

# Enabling a Data Culture to Drive Data-Centric Practices Across the Military—from Training to Operations

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## ABSTRACT

From the first transmission of dots and dashes over a telegraph to today’s AI-powered decision systems, data has been a transformative force in military operations. Establishing a robust data culture is now imperative to ensuring the U.S. military maintains its technological and strategic edge across both training and operational domains. This paper explores key strategies for institutionalizing data-centric practices within military organizations, emphasizing the importance of data literacy, tailored training programs, and the integration of advanced analytics and artificial intelligence (AI).

A fundamental pillar of this transformation is data literacy—the ability to read, analyze, and communicate with data effectively. Developing these competencies empowers warfighters to interpret real-time intelligence, recognize operational patterns, and make informed decisions in complex and rapidly evolving environments. This paper examines how embedding data literacy within military training frameworks aligns with the broader Department of Defense (DoD) Data Strategy, fostering a force that is agile, adaptive, and data-driven.

The DoD Data Strategy underscores the need for integrating data, software, and AI to sustain decision superiority in multi-domain operations. It advocates for data-sharing reforms, enhanced interoperability, and the application of machine learning-driven analytics to expedite battlefield decision-making. A key area of focus in this paper is the role of AI-powered training environments, such as large language models and real-time data analytics, in enhancing unit readiness, mission planning, and performance assessment.

This paper concludes that building a data-centric culture within military organizations demands a holistic, multi-faceted approach—one that includes scalable data education programs, strategic data governance, and the deployment of state-of-the-art analytical tools. Ultimately, fostering a data-driven military enhances training outcomes, accelerates real-time decision-making, and strengthens mission effectiveness in complex and contested operational environments.

## ABOUT THE AUTHOR

**Ray Compton:** Ray Compton serves as a Fellow - Solution Architect and RDT&E Subject Matter Expert (SME) at LMI, driving innovation in integrated solutions. He focuses on transforming cutting-edge technical concepts into sustainable and supportable data-informed that address federal critical needs, and fostering robust collaborations with industry, academia, and government. As a retired U.S. Army colonel with over 30 years of leadership and strategic experience, Ray has worked across all aspects of the acquisition lifecycle—from research and development to the production of complex systems supporting national defense. Over the years, he has had the honor of serving on the Army Science Board (ASB), with the most recently, he chaired the Data-Centric Command and Control (C2) effort, and over 20 years supporting IITSEC to include Chair of Simulation Subcommittee. He holds a master’s degree in strategic studies from the U.S. Army War College, a master’s degree in simulation modeling and analysis and a graduate certificate in training simulation from the University of Central Florida, and a bachelor’s degree in computer science and mathematics from Christopher Newport University.

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## I. INTRODUCTION: WHY DATA CULTURE MATTERS NOW

From the first Morse-coded battlefield messages to today’s real-time decisions powered by artificial intelligence, data has always been fundamental to military operations. Yet as the velocity, volume, and complexity of data accelerate, so too does the challenge: raw information alone no longer guarantees advantage. The force that wins is the one that can rapidly interpret, share, and act on data across domains, from the training ground to the front line.

In 2020, the U.S. Department of Defense (DoD) recognized this imperative with its landmark *Data Strategy*, which declared data a “strategic asset” and outlined the need for it to be visible, accessible, understandable, linked, trustworthy, interoperable, and secure across the enterprise (DoD, 2020). But strategy without culture is inert. Despite increased access to advanced tools and AI-driven platforms, the military continues to face a fundamental gap—a lack of a deeply embedded, institution-wide data culture.

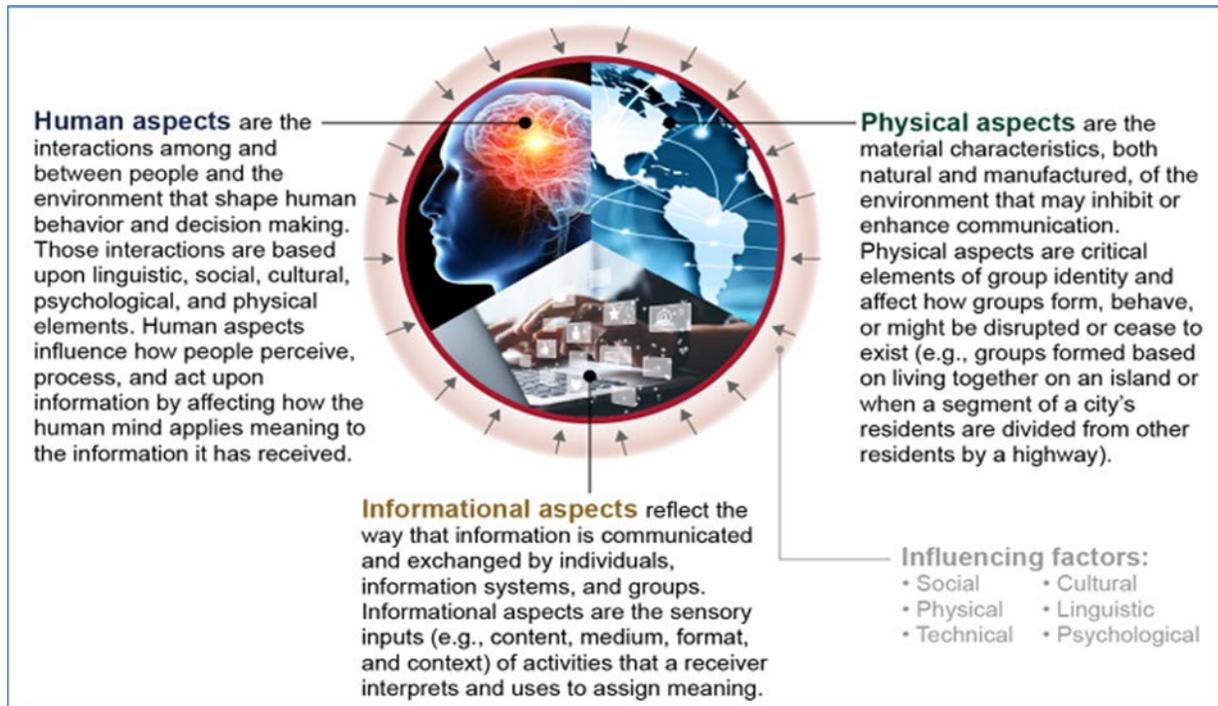
At the heart of this cultural transformation is data literacy: the ability to read, analyze, and communicate with data effectively. Without this fluency, even the most sophisticated systems risk being misinterpreted or ignored in critical moments. Programs like West Point’s Data Literacy 101 reflect a growing realization that data competency must be treated as a core military skill, not a niche capability (Starling, 2024).

