The Army Science Board

Five Priorities for the United States Army in the First Half of the 21st Century

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This summary is a product of the Army Science Board (ASB).
The ASB is a Federal Advisory Committee established to provide independent advice to the Secretary of the Army. Statements, opinions, conclusions and endorsements in this summary do not necessarily represent the official position of the Department of the Army (DA).

Dedication

This summary of the Army Science Board's (ASB) activities is dedicated to Dr. Joseph V. Braddock, who has served as an uncompensated Chair, member, and volunteer consultant of the ASB for over 34 years.

Dr. Braddock received his B.S. in Physics at St. Peter's College, N.J. in 1951, and his M.S. and Ph.D. in Physics from Fordham University, N.Y. in 1952 and 1958, respectively. He served as an instructor in Physics at Fordham University and as an Assistant Professor in Physics at Iona College, N.Y. In 1959, with Drs. Dunn and McDonald, he founded BDM, a technology-based professional services firm.

The skills Dr. Braddock acquired and honed from his time in the commercial sector made him a unique asset to the Army and the Department of Defense. He began his service with the ASB on July 20, 1982. Since then, he's devoted countless hours to helping the Army to solve some of the most technologically complex problems it's faced. Over his many years of service, Dr. Braddock has personally chaired or co-chaired 9 ASB studies, participated as a study team member in 39 more, and contributed as a Red Team member for more than 40 others. In 2002 Dr. Braddock was selected to lead the ASB as Chair, which he did with distinction until 2004. His efforts have proven influential for Army senior leaders, and the far-reaching impact of his work continues throughout the Army today.

In addition to the ASB, Dr. Braddock's service includes contributions to the Defense Science Board, the National Security Agency Scientific Advisory Board, the Defense Nuclear Advisory Group, the Defense Special Weapons Agency Advisory Group, and Sandia National Laboratories. His volunteer work extends beyond the Army and the Department of Defense to institutions throughout society at the local and national levels.

Dr. Braddock continues to serve the ASB as a senior fellow and consultant, mentoring and advising the Board's Executive Committee, study chairs, members and consultants. His efforts develop the capacity of the Board and its members, ensuring the Board continues to fulfill its mission of providing timely and relevant advice to senior Army leadership.

In his honor, the ASB presents the Braddock Award annually to members who exemplify Dr. Braddock's extraordinary and selfless service to the ASB.

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Foreword

The Army Science Board (ASB), organized under the Federal Advisory Committee Act (FACA) in 1977, provides the Army with independent advice and recommendations on matters relating to the Army's scientific, technological, manufacturing, acquisition, logistics and business management functions, as well as other matters the Secretary of the Army deems important to the Department of the Army.

ASB members and consultants are eminent authorities in the disciplines of science, technology, engineering, math, social science, business and governance. The Board also draws upon the expertise of senior retired military officers from all branches of service. All are dedicated experts who volunteer their time to provide independent assessments to Army civilian and military leadership.

For forty years, the ASB has assisted the Army with addressing some of its most difficult scientific and technical issues. The following summary of ASB activities highlight six areas of study over the last decade that will have consequence for the future Army:

1. **Introduction: The Future Force** – The ASB developed innovative, disruptive concepts based upon the projection that the Army will soon face more lethal forces than the terrorist movements that have emerged in the Middle East.

2. **Information Systems –** The commercial sector continues to create innovative information systems critical to the success of the Army.

3. **Robotics and Autonomy** – The land force will increase performance and survivability with reduced manpower by applying this emerging technology.

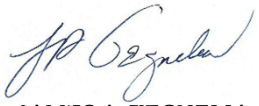
4. **Innovation in the Army** – The Army doesn't foster innovation among the professionals in its Science and Technology and acquisition communities.

5. **The Soldier and Small Teams** – New technology is becoming available to greatly increase the effectiveness of the individual Soldier.

6. **Efficiencies** – Advancing technology opens opportunities to reduce costs and demands on Army resources.

While conducting its studies over the past decade, the ASB has factored into its analyses the fiscal realities of ongoing budget constraints. The ASB didn't recommend innovative ideas without understanding and acknowledging the major tradeoffs required with existing programs.

For more detailed explanations of the topics and the official findings and recommendations of the Board, the relevant studies are listed at the end of each section.



JAMES A. TEGNELIA
Chair

Introduction: The Future Force

Looking to 2030 and Beyond

Michael Heinz & Jeffrey Isaacson, Ph.D.

The Army faces evolving global conditions and influences, such as the pervasive nature of advanced technology and information, that will alter the future character of warfare. The coming changes present both challenges and opportunities for the Army to shape, deter and win future conflicts. If the Army is to maintain an edge over adversaries across the full spectrum of conflict, it needs to transform itself to respond to and exploit these changes.

The ASB believes the "big ideas" that drove previous Army transformations (such as the "Big 5" from the AirLand Battle concept, and Force Digitization), have yet to emerge for the coming century, in part because the threats that serve as catalysts for revolutionary ideas and concepts have yet to clearly develop. However, extrapolating current conditions, with emphasis on the accelerated development of various technologies, it's possible to postulate near-peer threats employing Hybrid Warfare in areas that include dense population centers, such as megacities (population >10 million).

The Army needs to address these threats by developing concepts through the close cooperation of Training and Doctrine Command (TRADOC) as the operations architect; the Assistant Secretary of the Army/Acquisition, Logistics and Technology (ASA(ALT)) as the technical architect; and Army Materiel Command (AMC) as the systems architect. Emergent concepts then need to be explored by means of a campaign of learning, employing war-gaming, simulation and warfighting experiments.

The ASB has identified three areas where the Army will need to develop capabilities to address emerging threats, which in turn will require the Army to harness the next "big ideas" that will secure its future force overmatch against potential adversaries.

Getting There and Staying There

During the 20th century, America's wars were fought on foreign soil, and by the turn of the century, the nation could boast of an ability to project power, anywhere in the world, in a matter of days, if not hours. That power, however, could not sustain the combat capability required for decisive operations against well-defended adversaries employing heavy armor and mechanization.

Sustained combat operations require the Army to deploy with a large logistics tail to keep the warfighters supplied. The sheer size of Army deployments hampers the speed with which its units become an operationally viable ground force in the combat zone. There are, for example, limited options for deploying armored Brigade Combat Teams (BCT) to meet and defeat the massed armor effects of near-peer threats, and each of those options take weeks to deploy.

Several approaches can be taken to make the Army more of an expeditionary force. For example, using Big data applications and the Internet of Things (IoT), the Army could automate its deployment planning process to prioritize the time-phasing of mission-critical units while deferring less critical (or unneeded) sub-units until later stages of build-up. The updated technology should tie into commercial air- and sea-lift providers to leverage, in close to real time, the improvements in the capacity and efficiency of their vehicles. The Army should also leverage technology to lighten its load, such as developing the ASB concept for a 25-ton class robotic, unmanned ground vehicle (UGV) with the deployability of a Stryker that could provide a Stryker BCT with the capability to engage enemy armor.

Once deployed, the Army and Joint Forces may have to fight their way into the point of debarkation against heavily-armed adversaries attempting to thwart U.S. movements. The Army's ability to gain access to a combat zone unscathed has become less assured, as Joint Forces conducting theater access and entry operations face an increasing proliferation of advanced anti-access/area denial (A2/AD) threats. The ASB recommends the Army counter those threats in

part by promoting a Joint capability that delivers an unpredictable, initial entry of tailored forces via multiple incursion points. These forces would secure lodgment for massed follow-on forces. To enable this, the Army would need to explore new technologies and associated concepts of operations (CONOPs), and tactics, techniques, and procedures (TTPs), to strengthen resiliency. That is, the Army will have to enable Soldiers or small tactical units to operate more independently, without needing to be tightly connected to logistics/supply lines. Part of that process should include the integration of kinetic, cyber and electronic warfare (EW) capabilities at the small unit/tactical level to fully enable the digital means of exploiting an adversary's hardware and software.

