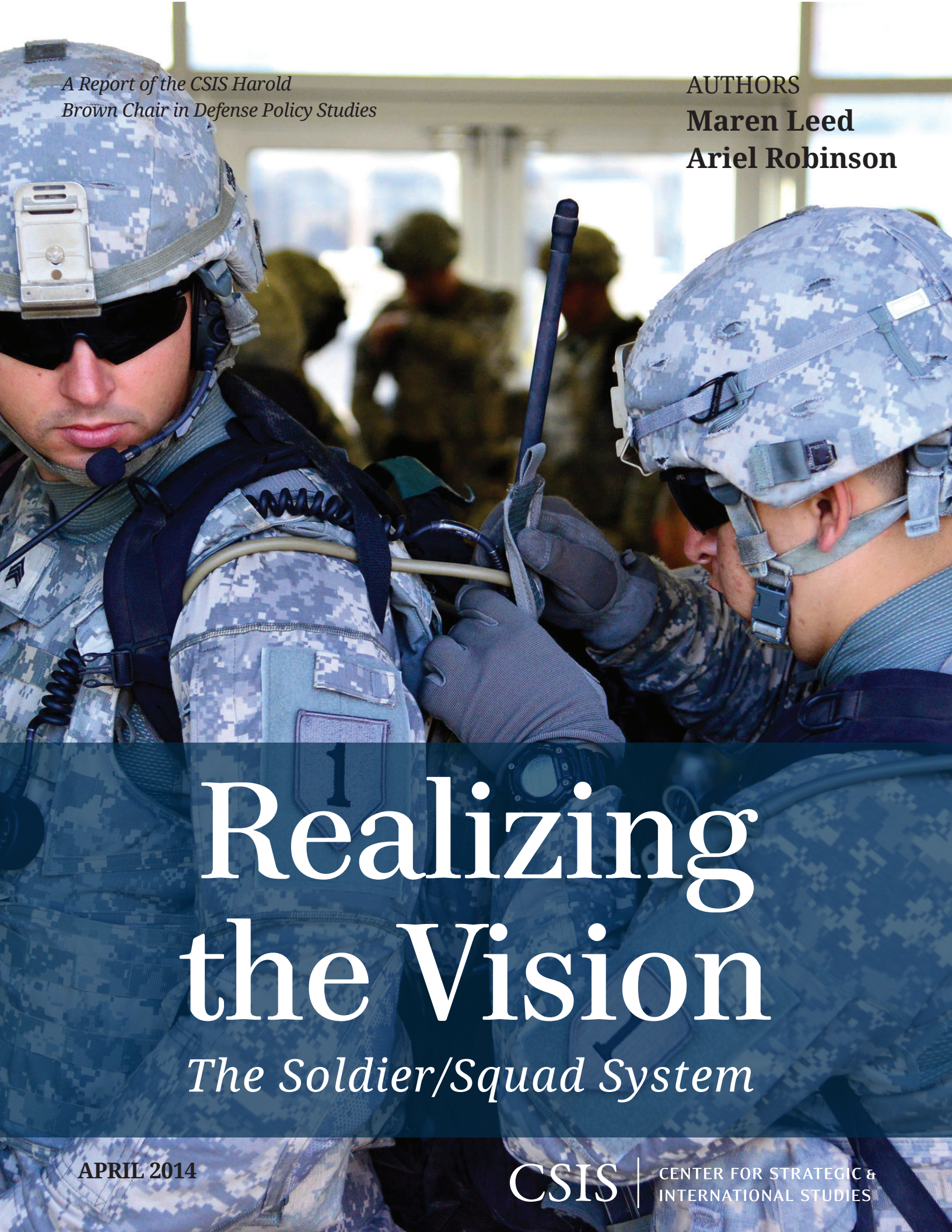

A Report of the CSIS Harold Brown Chair in Defense Policy Studies

AUTHORS
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Realizing the Vision

The Soldier/Squad System

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While there is no way that this study could have happened without the assistance of those mentioned above, if there is one thing that has been reinforced to the authors throughout this effort, it is the centrality of the "human dimension." Thus, despite the best efforts of the broader team, the authors are solely responsible for any errors.

Executive Summary

The U.S. Army is facing a time of great change. The security environment is becoming increasingly complex and uncertain, with defense challenges multiplying. At the same time, the Army is adjusting to rapidly diminishing operational demands, falling endstrength, reorganization, and tightening budgets. Despite this churn, the Army has continued its long-standing emphasis on the centrality of the soldier and squad as the cornerstone of future operations. Chiefs of staff going back decades or more have reiterated the theme that soldiers (and more recently, squads) remain the fundamental essence of the institution.[1] Indeed, the current chief has said that "[t]he Soldier and the Squad are and will remain the centerpiece of our Army . . . [and are] essential to the success of our force."[2]

Over the last 20-plus years, there has also been a recognition that the best approach to delivering the most capable soldier (and squad) requires applying the principles of systems engineering. This idea of the "soldier as a system" has long been evident in both official and unofficial dialogue, but multiple studies continue to find that its implementation remains a challenge.

The U.S. Army is at a time when the importance of making progress toward realizing the soldier/squad system is greater than ever. Over the last 12 years, the nation has devoted significant effort and national treasure to enhancing soldier equipment and protection, an investment that has saved numerous lives and limbs. We are heading into a period where resources will be much more scarce, creating a strong imperative for ensuring those investments are leveraged to their maximum extent going forward. At the same time, the environment in which soldiers and small units must operate continues to evolve, creating a challenge that must be overcome despite fewer resources. Funding reductions will also bring about shifts in the relationship between the government and industry, a crucial partnership that must be maintained to enable future success. How the Army manages this range of challenges will be critical not only for soldiers and squads, but for the institution as a whole.

Given this point of inflection, the Harold Brown Chair in Defense Policy Studies at the Center for Strategic and International Studies examined the current state of the soldier/squad system and how it might be best advanced in the face of constrained budgets. The effort was conducted under the rubric of the Ground Forces Dialogue, a Brown Chair effort aimed at facilitating a broad, sustained, web-based conversation about the future of U.S. ground forces. While the study team consulted with the Marine Corps, the study's content and recommendations are restricted to the Army. The study was conducted over six months (from October 2013 to April 2014), a period too short for the complexity of the subject. While its results are by no means comprehensive, the study resulted in a few key takeaways:

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[1] See, for example, the FM 3-0 release letter from GEN George Casey Jr., March 14, 2008, http://www.army.mil/docs/CSA_FM3-0_Letter.pdf.
[2] GEN Raymond Odierno's address to the U.S. Military Academy class of 2013, November 2, 2012, http://www.army.mil/article/90671/Gen__Raymond_T__Odierno_addressing_the_USMA_class_of_2013/.

- Over the last 13 years of war, operational exigencies have meant the soldier has taken priority over the soldier system. Over the last 5-plus years, systems ideas have become more firmly embedded in Army concepts and some processes, but in practice much of the institution continues to advance piecemeal solutions to equip the soldier and squad.
- How the Army generates requirements (heavily influenced by acquisition and resourcing practices) drives much of the disconnect between concepts and reality.
- Among the major organizational stakeholders involved in advancing the soldier/squad system, there is not yet a shared view of either the boundaries of what the "system" should encompass or the vision for the soldier/squad system needed for the future.
- Multiple factors suggest that while the Army will remain heavily dependent on the private sector as a source of innovation for future soldier/squad capabilities, the ability or willingness of the industrial base to play this role is at risk.

Based on these findings, the study team makes three recommendations to help accelerate the realization of a true systems-based approach. These include:

1. Develop options to improve soldier/squad requirements to accelerate their approval and increase their alignment with a systems-based approach.

2. Review the current cooperative and collaborative teams, boards, and other governing bodies that influence soldier and squad governance.

3. Approve an Army-wide architecture establishing the scope of the soldier/squad enterprise, and increase funding to support ongoing integration as well as to build out and maintain the analytic toolset to inform enterprise decisions going forward.

To ensure continued innovation for soldier and squad equipment,[3] the team recommends Army leaders take five additional steps:

4. Protect and, if possible, increase funding for the Soldier Enhancement Program and Deployer Equipment Bundles, as both a spur to innovation and a mechanism for accelerating broader consideration of soldier/squad equipment that might be necessary in different regions and environments.

5. Identify modifications to current practices guiding government ownership of privately produced intellectual property that will protect government interests and better meet commercial needs.

6. Develop a robust plan for fielding of integrated increments of soldier/squad equipment, as part of a broader systems architecture (e.g., that also includes the requisite training and other enhancements to optimize those investments).

[3] This report focuses primarily on the equipping element of the soldier/squad system. There are multiple and equally important steps the Army can and should take with respect to the other elements of that system that contribute to its overall capability. They fall outside the scope of this report, but are crucial to the ultimate success of realizing a family of systems approach.

7. Meet with representatives of the soldier/squad industrial base to determine whether existing tools and processes provide sufficient insight into Army priorities to inform private-sector investments.

8. Assess the breadth and health of the current soldier/squad industrial base and its ability to support future Army needs. This review should include an examination of whether the requisite contracting tools and other collaborative support mechanisms are in place to encourage public-private and private-private partnering in support of future soldier/squad capability development.

Introduction

This study was borne out of multiple conversations between Brown Chair staff, U.S. Army leaders, representatives of private companies providing soldier-related products, and congressional staff about how one of the Army's top priorities, the soldier and squad system, might weather the transition to smaller budgets, decreasing pressure for rapid acquisition, and a more broadly conceived operational environment. The study team began its investigation principally interested in equipment included in the "soldier system," often defined as "everything a soldier wears, shoots, and carries."[1] As the study progressed, however, the limitations of this perspective became readily apparent.