Meanwhile, artificial intelligence and advanced analytics are rapidly reshaping how the military trains, plans, and operates. AI-enabled tools such as the Thunderforge initiative, developed through the Defense Innovation Unit and partners like Scale AI, exemplify how data-driven innovation is already transforming the battlespace for strategy development (DIU, 2024). Similarly, tools like COA-GPT use large language models to automate course-of-action generation in operational planning (Goecks, & Waytowich, 2024). Recent Air Force trials involving autonomous systems such as the X-62A VISTA demonstrate what’s possible when machines and humans collaborate effectively in real-time tactical environments (Losey, 2024). But scaling these innovations demands more than technical upgrades—it requires a mindset shift. Data must become a shared language, not the domain of specialists.

This paper outlines a framework for institutionalizing data-centric practices throughout the military. It focuses on three pillars: cultivating data literacy across all ranks, building training systems that embed analytics and AI, and enacting organizational reforms to sustain a culture where data drives every decision. In an era defined by information speed and complexity, a data-driven culture can enhance training outcomes, accelerate real-time decision-making, and strengthen mission effectiveness in complex operational environments.

## II. THE STRATEGIC VALUE OF A DATA CULTURE IN DEFENSE

In modern military operations, cultivating a robust data culture is not merely advantageous—it is essential. A data culture refers to an organizational environment where data is treated as a strategic asset, and its effective use is ingrained in daily practices across all levels. This cultural shift ensures that data is not only collected but also analyzed and leveraged to inform decisions, enhance operations, and maintain a competitive edge. As detailed in the U.S. Government Accountability Office report GAO-23-105608: *Contested Information Environment*, the GAO developed a conceptual model (Figure 1) to illustrate the multifaceted nature of the information environment. This model broadly categorizes the environment into three interrelated dimensions: human, physical, and informational. The human aspect encompasses the cognitive, cultural, and behavioral factors that influence how individuals and groups perceive and respond to information. The physical aspect includes the hardware and infrastructure—such as satellites, servers, and communication networks—that support the transmission and reception of information. The informational aspect covers the data itself, including its content, flow, and integrity. Together, these components shape how information is created, shared, contested, and acted upon in both peacetime and conflict. In today’s operational environment—characterized by rapid technological change and information saturation—understanding and effectively operating within this contested space is essential to mission success and national security (GAO, 2023).



**Figure 1 The Environment and Factors That Influence the Processing of Information**

The Department of Defense (DoD) recognized this imperative in its 2020 Data Strategy, which envisions the DoD as a data-centric organization that uses data at speed and scale for operational advantage and increased efficiency. The strategy emphasizes making data visible, accessible, understandable, linked, trustworthy, interoperable, and secure across the enterprise (DoD, 2020). However, achieving this vision requires more than technological solutions; it necessitates a cultural transformation where data-driven decision-making is the norm.

Without a strong data culture, even the most advanced technologies can fall short. For instance, the absence of standardized data practices can lead to silos, hindering interoperability and slowing decision cycles (Hillner, 2025). A lack of data literacy among personnel can result in misinterpretation of information, leading to suboptimal decisions (Farina, 2022). Moreover, without a culture that values data, there is a risk of underutilizing available information, thereby compromising mission effectiveness.

Conversely, a robust data culture empowers military personnel to make informed decisions swiftly and confidently. It fosters an environment where data is seamlessly integrated into operations, enhancing situational awareness and enabling proactive responses to emerging threats (Starling, 2024). By embedding data-centric practices into the organizational fabric, the military can ensure that data serves as a force multiplier, enhancing readiness and operational effectiveness.

In conclusion, the strategic value of a data culture in defense lies in its ability to transform data from a passive resource into an active catalyst for decision-making and operational excellence. By prioritizing data literacy, standardization, and integration, the military can harness the full potential of its data assets, ensuring superiority in an increasingly information-driven battlespace.

### **III. BUILDING DATA LITERACY ACROSS THE FORCE**

In an era where data is integral to military operations, building data literacy across the military is essential to operationalizing the Department of Defense's (DoD) data strategy and achieving decision superiority in multi-domain operations. Data literacy—the ability to read, analyze, and communicate with data—must become a core competency across all ranks and roles, from commanders to frontline operators. This section outlines key efforts to develop data literacy across the force, highlighting initiatives within the U.S. Space Force and Air Force.