Finally, once the Army is established in the combat zone, it faces challenges associated with sustaining an expeditionary force, from the increasing lethality of enemy weapons to the complexities of maintaining robust lines of logistical support. The Army's response to these trends should focus on means for reducing the amount of supplies needed to support forward-deployed forces. For example, the Army should foster initiatives that improve the survivability of Soldiers in combat outposts and patrol bases, such as the use of rapidly erectable barriers to establish protective perimeters. It also needs to explore the use of more efficient generators and generator/solar/battery hybrid power systems to improve power consumption.

Shifting Overmatch

For the first time in a generation, the Army faces the reemergence of legitimate threats from near peer states, as well as persistent threats from non-state actors and terrorist organizations. Deterring and addressing these threats simultaneously will require difficult decisions about balancing resources. The ASB believes the Army needs to shift focus toward the actions of potential adversary nations that are beginning to develop capabilities which will challenge U.S. dominance on the battlefield. For example:

- Integrated Air Defense Systems (IADS) – U.S. forces' long-standing ability to win air superiority over contested airspace is being challenged by the proliferation of capable counter-air threats that place aviation assets at high risk. As Joint strike capabilities evolve to counter emerging threats in enemy air defense, the Army must ensure its combat aviation operations aren't inhibited. Close air support and deep-shaping missions directly enable ground force maneuvers.

- Indirect Fires (IDF) – the massed, long range capabilities of potential adversaries hamper the Army's freedom of movement on the battlefield. In some cases, a nation's failure to adhere to certain treaties gives it advantages in range, and as a result, second- and third-order effects are brought to bear by IDF. U.S. Army fires run the risk of being outranged and outgunned (in numbers at each echelon) and becoming less lethal by a factor of 5 or more for comparable throw weights.

- Massed Armor – other nations can mass their forces, including armored assets, far more quickly than the U.S. can respond in kind. U.S. air transport assets currently struggle to satisfy requirements for both the expeditionary and operational maneuver of dispersed, mechanized forces. Thus, in some cases, an adversary's "heavy" brigades can present a *fait accompli* in terms of securing terrain before the Army can deploy its armored and mechanized vehicles.

In developing concepts to address these challenges, the ASB has examined a spectrum of manned-unmanned teaming (MUM-T) approaches that would enhance the lethality and survivability of the Army's lighter, more deployable BCT forces (i.e., Infantry and Stryker BCTs). One approach, the ASB concept for a 25-ton class UGV, would give the Army a new capability to engage enemy armor with the lethality of an Abrams, the survivability of a Bradley, and the deployability and maneuverability of a Stryker. Another approach would see the Army develop an unmanned air system (UAS) in which a small, low-cost, loitering UAS platform would have a modular capability to switch between intelligence, surveillance and reconnaissance (ISR), signals intelligence, EW, spoofing, and/or kinetic attack payloads. The operational concept for the UAS would be to open an air corridor within the mobile tactical components of an enemy IADS to allow Army aviation to conduct missions.

Any MUM-T approach the Army pursues will need a focused campaign of learning and

advanced concept development to fully understand the operational benefits. The ASB also advocates the Army develop a modular, open systems architecture for all autonomous technology.

New and Contested Domains

The outcome of future battles in the traditional domains of air, sea, and land will increasingly be decided in the unseen layers of the electromagnetic (EM) spectrum, where adversaries will be well-equipped to operate. Adversaries will also continue to innovate by applying varying mixes of heretofore advanced technologies, whose growing ubiquity and affordability make them available to non-state actors. Similar advances will also be made in the human dimension, both in terms of human interaction (using information technology to compress decision response times) and in terms of human beings (where developments in bio-technology, pharmaceuticals, etc., will give adversaries opportunities to outperform U.S. Soldiers).

The IoT has emerged as a global phenomenon using the EM spectrum to produce a variety of physical effects in the world at hand. The ASB believes that while the Army needs to explore methods of protecting equipment and forces from adversary exploitation of the IoT, it should also learn to exploit the IoT, especially prior to combat operations, to shape and deter impending conflicts. By using loT to conduct influence operations that affect patterns of life, the Army could achieve some strategic objectives and prevent the need for kinetic operations. Likewise, the Army should develop the capability to exploit enemy reliance on the IoT by monitoring the adversary's military patterns, collecting exploitable signatures, identifying vulnerabilities, and degrading the environment through spoofing and disruptive phenomena. The technique could be especially useful for countering near-peer IDF and IADs.

Social media (SM) has likewise emerged as a global phenomenon. Where the IoT produces effects with things, SM produces effects within the human dimension among people. Adversaries have begun to militarize SM by using it to recruit forces and to disseminate propaganda. In the future, the ASB foresees more personalized attacks, where Soldiers and military and political leaders will be known via their SM accounts, will be tracked and/or engaged through their SM activity, and will be targeted, hacked, and/or threatened, adding a new dimension to the physical threats and psychological stresses they already face.

Within the human dimension, the Army faces a greater challenge in determining whether and how to enhance the physical, cognitive, and psychological capabilities of Soldiers within legal, ethical, and moral bounds. The ASB determined that current technology provides multiple avenues for either optimizing Soldier performance through education and training or for enhancing performance (after informed consent) using pharmacological (molecular), biological (cellular), or technological (hardware/software) applications. In the near-term, Army efforts should focus on optimizing physical performance using individual standards based on military occupational specialties (MOS) tasks. In the far-term, the Army should evaluate alternative, ethical means for enhancing physical, cognitive, and psychological performance, while recognizing that adversaries will not necessarily be constrained by the same ethical standards.

Related ASB Reports:
Strengthening Sustainability and Resiliency of a Future Force I (2010)
Strengthening Sustainability and Resiliency of a Future Force II (2011)
Decisive Army Strategic and Expeditionary Maneuver (2014)
ASB Senior Advisory Panel: Force 2025 and Beyond (F2025B) (2014)
Robotic and Autonomous Systems of Systems Architecture (2016)
Future Armor Anti-Armor Competition (2016)
Countering Enemy Indirect Fires, Target Acquisition Using Unmanned Aerial Systems, and Offensive Cyber/Electronic Warfare Capabilities (2016)
Army Efforts to Enhance Soldier and Team Performance (2016)

Information Systems

Consolidating Gains

Marc Zissman, Ph.D. and Gisele Bennett, Ph.D.

Over the past two decades, Internet connectivity became abundant, inexpensive handheld smartphones brought powerful services to our fingertips, new information distribution models made access to news and entertainment instantaneous and cheap, the Cloud made computing and data storage an affordable commodity, and social networking applications provided novel ways to communicate with friends, family, and others who share our interests. These advances have been driven by a combination of massive commercial infrastructure investments (e.g. terrestrial fiber, cellular networks, cloud data centers, etc.) and the rapid development of new applications created by large companies, startups, and individual inventors, all leveraging that infrastructure.

The high-value processes and data associated with these new IT capabilities have motivated bad actors to exploit and attack the systems and applications. Early on, hackers merely wanted to earn bragging rights, but the theft of data soon became a lucrative business for criminals. Today, cyber exploitation and attack have become tools of statecraft. Nation-state adversaries target both government and commercial systems for intelligence collection, and there are even a small number of examples (e.g. Stuxnet) of sophisticated actors seeking to attack physical systems through the cyber domain. Fortunately, at least for the moment, the full potential of cyber-attack (i.e. denying, destroying, or distorting data to subvert some cyber or kinetic process) has yet to be demonstrated.

Facing both rapid advances in IT and the equally rapid adaptation of adversaries' IT-related capabilities, the Army has sought to leverage IT to improve the effectiveness of its warfighting operations and its ability to generate the force. Slowly, it has begun providing low data rate connectivity and very limited situational awareness and/or command and control services down to the level of the individual Soldier (e.g. Rifleman Radio and Nett Warrior). The Army has moved some enterprise-wide applications (e.g. email) into the Cloud, and it has begun to address the threat that adversaries with advanced cyber capability pose to operations.