As the study team worked through a broad literature review and engaged in discussions with subject-matter experts across the soldier/squad enterprise, the necessity of thinking more broadly not only about equipment but also about how that materiel interacts with the human that employs it was obvious. This concept goes well beyond what is traditionally conceived of as the "human-machine interface," to considering the full dimensions of the individual,[2] including how that individual interacts with others in his or her small unit ("human-human interface") as well as with materiel in a task/operational context. The complexity of these interactions is astounding, with many degrees of freedom. This is the challenge posed by truly treating the soldier and squad as a system.

Multiple bodies of scientists, including the Army Science Board and the National Academies of Sciences' Board on Army Science and Technology (BAST), have produced detailed reports recommending key areas of technology focus.[3] This study, by comparison, focused largely on identifying how well the Army is implementing the soldier/squad system, and on the steps to hasten its realization.

With that broad concept in mind, the study team visited some of the major organizations engaged in the soldier/squad enterprise. These included the Maneuver Center of Excellence (MCOE) at Ft. Benning, the office of the Program Executive Office (PEO) Soldier at Ft. Belvoir, various Army staff offices at the Pentagon, and the Project Manager Marine Expeditionary Rifle Squad (PM MERS) at Marine Corps Base Quantico. In addition, the study team hosted a large workshop that included, either in person or via teleconference, representatives of those organizations, as well as the Army Training and Doctrine Command (TRADOC), Army Capabilities Integration Center (ARCIC), Natick Soldier Research Development and Engineering Command (NSRDEC), Office of the Deputy Assistant Secretary of the Army (Research and Technology), Marine Corps Combat Development Command (MCCDC), various

[1] Soldier and squad equipment generally includes the following: boots, gloves, and jackets; armor, helmets, and eyewear; personal power systems; packs and pouches; unmanned systems; handheld electronics; radios and tactical networks; night vision, sights, and scopes; lasers; lights; weapons; and ammunition.
[2] That is, physical, psychological, cognitive, and social.
[3] See, for example, Army Science Board, *FY2001 Summer Study Final Report: The Objective Force Soldier/Soldier Team* (Washington, DC: Department of the Army, November 2001) [ASB, 2001], and Board on Army Science and Technology, *Making the Soldier Decisive on Future Battlefields* (Washington, DC: National Academies Press, 2013) [BAST, 2013].

representatives from private industry, the White House's Office of Science and Technology Policy, and congressional staff from the Armed Services Committees. The study team also conducted numerous interviews, either in person or by phone, with some of these organizations, as well as with multiple former officials who played a role in past positions.

While the study team conducted as much outreach as was feasible within time and budget constraints, these organizations represent just some of the entire soldier/squad enterprise. Because this effort was not comprehensive, the study team, though confident in its identification of issues, has cast its recommendations cautiously. As a result, the study recommends that the Army conduct additional analyses in key areas, to ensure that all of the perspectives are incorporated.

This report is organized into four chapters. Chapter 1 provides background for the "soldier/squad as a system" and defines some of the key attributes of the soldier/squad portfolio. It then reviews how those attributes, in conjunction with other Army processes, result in official requirements documents that are largely misaligned with a systems-based approach. Chapter 2 examines other impediments to broader integration across the portfolio, and to its ability to deliver key capabilities for the future. Chapter 3 explores how a variety of factors present challenges to the Army's ability to continue to draw upon private-sector innovation. Chapter 4 summarizes the issues raised in the three previous chapters, reviews alternatives to resolve them, and recommends actions to Army leaders.

1 | The Soldier/Squad as a System

Background

> "The Soldier of the 21st century will be acting in a new environment. The tools of soldiering (i.e., the technologies supporting command and communications, mobility, lethality, survivability and sustainment) are so different that the very nature of warfare and threat, and ultimately even the strategies of defense and offense, may be radically altered. As a consequence of enhanced capabilities, the mission, role, and function of today's soldier will be significantly enlarged and changed. As we move forward, we must match technology vision with the soldier's inherent capabilities and maximize the future potential of both."—Army Science Board, 1991

The recognition of the need to take a more comprehensive, systems-engineering approach to soldier equipment dates back more than two decades. In 1991, the Army Science Board (ASB) conducted a study "to explore in greater depth the logical evolution and implications of pursuing an integrated approach to development, fielding and management of soldier-related materiel."[4] Among other things, this study concluded that "soldiers are not managed as a system [and] they need to be."[5] Ten years later, the ASB reiterated and expanded on this finding in *The Objective Force Soldier/Soldier Team* report, which found that "a systems approach is mandatory," and that "10x" improvements in soldier capabilities were possible but "will not become a reality unless a systems approach is taken."[6]

In response to these recommendations, in June 2002 the Army's Training and Doctrine Command (TRADOC) created a Soldier as a System Integrated Concept Team. Later that year, the Army's acquisition community established a new Program Executive Office, PEO Soldier, which was charged with the responsibility to "utilize the Family of Systems concept to ensure integration and interoperability are achieved between U.S. Army programs to support a full-spectrum force."[7]

Just as the pieces to manage soldiers in a more integrated fashion were being established, the Army began to face significant challenges fielding sufficient numbers, and in some cases types, of equipment to soldiers as they fought or prepared to deploy to operations in Afghanistan and then Iraq. Unit leaders were rapidly identifying shortfalls in soldiers' individual clothing and equipment in particular, concerns echoed by members of Congress and their constituents. In response, the chief of staff of the Army directed the creation of what became known as the Rapid Fielding Initiative (RFI), a division within PEO Soldier focused solely on identifying, purchasing, and fielding packages of the best-available equipment to units as quickly as possible. The RFI process was aimed at leveraging well-developed (frequently commercially available) technologies to enhance soldier and unit capabilities,

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[4] Army Science Board, *1991 Summer Study Final Report: Soldier as a System* (Washington, DC: Department of the Army, December 1991): report documentation page. [ASB, 1991]. http://www.dtic.mil/dtic/tr/fulltext/u2/a250381.pdf

[5] ASB, 1991: report documentation page, continuation page.

[6] ASB, 2001: 9.

[7] Slides provided to study team by PEO Soldier, PD Integration, January 2014.

bypassing the traditional acquisition system that was too inflexible and slow to meet operational demands.

These efforts had at least two major outcomes. First, the equipment Army soldiers wore or carried became much more advanced and capable, across the board. Today, soldiers' "kit" closely tracks some of the best materials, optics, and personal protection equipment available. Second, the Army's overwhelming focus on ensuring delivery of that gear meant less attention was paid to longer-term efforts aimed at the holistic integration envisioned when the Army began to put the pieces of a systems-based structure in place.[8]

As the demands of rapid fielding began to moderate, the Army again refocused on expanding integration across the soldier system. Starting in 2007, various organizations within the Army led multiple reviews.[9] Some resulted in the creation of new governance bodies designed to inform the development of soldier, and (more prevalently than in the past) squad, capabilities. Various organizations within the soldier/squad enterprise continue to carry out periodic reviews, whose results represent real progress toward a more coherent approach to ensuring the most capable soldiers and squads. That said, numerous challenges remain to fully realizing the benefits of a truly systemic approach.

The Soldier/Squad Portfolio

Almost every organization in the Army touches soldiers and squads in some way. However, even within the community of stakeholders most directly involved in providing current and future squad capabilities, terminology varies. This in part reflects their different roles and responsibilities. As noted above, in recent years the idea of treating individual soldiers as systems has given way to an even greater focus on treating the squad as the relevant unit of analysis. In either instance, some Army organizations—for example, those in the research and development and requirements communities—are primarily concerned with optimizing across the full range of DOTMLPF[10] solutions that comprise the inputs to soldiers' capabilities. Other organizations are focused more narrowly on the interplay *within* a given solution area: for materiel, for example, the acquisition community focuses on how the equipment pieces interrelate, whereas in personnel, specific laboratories examine the interactions between soldiers' physical, cognitive, and psychological capabilities.

With respect to the materiel aspect of the soldier/squad system, both the items and how they are approached vary widely across organizations. Table 1 illustrates some of those differences across three major stakeholders in the soldier/system enterprise. While it may appear just a question of taxonomy, variations in how items are typically

[8] This is not to say that *no* integration occurred during this time. However, particularly earlier in the decade, much of it was post hoc, in response to challenges that arose after fielding. For example, the Army had to revise the design of its helmets and body armor when it became apparent that the two collided behind the neck when soldiers were in a prone position (e.g., when shooting). Study team interviews, December 2013–February 2014.
[9] These included a series of soldier system reviews, multiple capability portfolio reviews (CPRs), and the establishment of the Soldier and Squad Systems Review (S3R).
[10] DOTMLPF: Doctrine, organization, training, materiel, leadership and education, personnel, and facilities.