## Defining Data Literacy in the Military Context

Data literacy in the military extends beyond basic data handling; it encompasses critical thinking, analytical reasoning, and the ability to derive actionable insights from complex datasets. Data literacy—the ability to read, work with, analyze, and communicate using data—is a critical enabler of multidomain operations. It provides military personnel with the competencies necessary to interpret complex information and make informed decisions across the maritime, land, air, space, and cyberspace domains (Morrow, 2021). This skill set enables service members to interpret intelligence, assess risks, and execute missions with precision. As military operations become increasingly data-driven, the demand for personnel proficient in data literacy grows correspondingly.

The Army Sustainment community identified a gap in data-centric operations, highlighting the need for sustainers to develop stronger analytical and technical skills. To address this, Army Logistics University (ALU) educators are implementing a multi-tiered approach to establish, deliver, and sustain data education across the force (Figure 2). These training methods are designed to support organizational change and promote a culture of data-driven decision-making (Spivey, et al., 2023).

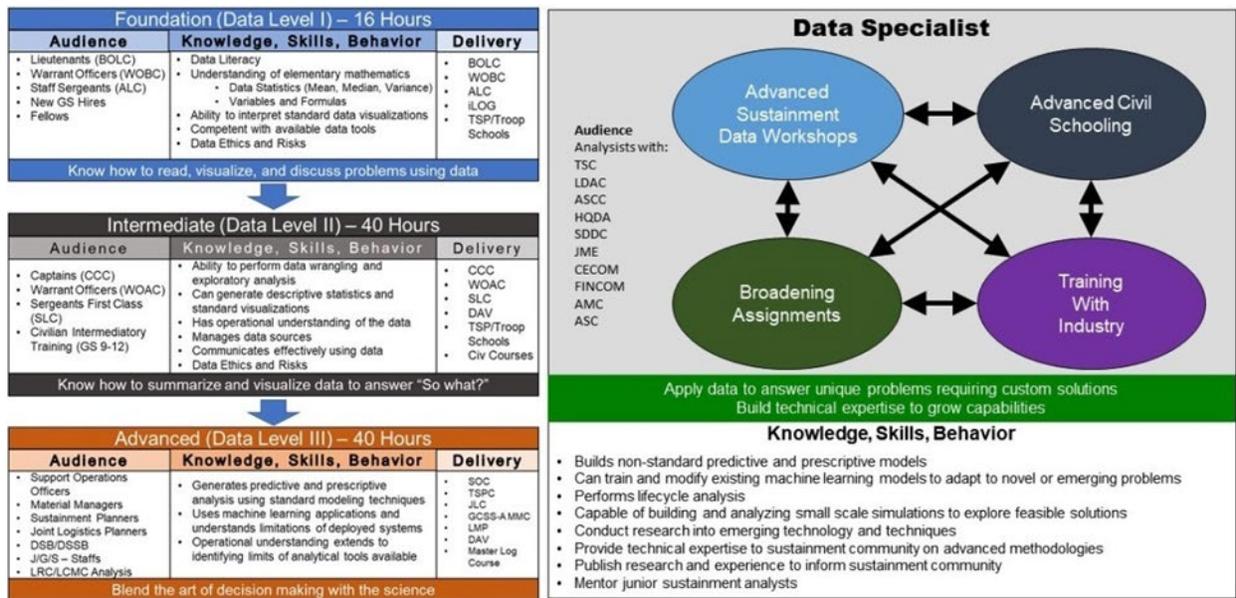


Figure 2 ALU proposed approach that integrates data education through an iterative and progressive framework

## Role-Based Literacy Models

Recognizing that different roles require varying levels of data proficiency, the military is adopting role-based literacy models. Commanders need to interpret data to make strategic decisions; analysts must delve deep into datasets to extract meaningful patterns; logisticians require the ability to forecast supply needs accurately like depicted in figure 2; and warfighters benefit from real-time data to adapt to dynamic combat situations. Tailoring data literacy training to specific roles ensures that each member of the force is equipped with the necessary skills to perform their duties effectively.

## Embedding Data Literacy in Military Education

Integrating data literacy into military education represents a strategic effort to institutionalize data competencies across the force. Recognizing the growing importance of data-informed decision-making in modern warfare, military institutions are embedding data literacy into professional development at all levels. One notable example is the United States Military Academy at West Point, which offers the "Data Literacy 101" course. Hosted by the Center for Data Analysis and Statistics, this five-day program is designed to train educators—officers, NCOs, and civilian faculty alike—to become multipliers of data knowledge within their units. The course covers core concepts such as data analysis, visualization, and critical thinking, with an emphasis on how to apply these skills in operational contexts (Starling, 2024).

In parallel, the Army University has developed the Data Foundations Seminar, a two-day professional development experience focused on building functional analytics capabilities. Participants explore the full spectrum of data analytics—descriptive, diagnostic, predictive, and prescriptive—through practical exercises that emphasize the value of data-driven insights in mission planning and execution. The seminar aims not only to increase individual competency but also to foster a broader culture of evidence-based decision-making within the Army (Bocanegra, 2024).

Together, these initiatives reflect a deliberate push to embed data literacy into the core of military education, ensuring that leaders at every level are equipped to leverage data as a strategic asset in both training and operational environments.