To improve its warfighting capabilities in the early 21st century, the Army will need to rapidly adopt, adapt, acquire and field capabilities used in daily (civilian) life. This will likely require the development of some process to more quickly acquire and incorporate advanced commercial communications and computation technology into the force. It will also require the Army to become a "smart buyer;" that is, to become more proficient at assessing the potential value of new technology. Continued improvement in its modeling and simulation capabilities and expansion of its ability to conduct realistic field experimentation will enable the Army to achieve a rapid integration capability.

As it incorporates new IT capabilities, the Army must ensure the systems are resilient enough to allow operational missions to withstand some level of adversary cyber and EW attack. This requires a full assessment of adversary capabilities. Thus far, the Army has implemented a thin level of basic cyber protection focused on enterprise computing, but mission-focused cyber defense capabilities are very limited. Assessments should focus on Army weapons systems, and they should lead to the development and implementation of mitigation strategies that will increase an adversary's workload required to hold those systems at risk. The assessments should also explore opportunities that offensive cyber capabilities could provide to Army operational missions. Eventually, the Army must develop appropriate offensive cyber capabilities that will support its kinetic missions against a wide range of adversaries.

Conclusion and Recommendations

The ASB believes the Army needs to take the following broad actions to develop its IT capabilities:

1. Continue to invest in the infrastructure required to provide connectivity in the areas where the Army operates, to include austere locations where there's been little investment in communications infrastructure, or where that infrastructure may be unavailable for Army use. When the Army must bring its own communications infrastructure, it's expensive and limits capability. A combination of space, air and ground assets would lessen that requirement.

2. Provide ubiquitous connectivity and modern collaboration and decision support tools to small unit warfighters. The goal should be articulated as connecting Soldiers with enough bandwidth and the right applications to go beyond merely executing the mission. The IT capabilities should enhance mission effectiveness.

3. Take advantage of the increased connectivity of equipment and items via the IoT. This would include development of a strategy to leverage the new capabilities produced by commercial industry, which offer opportunities to save money and increase performance. It must also include defensive and/or mitigation measures to guard against cyber threats.

Related ASB Reports:
Options for an Affordable LandWarNet (LWN) (2007)
Persistent CSR for the Current and Future Force (2008 & 2009)
ASB Task Force: Considerations for a Viable and Affordable LandWarNet (LWN) (2008)
An Approach to Developing an Affordable LandWarNet (LWN) for Future Forces (2009)
Small Unit Data to Decision (D2D) (2013)
Air and Missile Defense Electronic Warfare (EW) Assessment (2014)
Army Cyber at the Tactical Edge (2015)
The Military Benefits and Risks of the Internet of Things (IoT) (2016)

Robotics and Autonomy

Conceptual Frameworks

James Shields and Tony Tether, Ph.D.

The 21st Century has already seen rapid advances in artificial intelligence, robotics and machine autonomy. While these technologies were originally developed with significant DoD support, industry has adopted them for commercial applications, ranging from automated warehouses, to self-driving automobiles, to drones. The Army has used robotic and autonomous systems (RAS) in the recent wars for surveillance and counter-IED missions. It's also developing applications for reducing the manning requirements in convoy operations and providing autonomous ground vehicles to assist the infantry with carrying its equipment.

RAS Combat Augmentation

The ASB has developed several conceptual models that focus on how RAS technology might directly support combat operations.

In the ongoing armor/anti-armor competition, the ASB found that while there are still self-protection enhancements available for armored vehicles, technologies are approaching their limits in terms of weight, mobility, and cost, relative to the degree of protection that may be obtained. However, significant potential exists to expand both lethality and survivability in cost-effective ways by teaming manned combat vehicles with unmanned armored ground systems. By removing Soldiers from the vehicles, human life is not at risk, and the robotic vehicle can be lighter, more mobile, and less expensive (see Fig. 1). Used in concert with manned vehicles, manned-unmanned teams can provide enhanced survivability and lethality by operating the unmanned vehicles as scouts and advanced echelon, drawing first fire from the adversary. Lower cost of the unmanned systems will allow for greater numbers to be deployed, increasing lethality and enabling new CONOPS.

In similar fashion, RAS applications to counter adversary IADS could use low-cost, unmanned systems to enhance survivability of Army aviation assets in challenging threat environments. The counter-IADS concept uses a low-cost, modular, UAV platform with a range of possible payloads (see Fig. 2). Using various

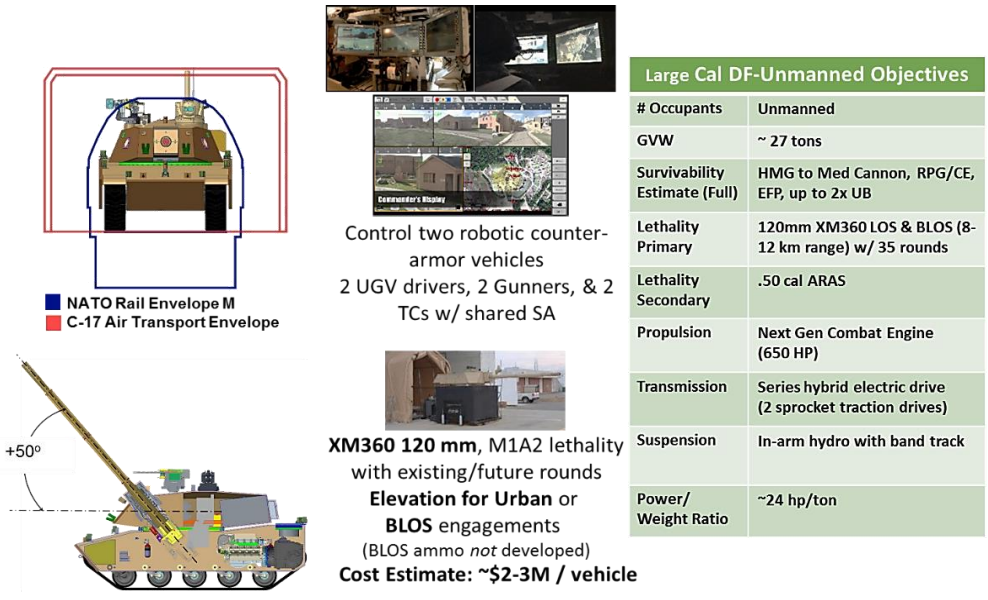


Figure 1. Baseline Robotic Armor Concept

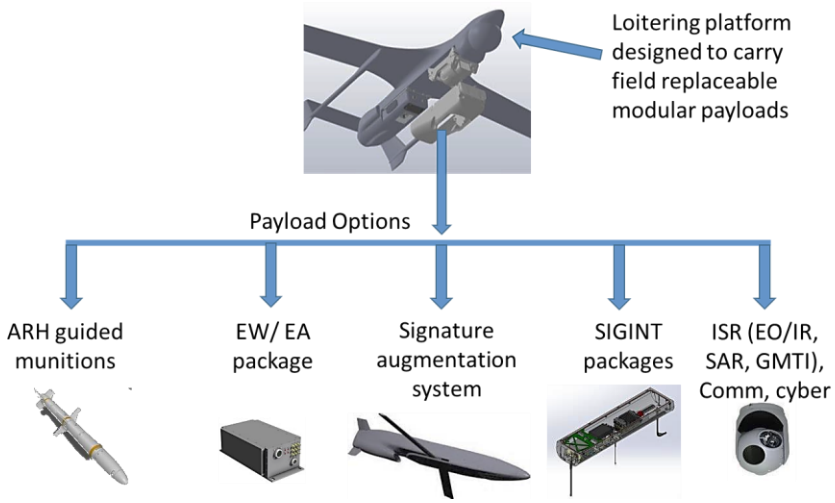


Figure 2. Low-Cost UAV with Modular Payloads

configurations of this unmanned system, the Army can penetrate and defeat enemy IADS by collecting threat radar signatures, detecting and tracking emissions and then attacking the source, providing jamming support, and decoying manned aviation assets. The fact that the system is unmanned keeps costs low because platform survivability is less critical, and the large numbers that can be acquired provide a quality factor of its own, even if individual systems are less capable than their manned counterparts.

