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ARTIFICIAL INTELLIGENCE AND PED: PREPARING HUMANS FOR HUMAN-MACHINE TEAMING

by

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ABSTRACT

The impending wave of artificial intelligence (AI) will soon permeate every aspect of modern warfare, and its impact will be particularly sweeping in the field of intelligence. With regard to processing, exploitation, and dissemination (PED) of intelligence data, the central claim is that these technologies will take over routine, codifiable tasks that currently dominate the majority of an intelligence analyst's time. As AI assumes these responsibilities, the analyst gains time to focus on uniquely human aptitudes requiring cognition and interdisciplinary problem solving. While the future of AI in PED is promising, taking advantage of its benefits requires a significant investment in human capital, which remains unfulfilled today. AI will profoundly change the attributes analysts are expected to exhibit, necessitating a comprehensive re-evaluation of the way analysts are developed and employed. Education and training of analysts currently focuses on building proficiency in tasks that will soon be assumed by machines, leaving them ill-equipped to perform the critical thinking and multi-source analysis necessary to succeed in an AI-enabled enterprise. In addition, the organizational structure and culture of Air Force PED, represented by the Distributed Common Ground System (DCGS), is characterized by historical rigidity, inhibiting the flexibility, creativity, initiative, collaboration and integration essential to maintaining information advantage in future warfare. Preparing human analysts for human-machine teaming demands a fundamental re-evaluation of how these analysts are educated and trained, shifting the prevailing paradigm from "what to think" to "how to think." Moreover, it requires the deliberate dismantling of the historically rigid governing structures of the DCGS, as well as purposeful movement toward a comprehensive culture change that inculcates an "analyst first" mindset within every intelligence Airman.

Maj Ricardo Colón – Vigilance Horizons

Introduction - A Focus on Humans

"Technology is nothing. What's important is that you have a faith in people, that they're basically good and smart, and if you give them tools, they'll do wonderful things with them."[1]
- Steve Jobs

Before they became machines, computers were people. The enormous server farms and seas of computer terminals in today's workplaces were preceded by groups of people employing human capacities to perform mathematical calculations by hand. The story of human computers began in the late eighteenth century with a group of astronomers collaborating to calculate the orbital path of Halley's comet and reached its pinnacle during the Second World War following the establishment of the Mathematical Tables Project (MTP) in 1938. Before the war ended, the MTP grew into a corps of 450 personnel conducting calculations for the armed forces, but accelerated progress in the field of electronic computing rapidly changed the landscape of the computing profession. The MTP was disbanded in 1948 as human computers were increasingly supplanted by machines.[2]

The introduction of computer technology into the labor force during the twentieth century provides a historical framework with which to assess the impending wave of artificial intelligence (AI). In a 1950 *Time* magazine article, Professor Norbert Wiener remarked that advances in computer technology will "devalue the human brain as the first industrial revolution devalued the human arm."[3] His comment largely reflects the viewpoints of his contemporaries and parallels today's commentary predicting the impact of AI. History reveals Professor Wiener's prediction was ultimately flawed. While the demand for human computers declined, the introduction of machines did not obviate the requirement for human skills or knowledge. Some human computers learned how to program and maintain the new machines. Others applied their mathematical backgrounds to validate the machines' outputs or perform calculations that

the machine was unable to perform. The gradual shift from human to machine computing revolutionized the landscape of the labor force, creating new professions while shrinking or eliminating old ones. As machines began to take on routine, codifiable tasks such as simple mathematical calculations, humans shifted to performing tasks which the machines could not perform. The introduction of AI will further amplify this dynamic, making the human brain increasingly valuable.

Human-Machine Teaming

"Game-changing systems of intelligence are built around the integration of AI with humans by combining the best of what computers do with the best of what humans do."[4]

- Malcolm Frank, Paul Roehrig, and Ben Pring

Considerable focus has been placed on AI technology and its anticipated revolutionary implications on future warfare, particularly in the area of intelligence. With regard to processing, exploitation, and dissemination (PED) of intelligence, surveillance, and reconnaissance (ISR) data, the central claim is that these technologies will take over routine, codifiable tasks that currently dominate the majority of an analyst's time.[5] Integration of AI in the PED workflow would instead allow "human brains and eyes [to focus] where they are needed most"—on tasks requiring human cognition such as in-depth analysis and interdisciplinary problem-solving (see Figure 1).[6] Such claims conjure up a world in which humans and machines work seamlessly side by side, each focusing on the aptitudes for which they are distinctly suited. This concept of human-machine teaming (HMT) will be vital to the successful integration of AI in PED and