### **Current Initiatives and Pilot Programs**

In addition to formal academic efforts, the Department of Defense is actively pursuing innovative initiatives and pilot programs to enhance data literacy across the force. These efforts reflect a broader shift toward integrating modern, data-driven capabilities into training and operations. The Defense Innovation Unit (DIU), for example, plays a key role in accelerating this transformation. In collaboration with various service branches, DIU develops and deploys cutting-edge, data-enabled training solutions. One prominent example is its partnership with the Air Education and Training Command (AETC) to create virtual pilot training platforms using commercial game engines. These immersive, scalable solutions offer realistic flight simulations and significantly expand access to high-quality training at reduced cost and logistical burden (DIU, 2023).

Another noteworthy example comes from the 513th Military Intelligence Brigade, which has taken proactive steps to increase data literacy within its ranks. The brigade has incorporated attendance at courses such as Data Literacy 101 into its professional development pipeline and is embedding data literacy concepts directly into its training programs. These efforts aim to close the data skills gap and enhance the brigade's ability to leverage information in operational contexts. By prioritizing data fluency, the brigade not only improves individual proficiency but also strengthens overall mission readiness (USA, 2023).

Together, these efforts demonstrate a shift in military culture—one that treats data literacy not as a niche skill, but as a core requirement for effective service in a modern, information-driven defense environment.

### **Space Force Initiatives**

The U.S. Space Force (USSF) has recognized the need for digital fluency within its workforce. According to the USSF Data and AI FY2025 Strategic Action Plan (USSF, 2025), the USSF has acknowledged the growing need for digital fluency and AI literacy within the Guardian workforce as essential to addressing modern operational challenges. In alignment with recent national guidance, the service has outlined a strategic plan focused on equipping Guardians with the knowledge and tools necessary to leverage artificial intelligence in support of mission success. Central to this effort are four key lines of effort: (1) maturing enterprise-wide data and AI governance; (2) advancing a data- and AI-driven culture; (3) rapidly adopting data, advanced analytics, and AI technologies; and (4) strengthening partnerships across government, academia, industry, and international allies. These initiatives aim to make data visible, accessible, understandable, rapidly adoptable, linked, trustworthy, interoperable, and secure across the enterprise. The importance of fostering a digital culture is especially emphasized by Space Training and Readiness Command (STARCOM), which plays a critical role in training Guardians and ensuring the force is prepared to operate in a contested and dynamic warfighting domain. Through these efforts, the Space Force is positioning itself to maintain operational advantage in an increasingly data-driven and technologically complex environment.

To support these goals, the Space Force has launched Digital University, providing access to free courses from Udemy, Pluralsight, and Udacity to all Department of the Air Force personnel. This initiative offers over 12,000 courses, aiming to increase digital literacy across the force (USSF, 2020).

### **Air Force Efforts**

The U.S. Air Force has placed a strong emphasis on advancing data literacy across its ranks as part of its broader digital transformation. Recognizing that data competence is critical to operational effectiveness, the Air Education and Training Command (AETC) has initiated a comprehensive program aimed at building foundational data skills among its personnel. This initiative stems from AETC's strategic operational approach and represents a key line of effort in preparing Airmen to thrive in a data-driven environment (AETC, 2025). In parallel, the Air Force Institute of Technology (AFIT) supports this objective through its Certificate in Data Analytics program—a multi-departmental, distance-learning curriculum that spans five sequential courses delivered quarterly. This program plays a pivotal role

in equipping Department of the Air Force personnel with the analytical knowledge and technical proficiency required to foster a more data-informed organizational culture (AFIT, 2020). Further bolstering the Air Force's commitment to digital proficiency, the Air Force Institute of Technology (AFIT) offers a Data Analytics Graduate Certificate program. This multi-departmental, distance-learning program comprises five courses, each delivered over a 10-week period. The curriculum is designed to balance theoretical knowledge with practical application in artificial intelligence (AI) and machine learning (ML), tailored to the needs of the Department of the Air Force.

Together, these efforts demonstrate the Air Force's commitment to integrating data literacy into professional development and operational readiness initiatives.

### **Challenges and the Path Forward**

Despite these initiatives, challenges remain. Resistance to change, skill gaps, and competing priorities can hinder the adoption of data literacy programs. Overcoming these obstacles requires leadership engagement, incentives, and integrating data literacy into daily workflows. By continuing to invest in tailored training programs and fostering a culture that values data-driven decision-making, the military can enhance its operational effectiveness in an increasingly complex and contested environment.

## **IV. TRAINING TRANSFORMATION THROUGH DATA-DRIVEN FRAMEWORKS**

The U.S. military is in the midst of a sweeping transformation in how it trains service members, shifting from traditional, standardized instruction to dynamic, data-enhanced training frameworks. This evolution reflects the urgent need for more adaptive, efficient, and mission-relevant methodologies that align with the complexities of modern warfare. Central to this transformation is the integration of real-time data, artificial intelligence (AI), and advanced analytics—technologies that are redefining how military personnel prepare for operational environments that are increasingly volatile, uncertain, and data-rich.

Historically, military training has relied on fixed curricula and static scenarios that often fail to simulate the unpredictable nature of today's battlespace. Recognizing these limitations, the Air Education and Training Command (AETC), in partnership with the Defense Innovation Unit (DIU), developed the Virtual Training for Air Dominance (VTRAD) program. VTRAD introduces high-fidelity virtual flight models and simulated cockpits that immerse pilots in realistic training environments. These advanced simulations allow for highly personalized, responsive training experiences that adapt to individual learning curves, ultimately boosting mission readiness (DIU, 2023).