Addressing Concerns Over "Robot Armies" and other Challenges

Several issues need to be addressed to accelerate the development and adoption of RAS, including: (1) public concerns about lethal autonomy; (2) lack of institutional advocacy; (3) validation of CONOPS; and (4) trust in the autonomous system.

The Army can help to ameliorate concerns about "robot armies" by educating the public on the human supervisor role in its emerging concepts. In keeping with the policy in DoD Directive 3000.09 (2012) requiring, "appropriate levels of human judgment over the use of force," all the point designs generated by the ASB have clear human control over lethality decisions. In fact, it's the view of the ASB that there are no fully autonomous systems and that all systems are supervised at some level by a human.

Institutional advocacy and responsibility for autonomous systems within the Army is fragmented. While there are a reasonable number of technology development and demonstration programs, it's difficult to transition technology into acquisition programs. Forcing new starts to compete with existing programs of record (POR), particularly in a tight budget environment, makes it difficult for new concepts to be accepted. As with any large organization, the Army experiences institutional resistance to new ideas, even when those ideas have the potential to provide capability at significantly reduced cost compared to legacy systems. To provide some breakthrough, several studies, including the ASB's, have recommended that the Army designate a single advocate, likely at TRADOC, to develop and promote RAS, and to ensure that senior leadership is encouraged to understand the benefits of RAS for operational missions.

The key to building advocacy and overcoming institutional resistance is conducting a robust campaign of learning to validate RAS concepts. The objectives of the campaign of learning should include: (1) validating operational value; (2) evaluating innovative CONOPS and TTPs; (3) maturing critical hardware, software, and system interfaces; (4) informing capability needs as an input to the Amy Requirements Oversight Council; and most importantly (5) building leadership trust.

The Army's understanding of RAS will be based upon a solid foundation of simulation, prototyping, experimentation, and operational

assessments, which all need to be coordinated into a single integrated program. The experimentation should start by using surrogate vehicles for demonstrations of operational interfaces and communications to control costs and speed the process of learning. Successful concepts, appropriately modified with feedback from the experimentation program, could then progress to prototyping of some of the critical components and capabilities, again using surrogates as appropriate, and culminate with rapid prototyping of purpose-built systems for evaluating integrated capability against a live opposing force (OPFOR).

Building high-fidelity simulations of the autonomous system will provide a design environment for developing the autonomy software. There's also an opportunity for early interactions with system operators, the Soldiers who will employ RAS, to ensure that their feedback can be incorporated into the design. This would establish trust in the resulting system. Simulations, refined as the design matures, will also provide the test and evaluation community an opportunity for cost effective exploration of "corner cases" in the operating envelope that might be difficult to assess in system testing.

The ASB believes the National Training Center (NTC) at Fort Irwin is ideally suited to test autonomous capabilities. NTC gathers real-time information used in after action analyses to develop the "true" situation and compare it to what was believed to be the "truth" by the Commanders exercising the forces. Autonomous capabilities could be tested and compared in much the same way that the Army tested the Javelin missile at NTC. When a single Soldier demonstrated that he could take out a company of tanks by using the "autonomous" capability to fire multiple geographically dispersed missiles, Javelin was quickly accepted by the Army.

If executed successfully, the campaign of learning and robust programs of experimentation, simulation, and model-based design should instill the confidence that RAS will operate as intended.

Imperative to Prepare for Adversary RAS

The U.S. is not alone in exploring the combat applications of RAS. Highly capable commercial technologies such as UAVs are readily available on the global marketplace at low-cost. RAS projects are standard in the curricula of research universities with engineering programs. There are few barriers to entry, as both the systems and the knowledge to use them have become broadly available. Consequently, it is inevitable that adversaries will use these technologies against U.S. Soldiers.

The Army must prepare to face adversary use of RAS on the battlefield by incorporating the threat into the development of doctrine and TTPs. Wargames, experimentation, and exercises must include these systems in the OPFOR arsenal. In planning these exercises, the Army should be careful to avoid the trap of mirroring its capabilities in anticipating the adversary's. It's likely that other nations will have more permissive rules of engagement for autonomy, thus the ASB expects our enemies will use RAS technology in ways that we would find ethically unacceptable.

Conclusion and Recommendations

The ASB has three high-level recommendations for the Army relative to robotics and automation:

1. Designate a single advocate, likely at TRADOC, to develop and advocate for RAS and to ensure that senior leadership is encouraged to understand and accept the benefits of RAS for operational missions.

2. Initiate a campaign of learning to validate operational value, establish innovative CONOPS and TTPs, and build leadership trust by using the NTC and other facilities that have the same capability.

3. Prepare to face adversary use of RAS on the battlefield.

Related ASB Reports:
Armed Ground Robotics (2009)
ASB Quick Reaction Task Reporting for Survivability (2009)
Robotic and Autonomous Systems of Systems Architecture (2016)
Future Armor Anti-Armor Competition (2016)

Innovation in the Army

Mapping a Course

Teresa Smith and Thomas Ramos

During the wars in Iraq and Afghanistan, the Army established over a dozen organizations to address specific threats and shortfalls that had been exposed in combat operations. Some of the better-known groups included:

- Rapid Equipping Force – developed materiel solutions for the urgent requirements of deployed forces
- Asymmetric Warfare Group – designed to blunt asymmetric attacks by understanding adversaries' abilities to innovate and adapt their techniques to exploit U.S. forces' vulnerabilities
- Task Force Odin – conducted reconnaissance, surveillance, and target acquisition against insurgent improvised explosive devices (IED) attacks in Iraq
- Joint Improvised Explosive Device Defeat Organization (JIEDDO) – the Army's counter-
- IED task force that was turned into a Joint IED Task Force reporting directly to the Deputy Secretary of Defense

None of these specialized entities existed before the wars. The Army established, funded and staffed them relatively quickly. Each operated under widely disparate organizations in terms of structure, function, and culture, but all of them were successful in addressing urgent operational shortfalls.

As combat wound down and the wars entered their final phases, the Army recognized the collective success of these ad hoc organizations. Before they dispersed or became institutionalized (and by extension, became less innovative), the Army sought to study, capture, and better understand the reasons for their success. The question was whether existing Army structure could replicate, sustain, and support the innovative strain it had established in these groups. There was also a related question about whether there could be relevant operational work to spur true innovation over time in the absence of an urgent threat.

The ASB found Army culture to be prohibitively conservative, process focused, and largely incapable or unwilling to deviate from established doctrine, systems, and force structures. Flexibility and variance were required to incorporate the innovative techniques that addressed emerging, urgent combat requirements, which explained the success of the ad hoc organizations. They were, by design, driven by hand-selected, creative, and collaborative individuals who prioritized innovation. Importantly, the people who worked in the ad hoc groups were disciplined and took care to calculate the risks associated with their new ideas. They also enjoyed, and earned, almost unprecedented access to, oversight from, and sponsorship by senior Army leaders.

A Pattern of Innovation

The ASB found that all the examples involving innovative solutions followed a similar pattern:

- There was a significant problem that required a new kind of solution.
- The problem elicited good, innovative ideas.
- The leader of the organization facing the problem recognized the viability of the innovation and decided to pursue it.
- The leader took personal charge of the organization to ensure that the idea was properly executed.
- The leader acted with the knowledge that the radical nature of the initiative entailed a level of risk that could have damaged his or her career.