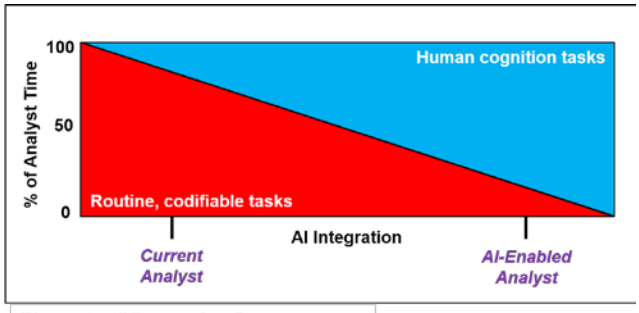

Figure 1: AI Integration Spectrum

raises some important questions.[7] What does an AI-enabled PED enterprise look like? How do the required attributes of successful analysts evolve as AI matures? And how can analysts and organizations prepare for such change? AI efforts thus far have been focused primarily on the machine portion of HMT. Given the fundamentally disruptive nature of AI in PED, front-line analysts are not prepared to deliver on the promises of AI advocates.

This paper examines the human element of the HMT concept when applied in the trenches of the Air Force PED enterprise, where individual analysts ply their trade. It focuses on the Air Force Distributed Common Ground System (AF DCGS), which is responsible for conducting the majority of Air Force PED, and highlights those analysts whose daily routine will be most impacted by the introduction of AI—the single-source analysts (geospatial analyst, signals analyst, etc.). It contends that integration of AI in the DCGS, combined with a requirement to remain agile in an increasingly complex world, demands a fundamental re-evaluation of how these analysts are educated, trained, and organized to accomplish their mission. AI will profoundly change the attributes analysts are expected to exhibit. In order to harness the full potential of AI, the Air Force's investment in human capital must be commensurate with its investment in AI technology. This requires "breaking down single-source stovepipes"[8] and transforming a PED culture which has historically measured, rewarded, and resourced expertise in the performance of routine, codifiable tasks. Instead, intelligence Airmen across all disciplines must prioritize and internalize their role as analysts first, a mindset that must be inculcated at initial training and re-inforced continuously throughout a career. Moreover, it demands incorporation of an education and training curriculum focused on multi-source analysis and critical thinking for both new and experienced analysts.

The PED of Tomorrow

"In addition to their many other challenges, IC analysts must contend with more requirements from more customers, and must answer more difficult questions more quickly and with greater precision than ever."[9]

- HAF/A2 White Paper (2014)

In *The Gilded Age*, Mark Twain and Charles Dudley Warner write, "History never repeats itself, but the Kaleidoscopic combinations of the pictured present often seem to be constructed out of the broken fragments of antique legends."[10] No one can accurately predict the character of future warfare, but given that history influences and often reflects the future, a close examination of the past and present may reveal trends that can sculpt a crude outline of what is to come. Such a review suggests that the operational environment will be characterized by volatility, uncertainty, complexity, and ambiguity. Today's strategic landscape reveals inter-state strategic competition between nation states reemerging alongside enduring threats to stability by rogue regimes and violent extremist organizations.[11] As weapon systems become more advanced, information technologies begin to suffuse nearly every object, and advanced technology becomes increasingly accessible to non-state actors, these political trends will present increasingly difficult challenges for military professionals.[12] The complexity inherent in these developments will breed increasing uncertainty and incentivize the pursuit of technologies and strategies aimed at countering the "fog of war." States will continue to acquire more and better ISR sensors, which will inevitably lead to a rapidly growing data pool of increasingly higher fidelity. Such an environment poses a formidable challenge for the intelligence organizations charged with making sense of it all.