Table 1: Categorizations of Soldier/Squad Equipment

Item Type	Maneuver Center of Excellence (MCOE)	Program Executive Office (PEO) Program Manager/Product Director[11]	Headquarters, Dept of the Army G-8
Boots, Gloves, Jackets	Soldier Systems	Soldier Protection and Individual Equipment	Protection
Armor, Helmets, Eyewear	Soldier Systems	Soldier Protection and Individual Equipment	Protection
Personal Power Systems (Batteries), Chargers	Operational Energy	Soldier Warrior	Sustainment
Packs/Pouches (soldier load)	Soldier Systems	Soldier Protection and Individual Equipment	Sustainment
Unmanned Systems	Unmanned Ground Systems	Robotics Systems Joint Project Office[12]	Lethality
Hand-held Electronics (e.g., GPS)	Electronics Special Developments	Soldier Warrior/Sensors and Lasers	Mobility/Situational Awareness
Radios and Communications	Electronics Special Developments	PEO Command, Control, Communications—Tactical	Situational Awareness/Mission Command
Night Vision, Sights, and Scopes	Electronics Special Developments	Soldier Sensors and Lasers	Mobility/Situational Awareness/ Lethality
Lasers	Electronics Special Developments	Soldier Sensors and Lasers	Sustainment
Lights (Flashlights, Weapons Lights)	Operational Energy	Soldier Sensors and Lasers	Mobility/Situational Awareness
Nett Warrior	Soldier Systems	Soldier Warrior	Situational Awareness
Weapons (Individual, Crew Served)	Lethality	Soldier Weapons	Lethality
Ammunition (Individual, Crew Served)	Lethality	PEO Ammunition Maneuver Ammunition Systems	Lethality

"binned" adds an additional element of complexity to an already complicated set of interactions.

While just one element of the soldier/squad system, even within materiel, achieving an integrated approach is difficult, particularly when there is no common vision of what role different types of items play in the whole. The challenge of generating that common vision is complicated by some of the attributes of the soldier system equipment portfolio and how those attributes relate to the processes for setting requirements; developing, acquiring, and fielding items to support them; and providing funding for those efforts over time.

[11] All program managers/product directors fall under PEO Soldier unless otherwise noted.
[12] Unmanned ground systems are procured through a joint program between the Army and the Marine Corps.

Portfolio Attributes

Infinite Variability

One of the primary and most unique attributes of the soldier/squad portfolio repeatedly raised in the course of the study team's research was the inherent variability of the human "platform." In engineering terms, unlike a vehicle or other piece of equipment, the soldier operates on a human chassis[13] of infinite variability. To carry the analogy further, the soldier also has an infinitely variable "operating system" comprising both bodily (cardiovascular, nervous, respiratory, etc.) and perceptive (cognition, affect, emotions, etc.) subsystems.[14] This complexity vastly increases the difficulty associated with developing and implementing a systems approach.

Operational Ubiquity

Another primary attribute of the soldier system that distinguishes it from most other Army systems is its ubiquity. Soldiers are employed in every operation, regardless of physical terrain, climate, mission, or any other distinguishing characteristic. This factor requires stakeholders to consider an immense number combinations with which the soldier/squad system must contend.

Degree of Component Interdependence

One of the most challenging aspects of realizing the vision of the soldier/squad system is that while all the pieces of soldier equipment *should* interoperate, the consequences of falling short of that goal are often masked. The rationale behind a systems-based approach is clear, but soldier equipment differs from, say, a tracked vehicle or helicopter program, which *must* be conceived, designed, and acquired using a systems model. For soldier equipment, the absence, failure, or shortcoming of any individual element of "the system" may or may not have a significant impact on soldier performance. In any case, it is rare that a single component's failure will render the soldier (or the rest of the "system") inoperable. The same general concept also holds for a squad.

For major platforms, however, critical component limitations can render the entire weapon system unusable, if not completely then at least under certain conditions. The effects of such failures are captured and reported to higher echelons through readiness reports and other metrics that help create the case for additional funding and attention. No reporting mechanism exists to promote that similar steps be taken to address soldier system component failures. Again, while the practical effects of shortcomings within the soldier and other platforms may in reality be equal, they are not seen equally by supporting processes. In practice, then, Army processes implicitly treat the soldier system as if its components are more loosely interdependent than is the case with other weapon systems.

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[13] The use of the word "chassis" is not intended to dehumanize the soldier; however, some people object to the term's use because of that connotation. The intent is solely to make the point that, unlike every other "system" the Army operates, soldiers cannot be "manufactured" to meet designated specifications.
[14] Study team interview, February 25, 2014.

The attributes described above have profound implications for the practical steps necessary to achieve a truly integrated, family-of-systems approach to soldier equipment. These attributes also place an extremely high premium on ensuring that the requirements, which set the parameters for the acquisition and resourcing processes that follow, reflect that systems-based thinking. However, as will be discussed more fully in Chapter 2, that level of integration has not yet been achieved. One reason for this is that, with limited exceptions, soldier/squad requirements continue to be crafted for the "piece parts" of the system rather than for a more cohesive whole.

Requirements: Where It All Begins

For materiel solutions, the generation of soldier requirements follows the Defense Department process known as the Joint Capabilities Integration Development System, or JCIDS.[15] JCIDS stipulates that valid requirements must align with gaps in military capabilities, which are identified through various reviews. Once gaps are identified, the military services propose "requirements documents" to address them. These documents align with various acquisition milestones, and must be approved at each step for programs to move forward.

In part because each piece of kit is capable of serving its purpose independently of the rest of the system, each has its own requirements document that specifies key functionalities at the component level. Each of these documents, in turn, undergoes a lengthy approval process.

Most of the requirements documents for soldier and squad equipment are initiated by the Army's Maneuver Center of Excellence's (MCOE) Capability Development Integration Directorate (CDID).[16] MCOE has been a leader in recent years' efforts to reinvigorate the "systems" mindset, and in highlighting the need to move to the squad as the proper unit of analysis.[17] Despite leading much of this conceptual work, however, CDID continues to produce requirements documents for individual pieces of soldier gear. According to multiple organizations, these documents frequently contain high levels of specificity about items' individual characteristics, enumerated across a vast range of conditions due to the platform variability and operational ubiquity attributes discussed above.[18]

Interviews conducted by the study team indicated that the main reasons for this apparent disconnect can be traced to other processes.[19] First, in order to develop or

[15] JCIDS applies only to equipment; solutions to capability gaps in other areas (doctrine, training, etc.) are captured in DOTMLPF Change Requirements, or DCRs. This process difference creates another gap that must be overcome in implementing a true systems-based approach.
[16] Each of the Army's Centers of Excellence has a CDID that is dedicated to capturing the future requirements for Army capabilities in its respective area of responsibility. Unless otherwise noted, in this paper "CDID" refers specifically to CDID at the Maneuver Center.
[17] This is because the squad is the smallest Army element, which serves as the building block for larger formations. (Soldiers, on the other hand, are not intended to operate as individuals.)
[18] There have been some areas where the requirements have been expressed at the subsystem level, such as the Soldier Protection System, which includes hard and soft armor, head and eye protection, and helmet sensors.
[19] Some interviewees also suggested that soldier/squad requirements writers are not sufficiently trained or experienced, a finding echoed in one study's conclusion that "Army requirements…core competencies

purchase a piece of equipment, that equipment must first go through a rigorous test and evaluation process. Determining whether or not an item meets the requisite standards necessitates a certain level of specificity.

A second driver of the detailed, individual component-level approach to requirements documentation for soldier systems comes from the Army's approach to resourcing. The Army has determined that, in order for items to be considered eligible for inclusion in the budget and program, they must have a validated requirement. Part of the validation process includes an affordability determination. If the Army resource community perceives that a proposed requirement cannot be paid for, approval is delayed until the requirements are adjusted. That process is informed by sophisticated cost analyses, which cannot be performed without some level of specificity about what is actually being proposed.

Study team interviews suggested a third, albeit more subjective reason that CDID writes such specific requirements, borne out of what appears to be inherent tensions and, at least to some degree, mistrust between some of the stakeholders. While some degree of tension is inevitable (and even desirable) between organizations that bring different perspectives and areas of expertise to bear on an already complicated system, study team interviews indicated that the way that soldier system organizations are funded has resulted in increased competition for rapidly decreasing funds between the stakeholders.

As a result, study team discussions indicated that CDID staff feel compelled to continue to produce requirements documents for most of the items that comprise the soldier/squad system, with a high degree of specificity.[20] Different ways to address these constraints have been proposed, and are discussed in more detail in Chapter 4. But current practices, whatever their origins, have resulted in a major drag on the system, for numerous reasons.

Throughput Problems

Whatever its cause, the practice of treating most component parts of the soldier system as separate items creates a huge amount of bureaucratic churn. MCOE has to produce multiple documents for 300 to 400 different items, each of which then goes through a complex vetting process with up to six separate staffing actions.

For many major systems, the time it takes to staff these documents roughly aligns with the timelines associated with technological development. But for programs that are relatively low-tech or rely on mature technologies (which characterizes much of the soldier systems portfolio), interviewees identified an overburdened staffing process as the limiting factor on progress.[21] On the one hand, the Army's practice of advancing

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have eroded in the last two decades and are in urgent need of repair." Final Report of the 2010 Army Acquisition Review, *Army Strong: Equipped, Trained and Ready* (Washington, DC: Department of the Army, January 2011), iii. [Decker-Wagner, 2011] The study team was not in a position to evaluate the degree to which this might play a role in requirements challenges.

[20] Study team interviews of MCOE and PEO Soldier staff, December 2–3, 2013, and January 15, 2014, respectively.

[21] The problem of lengthy staffing for requirements is broadly acknowledged. The 2011 Decker-Wagner report on Army acquisition identified it as a major issue, and offered recommendations to make the process more collaborative and timely (Decker-Wagner, 2011: xii–xii). Study team interviews revealed

requirements for individual components of the soldier system increases the burden on staffs to process those actions, which in turn affects the quality of the deliverables. On the other, it allows more straightforward (i.e., more developed or low-tech) programs to move forward without being slowed by other parts of the system portfolio that might require a more deliberate approach.