Each of the specialized organizations developed innovative ideas that were complex and technical, and the organizational leader identified the need to recruit one or more world-class technical

experts to take charge of the implementation. Furthermore, leadership ensured the team was properly funded for the time it would take to address the problem and made certain that developers of the innovative solutions were isolated from institutional push-back and/or encumbering processes that might kill off the innovation.

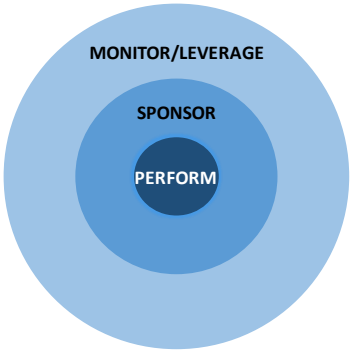
Sustaining Innovation

To help the Army foster innovation after the wars, the ASB recommended that the Army establish a separate staff function (e.g., a G-9-type Innovation organization) to advance experimentation and prototyping in the development of solutions for new, difficult problem sets. Senior leader sponsorship would be critical to the establishment of the organization. Key elements for success would include a talent pool of innovators allowed to produce a forward-looking culture, with minimal formal processes or organizational structure.

The resulting organization was envisioned to act like a type of incubator where creative solutions would be developed, but more importantly, they would be demonstrated and forwarded with a solid implementation plan. The ASB recommended a similar type of prototyping activity to bridge the gap between research in S&T efforts and more applicable mission capability development.

Targeting Innovation

Each of the original ad hoc organizations had a major stake in addressing an operational requirement, directly supporting the Operating Force to produce effects on the battlefield. However, the larger part of the Army, the Generating Force, doesn't have the immediacy of battlefield operations to serve as a forcing function for innovation. Instead, it responds to pending or foreseeable circumstances that will affect the Army, such as budget and personnel fluctuations, as well as strategic concerns about the spread and accelerated development of threats the Army could potentially face. What would innovation look like under these circumstances?



The Army needs to focus its S&T resources on unique, core technologies while partnering with outside, best-in-class performers. For example, the Army should "perform" S&T in areas where it holds world-class expertise, such as munitions and armor. It should "sponsor" S&T in areas where the technology is important to the Army but it lacks expertise, such as in the development of power sources and batteries, Finally, the Army should "monitor/leverage" S&T where expertise clearly resides outside of the organization and technology is developed and supported at levels that meet Army requirements, such as the development of personal computers, smart phones, etc.

In the parts of the Generating Force that house the Army's S&T portfolio, the ASB identified opportunities for the Army to focus its efforts to innovate around key areas where the Army has unique, world-class expertise. For example, the Army should continue to innovate in systems engineering, command and control platforms, and rotorcraft, but it shouldn't expend S&T resources on developing the next generation personal computer.

Cultivating Innovation

There's a difference between an Army that fosters innovation and an innovative Army. The latter drives creativity and innovation beyond a specific organization and into the Army as an institution. But could an institution like the Army establish and sustain a pervasive ethos of innovation within the dominant, process-focused and risk-averse culture?

The ASB identified six factors that would enable and drive innovation down to the lowest echelons of the Army:

1. Leadership – effective change in any organization requires senior leaders to openly take direct ownership of the change; mixed signals lead to floundering execution. Where implementing a culture of innovation would require the Army to change its culture, senior leaders would have to shepherd those changes and stand by them.

2. Education – the ranks and leadership of the Army need to understand the value of innovation, how to define problems and challenges, and when and how to engage the broader population outside of the Army to solve existing and enduring problems.

3. Processes – collaborative tools that enable communication and engagement in solving problems should be used to encourage participation and enduring behaviors.

4. Metrics – the Army will need measurements of behaviors to assess and understand the impact of its efforts to achieve a more innovative culture. For example, the number of suggestions or ideas generated, the participation level in problem solving forums, etc.

5. Communication – the beliefs, expectations, and ideals of innovation initiatives should be clearly defined and explained.

6. Recognition and Reward – the Army must promote educated risk-taking, highlighting lessons learned from interim failures and unsuccessful outcomes, while rewarding excellence in organizational and individual innovation.

Conclusion and Recommendations

If the Army is to maintain future overmatch capabilities against adaptive adversaries, it will need to adopt a model of innovation, develop a method of innovation, and drive up the rates and speed of innovative work. This may require pervasive cultural change within the Army.

Related ASB Reports:
Institutionalization of Innovative Army Organizations (2008)
Institutionalization of Innovation in the Army (2009)
The Strategic Direction for Army Science and Technology (2012)
Army Science and Technology Essential Core Competencies (2013)
Creating an Innovation Culture in the Army (2014)

The Soldier and Small Teams

Maintaining Competitive Advantage

Lester Martinez-Lopez, M.D. and Bruce A. Swett, Ph.D.

The Army has long maintained that its success in preventing conflict and winning the nation's wars over two centuries comes from the quality of its Soldiers. The Army's people – its Soldiers and Civilian employees – define the Army and will always constitute its greatest capital investment. It follows that the Army would have a deliberate, well-tested enterprise to recruit, train, and promote its people. But after fifteen years of sustained conflict, the longest such period in our Nation's history, the Army recognizes the need to refocus on its human capital and to determine how best to recalibrate its personnel processes.

Throughout its history, the Army has evolved, adopting new techniques to ensure it had the right people to meet mission requirements while balancing the social and political demands of the nation. The Army has developed a professional Officer corps, has normalized its ranks through the period of mandatory conscription and drafts, has adopted today's all-volunteer force, and has produced a specialized Non-Commissioned Officer corps. Not surprisingly, at one point, the Army was looked upon as the standard bearer for training and developing people. Now, however, the ASB has identified a shift that's occurred over the course of the last decade, where civilian institutions are leading the way in terms of talent management (TM), education and training, and recruitment.

For the Army to resume its leading role in personnel management, it must first catch up. It can do so by positioning itself to leverage best practices in human resource development. The Army's new Human Dimension Concept represents a good first step and promotes developing technological solutions to improve human performance in both individual Soldiers and small teams. The ASB found that most of the S&T related to these goals already exists, and the Army can adopt much of it with minor modifications.

The Soldier: Preventative, Predictive, Prescriptive

One major legacy of the Army's experience in the wars in Iraq and Afghanistan will be a new and better understanding of the relation between an individual Soldier's stressors and the Army's readiness. A focus on Soldier resilience will allow the Army to enhance Soldier performance, minimize "burnout," maintain the psychological health of its members, promote better post-deployment re-adjustment, and later, ease the reintegration into civilian life. This aspect of personnel management is unique in the sense that it's not found in the civilian sector, but there are analogs which may be useful in the first responder community. To address the issue adequately, the Army must develop quantifiable, reproducible, physiological, and psychological metrics for the assessment and prediction of Soldier resilience. Current programs would need to be incorporated and modified as necessary to collect the data.

As the Army becomes more proficient in managing the physiological and psychological health of its force, it will gain the ability to evolve from a purely preventative model to a predictive one. A program based on predictive analytics that's able to identify attributes of high risk behavior, using the Army's multitude of data, would provide a powerful tool for mitigating harm to self, harm to others, and harm to the Nation. Before implementing any such program, the Army must develop, deploy, and assess a prototype process with supporting components, such as learning algorithms, reliable and robust behavior models, etc., in place.

Beyond identifying attributes of high risk or unfavorable behavior, there lie opportunities to modify and/or eradicate such behaviors. Advances in biological, biomedical, and pharmaceutical technologies point to the potential for the Army to define and then chemically or biologically shore up the traits and attributes it values in its Soldiers. Similar advances promise improvements in cognition

and learning, which could improve Soldiers' capacities to navigate and understand complex situations on the battlefield.

In general, the Army needs to engage the fields associated with human enhancement techniques and practices. The ASB found Soldiers are already engaged in various methods of optimizing their performance, whether it involves supplements, prescriptions, or caffeine. Moreover, there's evidence that adversaries have engaged in attempts to optimize and enhance their combatant forces. To ensure its Soldiers don't get outperformed on the battlefield, the Army should charter an integrated product team to conduct a one-year Human Performance Study that explores the potential of performance optimization and enhancement technologies. To provide a context for its findings, the Army must also develop a focused effort to collect intelligence assessments of adversary capabilities in human performance optimization and enhancement technology.