To help address this challenge, Deputy Secretary of Defense Robert Work established the Algorithmic Warfare Cross-Functional Team (AWCFT) in 2017, seeking to integrate AI across the department's operations.[13] Long-term, AI is expected to permeate every facet of PED

operations, significantly altering the way front-line intelligence analysts currently execute their craft. Advocates contend that AI's contributions in conditioning data for subsequent analysis by humans makes it an indispensable element of any strategy to prepare PED for the speed and scale of future warfare.[14] In the short term, the AWCFT was charged with finding ways to employ AI in order to reduce the human workload associated with PED of full motion video (FMV). While an AI-enabled DCGS will look, act, and feel very different from the current enterprise, it will remain a human-centric organization. A fielded computer vision solution in FMV exploitation will identify vehicles, equipment, and personnel within an image or video. However, the algorithm will require a human imagery analyst's validation of its assessments to continuously refine itself and guard against erroneous calls. Moreover, humans will be necessary to discover new threats, targets, and opportunities, as well as make sense of all the data conditioned by the algorithm.[15] As AI technologies mature and machines take on an increasing number of routine tasks, analysts will have more time to focus on these cognitive responsibilities. They will "spend less time finding a tank and more time thinking about why the tank is there at all and what the tank might be doing tomorrow."[16]

In a recent article on future warfare, General David Goldfein, Air Force Chief of Staff, writes, "The primary warfighting attributes will be decision speed and operational agility."[17] He argues that battlefield advantage in future warfare will largely be dependent upon making sense of vast amounts of information and getting to the decision point quicker. In the context of John Boyd's OODA Loop,[18] this requires swifter navigation of the observe and orient phases, where human-machine teaming is projected to make a big impact. In PED terminology, the observe and orient phases are roughly analogous to the processing, exploitation, analysis, and production functions, which are executed on a time-dominant basis within the DCGS. As AI assumes the

previously labor-intensive task of data conditioning and creates time and space for analysis, single-source analysts at the DCGS will play an increasingly prominent role in the multi-source, fusion process. Lieutenant General Veralinn Jamieson, Air Force Director of Intelligence, views the transition to a fusion warfare concept as an operational imperative, enabling shaping of the battlespace by integrating information from multiple sources and domains.[19] This means that future analysts will require fluency in multiple domains, as well as an ability to conduct the type of thinking and connecting necessary to gain and maintain information advantage in a dynamic operational environment. Success in PED will no longer mean simply identifying items of interest within images or intercepted communications quickly and accurately. Information advantage will be gained by the side that can quickly exploit the mountains of data resident across multiple domains to improve situational awareness of the operational environment and enable multi-domain freedom of action.[20]

While future warfare in an AI-enabled world demands analysts with an ability to research, contextualize, and think critically about what they are seeing or hearing, simply substituting analytic expertise for expertise within a specific intelligence discipline would mark an egregious misstep for two reasons: (1) Humans will remain the supervisors of AI algorithms, and (2) humans will serve as trainers for new AI algorithms. This inherently requires that analysts retain expertise in their single-source specialty while gaining heretofore uncultivated expertise in critical thinking and multi-source analysis. Because the character of the next conflict remains unpredictable, analysts must be sufficiently agile and flexible to operate across the entire spectrum of warfare. Operational agility stands out as a common theme across multiple department and service-level guidance documents, such as the Air Force Strategic Master Plan[21] and the Air Force Future Operating Concept.[22] In addition, Joint Publication 2-0 states,

"Intelligence structures, methodologies, databases, products, and personnel should be sufficiently agile and flexible to meet changing operational situations, needs, priorities, and opportunities."[23] Yet, AI algorithms are not inherently agile and need humans to meet these demands. Discovery of new structures, equipment, and objects will require large data samples and sufficient time to train AI algorithms.[24] Colonel Jason Brown, lead Wing Commander of DCGS, notes, "Algorithms will lag behind adaptive adversaries and an ever-changing battlespace."[25] For example, during Operation Inherent Resolve, as coalition targeting shifted its focus to ISIS banks, oil logistics, and unmanned aerial systems, geospatial analysts were combing through imagery in search of objects which may not have previously been important. Since human analysts will be the ones training these new algorithms, retaining expertise in their specific intelligence discipline remains paramount.