The volume of documentation has grown still further as a result of operations in Iraq and Afghanistan. Over the last decade, the Army rightly expedited equipment acquisition by using "operational," "urgent," or "joint urgent operational" needs statements (ONS, UNS, or JUONS) generated by deployed or deploying units to serve as the initial requirement. The acquisitions that followed were primarily funded with supplemental, or "other contingency operations," funding, rather than funds that had been requested and approved in the base budget.[22] While this process was wholly appropriate for the circumstances and resulted in much faster fulfillment of soldier needs, a known second-order effect was that funding to sustain or modernize anything fielded during this time would have to be addressed later. CDID is now taking on the challenge of writing requirements documentation for the RFI-procured items that the Army has determined it needs to retain.[23]

This added workload is supplemental to both CDID's traditional soldier system responsibilities and the recent addition of two new branches: unmanned ground systems and operational energy. The expansion of the soldier system portfolio was widely recognized as necessary and appropriate in the study team's interviews. However, MCOE did not receive additional personnel to address the broadening of its remit.

As CDID's workload has increased, factors have influenced the speed and ability of the organization to address it. Beyond the specific staffing challenges noted above, the Training and Doctrine Command (TRADOC)—of which MCOE and CDID are a part—as a whole received fewer personnel over the last decade, because manning deploying organizations became the highest priority.[24] The operational demands have lessened, decreasing one source of pressure on the personnel system, but the need to downsize the Army has created another. Thus, while it is by no means unique in this regard, CDID remains well below the levels of personnel it is officially recognized as needing to perform its duties, despite the recent expansion of those responsibilities. Ultimately, the increased workload without a commensurate rise in resources has contributed to a decrease in quality of the requirements documents themselves, a frustration recognized and shared by almost all interviewees.

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little progress and a recent Army Capabilities Integration Center (ARCIC) analysis identified the ability of numerous entities to say no and the continuation of "serial staffing" as continued impediments. (Untitled ARCIC slides provided to the study team, September 2013.)

[22] According to PEO Soldier, the baseline of common and duty-position equipment for a squad leader includes 81 items, of which 18 were procured with other contingency operations funding.

[23] It is also, to some extent, writing requirements for items that the Army has procured for decades, before the Joint Capabilities Integration Development System (JCIDS) process was designed. As new technologies in some of these areas (e.g., lightweight ammunition) are being developed, the Army's ability to acquire them rests on the existence of a validated requirements document.

[24] Deploying units were manned at above their authorized levels to ensure they had sufficient personnel during their tours, which created shortfalls in the staffs of "institutional" organizations such as TRADOC.

Increased Oversight

The Joint Capabilities Integration Development System (JCIDS) was primarily designed for large or complex weapon systems, in part to ensure that such systems received a level of oversight commensurate with their significant expense. The time inherent in following the process, while frequently bemoaned, is in many cases tolerated because other aspects of the process (systems integration, technology maturation, etc.) are also lengthy. Increasingly, however, efforts like those of the Army's RFI and the Office of the Secretary of Defense's Rapid Fielding office that were created over the last 13 years of war highlighted JCIDS's shortcomings when applied to the full range of Defense Department acquisitions.

These shortcomings manifest themselves in some portions of the soldier/squad portfolio in particular. As alluded to above, some parts of the portfolio (e.g., sensors, robots, or night vision equipment) include items that are highly complex, utilize advanced technologies, or are expensive (all of which are better aligned with the attributes for which JCIDS applies most aptly). Other parts, however, such as clothing or load carriage, are either directly available commercially or are modifications of commercially available products.[25] These tend to be much cheaper and have a much shorter timeframe for obsolescence. While JCIDS contains sufficient flexibility for the Army to purchase the latter items with a lesser degree of oversight than is required for many larger programs, study team interviews indicated that much of the soldier system portfolio is on the more onerous path. One reason has already been discussed: to obtain sufficient funding for both the initial fielding but also the sustainment, Army resourcing organizations require a JCIDS-approved requirement, even if it may not be technically necessary. Another reason discussed in our interviews was that, while the authority exists to use more streamlined approaches, applying that authority requires so much justification that it is ultimately easier and faster to take the traditional path.[26]

Both of these circumstances fall within the Army's control, and thus could be changed. That said, for many items within the soldier system portfolio, JCIDS offers less discretion. This is due principally to the Army's scale. One of the "triggers" for greater acquisition oversight is the total amount of funding required.[27] Even if the individual unit cost of a certain soldier item (e.g., ear protection) might be relatively small, if those items must be bought for the entire force, sometimes in multiple sets for each soldier, the costs exceed acquisition-funding thresholds. This results in the application of processes that add time and staff effort, while slowing opportunities to refresh what is ultimately bought with newer technologies.

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[25] In many cases, the private sector's ability to produce items that meet military needs reflects a collaboration with the Department of Defense's science and technology (S&T) community. The S&T enterprise provides, among other things, methodologies, standards, testing, and other resources that inform product development, transitions that are often masked but are an essential enabler to commercial production.

[26] Study team interview with acquisition colonel, December 2013.

[27] The Defense Department recognizes four major acquisition categories (ACATs), some with additional subcategories. Categorization is determined by various thresholds on total research and development or procurement expenditures, and affects the level of ultimate approval authority, among other facets of oversight.

Complex Contracting

A final implication of the Army's practice of pursuing many requirements documents for individual items within the soldier systems portfolio relates to how that practice aligns with the companies that produce those items. The soldier system portfolio is incredibly broad. As a result, its supplier base includes companies that are both large and small, that are exclusively focused on federal customers and are principally commercially focused, and that run the gamut from advanced to basic technologies. For many items within the soldier system portfolio, this means that there are many qualified bidders. One former PEO Soldier commander has written that solicitations can get a dozen or more potential responses.[28] On the one hand, this enhances competition and offers the government the potential for better prices. On the other, it can complicate the contract-award process and increase the likelihood of protests once determinations are made, resulting in delays. Ultimately, the sheer number of individual programs that soldier system program managers and product directors must manage creates additional challenges both to timeliness and to integration, as discussed in Chapters 2 and 3.

For all of these reasons, despite best efforts of all involved, soldier equipment is currently caught up in a process that is behind, slow, and in many ways ill-suited to the characteristics of the portfolio. Not surprisingly, this is inhibiting progress toward realizing the vision of a fully integrated soldier/squad system.

[28] BG(Ret) James R. Moran, "Soldier Systems: Outfitting the Army," *Army Magazine*, June 2013, 22.

2 | Integration: The Key to a Systems Approach

As noted in Chapter 1, over the last five to six years, the Army has made significant progress in shifting its thinking about soldier equipment to reflect a systems construct. Implementation, however, has lagged behind.

The generation of item-specific requirements, which in turn drives the acquisition of individual items, is not inherently at odds with a systems-engineering approach. That is, it is possible to buy individual items (as the Army largely does today) that can then be integrated into a coherent whole, but this task is greatly complicated if their purchase is not preceded by a systems design. That design exists conceptually,[29] but not with sufficient subsequent fidelity to directly inform acquisition. There are other dimensions to the integration challenge as well, some of which have seen good progress and others of which remain a challenge.

Achieving Unity of Effort

Perhaps the biggest challenge to implementing a systems approach is harnessing the respective strengths of the range of stakeholders who affect the soldier/squad system. For example, within the Centers of Excellence (COEs) alone, as the proponent for the Infantry, the Maneuver Center has primary responsibility for developing requirements for the "baseline" soldier.[30] However, each of the other seven[31] COEs advocate for unique needs of soldiers associated with their areas of interest (maneuver support, intelligence, etc.). Similarly, for acquisition, while PEO Soldier has responsibility for most soldier equipment, most of the other PEOs (Ammunition, Electronic Information Systems, Aviation, etc.) have direct ties into the soldier portfolio, and all of them affect it at least indirectly. This same challenge—driven in part by the ubiquity discussed in Chapter 1—exists within every other function that relates to realizing the soldier/squad system, from resourcing to science and technology.

In addition to the challenge of synchronizing efforts within each element of the stakeholder community (currently addressed by assigning a "lead" within each, but whose influence varies), there is the added (and perhaps even more significant) difficulty of achieving synergy across the functions. At its essence, a systems-based or systems-engineering approach requires optimizing across the entire system. The main players in soldier/squad system design and development are the requirements generators (with MCOE as the lead), the research, development, and engineering (RD&E) and science and technology (S&T) community (with the Natick Soldier RD&E Center, NSRDEC, as the lead), and the acquisition community (with PEO Soldier as the

[29] For example, in MCOE's squad-based analyses from which capability gaps are generated.
[30] And, more recently, for the baseline squad, an infantry rifle squad.
[31] The Army is standing up a ninth COE for cyber.

lead).[32] The first two organizations fall under different Army four-star commands (Training and Doctrine Command, TRADOC, and Army Material Command, AMC), while the latter reports to the Office of the Assistant Secretary of the Army (Acquisition, Logistics and Technology) in the Army Secretariat. As a result, the only person with authority and responsibility over all the players is the secretary of the army.

Not surprisingly, then, no single entity within the soldier/squad system community is empowered to make system-informed trades. This challenge is not unique to soldier/squad systems, but different roles and responsibilities, coupled with some degree of mistrust between the players, complicate the development of a shared and consistent vision.[33]

As noted in Chapter 1, the nature of the interdependence within the soldier/squad system (i.e., the ability of many components to perform relatively independently) means there is less an obvious *need* for that shared vision. For a major weapons system, that shared vision is a prerequisite for achieving support in Army and Department of Defense acquisition and budgeting processes. This does not hold for soldier or squad equipment, which removes a major forcing function.

Another potential inhibitor to that shared vision is that the three main players (MCOE, PEO Soldier, and NSRDEC) are not colocated.[34] Multiple interviewees noted that programs, both past and current, that have at least two of the main stakeholders on the same installation benefit from stronger relationships that proximity enables. That said, none of those we interviewed suggested that this reality is likely to, or necessarily should, change. Indeed, the rationale for the primary stakeholders' current locations is strong, based on the totality of their respective missions. However, it was noted that the geographic dispersion between key stakeholders makes building relationships, developing a common outlook, and working through trust issues a more difficult proposition.

