Show is an annual tradeshow for the shooting, hunting, and firearms industry. It is the biggest event of this type in the world together with IWA & Outdoor Classics ("IWA Nuremberg"), also taking place annually. "SHOT," besides being a general reference to shooting, is an acronym for "Shooting, Hunting, and Outdoor Trade" (show).

² Daniels, Jeff. "Why a \$1 trillion endeavor to modernize the US nuclear arsenal could get more bipartisan support." CNBC. March 08, 2017. Accessed April 12, 2017. <http://www.cnbc.com/2017/03/07/why-modernizing-us-nuclear-arsenal-may-find-more-bipartisan-support.html>

³ Guns, not roses: Conflicts fire up Bulgaria arms trade – Europe," Hurriyet Daily News, June 15, 2016, accessed 6 May 2017, <http://www.hurriyedailynews.com/guns-not-roses-conflicts-fire-up-bulgaria-arms-trade-.aspx?pageID=238&nID=100541&NewsCatID=351>

⁴ Kathleen J. McInnis. "The 2015 National Military Strategy: Background and Questions for Congress." Congressional Research Service: Report (July 29, 2015), 1-2. International Security & Counter Terrorism Reference Center, EBSCOhost (accessed March 30, 2017).

⁵ Timothy Walton. "Securing the Third Offset Strategy." JFQ: Joint Force Quarterly no. 82 (2016 3rd Quarter 2016), 6. Military & Government Collection, EBSCOhost (accessed March 26, 2017).

⁶ "Squad Needs 'Overmatch' Capability." States News Service, 2011, 1. Biography in Context, EBSCOhost (accessed March 21, 2017).

⁷ IBIS World. "Guns & Ammunition Manufacturing in the US." (Aug, 2016), 24. WWW.IBISWORLD.COM, EBSCOhost (accessed April 11, 2017).

⁸ "PM Soldier Weapons Developing First Integrated Fire Control for Small Arms Weapons." PM Soldier Weapons, January 2017, 1. <https://www.army.mil/article/180370> (accessed March 27, 2017).

⁹ Joby Warrick, Use of 'Weaponized' Drones by ISIS Spurs Terrorism Fears The Washington Post, 2017).

¹⁰ "C-sUAS" is an acronym in use by the USAF, defined as C-UAS (Counter-Unmanned Aircraft (or Aerial) Systems) with the addition of the small "s" to delineate both the smaller, less capable targets (commercial drones) as well as the smaller weapon systems intended to defeat them. This is from USAF force protection leadership comments from discussions with the author.

¹¹Of note, countering Group 3 and 4 UAS are a different story regarding long-range detection, jamming, and kinetic intercepts that may include directed energy or hypersonic projectiles, which would be overkill for sUAS.