The requirements of an AI-enabled DCGS in future warfare are formidable. Single-source analysts must retain expertise in their intelligence discipline (geospatial, signals, etc.) while building expertise in multi-source analysis and critical thinking. Moreover, the structure of the enterprise must promote collaboration and exhibit a degree of flexibility that enables it to seamlessly adapt to new requirements in an environment marked by constant change. The PED of tomorrow demands an increased focus on skills, attributes, and behaviors which are not sufficiently emphasized today. According to the Air Force Future Operating Concept, flourishing in the new environment requires Airmen who are "equipped with honed critical thinking and collaboration skills…adaptive behaviors, innovation, creativity, [and] collaboration."[26] The checklist-driven routine processes of today's DCGS will be increasingly performed by AI, leaving analysts in unfamiliar, relatively unstructured territory. There are no checklists for the aforementioned skills, attributes, and behaviors. Single-source analysts will be expected to

execute their missions across the entire spectrum of operations. As of today, they are not prepared.

Human Capital is Unprepared

"The vast majority of ISR professionals, both junior and senior, are largely unprepared for the tidal wave of synthesized information fusion warfare will demand in the years to come."[27]
- Lieutenant General "Dash" Jamieson

Today's DCGS organizations rely on precise, deliberate training delivered in relatively standardized fashion to a large number of analysts within constrained timeframes. Once qualified, analysts are assimilated into operational crews who execute their missions according to checklists, templates, and relatively rigid procedures. This labor-intensive process has historically restricted an analyst to "simply answering the question 'what is happening?' instead of finding patterns or determining what it will be doing next."[28] Much of this may be attributed to the fact that analysts largely train and execute within the "stovepipes" of their intelligence disciplines (geospatial, signals, etc.), leaving the amalgamation of disparate pieces of intelligence to end users. [29] The structure and rigidity embedded in the enterprise serves to enshrine consistency and predictability in its outputs. However, it also engenders a narrow, task-focused mindset within analysts that inhibits creative and critical thinking. Lieutenant General John Shanahan, who owns the AWCFT portfolio, called this construct "archaic, industrial-age PED."[30]

The DCGS enterprise is not yet ready for the wholesale integration of AI technology. While incorporating the latest AI algorithms represents a formidable technological hurdle, the most difficult challenge exists within the sphere of human capital. Because PED inherently involves analysis and often drives life or death decisions, humans will remain at its center.

Hence, any strategy to integrate AI into the PED enterprise must include a significant investment in the preparation of human capital. Human capital, comprised of people and organizations, is defined by the Office of the Secretary of Defense as the "inventory of skills, experience, knowledge and capabilities that drives productive labor within an organization's workforce." Featuring 27 globally networked sites and a work force of more than 5,000 people, human capital remains at the core of the DCGS mission.[31] A number of people- and organization-centric issues within this vast enterprise and the education and training pipelines that support it present hurdles for the successful integration of AI technology.

People-Centric Analysis

Single-source analysts within the DCGS lack the critical thinking and multi-source analysis skills necessary to operate effectively in the PED enterprise of tomorrow. This is largely the consequence of a development pipeline focused on producing analysts for the PED enterprise of today, which prioritizes training over education. For the purpose of evaluating preparedness, this analysis examines the responsibilities, education, training, and evaluation of a 1N1A Geospatial Intelligence (GEOINT) Airman assigned to DCGS as an FMV analyst. A review of 1N1A positional responsibilities within today's DCGS reveals an enterprise overwhelmingly oriented toward mastering routine, codifiable tasks within the GEOINT stovepipe. Fluency within multiple intelligence disciplines is left almost exclusively to qualified Multi-Source Analysts (1N0s) on the operations floor, erecting functional barriers within teams that impede mission

Curriculum	# Future Attribute Items*	Total Items	% Future Attribute
1NX CFETP	11	56	19.6%
1N1X1X CFETP	5	89	5.6%
DCGS FTU (IQT)	1	28	3.6%
DCGS MQT	1	13	7.7%
Total	**18**	**186**	**9.7%**

Figure 2: 1N1A Education and Training

*Items referencing critical thinking, other intelligence disciplines, integration, or intelligence research

optimization. For GEOINT Airmen, only the Screener position specifically delineates providing "real-time multi-intelligence analysis" as a core responsibility of the position.[32] However, neither the Job Qualification Standards nor the evaluation profile associated with the position enumerate this skill as a prerequisite for qualification.[33] Moreover, given the Screener's current pre-occupation with routine tasks such as chat communication and imagery review, there is little time available for analysis.[34] Recognizing a need for imagery expertise within its fusion-focused DCGS Analysis and Reporting Team, the DCGS has experimented with the Geospatial Fusion Analyst (GFA) position over the past four years. However, the position remains small-scale, officially unresourced, and ungoverned by a standardized training and evaluation program. On the whole, the enterprise is largely constructed to keep single-source analysis within one cylinder and multi-source analysis within another. These training, evaluation, and execution processes serve to enshrine a mindset within the vast majority of single-source analysts that multi-source analysis is simply outside of their "job jar."