Conceptual and Practical Challenges

Beyond organizational frictions (some of which actually add value to the process), achieving a systems-based approach requires the development of a common framework supported by a set of analytic tools. That is, unity of effort is hampered first by the lack of a unified vision, not least because of differing roles and responsibilities among the major players. MCOE is charged, for example, with recommending solutions to gaps in soldier and squad capability from across the full range of DOTMLPF alternatives. Its "trade space" consists not only of soldier equipment, but multiple other ways to address shortfalls, which could include adjustments to training, the types of soldiers selected to perform different roles,

[32] Other major stakeholders include the contracting community, ARCIC, the Army staff (both the operations and programming and budgeting communities), and industry.
[33] Again, some interviewees suggested that funding competition, particularly within the "base" budget, contributes to this mistrust. Recognizing others' organizations, it was argued, can come at the (literal) expense of one's own.
[34] The Maneuver Center is at Ft. Benning, Georgia; PEO Soldier is at Ft. Belvoir, Virginia; and NSRDEC is in Natick, Massachusetts. However, it is worth noting that PEO Soldier matrix support teams are also located in Natick to work in concert with NSRDEC.

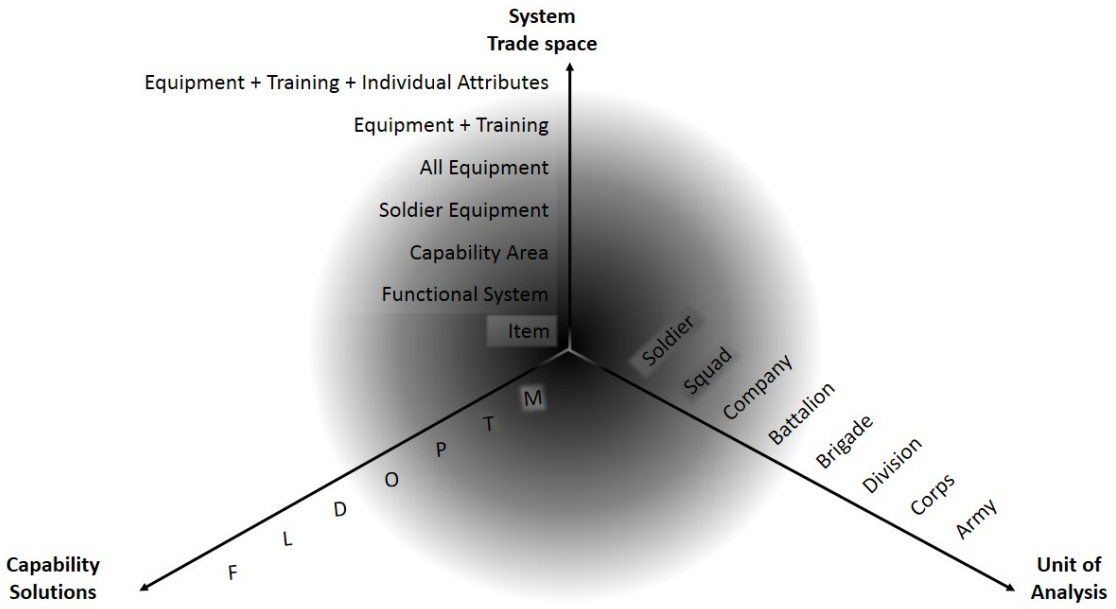
organizational changes, or new doctrine. PEO Soldier, on the other hand, focuses on materiel; its trade space generally falls within the soldier equipment portfolio. NSRDEC, which is responsible for taking basic research and developing it into soldier-specific applications, has a trade space that extends across the full DOTMLPF portfolio as well, though some argued that they also focus primarily on materiel aspects. Unlike MCOE, however, NSRDEC's approach to that trade space places less emphasis on the doctrine, organization, logistics, and facilities solutions, and a much stronger one on what NSRDEC representatives term "the inside and the outside" of the "soldier chassis."[35] None of these frameworks neatly aligns with Army resourcing processes, which assess funding in six Program Evaluation Groups, or PEGs: manning, training, organizing, equipping, sustaining, and installations. Though almost every portfolio touches more than one PEG, the soldier/squad portfolio is particularly fragmented, and the effects of that resourcing reality are felt more acutely as a result.

In recent years, the soldier/squad community has taken steps to help better reconcile their respective contributions and emphases. The current focus is on establishing a baseline for soldier equipment as a departure point for broader systems analysis. While apparently a straightforward task, developing this baseline is taking time. Because soldier equipment is highly variable—by operational environment, mission, type of unit, and role within the unit—stakeholders have had to work through the development of representative tasks, environmental conditions, and other features. From a process perspective, this work is being vetted through a new Configuration Control Board (CCB), cochaired by PEO Soldier and MCOE. Approval of the equipment baseline is one of the first actions the CCB is expected to determine.[36] To support this work, the Army has had to recover and analyze data detailing which generations of a given piece of equipment have been fielded to whom and for what purpose. Because of the iterative process of fielding over the last decade-plus, like units have multiple variants of the same piece of equipment, and/or different pieces altogether.

The study team developed a basic model of the integration challenge, depicted in Figure 1. The model has three major dimensions: one relates to the unit of analysis (which ranges from the individual soldier to the entire Army), one covers the full range of DOMTLPF solutions,[37] and one relates to the scope of the trade space (which ranges from an individual piece of equipment to the breadth of interactions between a piece of equipment, the individual, and the environment and task).

[35] By this they mean optimizing across soldier skills, knowledge, and attributes (the inside) and the full range of soldier- and squad-relevant equipment.
[36] Study team interviews with MCOE and PEO Soldier.
[37] Albeit in a different order.

Figure 1: Scoping "the Soldier/Squad System"



Color intensity indicates degree of common focus/scope across Army organizations.

As discussed in Chapter 1, the locus of Army activity in the requirements, acquisition, and funding realms remains close to the axes' origin—that is, at the individual item level, in the materiel solution space, and on the "outside" of the soldier. There are, however, multiple indications that this is changing at least to some degree. MCOE's CDID, for example, has placed a growing emphasis on integration across their divisions (though our interviews suggested that these efforts may be closer to deconfliction than true integration, and that they largely focus on materiel). In cooperation with other organizations, PEO Soldier's Integration Division is also taking multiple steps to strengthen both bureaucratic mechanisms and analytic tools to support more of a systems-engineering approach.[38] Limited resources inhibit these efforts, however, and (appropriately) they are also principally equipment oriented.

NSRDEC is attempting to foster broad-based support for what they term an "Anthropocentric Systems Engineering and Soldier Systems Engineering Architecture." This is the most comprehensive and ambitious formulation, attempting to establish a framework at the squad level that encompasses the human (including both individuals and group interactions), equipment, and task dimensions, and that envisions soldier/squad development as "mostly human with a materiel interface." Though still in its early stages, NSRDEC is developing a more cohesive and coordinated

[38] These include the aforementioned establishment of a configuration control board, but also the development of models like the Load Effects Assessment Program–Army (based on a Marine Corps tool), as well as applications that will help squad leaders to match missions and optimized loads, etc.

alliance across multiple organizations that will be informed by analysis and data reflecting this broad architecture.[39]

Ultimately, though all of these efforts move the Army along each of the axes in Figure 1, there is still no shared view of how far is far enough. Progress is being made along each axis, and some of the tools to enable a better understanding of the trade space are being put in place. But these efforts are under-resourced, and the building of consensus to advance them is slow.

A System for What?

While there is obvious value to a more systemic approach to the soldier and squad, that utility is diminished if the capabilities it results in are misaligned with the environment in which they must operate. The study team was not able to conduct a thorough examination of the entire soldier and squad enterprise, but our interactions with the major players in the Army revealed infrequent mentions of the future and relatively little explicit consideration of its implications for their activities.

Supply and Resupply

A key challenge facing soldiers today is a lack of confidence in supply lines. Soldiers carry extra weight beyond what they immediately need because they want to be prepared. In future operating environments where reliable supply lines are even less likely, mitigating these risks will come down to trust in leadership, an individual's ability to "live off the land," and the potential employment of mixed-use technologies.

That is not to say that the Army as a whole has not done significant work on examining the future operational environment. Led by TRADOC, the Army has analyzed dozens of major trends, from demographics to technology to social networks, to develop a vision of what the future environment might entail. The Army's view includes a growing emphasis on small-unit, widely dispersed actions, the increased likelihood of operations in urban terrain, and a need to be able to deliver precise effects along the lethal and nonlethal spectrum.