Talented Small Teams

Soldiers don't work alone. An individual Soldier's ability to work successfully as part of a team is essential to how the Army functions. Advances have been made over the past decade that will improve the Army's ability to forge solid teams, especially at the small unit/tactical level. For example, TM has emerged as a leading method for selection/recruitment, training, advancement and retention of the right personnel. The Army could transfer best practices in these areas by designing an integrated TM enterprise. This should include creating a TM "proving ground" to test advances in various fields and to ensure they scale to the Army. Importantly, the ASB believes the Army's TM enterprise should build upon the initiatives in Soldier resiliency and predictive analytics by bringing all human capital activities together under a systems integration laboratory. Only then will the Army complete its picture of the individual Soldier as part of a team.

Leveraging the Human Dimension

As the Army invests in understanding, developing, and crafting its Soldiers and small teams, it will implicitly gain an advantage in its ability to exploit our adversaries' human capital. For example, the Army has long maintained a function to influence our enemies, whether through the behaviors of civilians or the operations of combatants. How might this function evolve with the advent of social media (SM)? The ASB maintains the Army must think of SM platforms – Facebook, Twitter, Instagram, etc. – as a new type of battlefield; places where people will be influenced by others who can and will exert their message with near impunity. To counter, the Army must engage human interaction beyond its traditional, physical realm and develop digital relationships. This will require proponency from an executive agency. Its immediate focus should be on developing an overmatch capability in human interaction.

To complement and perhaps validate its activities in the digital realm, the Army should continue to develop the tactical, biometric systems that were deployed during OIF and OEF. During the wars, the Army's use of biometrics was geared toward identifying persons of interest. Since then, biometric technology has evolved, and a large database of physiological biometric samples has been built which will enable the Army to expand the use of biometric modalities. The Army should specifically explore biometrics that can be collected at stand-off ranges and/or through covert means, which will effectively expand the capabilities and verify targets of small, tactical units.

Conclusion and Recommendations

The Army must accept the idea that having a deeper understanding of its people, on an individual basis, is becoming just as important as having in-depth situational awareness of a battlefield. Each of the improvements outlined above will require the Army to use technology in ways that it has yet to fully embrace.

To that end, the ASB would endorse, as a critical step, that the Army develop an enterprise-wide data analytics program to support efforts in predictive analyses, the assessment of talent, the development of high performing teams, etc. By leveraging the vast quantity of data already collected by the Army, the program will inform the institution at all levels, individually, in small teams, and at the enterprise level. The program should be designed to remain flexible enough to grow and develop with the Army as it evolves. The program should also be allowed to reveal

objective data that would otherwise remain hidden and/or unknown.

The benefits of developing a data analytics program will grow over time, as the Army becomes proficient in the field. Eventually, the power of data will improve decision making at all levels, allowing the Army to tailor training and education down to the level of each individual Soldier. Accelerated learning will enable the design of specialized teams that provide unique capabilities for very specific missions. The Army as an enterprise, capable of harvesting the products of Soldier and small team learning, will also accelerate its own ability to learn. Indeed, the Army's competitive advantage in the future will boil down to how fast the organization learns and adapts. Technology, globalization, and the disruptive techniques of potential adversaries will advance faster than the Army can keep up with its current methods.

Related ASB Reports:
ASB Subcommittee: Army Suicide Mitigation (2008)
Soldier Resilience and Performance Sustainment (2010)
Tactical Non-Cooperative Biometric Systems Phase I (2010) & *Phase II* (2011)
Evaluation of the Army Use of Data to Predict High Risk Behavior (2013)
Talent Management (TM) and the Next Training Revolution (2014)
Human Interaction and Behavior Enhancement (2015)
Army Efforts to Enhance Soldier and Team Performance (2016)

Efficiencies

Weathering Uncertainty

Nancy Chesser, Ph.D. and William Crowder

Significant reductions in resources over the last decade have driven the Army to find efficiencies that allow it to operate within the imposed constraints. For example:

- The Army's budget has decreased from a peak in fiscal year (FY) 08 of $252B ($131B budget and $121B in Overseas Contingency Operations (OCO) money), to the current FY16 low of $148B, ($127B budget and $21B in OCO).

- The authorized end strength for the Active Duty Army peaked at 569,400 in FY10 and FY11 and is now at a low of 475,000 for FY16.

It's often expedient for the DoD and Services to meet mandated budget and end strength reductions by eliminating combat forces. For the Army, this translates into reducing its number of BCTs. After several years of study, the ASB has recommended the Army follow a different course by identifying potential efficiencies that can be found within the Army's Generating Force (GF) which, if realized, would produce savings to help preserve the combat capabilities in its Operating Force (OF).

To realize efficiencies identified in the GF, the ASB believes the Army should adopt best practices in commercial industry, whether they come in the form of innovative technology solutions or streamlined processes. Information technology is an area particularly suitable to reap the benefits of this approach, from garrison services that support the operation of an installation, to weapons systems in combat operations.

Before any substantial gains can be obtained, the Army needs to develop tools to manage the GF as well as it manages the OF. A decade ago, the Army commissioned a contractor-performed GF Census that linked GF functions to authorized and on-hand personnel. Data provided by an updated, similar effort could support a model to determine GF shortfalls and risk. The goal would be to base manpower authorizations on deterministic requirements and funding, rather than simply on prior year budgets, which don't necessarily follow changes in personnel authorizations.

A similar effort should be accomplished to gather data on contractor manpower equivalent levels. A surge in the contractor work force during OIF and OEF, coupled with the trend to outsource jobs that Soldiers no longer perform, warrant a closer study by the Army to ensure it's adequately managing contractor manpower support. The ASB believes there are several areas, including installation support, logistics, and certain maintenance functions, where better integrated contract support could maintain operational capabilities while releasing force structure to reposition in the OF.

The Army could also realize efficiencies by applying the latest technology and techniques to its support functions. For example, the use of data analytics to identify maintenance efficiencies and a focus on condition-based maintenance could extend maintenance intervals and reduce personnel and supply requirements. Likewise, the Army should vest the Installation Management Command (IMCOM) with an enterprise planning capability that would better integrate into the Army processes. This would allow the IMCOM Commander to develop future assessment models, to update doctrine and design training, and to collaborate with communities to develop regional growth plans for each installation.

Conclusion and Recommendations

The ASB believes the Army has opportunities to identify and enact more efficient processes, but the efforts must be targeted, not blunt cuts, with an eye towards maintaining or growing capabilities and force structure in the OF. In general, whenever it undertakes efforts to enact budget or force structure cuts, the Army should follow prescribed steps:

1. Adopt best practices in commercial industry, whether in the form of innovative technology solutions or streamlined processes, especially in IT.

2. Develop tools to manage the GF as well as it manages the OF; include both the civilian workforce and contractor manpower equivalents.

3. Use data analytics to identify maintenance efficiencies and focus on condition-based maintenance.

Related ASB Reports:
Ensuring the Financial Viability of the Objective Force (2002)
Generating Force Census (GFC) Utilization (2008)
Installations 2025 (2009)
Strategies to Optimize Operating and Generating Forces for 2025 and Beyond (2015)

Conclusion

The Army should not and, based upon the bitter lessons learned from its past engagements, must not wait until the next armed conflict to reinvent itself. Even in a global environment where threats have proliferated but remain indeterminate, the Army can plan and experiment to adapt to the strategic instability defining the first half of the twenty-first century. The best way to do so will be to unleash the creative potential of the Soldiers in the organization.