The single-source mentality begins at initial skills training and is continuously reinforced throughout an Airman's career. A review of the 1NX Career Field Education and Training Plan (CFETP), which outlines a common core of fundamental training for all enlisted intelligence professionals, reveals only very limited emphasis on establishing an analytic baseline. Just 19.6 percent of tasks within this training plan focus on cultivating the attributes necessary to succeed in the PED enterprise of tomorrow.[35] Moreover, within the 1N1A GEOINT CFETP, priorities appear overwhelmingly focused on discrete knowledge such as order of battle identification—"what to think." Only 5.6 percent of tasks relate to multi-source analysis or critical thinking—"how to think."[36] These findings correlate with the curriculum of the GEOINT fundamentals course, where order of battle identification comprises six of fifteen blocks of instruction.[37] Prior

to performing their newly acquired craft during real world operations, GEOINT trainees must also successfully navigate DCGS Initial and Mission Qualification Training programs. These are classic training programs that focus on prescriptive execution of specific tasks. Just 2 out of 41 line items correlate with attributes previously identified as necessary in future warfare.[38] Formal training of GEOINT professionals currently prepares them to operate extremely well on the left side of the AI integration spectrum, executing tasks that will soon be assumed by machines (see Figure 1, p. 5). It does not prepare them to operate on the right side of the spectrum, where AI advocates predict these analysts will spend the vast majority of their time in the future.

Organization-Centric Analysis

Shortfalls in the development pipeline of single-source analysts represent just one major obstacle that must be negotiated in order to flourish in the PED enterprise of tomorrow. Additional hurdles lie in the organizational realm, and these can be categorized as structural or cultural in nature. To ensure predictable outputs, the structure of the DCGS embeds rigidity within the organization. Moreover, this structure has inculcated a culture that measures, rewards, and resources performance in tasks that will soon be taken over by machines. If these issues are not sufficiently addressed, AI will simply make the enterprise more efficient without making it more effective.

The evolution of the DCGS from its beginnings to its current state is consistent with the fundamentals of organization theory. The current DCGS weapon system traces its lineage to the Contingency Airborne Reconnaissane System, which was formed at Langley Air Force Base in 1992. While the weapon system has changed significantly since its inception, its fundamental purpose has remained relatively steadfast: “To provide critical and actionable intelligence to

leadership and supported commanders worldwide."[39] The organization was established with this specific purpose in mind and adopted structures, procedures, and a division of labor to exploit efficiencies in pursuit of that purpose.[40] As the economist Adam Smith notes, "By dividing labor, specializing according to function, and training members of the organization to perform in routine fashion, an organization harnesses the individual behavior of tens or hundreds or thousands to produce a uniform product in numbers unimaginably greater than what would be produced by each of these individuals working independently."[41]

The structure of the DCGS enables the Air Force to efficiently make sense of the mountains of data collected by intelligence platforms across the globe. However, it also inhibits the collaboration and integration necessary to flourish in the PED enterprise of tomorrow. Labor within the organization is divided according to intelligence discipline. Language analysts, imagery analysts, and signals analysts operate in separate teams with multi-source analysts spread thinly across the crews to provide battlefield situational awareness and make sense of the disparate pieces of intelligence collected. This structure ensures that single-source analysts are very good at their specific tasks but lack the skills or knowledge to connect the different teams effectively. Moreover, it fosters an environment in which signals intelligence analysts rarely engage with their imagery analyst colleagues, despite being in close physical proximity. Because inter-disciplinary collaboration and integration is not necessary to meet current minimum standards for single-source analysts, it happens largely by exception.