These projections are being at least partially incorporated into thinking about soldier and squad development. For example, expectations of dispersal form the conceptual underpinning for the Army's emphasis on pushing the network down to the lowest possible level to support more dispersed, smaller formations, and on ensuring adequate supplies of power and enhanced situational awareness. However, some analyses suggest that other implications may be less fully addressed. For example, one study indicates that in the future, Army units will be required not only to rapidly deploy long distances (a requirement the Army acknowledges), but also to be employed immediately upon arrival and then rapidly extracted, a timeline that may be too stringent for the establishment of traditional supply lines.[40] Another recent book on the implications of technology and urbanization concurs with the Army's

[39] This view predates but is also consistent with that recommended by the National Academy of Sciences' Board on Army Science and Technology (BAST), which recently found that the Army "does not adequately include the complexities of individual Soldier tasks and human interactions within teams." BAST, 2013: 3.
[40] Nathan Freier et al., *Beyond the Last War: Balancing Ground Forces and Future Challenges Risk in USCENTCOM and USPACOM* (Washington, DC: CSIS/Rowman & Littlefield, April 2013), https://csis.org/files/publication/130424_Freier_BeyondLastWar_Web.pdf.

views on the growing likelihood of future operations in cluttered mega-cities. It also goes on to suggest, however, that there may therefore be a need to design units at sizes much smaller than the current squad—for example, in teams of two or four—that are prepared to be self-sufficient for as much as 72 hours.[41]

On the "human" side of the equation, for at least the last five years various organizations with the Army have been developing ideas about what has come to be known as the "human dimension." While the term is used inconsistently, it essentially refers to soldiers' cognitive, physical, and social attributes.[42] This work is informed by expectations that future operations will be increasingly fast-paced and that information will be pervasive, placing increasing demands on soldiers and teams. These ideas are also a core element of the Army's evolving work on the concept of "strategic landpower," and are being explored in the context of recruiting, training, leader development, and education.

Again, however, the tie of these efforts into the development of soldier and squad materiel-enabled capabilities appears tenuous, at least as far as the study team could discern. They are addressed much more explicitly in the systems approach being proposed by NSRDEC, and thus the potential for a more robust linkage is at least under consideration. But at present the efforts seem relatively loosely linked.

To reiterate, this is not to suggest that all of the ideas above are not being explored by one or more organizations within the Army; they may well be, and likely with great rigor. But the study team did not encounter signs that the requirements, acquisition, resourcing, or R&D organizations with whom we interacted had a clear, shared vision of the future operating environment that was informing their activities aimed at advancing the soldier and squad. It may be that some of the expanding systems architecture being advanced may bring about that shared vision, but it does not appear to exist today.

[41] David Kilcullen, *Out of the Mountains: The Coming Age of the Urban Guerrilla* (New York: Oxford University Press, 2013), 285.
[42] The National Academies' BAST report offered an even more comprehensive definition that covered "all of the attributes of the individual Soldier and of the collected Soldiers of the [tactical small unit] that impact performance of mission tasks." BAST, 2013: 22.

3| Meeting Future Needs

In the absence of a shared vision for both the architecture for the soldier/squad system and the future needs that system must be prepared to address, the Army is likely to continue along a path that places greater emphasis on the individual soldier (specifically, soldier equipment, and more specifically, individual items of equipment) than on the system as a whole. Resisting the pull of inertia will require more than achieving those shared visions, however. It will also necessitate developing a response to address threats to continued innovation, one that accounts for some of the unique attributes of the soldier system portfolio.

Over the last decade, the primary driver of innovation has been the imperative to meet and seek to overcome adaptive adversaries. Bureaucratic processes gave way to workarounds, supported by funding dedicated to fielding the best available solutions as rapidly as possible. Looking forward, the Defense Department sees an environment that is no less challenging. However, as force levels fall in Afghanistan and other engagements remain limited, battlefield needs will be less of a forcing function driving innovation. Furthermore, budgetary constriction is forcing major reductions to even basic levels of modernization.

As a result, both Defense Department and Army leaders have recognized that fostering continued innovation will be a challenge. They plan to continue to modernize existing equipment as needed, but also to protect key investments in science and technology in order to "focus on the development of next generation breakthrough technologies that will define the Army of the future."[43] While Army organizations will play a key role in that research and development, the soldier systems industrial base, and the funds those companies invest in internal research and development (IRAD), is an equally important partner.[44]

While a sound approach, this strategy's application to the soldier systems portfolio may prove challenging. With respect to leveraging private-sector IRAD, there are aspects of the soldier system portfolio that make this particularly tenuous. First, as noted in Chapter 2, the Army has not expressed a clear vision about what its priorities are for the future soldier/squad system. While the Army science and technology community has identified priorities,[45] how those priorities specifically relate to soldier systems is less clear. Companies involved in the soldier system enterprise acknowledge the Army's long-standing and continued desire for equipment to be "lighter, faster, cheaper, and more efficient," but the study team was unable to

[43] Assistant Secretary of the Army Heidi Shyu, as quoted in Amy Guckeen Tolson, "Shyu defines strategy for modernization at AUSA," February 24, 2014, http://www.army.mil/article/120398/Shyu_outlines_strategy_for_modernization_at_AUSA/.
[44] Association of the United States Army (AUSA), "Phillips outlines acquisition reforms," September 12, 2012, http://www.ausa.org/news/2011/Pages/AUSAILWBreakfast.aspx.
[45] See, for example, DASA(R&T) Mary Miller's comments in December 2013, quoted in Dan Lafontaine, "RDECOM discusses contracting opportunities at 2013 APBI [Advanced Planning Briefing for Industry]," December 5, 2013, http://www.army.mil/article/116523/RDECOM_discusses_contracting_opportunities_at_2013_APBI/.

identify well-understood priorities or objectives in more than a few cases, and not at a system-wide level.[46]

A second and perhaps even greater impediment to efficient and effective investment of industry IRAD funding is the uncertainty of the soldier systems budget. Because of how soldier systems are funded, there is less clarity on the exact amounts planned and budgeted than is typical for more traditional weapons systems.[47] Nor is there much apparent appetite within the Army to offer greater clarity, as the expected result would be more difficulty in moving funds around in response to changing circumstances. The opaque and uncertain nature of the soldier systems budget was less concerning when funding was more readily available and suppliers felt that the Army was ready and willing to field improvements when developed. As that reality changes, however, industry leaders are arguing that they cannot justify IRAD investments without the budgetary information to support a reasonable business case. Again, this is a challenge for defense industry as a whole, but it is particularly acute for many suppliers to the soldier systems portfolio, some of whom rely on small and medium companies along complex supply chains. Confidently anticipating potential future revenue streams is difficult because of the high level of aggregation (i.e., lack of specificity) in publicly available budget information. It is further complicated by the inherent flexibility of the type of funding that dominates the portfolio (which means previously planned purchases can easily be moved if priorities change).

Defense companies in the soldier systems enterprise will likely continue to invest at least some level of IRAD, as this forms the "seed corn" for expected future business. In addition, many companies in the soldier systems enterprise have commercial interests as well that can both drive and benefit from defense-related advances. The Army leaders the study team spoke with generally believed that, while not optimal, the available information and incentives were sufficient to continue to meet the Army's needs over the long term.

This may well be true. But there are also reasons to believe that a more active approach is warranted. First, it is clear that funding for soldier systems will fall dramatically—indeed, it has already dropped from wartime highs in the $5 billion/year range to approximately $1 billion/year.[48] Again, future funding levels are unclear, and the Army representatives the study team spoke with expressed a desire to maintain future flexibility by not committing to specifics in this area. While this is an appropriate response given the degree to which soldier equipment has been modernized in recent years and broad and intense budgetary pressure, it ensures that the soldier system industrial base will also contract.

What is less clear is exactly how this contraction will occur. While the Office of the Secretary of Defense and the Army both monitor the health of the industrial base, for the most part those efforts focus on high-technology suppliers. This characteristic

[46] There are a few programs in which performance parameters and objectives have been identified, along with constraints, and industry has been asked to develop approaches that seek to optimize against those objectives in support of an improved system capability (e.g., the Lightweight Advanced Combat Helmet).
[47] Much of the funding for soldier equipment comes through the operations and maintenance appropriation, which has broad funding categories within which funds can be readily adjusted. This means that companies have limited ability to see how much is actually planned to be invested in certain soldier systems in the future.
[48] Study team interview, February 25, 2014.

holds for certain aspects of the soldier systems portfolio (e.g., night vision goggles and sensors). It applies less well to items that are commercially based, but that have military-unique features (e.g., gloves). The study team's interviews revealed less concern about these less advanced but still critical producers.

Another wrinkle that affects at least some of the soldier systems suppliers is the application of the so-called "Berry Amendment," which requires the Defense Department to give preference to U.S.-manufactured textiles. In order to comply with this restriction, there are companies that maintain production facilities in the United States solely for the portion of their inventory sold to the Department of Defense, while the rest is manufactured in cheaper overseas facilities. Thus as quantities decline, these companies may stay in business but close domestic production locations, effectively eliminating them from the defense supply chain.

The soldier systems industrial base also has attributes that exacerbate difficulties faced by defense industry more broadly. Because of the relatively small value and large number of competitors for many soldier equipment programs, small businesses in the soldier system enterprise are particularly challenged by high barriers to entry such as the costs associated with responding to requests for proposals. Many industry partners are particularly frustrated with the practice of choosing contractors based on lowest price, technically acceptable proposals—vice "best value" options—arguing that this practice is best suited for programs with stable configurations but that it is being misapplied to efforts where the Army is seeking innovation and improvements in soldier or squad capabilities.

A final factor the study team's interviews revealed that may inhibit the Army's ability to access privately funded innovation is how it addresses intellectual property (IP) rights. Over time, DoD and Army officials have been increasingly insistent on the need to move to open architecture, nonproprietary solutions. While industry may not like this demand, most companies accept it (and those that do not simply choose to restrict their customer base). But as defense markets shrink and become more uncertain, companies with technologies with dual-use (commercial and military) applications increasingly need to take products to both markets in order to achieve adequate returns on investment. If the Army wishes to leverage those investments, it cannot insist on complete IP control. This reality was acknowledged by Army leaders during discussions as part of this study, who conceded that the Army's current approaches to IP must be updated.