One of the most impactful innovations is scenario-based learning enhanced by real-time data injection. The Secure Live-Virtual-Constructive Advanced Training Environment (SLATE) exemplifies this capability. SLATE integrates live aircraft operations with virtual and constructive simulation elements, enabling the seamless injection of real-time data into training exercises. As scenarios evolve based on participant decisions and actions, trainees gain exposure to a wider range of tactical and strategic challenges, strengthening their critical thinking and decision-making skills under pressure (AFRL, nd).

Artificial intelligence further enhances training by enabling adaptive, responsive simulations. AI-powered platforms can process extensive operational data, identify patterns, and modify training scenarios in real time. These systems assess individual performance and tailor challenges, accordingly, ensuring that each trainee is pushed to develop new skills continuously. The use of machine learning algorithms allows for predictive modeling that adapts as training progresses, making simulations not only more realistic but also more effective at preparing personnel for real-world conditions.

The implementation of closed-loop feedback mechanisms is also transforming how training effectiveness is measured and refined. The Air Force's competency mapping initiative, for instance, links specific training events to key knowledge, skills, and abilities (KSAs). By analyzing performance data, instructors can identify proficiency gaps and provide targeted support where needed. This data-driven feedback system promotes continuous improvement and ensures that training objectives are aligned with operational demands (AETC, 2025).

At the unit level, data-driven training requires structured and scalable models to achieve widespread impact. One such framework is the use of digital twins—virtual representations of equipment, systems, or processes—that allow for the simulation of real-world operational scenarios. The Air Force's Model One initiative is leading this effort by integrating multiple simulation systems into a unified platform. This approach enables holistic, multi-domain training that mirrors real-world complexity while maintaining safety and cost efficiency. In addition, the use of AI-driven scenario generation tools allows units to rapidly design and execute diverse and context-specific training exercises, ensuring personnel are continuously challenged and engaged (Istari Digital, 2025).

Overall, the military’s shift toward data-driven training frameworks is significantly enhancing the effectiveness and agility of U.S. forces. By leveraging AI, real-time data integration, and immersive simulations, the Department of Defense is cultivating a force that is not only technically proficient but also more adaptable and resilient in the face of evolving threats and operational demands.

**V. OPERATIONAL APPLICATIONS: DATA IN THE FIELD**

The U.S. military’s transition to a data-centric culture is fundamentally reshaping the conduct of operations in the field. By integrating artificial intelligence (AI), real-time analytics, digital simulations, and predictive modeling, the Department of Defense is enhancing decision-making, improving readiness, and boosting overall mission effectiveness across all domains—land, sea, air, space, and cyber.

**Real-Time Decision-Making Support**

One of the most impactful advancements is the use of AI-driven systems to support real-time decision-making. These technologies rapidly process vast volumes of data from sensors, satellites, intelligence platforms, and battlefield systems to generate actionable insights. A prime example is Project Maven, an initiative that applies computer vision and machine learning algorithms to full-motion video and imagery collected by ISR platforms. By automating target detection and identification, Project Maven streamlines the targeting process and significantly reduces the time between detection and engagement (Choudhury, 2024).

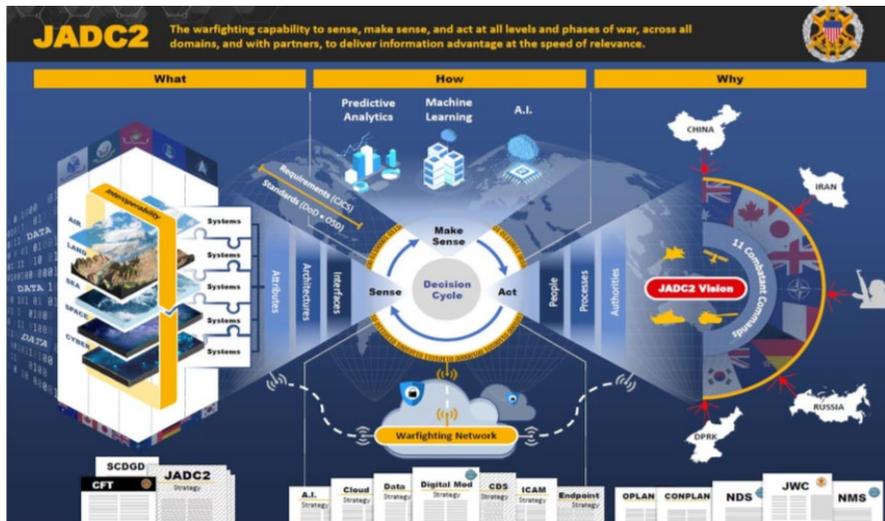
In logistics, predictive analytics are transforming sustainment operations by enabling proactive maintenance and supply chain optimization. The U.S. Air Force’s Predictive Analytics and Decision Assistant (PANDA) system forecasts potential equipment failures using historical data and sensor inputs, enabling maintenance crews to address issues before they escalate. This minimizes downtime and extends the lifecycle of mission-critical systems (Hardin, 2023).

For intelligence, surveillance, and reconnaissance (ISR), AI algorithms fuse and analyze data from multiple sources, enhancing situational awareness. These tools assist commanders by surfacing relevant patterns, flagging anomalies, and enabling faster and more informed decision-making in fast-paced operational and emerging threats environments.