While organizations generally provide increased efficiency and reduced error rates, they also introduce rigidity and diminish flexibility, creativity, and initiative. Military organizations are even more susceptible to these costs than private organizations due to their affinity for predictability and aversion to uncertainty. The political scientist Barry Posen writes,

"Commanders must have orders to give that generate predictable responses. Thus, it is strongly in the interests of a military organization to impose its 'standard scenario' on the adversary."[42] The DCGS runs on this principle, emphasizing adherence to checklists as a key focus area during training and evaluation. Checklists govern responses to everything from setting up a workstation to supporting a troops-in-contact situation. Checklist usage is heavily scrutinized during positional evaluations, and Airmen are penalized for any deviations. In addition, product standards and templates constrain the types of materials that analysts produce. Analysts often interpret these guidelines as firm rules that demand strict adherence. If a mission situation arises that does not neatly fit a checklist scenario or product template, the analyst would likely force the situation into a prepackaged scenario for which he or she has previously prepared.[43] In a future operating environment dominated by volatility, uncertainty, complexity, and ambiguity, the "standard scenario" will be increasingly rare, and analysts will be expected to exhibit the flexibility required to generate products based on the deduced needs of the decision maker. Today's single-source analysts and the organizational structures within which they operate are largely unprepared to support such environments.

In addition to structural hurdles, reaping maximum rewards from the impending wave of AI requires confronting the cultural barriers present within the DCGS. Edgar Schein defines culture as "a pattern of shared basic assumptions learned by a group as it solved its problems of external adaptation and internal integration, which has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems."[44] The experiences of single-source analysts transpired largely within the stovepipes of their respective intelligence disciplines, and their identities are defined by these experiences. Proficiency for single-source analysts in today's DCGS is measured by

their ability to identify, label, log, and communicate collected information. Moreover, current outputs are generally discrete and quantifiable, leading to the development of metrics within the DCGS such as quantity of images produced, hours of video reviewed, and imagery error rates, which focus largely on administrative and procedural errors such as typos, classification, and proper notation of the cardinal directions.[45] As long as proficiency in routine tasks is measured, rewarded, and resourced above multi-source analytic capability, single-source analysts will hesitate to adopt an "analyst first" mindset. This is abundantly evident on today's DCGS operations floor. For example, when a single-source analyst sees "target research" in his checklist, he conducts a brief review of previous reports within his specific intelligence discipline. For a geospatial analyst, that includes examining previously collected images of the target and noting any patterns of activity. An AI-enabled PED enterprise demands a different interpretation of that term, expecting single-source analysts to view "target-research" as a comprehensive, data-agnostic review of intelligence across multiple domains. Moreover, it requires a broader understanding of the context and intent surrounding the target. Such a lofty goal requires a revolution in education, training, organizational structure, and culture.

Preparing for Tomorrow

Education and Training

In 1976, the U.S. Army published Field Manual 100-5 to codify operational doctrine across its force. This edition of the manual focused exclusively on the "science of tactical engagements," instructing its readers on the specific methods of warfare, such as how to execute a movement to contact.[46] This approach continued the U.S. Army's lengthy history of promulgating the prescriptive approach to warfare advanced by Antoine-Henri Jomini, who

asserted that victory on the battlefield is largely a product of science and geometry. In 1983, Colonel Huba Wass de Czege highlighted the risks associated with such thinking, stressing that "how-to training" will not develop soldiers sufficiently adaptive and innovative to win wars in an uncertain future."[47] He argued that education in theories and principles would be needed to cultivate both "how and what to think about war."[48] The international environment has grown even more uncertain and complex following the end of the Cold War. If predictions bear out, AI will gradually assume the tasks associated with "what to think"—identifying objects in images, translating intercepted communications, etc. This provides an opportunity to broaden single-source analysts' understanding of the environment via an education and training curriculum increasingly focused on "how to think."

Preparing humans for human-machine teaming requires updating eduation and training at the institutional level to reflect the evolving expectations for single-source analysts. This starts with a clear articulation of analyst responsibilities on the front lines of PED and continues with corresponding modifications across the entire length of the analyst development pipeline. While some single-source analysts today move fluidly across multiple intelligence disciplines to produce valuable and insightful products, this is largely the result of individual initiative, not the product of purposeful training and preparation.[49] The deliberate transformation of single-source analysts requires a two-pronged approach to education and training, targeting both new accessions and experienced analysts.