All of these factors inhibit the goal of leveraging private-sector IRAD efforts as defense spending falls. Many of them may also have the effect of driving some suppliers out of the soldier systems market. The huge number of companies involved in soldier system equipment—and their extreme variance, from small businesses that are direct suppliers to multinational companies with extended supply chains—collectively represent a diverse and nuanced industrial base that will, as a result of current budgetary realities, inevitably contract. What the study team's interviews failed to discover, however, is whether the Army has a clear understanding of how that contraction will or should occur. If it does not, the resulting industrial landscape may not be properly structured to support desired innovations and potential future production.

4 | Summary and Recommendations

For over two decades, the Army has endorsed the idea of moving to addressing soldiers—and more recently, squads—in a holistic and integrated fashion. Initially, this concept was considered principally in the context of soldier equipment. More recently, the benefits of expanding the concept to include both the human and materiel aspects—"the inside and the outside"—has gained increasing traction.

While these ideas are becoming more deeply embedded in Army thinking and some of its processes, many other process and organizational barriers hamper their full implementation. What the study team's review found is consistent with the much more fulsome examination conducted by the Board of Army Science and Technology: the Army still needs to "Get Serious About Systems Engineering."[49] This chapter reviews some of the barriers identified in Chapters 1 through 3, summarizes options that might help to overcome them, and makes recommendations for the way ahead.

Item-based, Highly Specific Requirements

The continued generation of soldier/squad requirements largely (though not exclusively) at the level of the individual item creates two problems. First, the practice inhibits system-level trades. Second, it increases the volume of requirements documentation, slowing the process considerably.

Some have argued that a much more efficient approach would be to craft requirements at the squad or platoon level, with detailed appendices covering individual supporting programs.[50] This would greatly alleviate the burden of paperwork, would allow for more rapid updates in specific areas as technology develops,[51] and could in theory facilitate higher system-level trades. Others counter that this idea would be difficult to implement, given the need to provide sufficient fidelity to support both testing and costing, and that a "bundling" approach could result in an even longer approval process, at least for smaller items that might get caught up in the staffing for a broadly cast effort.

There have been multiple other proposals to streamline the requirements process overall,[52] as well as to (at a minimum) fully staff the organizations producing and vetting the documents.[53] While both could provide some much-needed relief from bureaucratic burdens, they would not necessarily address soldier/squad integration problems. (It is possible that a systems framework could be established outside of the official requirements process and then used to inform program- or function-specific requirements, but resulting documentation would have to be carefully crafted to ensure that it did not serve as a barrier to eventual trades among individual capabilities.)

[49] BAST, 2013: 3.
[50] See, for example, Moran, "Soldier Systems," 19–22.
[51] Because program-level changes could be handled with engineering change proposals rather than an entirely new requirements document, a much less burdensome staffing process would result.
[52] For example, Decker-Wagner, 2011, ARCIC proposal.
[53] Study team interviews, December 2013.

- **Recommendation 1:** ARCIC, as the Army organization responsible for requirements generation, should develop options for the chief of staff and secretary of the army with the goals of both accelerating the process for approval of soldier/squad requirements and increasing their alignment with a systems-based approach.

Governance Challenges

Some have recommended that the Army bestow greater authority and influence to one entity or another within the soldier/squad enterprise. The BAST, for example, suggested the creation of a systems-engineering executive authority to provide more consistent direction within the Army acquisition community.[54] Others we interviewed suggested ARCIC, or the Army G-8, or even the vice chief of staff of the army become a "czar" to help bring clarity and focus to soldier and squad development.[55]

There may be a need for a stronger hand within organizations that already fall under a single chain of command within the soldier/squad enterprise (within ASA(ALT) or TRADOC, for example). But the breadth of the enterprise, which spans multiple Army major commands and key organizations in the Army Secretariat, suggests that designating a single individual or organization vested not only with the responsibility but also the authority to direct the soldier/system endeavor would be almost impossible. While not satisfying to a culture that treasures clear lines of command, the reality suggests that the soldier/squad enterprise can only be effectively marshaled by a cooperative, collaborative effort. The good news is that this is largely how the enterprise is governed today, with multiple forums led (often cooperatively) by major actors such as the MCOE, PEO Soldier, or NSRDEC. Newer bodies such as the Configuration Control Board are also being established to help shepherd the systems approach at some level (in this case, materiel). However, it is likely that a review of existing bodies to ensure their activities are well aligned and nested within a systems-engineering architecture would likely further that progress.

- **Recommendation 2:** The secretary of the army should charter a review of the current cooperative and collaborative teams, boards, and other governing bodies that influence soldier and squad governance. That review should assess (1) how well each entity's activities align with a broader soldier/squad system architecture; (2) whether each body has the appropriate scope and authority; (3) whether each is supported by the requisite tools to act within their own authorities and make recommendations to higher bodies in order to best advance the system design; and (4) whether the appropriate incentives exist to foster collaboration.

Shared Scope and Vision

As discussed in Chapter 2, the problems of governance structure and the lack of a common view of the appropriate scope and direction for the soldier/squad system are interdependent. If governance remains collaborative, which the study team believes is a necessity, setting a clear direction is a more complex and time-consuming task. Yet this vision is essentially the premise upon which all else rests, and should be a high

[54] BAST, 2013: 3.
[55] Study team interviews, December 2013–February 2014.

priority for senior Army leaders. As depicted in Chapter 3, Army activities need a common understanding of where along the three axes (unit of analysis, scope of the trade space, and capability gap solutions) the entire soldier/squad enterprise is bounded, and what their individual roles are within that framework. They must then determine how to align all of their activities (e.g., the writing of requirements or the prioritization of research projects) to support that role.

One of the key constraints inhibiting this from taking place is the lack of adequate tools to inform the desired analysis. This is in part because responsibilities remain unclear (and thus who should be responsible for acquiring key tools is also unclear). But more importantly, it is because the Army has not properly resourced soldier/squad integration efforts.[56] The 2013 BAST report laid out a clear set of activities that must be undertaken to enable real integration, from the formulation of measures of performance and effectiveness to expanding analytic models to better understand interactive effects.[57] The MCOE CDID, PEO Soldier, NSRDEC, and other organizations are doing what they can to invest in and advance these activities to the extent possible, but they are not sufficiently funded to do so.

The study team fully appreciates the Army's broader budget situation. That said, the investments to build the analytic foundation for truly realizing an integrated soldier/squad system are sufficiently modest and critical that they should receive a higher priority than is currently the case. Competing for resources in the Army's funding processes is complicated by the breadth of the soldier enterprise, which touches multiple program evaluation groups (PEGs). If Army leaders wish to make the soldier/squad a priority, then an integrated budget proposal should be considered holistically at the highest levels, in addition to a view that presents the compiled recommendations from the individual PEGs. While all platforms must deal with challenges like human systems integration and human factors, soldier and small unit systems rely on the human to a much greater extent. Bureaucratically, materiel and nonmateriel approaches are carried out across a broad spectrum of organizations, which will likely always be so. But the Army needs to remove functional barriers—those that keep the whole system separated and distinct from each other—to the greatest possible extent.

- **Recommendation 3:** The secretary and chief of staff of the army should approve an Army-wide architecture establishing the scope of the soldier/squad enterprise. Based on the review conducted in accordance with recommendation 2, they should also approve additional resources to build out and maintain the analytic toolset to inform enterprise decisions going forward.

[56] This is another problem that is affected by the uniqueness of the "soldier system." For most major weapons systems, materiel integration is an integral function funded either at the program office or as part of a contract if the work is performed by a lead systems integrator. PEO Soldier receives minimal funding for integration, according to interviews conducted by the study team.
[57] BAST 2013: 6; the Defense Advanced Research Projects Agency's (DARPA) "Squad X" program involves a substantial effort to develop technologies to enable digitization of the squad to better measure both internal squad parameters (e.g., soldier health and well-being) as well as better sense the environment. The program includes performance measures and metrics related to these objectives.

Continued Innovation

The study team believes that the Army will continue to need advancements in soldier and squad capabilities that emanate, directly or indirectly, from the private sector. For a number of reasons, some of which are beyond the Army's control, the potential for those advancements is threatened.

There are multiple steps the Army can take to improve this situation. First, as noted above, the Army should develop a shared, long-term vision of future soldier/squad capabilities that reflects a systems architecture and that can be shared with trusted industry partners. Some interviewees suggested that the Army's Long-Range Investment Requirements Analysis (LIRA), a 30-year look at modernization priorities, may help (and may even be sufficient) to meet this need.[58] However, the LIRA has not yet been shared outside the Army, and thus it remains unclear whether it can provide sufficient indications to private companies about where they might most usefully invest their IRAD funding.[59]

More robust communication with industry, whether about the LIRA or other aspects of the soldier/squad endeavor, was also a frequent refrain in the study team's interviews. Various Army leaders have acknowledged, both as part of this effort and more broadly, that communication has been insufficient.[60] At the same time, they point to restrictions on travel stemming from both policy guidance and fiscal constraints. How long these circumstances might prevail is unclear, but finding ways to overcome them will be important to the progress made for soldier and squad systems.

- **Recommendation 4:** TRADOC, ASA(ALT), AMC, and Army G-8 should meet with representatives of the soldier/squad industrial base upon release of the LIRA to determine whether it provides sufficient insight into priorities to inform IRAD investments. If not, PEO Soldier should make recommendations to Army leaders to better address this challenge.