In the future, the Army will exercise its decisive advantage through the novel ways it deploys its resources. Army leaders will need to learn to craft combinations of Soldiers, equipment, and technology into disruptive force packages that maintain decisive advantage over a spectrum of adversaries, from near-peer threats having the same technological capabilities, down to non-state actors using ubiquitous technology in asymmetric attacks.

Postscript: The Army Science Board's Impact in 2016

ASB studies are defined and performed under terms of reference (TOR) signed by the Secretary of the Army and coordinated through the Chief of Staff of the Army. In response to their tasking, ASB study chairs brief the Secretary and Chief on the Board's findings and recommendations. The Secretary and Chief then determine whether and how to implement the Board's recommendations.

The ASB's work is future-looking, and the findings and recommendations take time to work their way through various Army agencies. Thus, it may take months, or in some cases years, to discern the Army's response to the Board's work. A measure of the Board's impact in any given year will likely include work completed by study teams from several past study cycles.

In 2016, the ASB's activity involved two FY study cycles: FY15, during which the Board completed study reports and out-briefs on four studies and a task force review for senior Army leadership, and FY16, in which the Board developed and adopted findings and recommendations for five studies and conducted out-briefs on those studies for the Secretary of the Army. The Board also coordinated with the Army TRADOC Analysis Center (White Sands Missile Range) and the Army War College on a sixth FY16 study to produce recommendations for Army investments in disruptive technologies. This study incorporated and built upon the work of the five FY16 ASB studies and was requested, as a stand-alone effort, by senior Army leaders.

The following summaries highlight the impact of these studies, as well as previous years' work that registered in 2016.

New and Contested Domains

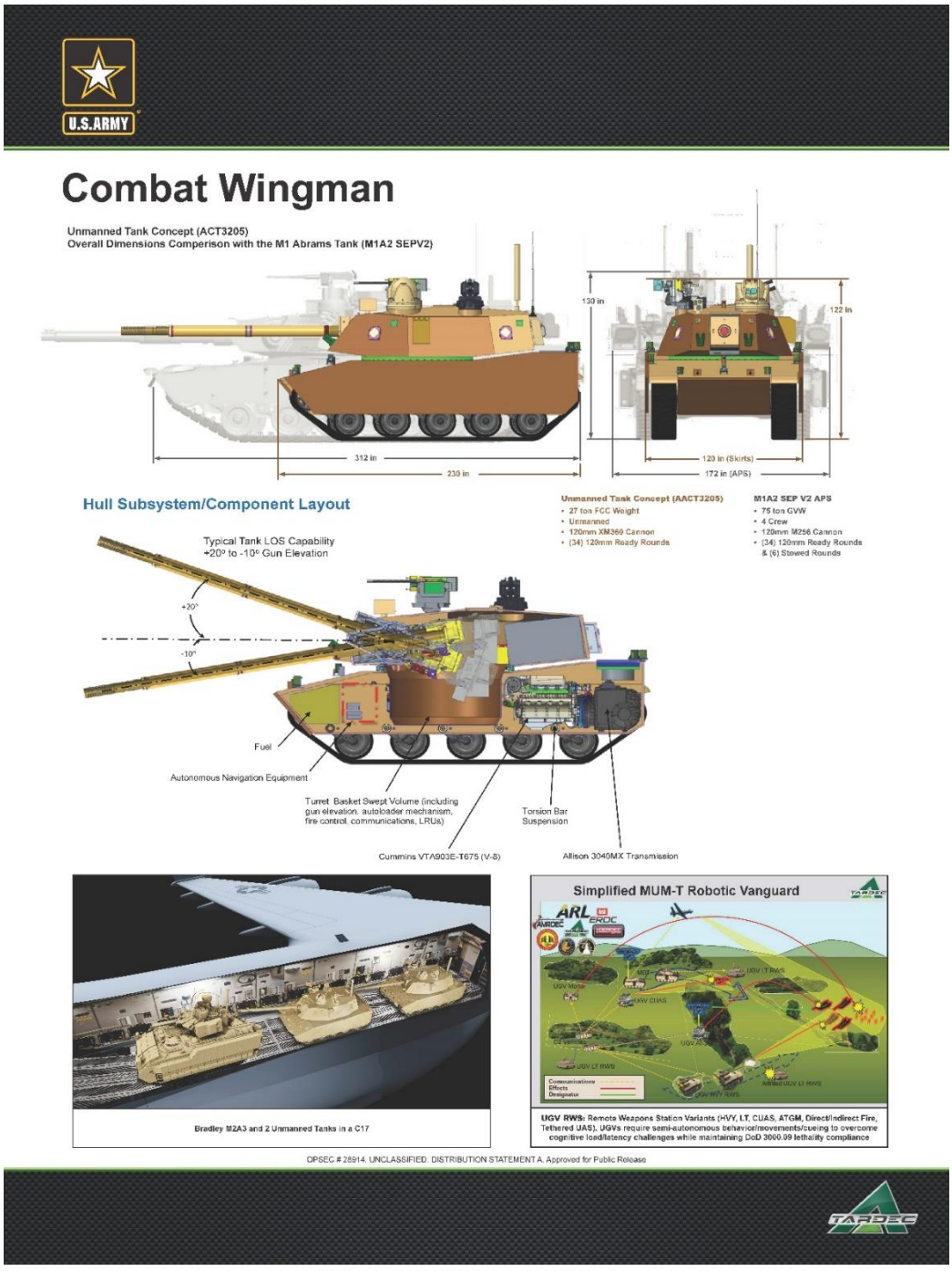
Adopting recommendations from the FY16 study on "The Military Benefits and Risks of the Internet of Things," the Army Research Lab (ARL) has solicited members for an Internet of Battlefield Things (IoBT) Collaborative Research Alliance (CRA) that will develop the foundations of an IoBT in the context of future Army operations. The ASB advocated for the Army to initiate research around defensive strategies against infiltration and attack through the IoT, as well as the offensive exploitation of an adversary's IoT. ARL plans to implement these capabilities by establishing an enterprise approach that couples multi-disciplinary Army research with extramural research from industry, academia, and other government organizations. By establishing a new venture that leverages private sector and government researchers, the Army will implement the Board's recommendation to develop a fundamental understanding of the IoT in all phases of warfare. The solicitation for CRA partnership echoed the findings of the ASB's study team: "In addition to Things and IoTs that the Army owns and controls, it may also need to make use of IoTs that it does not own or fully control. A foundational problem to be addressed by the CRA is the fundamental understanding of how to learn and devise complex models of IoBT goals, networks, information, and analytics to enable intelligent command and control, and battlefield services. A critical issue embedded throughout all aspects of IoBTs is cyber physical security as the Army will need to use things it does not control (military (blue), adversary (red), civilian (gray)), accommodate deceptive data, and counter advanced persistent threats."

The Army also developed the ASB's recommendations in tactical cyber operations. Specifically, CG ARCYBER (LGEN Edward C. Cardon) used the Board's findings and recommendations from the FY15 study "Army Cyber at the Tactical Edge" to bolster cyber resiliency within the Army. These efforts included conducting a cyber assessment of a classified Army system. Results are being incorporated into the "cyber hardening" of other Army weapons platforms.

Army Strategy on Robotic and Autonomous Systems (RAS)

Findings and recommendations from the 2016 "Robotic and Autonomous Systems of Systems Architecture" study validated previous Army analyses that indicated MUM-T/RAS opens a design space that the Army needs to explore. The ASB's concept for a robotic tank killer was

adopted by the Army Capabilities Integration Center (ARCIC), and the Maneuver Center of Excellence added RAS to the Maneuver Force Modernization Strategy, calling it Mounted RAS or MRAS. The Army has also moved forward with developing an open, modular architecture for RAS, which was a key recommendation of the ASB study. As of this publication, a full trial has been scheduled for Fall 2017. One of the main proponents of RAS in the Army, the Army's Chief Roboticist, Dr. Robert W. Sadowski, used the ASB findings to validate the Army's approach to developing robotic systems and adopted the ASB's tank killer concept into the Combat Wingman Unmanned Tank concept (see figure below).