Preparing new single-source analyst candidates for human-machine teaming demands overhauling the training pipeline, which is currently designed to create expertise on the left side of the AI integration spectrum, encompassing tasks primed for machine substitution. In order to prepare for an AI-enabled future, the Air Force should invest in an expanded common core

curriculum for all enlisted intelligence professionals. Currently, the 1NX CFETP aims to serve this purpose, but its limited focus on multi-source analysis and critical thinking is insufficient for the future PED enterprise, where multi-source analysis, critical thinking, and problem solving become primary tasks for single-source analysts.

The new curriculum must "deemphasize memorization and routine in favor of curiosity and experimentation."[50] This means finding trade space by eliminating some knowledge-based material and replacing it with a heavier emphasis on teaching analysts how to think. For a 1N1A geospatial analyst, that may manifest itself in fewer instructional hours on order of battle identification and DCGS history and more hours on critical thinking. Moreover, the new curriculum must include baseline instruction on computer science and AI to establish a "bedrock for enabling digital literacy."[51] It is imperative that analysts have a general understanding of how AI algorithms work so they may understand how to interpret the provided solutions.[52] Trust will be at the center of the human-machine relationship and must be balanced by an enduring healthy skepticism to ensure that humans retain control of their machine coworkers. Responsibility for delivery and completion of this CFETP should shift to initial skills training in the form of a foundational course attended by all intelligence professionals. This would establish a common analytic baseline and facilitate the shift to an "analyst first" mindset.

Training new accessions for an AI-enabled PED enterprise is a necessary but insufficient step toward successful integration. The proposed education and training campaign must also reach experienced individuals whose acceptance of the technology and its impacts on analyst roles will be vital to any implementation plan. New analysts will perform largely according to the demands and expectations of their more experienced supervisors so it is extremely important that those demands and expectations fall primarily within the sphere of human cognition. While

much of this will be dependent on a successful culture shift, these experienced analysts also require exposure to advanced analytic training. One potential solution is the formation of mobile training teams postured to deliver the common core intelligence curriculum outlined above. The intent of these courses would not be to immediately produce expertise within students; rather, it would deliver a baseline of knowledge that would be reinforced by altered execution processes and reward structures.

Organizational Structure

The successful integration of AI within DCGS hinges on more than the optimization of education and training for its analysts. Even well-prepared analysts produced via a recalibrated training pipeline would have to contend with the manifestations of an organization beholden to its historically rigid character. The organizational structure of DCGS sites requires modification to take full advantage of what AI has to offer. Malcolm Frank, Paul Roehrig, and Ben Pring argue that every organization seeking to optimize its operations in light of the AI revolution should ask themselves one question: "If digital technologies were available when we designed this process, would we have structured it differently?"[53] With regard to the DCGS, the answer is undoubtedly yes.

Any effort to restructure an organization must start with its purpose. In *Strategic Leadership*, John Adair writes, "Reorganizing is about achieving the purpose more effectively in the present and in the future."[54] The purpose of the DCGS is to provide critical and actionable intelligence to leadership and supported commanders worldwide. Over the course of its history, the DCGS has pursued this purpose in the face of growing requirements by emphasizing efficiency and predictability. The monumental leap in efficiency promised by AI integration will

provide an opportunity to focus primarily on effectiveness. The rigid divison of labor and functional specialization advocated by Adam Smith will no longer be an operational imperative and may actually inhibit the organization from achieving its purpose. Given the demands of future warfare, restructuring the DCGS must focus on improving collaboration, integration, and flexibility. The organization has made significant inroads throughout its history in placing liaison officers throughouts its vast network of partner and supported organizations. However, collaboration and integration on its operations floors remain suboptimized, largely due to the structure of its execution processes. Currently, teams of single-source analysts are assigned to specific missions for specific periods of time to perform a specific function. In contrast, future warfare favors a concept of operations in which team members from multiple intelligence disciplines coalesce to solve specific intelligence problems.[55] AI's projected ability to sift through and label data provides analysts with the time and space to operate in such a manner. Not all airborne ISR missions will require time-sensitive human exploitation of data. If machines can facilitate detaching human exploitation crews from some or most ISR missions in real time, analysts gain time and space. The resulting flexibility enables their employment against the warfighter's most pressing intelligence questions.[56]