**Command and Control Integration: Data Fusion and Dynamic Dashboards**

Modern command and control (C2) systems are evolving to incorporate real-time data fusion and intuitive user interfaces. The Department of Defense’s Combined Joint All-Domain Command and Control (CJADC2) initiative aims to seamlessly connect data across all warfighting domains and service branches. By integrating intelligence and operational inputs from land, air, sea, space, and cyberspace, CJADC2 (Figure 3) enables synchronized joint operations and faster decision-making cycles (CSIS, 2022).

As outlined in GAO-25-106454: Defense Command and Control, the Department of Defense (DoD) operates command and control (C2) capabilities that are critical for enabling rapid, accurate decision-making. These capabilities allow commanders to communicate and act decisively—often before adversaries can anticipate or respond. At the core of C2 is the ability to collect and share information effectively, empowering military leaders to make timely strategic decisions and execute tactical actions aligned with mission objectives, particularly in fast-changing threat environments. However, current C2 systems often rely on what is known as a “swivel chair” approach



**Figure 3 - JADC2 Placemat: Summary of the Joint All-Domain Command and Control (JADC2) Strategy, March 2022**

to data collection and analysis. In this process, analysts manually gather, assess, and transfer data between systems—often by reentering the same information into multiple platforms—creating inefficiencies and increasing the potential for error. CJADC2 initiative (Figure 3) aims to overcome these limitations by enabling units to gather and process large volumes of information more rapidly. CJADC2 has the potential to significantly improve data fusion and reduce barriers to information sharing, such as stove-piped data flows and non-interoperable system interfaces that hinder discovery and integration of mission-critical data (GAO, 2025).

Dynamic data dashboards are a critical component of this ecosystem. These interactive interfaces visually aggregate and display operational data—such as mission progress, threat activity, and resource status—in real time. By simplifying the complexity of battlefield information, dashboards provide commanders with clear, actionable insights that support more agile and informed decisions.

### **Digital Twins and Training-Operations Convergence**

The use of digital twin technology—virtual representations of physical systems—is bridging the gap between training and operations. The Air Force’s Model One initiative integrates multiple simulation environments into a unified platform that supports realistic, mission-relevant training. These digital twins allow personnel to rehearse operations, assess system behavior, and test tactics in a safe, simulated environment before actual deployment (Boreham, 2024).

Live, virtual, and constructive (LVC) training environments powered by digital twins offer a holistic view of system dynamics and operational interactions data. This enhances readiness by providing personnel with experiential learning that mirrors real-world complexities and prepares them for high-stakes scenarios

### **Risks and Limitations: Trust in Automation, Adversarial AI, and Cybersecurity**

Despite the operational benefits of AI and data integration, significant risks remain. Overreliance on automation may lead to diminished human oversight, where operators defer too readily to AI-generated recommendations without critical evaluation. This can result in misjudgments, especially in ambiguous or high-pressure scenarios.

Adversarial AI poses another serious threat. Malicious actors can exploit vulnerabilities in AI systems through techniques like data poisoning, model inversion, or adversarial inputs, leading to false conclusions or compromised outputs. Ensuring the robustness and integrity of AI models is essential to prevent such exploitation.

Cybersecurity is a persistent concern, as AI-enabled platforms are attractive targets for cyberattacks. Unauthorized access to these systems could compromise sensitive operational data or disrupt decision-support tools during critical missions. Protecting these systems requires robust, layered cybersecurity protocols and continuous monitoring to detect and mitigate threats in real time.

The operational integration of data and AI is revolutionizing the way the U.S. military fights, plans, and trains. From enhancing ISR and logistics to empowering predictive maintenance and multi-domain C2, data-driven systems are improving efficiency, responsiveness, and mission outcomes. However, to fully realize these benefits, the military must remain vigilant against the risks posed by automation, adversarial manipulation, and cyber threats. With balanced oversight, secure infrastructure, and continued innovation, data and AI can serve as powerful force multipliers on tomorrow’s battlefield (DoD, 2020).

## **VI. INSTITUTIONAL ENABLERS: GOVERNANCE, INTEROPERABILITY, AND SCALABILITY**

To realize the full potential of a data-centric military, institutional enablers must be strategically established to support the seamless integration of data across all levels of the Department of Defense (DoD). These enablers include robust data governance, effective interoperability mechanisms, and scalable digital infrastructure. Together, they are essential for transitioning successful pilot programs into standardized, enterprise-wide practices that drive mission success and decision advantage.

### **Data Governance as Infrastructure**

Effective data governance forms the foundational layer of a modern digital military. The DoD’s Data Strategy underscores that data must be visible, accessible, understandable, linked, trustworthy, interoperable, and secure (DoD, 2020). Achieving these goals requires more than policy declarations; it demands clearly defined data ownership, standardized data formats, and rigorous data classification and access protocols. Without such structure, data remains siloed, inconsistent, and underutilized. Agencies such as the Defense Contract Management Agency (DCMA) have taken proactive steps by establishing processes that identify, prioritize, and validate mission-critical data. By

mandating the use of standardized data elements, DCMA enhances usability and interoperability throughout its organization and the broader DoD ecosystem (DCMA, 2022).