TARDEC Combat Wingman Using ASB RAS Concept

Investing in the Army's S&T Enterprise

In reevaluating and reprogramming the FY18-22 POM, the Chief of Staff of the Army (CSA) tasked HQDA DCS G-3-5-7/DAMO-SS (MG William Hix), in collaboration with the DCG ARCIC, DASA (S&T)/Army Chief Scientist (Thomas P. Russell, Ph.D.), CG RDECOM (MG John F. Wharton) and the Army Centers of Excellence, to prioritize programs by focusing on the new Army Operating Concept. During that process, Army leaders were informed by two earlier ASB studies on the Army's S&T enterprise: FY12 "The Strategic Direction for Army Science and Technology (S&T);" and FY13 "Army Science and Technology (S&T) Essential Core Competencies." Specifically, Dr. Russell employed the methodology developed by the ASB that made use of core competencies, which was the major recommendation of the FY13 study. Recognizing the importance of these studies for the Army, the CSA added them to his reading list to help inform a wider audience of officers on issues affecting S&T investment.

The ASB's FY15 "Strategies to Optimize Operating and Generating Forces for 2025 and Beyond" study was also used by Dr. Russell to determine which advanced technology development programs (BA 6.3) the Army would divest over the Program Objective Memoranda (POM), resulting in savings of approximately $641M. Dr. Russell relayed, "It was an outside, independent, technical look which provided valuable insight into the program and its future alignment. It was the only outside assessment accomplished to help provide feedback to ASA(ALT) and G3/ARCIC."

The ASB's entire FY16 study schedule, including the unprecedented decision to hold a sixth, overarching study on "Disruptive Innovative Concepts for the Future Army," grew out of the Army's adoption of the recommendations from another FY15 study, "ASB Senior Advisory Panel: Force 2025 and Beyond (F2025B)." The Board's work in FY16 represents the ASB's sustained, multi-year focus on addressing adversaries' emerging challenges to the Army's overmatch capabilities.

Independent Assessments for the Army

The Army relied on the Board's status as an independent and transparent FACA body to investigate two potentially controversial areas of technology where enquiry by the Army on its own may have raised concerns as to propriety and the Army's motivation. These exploratory studies, the FY16 "Army Efforts to Enhance Soldier and Team Performance," and the FY15 "Human Interaction and Behavior Enhancement," provided senior leadership with assessments on whether and how to engage these technologies, balanced against the risks associated with doing nothing while adversaries exploit their effects. In response to the latter study, an Army initiative lead Special Operations Command to create a roadmap for expanding military information support operations (MISO) training into social media use, online advertising, and web design.

Army Aviation

CG TRADOC (GEN David G. Perkins) used the FY15 study "Army Science and Technology for Army Aviation 2025-2040" to evolve the TRADOC concept of Multi-Domain Battle. The study contributed to the development of Army concepts on MUM-T throughout the research, development, testing, and evaluation enterprise.

The study team also shared its findings and recommendations with the Secretary of the Air Force and conducted discussions with Air Force leadership to develop a common understanding of the viability of U.S. air superiority in future conflicts and the impact on Army aviation.

Talent Management

The FY14 study on "Talent Management and the Next Training Revolution" was used by CG TRADOC (GEN David G. Perkins) as a reference for the Army's TM Concept of Operations. The Board's recommendations helped focus TRADOC's efforts and enabled the Combined Arms Center team to develop associated TM white papers and the Army Talent Management Strategy. The study chair was asked to provide recommendations for an Army level TM Task Force that would also accelerate iterative development of the Integrated Personnel and Pay System – Army, and provide renewed focus on the governance/planning within the Army's human capital enterprise.

Due to the extensive impact the study had on the Army's move to a TM model, the study chair was also invited to participate in DoD's Force of the

Future Initiative, sponsored by Acting Under Secretary of Defense for Personnel and Readiness, Brad Carson. The goal of this initiative was to maintain the United States' competitive edge by bringing in top talent to serve the nation.

COL Peter S. Im, Director of the Human Dimension Capability Development Task Force, said, "Working with the ASB on Talent Management was fortuitous for TRADOC. It was apparent that the scope of the ASB's investigation, interviews, and ASB team composition – the Talent Management Study was far more comprehensive than what we understood in TRADOC. Of note, the ASB Talent Management Bibliography (research) confirmed key stakeholders and SMEs, as well as expanded our later outreach and exploration efforts."

Innovation in the Army

Ongoing interest by the Army to improve innovation has motivated three ASB studies: FY08 and 09 "Institutionalization of Innovative Army Organizations, Parts I and II;" and FY13 "Creating an Innovation Culture in the Army." The latter was used by the Military Deputy to the Assistant Secretary of the Army (Acquisition, Logistics and Technology) (LTG Michael E. Williamson) to inform the formation and structuring of the Rapid Capabilities Office. Another recommendation from the study led to the development of what became the Army Ideas for Innovation (AI2) program.

Suicide Prevention

The Army's Study to Assess Risk and Resilience in Service Members (STARRS) was awarded $40M by OSD to lead the largest longitudinal study of suicides in the military services. STARRS was founded out of the collaborative work between the ASB (commissioned by the Secretary of the Army to identify risk factors in a 2008 task force), the Army Analytics Group (AAG), Harvard University, NIH, the University of Michigan, and the Uniformed University of the Health Science.

Ethical Data Acquisition

The STARRS program required integrated and correlated data from at least 40 separate databases to provide insights into potential triggers for harmful behavior. The effort to obtain the data was time consuming (over 2 years to gain access to the data) and complex, given the size of data sets the Army would need. As Big data techniques became pervasive, the Secretary of the Army tasked the Board to study the legal and ethical approaches to using these tools.

As a result, the AAG used an ethical framework developed by the ASB in the FY13 study "Evaluation of the Army Use of Data to Predict High Risk Behavior," to frame their work. AAG maintains the Person-Event Data Environment (PDE), a consolidated data repository that contains unclassified but sensitive manpower, training, financial, and health and medical records covering U.S. Army personnel. These data provide a veridical timeline capturing each Soldier's military experience from entry to separation, affording researchers and military scientists a single, computerized repository to draw from. Based upon the ASB's findings and recommendations, AAG changed PDE's data acquisition policy to include all consent forms and data protection restrictions from public data. The PDE maintains the ethics of use governed by what the Solider thought his or her data was being used for when it was collected, as well as what PDE does with analysis after the fact.

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Acronyms

A2/AD	Anti-Access/Area Denial
AAG	Army Analytics Group
ARCIC	Army Capabilities Integration Center
AMC	Army Materiel Command
ASA(ALT)	Assistant Secretary of the Army (Acquisition, Logistics & Technology)
ASB	Army Science Board
BCT	Brigade Combat Team
CONOPS	Concept of Operations
EM	Electromagnetic
EW	Electronic Warfare
FACA	Federal Advisory Committee Act
GF	Generating Force
IADS	Integrated Air Defense Systems
IDF	Indirect Fires
IED	Improvised Explosive Device
IMCOM	Installation Management Command
IoT	Internet of Things
ISR	Intelligence, Surveillance and Reconnaissance
IT	Information Technology
JIEDDO	Joint Improvised Explosive Device Defeat Organization
MOS	Military Occupational Specialties
MUM-T	Manned Unmanned Teaming
NTC	National Training Center
OCO	Overseas Contingency Operations
OEF	Operation Enduring Freedom
OIF	Operation Iraqi Freedom
OF	Operational Force
OPFOR	Opposing Force
PC	Personal Computer
POR	Program of Record
RAS	Robotic and Autonomous Systems
S&T	Science & Technology
SIGINT	Signals Intelligence
SM	Social Media
TM	Talent Management
TRADOC	Training and Doctrine Command
TTP	Tactics, Techniques, and Procedures
UAS	Unmanned Air System
UGV	Unmanned Ground Vehicle