In the shorter term, declining operational commitments may deprive "the system" of one of the most powerful drivers of innovation—actual need. The challenge of how to maintain a sense of urgency and focus on present-day requirements that are less immediate is not unique to the soldier/squad portfolio, but the ability for soldiers to "demand-pull" new solutions may be at more risk than higher-profile capability gaps put forth by combatant commanders. The Army plans to maintain the Soldier Enhancement Program (SEP), which provides a small pot of money to support a "buy, try, decide" model for bringing new solutions into the formal system. Pairing these funds with an expanded experimentation force as part of Army 2025, and potentially

[58] Michael Hoffman, "Army Pursues 30-year Modernization Strategy," Military.com, October 25, 2012, http://www.military.com/daily-news/2012/10/25/army-pursues-30-year-modernization-strategy.html.
[59] Further, it is likely that whatever the LIRA contains does not fully reflect a broad systems architecture, since that architecture isn't yet agreed upon. Thus even if the LIRA represents a viable mechanism, it would likely require updates as steps to strengthen the enterprise approach.
[60] See, for example, the 2011 Decker-Wagner report on Army acquisition, which made a broad recommendation for Army leadership to "improve communication with industry." Decker-Wagner, 2011: xx.

with Regionally Aligned Forces as that concept expands throughout the force, could prove a key element of identifying and incentivizing advances.

The proposed Deployer Equipment Bundle (DEB), which envisions funding sets of specialized soldier and squad equipment specific to certain locations or missions, should also help stabilize funding (and thus incentives) for private-sector investments in materiel development. Thus these efforts have a key role to play in keeping industry engaged and active in developing new solutions, both incremental improvements to existing products and new options for emerging problem sets.

Another benefit of increasing the conceptual linkage between SEP, DEB, and RAF could be as a validation of the Army's plans for preparing for a more global mission set. Both developing the DEB packages and receiving more country- and region-specific inputs from RAF units will highlight a broad range of environments that can help to validate existing models.

- **Recommendation 5:** Informed by a systems architecture that extends beyond materiel, Army leaders should protect and, if possible, increase funding for the SEP and DEB programs, both as a spur to innovation and as a mechanism for broadening global considerations of soldier/squad equipment as rapidly as possible.

As noted in Chapter 3, another key factor for many producers in the soldier/squad portfolio is the ability to apply advances in commercial, as well as military, markets. Thus if the Army wishes to maintain innovation in this area, it must review its approaches to ownership of intellectual property.

- **Recommendation 6:** ASA(ALT) and AMC should make recommendations to Army leaders and the appropriate offices in the Office of the Secretary of Defense, if necessary, for modifications to current practices guiding government ownership of privately produced intellectual property that will both protect government interests but better meet commercial needs.

For companies to participate at all in government markets, however, they must be able to identify some plausible path to a production contract. Obviously such contracts can never be guaranteed, but being able to compete for one at some reasonably reliable future point will be critical to whether or not internally funded projects go forward. This represents a particular challenge for the Army, because its overall budget situation is bleak and uncertain. However, the study team believes that additional fidelity could be provided to address this problem.

Some in Congress, for example, have suggested that the Army be required to submit more detailed information about soldier systems budget plans as part of their larger budget submission. This would help industry gain greater insight to inform investments. Depending on how those budget lines were presented, however, it could also limit the Army's ability to communicate or execute a system-based architecture.[61]

[61] If budget lines reflected individual items or capability areas (e.g., lethality or protection), it might discourage companies working within those areas to conceive of cross-capability trades (where funding

Another approach could be to develop a more robust plan for incremental fielding of soldier/squad capabilities, funding increments of equipment over time that include the most up-to-date capabilities. This approach has worked well in other areas, and is consistent with the Army's broad modernization strategy. Fielding in increments requires a baseline (1.0) from which to improve, work that is already underway. Fully implemented, the Army could then continuously modernize soldiers and squads, at whatever levels it could afford from year to year, but with clear "on-ramps" into the next increment at set points in time.[62] (This approach could also address some of the challenges in requirements approval. Since affordability is a major factor in approving requirements, they could be written with an annual, rather than total, acquisition objective—for example, for some portion of the force—which would greatly reduce total costs while still allowing for sufficient quantities over time.)[63]

- **Recommendation 7:** PEO Soldier should lead the development of a robust plan for incremental fielding of soldier/squad equipment.[64] Initially it should be based on current materiel-centric practices, but should evolve to incorporate the fielding of both human- and equipment-based capabilities. To support this effort, the director of the Army staff should evaluate whether modifications to Army resourcing processes (e.g., the PEG structure) are necessary, or whether they can be adjusted to accommodate a system-based approach.

Perhaps the greatest challenge to continued innovation, however, is that there appears to be no broad appreciation or strategy to address the inevitable shrinking of the soldier/squad systems industrial base. Further, that base as it currently stands reflects the materiel focus of its customer. If the Army wishes to encourage greater interplay between human and equipment dynamics in determining future capability development, it may need to deliberately broaden its outreach and communications strategy, as well as ensure that appropriate incentives for collaboration across nontraditional industry partners are in place.

Overall, the study team's interviews indicated that many of the stakeholders who influence the viability of the industrial base are not aware of the "whole elephant," so to speak, nor of an explicit strategy to inform their actions. As a result, the Army risks inadvertently losing important capabilities that could be costly and time-intensive to revive if and when they are needed. Again, this is not to suggest that the entire soldier/squad industrial base should be preserved, an impracticality in today's budget environment. However, a deliberate and explicit approach to, at a minimum, preserving key areas that might be most critical in advancing and delivering soldier/squad capabilities is warranted.

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would be less certain). It might also restrict the Army's ability to make those trades, if Congress sought to keep previously planned funding streams in place.

[62] Producers would know when their next opportunity to provide a new solution in one or more capability areas (or ideally, a multifunctional item that offered improvements in more than one capability area) would be, and in theory could anticipate total sales, though the period for the complete buy might accelerate or slow to some extent as budgets ebb and flow.

[63] This approach is not without some risk, as it ensures that some portion of the force will always have less modern equipment than others. This is a practical reality today, however, and is likely to become even more true, at least in the near term.

[64] To reiterate, such a plan would not represent a manifestation of a systems approach, as it pertains to only materiel. To be most effective, that fielding plan should be continuously informed by and updated in accordance with knowledge gained in the soldier and task elements of the total system.

- **Recommendation 8:** The under secretary of the army should direct an assessment of whether the current soldier/squad industrial base is sufficiently broad to support a systems-based approach. AMC should also review whether the requisite contracting tools and other support mechanisms are in place to encourage public-private and private-private partnering in support of future soldier/squad development. The assessment should also include an evaluation of the health of the soldier/squad industrial base in its entirety, and its ability to continue to support future Army needs.

The recommendations above focus more on additional assessment rather than deliberate action. This in part reflects the complexity of the topic, but also recognizes that the study team could not delve deeply enough into the issues to confidently identify actions and weigh their costs and benefits. Despite that limitation, the study team believes that if the recommendations above are followed, they will contribute to a long-standing vision that the Army finally treat the soldier (and squad) as a system.

In closing, the authors offer a final observation. In this realm, as in every other aspect of Army business, trust is key. This point was made repeatedly throughout this effort, in multiple contexts. One context was the trust that soldiers have in their leaders, and in each other. Another was the trust that soldiers have in their supply chains, which dictates how much risk they are willing to take when deciding how much to carry with them on a mission. Another was in other individuals or organizations in the bureaucracy, and whether they had the "right mindset" to make decisions that would best support the soldier. Another context was the trust that government must have that industry wants to stay in business, but also to provide the best they can for those who go to war. Our discussions made clear that it is trust that will ultimately play the greatest role in determining how far the Army progresses in realizing the soldier/squad system vision.

Appendix A: Soldier Load and Cost Baselines

Interim data based on a 72-hour mission provided by PEO Soldier, current as of March 14, 2014.

Baseline Soldier Load by Duty Position (in lbs.)

	Squad Leader	Team Leader	Rifleman	Grenadier	Auto Rifleman
A. Common equipment Weight	78.7	78.7	78.7	78.7	78.7
B. Duty Position Weight	38.8	33.4	20.3	41.5	49.6
C. Total Assault Weight	**76.4**	**75.5**	**64.9**	**74.6**	**81.4**
D. Total Approach Weight	**41.6**	**37.1**	**34.6**	**46.1**	**47.4**
Total Soldier Weight (Assault Mode)	117.5	112.1	99	120.2	128.3
Total Soldier Weight (Approach Mode)	159.1	149.2	133.6	166.3	175.7

Total Soldier Weight (Assault Mode) = A+B+C; Total Soldier Weight (Approach Mode) = A+B+D.

Soldier Baseline Equipment Costs (in FY2013 dollars)

	Squad Leader	Team Leader	Rifleman	Grenadier	Auto Rifleman
Common Equipment Cost	$7,095.24	$7,095.24	$7,095.24	$7,095.24	$7,095.24
Duty Position Cost	$43,261.43	$18,305.46	$13,179.64	$14,048.42	$19,647.67
Total Soldier Cost	**$50,356.67**	**$25,400.70**	**$20,274.88**	**$21,143.66**	**$26,742.91**

Appendix B: Study Participants

ADS

Army Capabilities Integration Center (ARCIC)

Army War College

Boeing

Center for Strategic and International Studies

Cypress International

Deputy Assistant Secretary for Research and Technology

DuPont

Exelis

Former OSD Acquisition/Industrial Base policy staff

Headquarters, Department of the Army, G-3

Headquarters, Department of the Army, G-8

House Armed Services Committee Staff

L3

London Bridge Trading Company

Maneuver Center of Excellence (MCOE)

Marine Corps Combat Development Command (MCCDC)

McCain Institute

Natick Soldier Research Development and Engineering Command

Office of Science and Technology Policy, Executive Office of the President

Program Executive Office - Soldier

QinetiQ-NA

Raytheon

Senate Armed Services Committee Staff

United States Marine Corps Capabilities Integration, Marine Expeditionary Rifle Squad, Maneuver Branch

Warrior Protection and Readiness Coalition

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