### **Interoperability Across Services and with Allies**

Interoperability is a critical enabler for joint and coalition operations. The Combined Joint All-Domain Command and Control (CJADC2) strategy represents the DoD's effort to connect sensors, shooters, and decision-makers across all domains—land, air, sea, space, and cyberspace. This integration allows for faster and more coordinated action, ultimately creating a decisive edge in contested environments. However, differences in systems, data architectures, and communication protocols across military branches—and with allied forces—pose challenges. To overcome these barriers, the DoD is conducting multinational CJADC2 experiments and integrating allied nations into system development cycles to ensure compatibility and real-time information sharing (CSIS, 2022).

### **Infrastructure Readiness: Cloud, Edge Computing, and Secure Data Pipelines**

Robust digital infrastructure is essential for modern operations. Cloud computing offers scalable, elastic environments for processing and storing large volumes of data, while edge computing brings computation closer to the battlefield, minimizing latency and enabling real-time analytics. The DoD's Secure Cloud Computing Architecture (SCCA) sets a standard framework for protecting cloud-based environments, allowing mission-critical systems to operate securely across diverse environments. Demonstrations by providers such as Amazon Web Services (AWS) have illustrated the viability of resilient edge-to-cloud systems, delivering real-time data processing capabilities at the tactical edge—critical for time-sensitive missions and situational awareness (AWS, 2025).

### **Scaling Success: From Pilot Programs to Force-Wide Execution**

Moving from proof-of-concept to enterprise adoption requires deliberate scaling strategies. The Chief Digital and Artificial Intelligence Office (CDAO) has emphasized the need for data to be available, accessible, and shareable so that AI developers and operators can innovate quickly while adhering to governance and risk principles. Additionally, the DoD's AI Education Strategy outlines plans to upskill personnel in AI literacy so they can more effectively define requirements and manage AI-enabled procurement processes. Feedback from early cohorts informs curriculum improvements and supports force-wide implementation (DoD, 2024).

Establishing robust data governance, ensuring interoperability, and building scalable infrastructure are critical institutional enablers for a data-centric military. By addressing these areas, the DoD can transform pilot initiatives into standardized practices, enhancing operational effectiveness and maintaining a strategic advantage in the modern battlespace.

## **VII. CULTURE SHIFT: LEADING, INCENTIVIZING, AND NORMALIZING DATA-CENTRIC BEHAVIORS**

Institutional enablers alone are not enough to foster a data-driven defense enterprise. Achieving a lasting transformation requires a fundamental cultural shift—where data is not just a tool, but a mindset embedded into daily operations, strategic thinking, and leadership behaviors. Cultural change demands a dual approach: top-down advocacy and bottom-up innovation, reinforced by training, incentives, and operational integration.

### **Top-Down and Bottom-Up: Command Advocacy and Grassroots Innovation**

Enduring transformation must be led from the top and cultivated from the bottom. Senior leaders set the tone by embedding data literacy and digital proficiency into institutional priorities. The Chief Digital and Artificial Intelligence Office (CDAO) has called for building “an enterprise-wide culture of data readiness” to sustain modernization momentum. Simultaneously, grassroots innovation is critical. Initiatives like Task Force Lima, which explores the use of large language models across DoD missions, illustrate how localized experimentation can feed strategic innovation and inform broader policy (DoD, 2023).

### **Leadership Engagement: Data Literacy for Commanders and Senior Officers**

Commanders must lead by example when it comes to data fluency. Data-savvy leadership ensures that digital tools are not just acquired but effectively employed. Programs at the Defense Acquisition University (DAU) and other professional military education institutions are equipping senior officers with the skills to critically evaluate digital tools, interpret data, and lead analytically informed operations (DAU, nd). By embedding data literacy into flag-level education and command courses, the DoD is ensuring data-centric thinking is woven into mission command philosophy—not relegated to specialized staff functions.

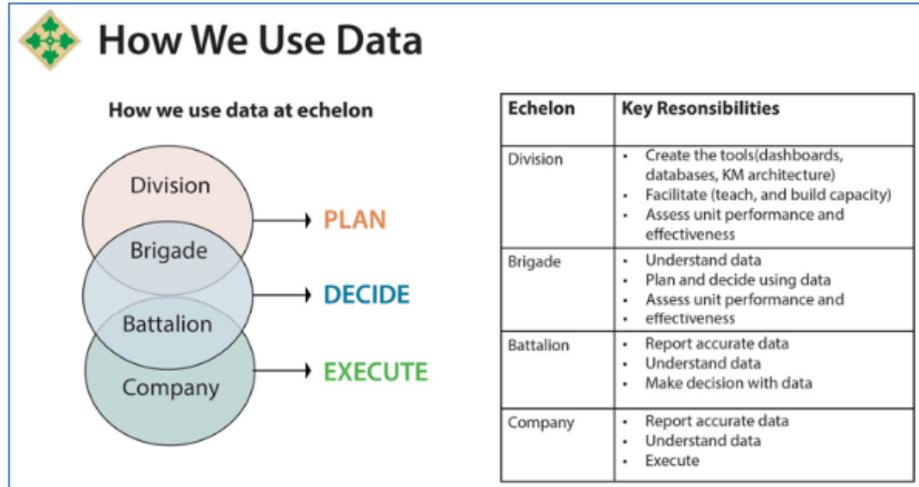
By integrating data literacy into command schools and flag-level education, the DoD ensures that data-centric thinking is not siloed within IT or intelligence branches but integrated into mission command philosophy.

**Incentives and Recognition: Promotions, Awards, and Performance Metrics**

Behavior follows incentives. To make data-driven performance a norm, promotion systems and performance evaluations must recognize data proficiency. Leaders and units demonstrating data-enabled innovation—whether through predictive maintenance, smarter logistics, or faster decision-making—should receive formal recognition. In 2023, the Air Force began updating its officer development pathways to include data and digital competency as a core requirement, signaling a broader shift toward data as a critical leadership trait (USAF, 2023).

**Behavioral Change: Making Data Part of Daily Workflows and Decision Loops**

A true culture shift occurs when data becomes not a “check-the-box” requirement but an integral part of daily operations. This means integrating analytics platforms into command centers, automating dashboards for decision briefings, and structuring meetings around data insights rather than intuition alone. It also involves embedding data capture and feedback mechanisms into training events, logistics cycles, and mission debriefs.



*Figure 4 Defining roles, standardizing formats, and creating intuitive templates simplifies the work subordinates need to execute.*

The 4th Infantry Division (4ID) launched its data literacy initiative in alignment with the Chief of Staff of the Army’s data-centric vision, aimed at building fit, disciplined, cohesive, and lethal teams. They established standardized frameworks and methodologies for data input and analysis promotes consistency and comparability across echelons and staff elements (Figure 4). Targeted training programs and workshops, designed for varying skill levels, build essential competencies in data interpretation and application. Moreover, cultivating a culture that prioritizes data-driven decision-making enhances collaboration and knowledge sharing, reinforcing the role of data literacy across the organization (Czerniakowski, et al., 2024).

Operational units across the services are also integrating data into daily missions. The Air Force’s Kessel Run initiative exemplifies this approach, using agile software development and real-time feedback loops to support combat operations dynamically (Air Force Kessel Run, 2022). Similarly, the Army’s Vantage platform offers near real-time access to enterprise-wide data, allowing commanders to shift from reactive to proactive decision-making (PEO E, 2022). These examples show how workflow-level integration turns cultural aspirations into tangible practice.

Building a sustainable data culture in the military requires more than systems and policy. It demands leadership buy-in, decentralized innovation, aligned incentives, and deeply embedded workflows. Cultural transformation is gradual, but as data-centric habits take root—from the strategic level down to the tactical edge the DoD will evolve into a more informed, adaptive, and operationally agile force.

**VIII. FUTURE WORK**

While this paper establishes a foundational framework for cultivating a data-centric culture across the U.S. military, much remains to be explored and operationalized. Future work must focus on refining, expanding, and stress-testing data-centric practices across diverse operational and training environments.

One priority is **developing adaptive, role-specific data literacy assessments and curricula**. While early efforts like West Point’s Data Literacy 101 provide a strong starting point, the next phase should include validated, tiered proficiency models aligned with occupational specialties and mission sets. These models can help commanders tailor upskilling efforts, measure impact, and adjust based on mission needs.

Another area prime for exploration is **human-machine teaming in decision-making loops**. As AI systems like COA-GPT and autonomous platforms grow in complexity and capability, future research should study how operators and commanders best interact with these tools under stress, ambiguity, and in contested domains. This includes examining trust, transparency, and explainability in battlefield AI systems.

Additionally, **cross-branch and allied data interoperability initiatives** deserve greater attention. Joint and coalition operations require harmonized data standards, governance protocols, and secure exchange mechanisms. Future work should examine how to accelerate policy, technical, and training convergence across services and partner nations, especially within frameworks like CJADC2.

Finally, longitudinal studies should be conducted to track **behavioral and cultural changes over time**. Embedding a data-first mindset is not a one-time fix; it demands continuous feedback loops. Future efforts should monitor how data literacy, usage, and integration evolve across cohorts, commands, and mission types—informing evidence-based adjustments to doctrine, training, and leadership development.

By advancing these lines of effort, future research can help ensure that the U.S. military doesn't just adopt data tools—but fully weaponizes data as a strategic, scalable, and enduring advantage.

## IX. CONCLUSION AND CALL TO ACTION

The U.S. military stands at a strategic inflection point. As adversaries leverage artificial intelligence, data fusion, and automated systems to gain tactical and strategic advantage, the margin for decision-making error continues to shrink. The future of warfare will not be won solely by superior firepower or platform capabilities—it will be won by forces that can out-think, out-decide, and out-adapt their opponents through data. As Gen. Gary M. Brito, Commanding General of the U.S. Army Training and Doctrine Command (TRADOC), noted in a recent journal article: “A data-literate force will be better prepared to best understand and operate in the current and future operational environment and leverage the full capability of the tools in their toolkit... Most simply stated, as an Army, we must be able to shoot, move, communicate, and sustain ourselves with all available tools and capabilities regardless of how our operational environment evolves (Brito, 2025).”

This paper has shown that a truly data-centric military requires more than technological investments; it demands a cultural transformation. Building data literacy across all ranks, embedding data-informed training systems, integrating real-time analytics into operations, and enacting institutional reforms are all essential. But the decisive factor will be leadership's willingness to prioritize, normalize, and scale data-driven practices across the entire force.

Now is the time to act. Commanders must lead by prioritizing data literacy as a foundational competency. Educators and trainers should align curricula with the evolving demands of a data-driven operational environment. Technologists are responsible for delivering infrastructure that is interoperable, secure, and scalable. Meanwhile, policymakers must institutionalize incentives, metrics, and governance models that embed a data-first culture across the force.

In conclusion, the tools are here. The strategy exists. What's needed is bold implementation. To secure and sustain operational advantage, the U.S. military must not just use data—it must live it. Every echelon, every function, every mission. Let data culture be the next great force multiplier.

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