While structural modifications to improve collaboration and integration is necessary, it is insufficient to thrive in future warfare. The DCGS must become comfortable with uncertainty, defying the tendency of military organizations to perennially pursue predictability and impose their "standard scenarios." Templates and checklists must be comprehensively scrutinized to ensure they do not place unnecessary limitations on the analyst. This entails paring down these products to a minimum acceptable threshold and encouraging analysts to adjust products to the demands of the situation. Projected AI-generated efficiencies will significantly expand product

throughput and enable a level of customization that human labor limitations previously rendered impossible.[57] Whereas DCGS has historically been known for large throughput and standardized products, AI offers an opportunity to maintain the size of its throughput while providing truly customized products for its supported organizations. Such a revolutionary development would embed flexibility within the organization's structure and contribute substantially to achievement of its purpose.

Culture

In addition to changes in education, training, and organizational structure, the practical implications of AI in PED demand a culture change. Culture is extremely difficult to modify in the short term, and progress on this front will rely heavily on success in the education, training, and organizational structure lines of effort. Articulation of a detailed culture modification plan is beyond the scope of this paper, but the goal must be for every intelligence Airman to internalize his or her role as an analyst first, capable of fluently navigating across multiple intelligence disciplines to solve operational problems. Just like "every Marine is, first and foremost, a rifleman," every intelligence Airman must be an analyst first. Such a mindset would equip analysts with the initiative, creativity, and flexibility needed to respond to the dynamic environment of future warfare.

Inculcating this mindset shift requires strong leadership and a deliberate re-wiring of three key organizational mechanisms: What leaders measure, reward, and resource.[58] Leaders in the DCGS have historically defaulted to measuring those items that lend themselves to easy quantification: number of signals intelligence reports and images produced, hours of video reviewed, etc. As AI-enabled machines gain proficiency in conditioning data, these measures of

performance must be supplanted by measures of effectiveness that evaluate the analytic quality of human assessments. The ISR community has struggled with this challenge for a long time, largely because assessment of effectiveness remains a labor-intensive endeavor requiring human interaction.

Along the same lines, the organization must shift the focus of its reward structure away from performance of routine tasks to quality of multi-source analysis.[59] Key to this development is a vocal demand for this type of analysis from supported organizations and a system of accountability within the PED organization to ensure that such demands are being met. Supported organizations must push back when the DCGS fails to provide the type of support and analysis demanded by the mission. Until organizational reward structures are modified to incentivize single-source analysts to focus on tasks requiring human cognition, the culture shift cannot materialize.

Finally, leaders within the PED enterprise must change how they allocate resources. In this context, resources refer to manpower, money, and time. Commanders will commit their limited resources to the items they deem most important. As those issues evolve over the next few decades, resource allocation must evolve commensurately, with an increased focus on critical thinking, multi-source analysis, collaboration, integration, creativity, initiative, and flexibility.

Conclusion – Balancing the Equation

"War is always an equation of men and machines. Efficiency comes of a proper balancing of the equation."[60]

- S. L. A. Marshall

The DCGS has been an analytic workhorse for military intelligence since its inception nearly three decades ago, vigorously pursuing its purpose and providing indispensable support to decision makers. It was designed for efficiency and remains effective in today's fight. But tomorrow's fight requires different attributes. The Air Force must adopt a comprehensive approach to break down single-source stovepipes and deconstruct a PED culture that has historically measured, rewarded, and resourced expertise in performance of routine tasks. This approach must focus on the human element of human-machine teaming, revamping the development pipeline and crafting an organizational structure that fosters flexibility, integration, and collaboration.

The approaching wave of AI will make the human brain increasingly valuable. As the field of computer science was gaining momentum in 1973, the sociologist Daniel Bell predicted a future work environment in which "muscular fatigue would be replaced by mental tension."[61] Computer automation fundamentally changed the landscape of the work force, and AI is postured to do the same for the PED enterprise. New demands will be placed on analysts as "mental" tasks will increasingly compete with "muscular" tasks for an analyst's limited time. This dynamic will challenge what it means to be an analyst in an AI-enabled PED enterprise. General David Goldfein notes, "Our asymmetric advantage in future battles depends on harnessing the vast amount of information our sensors can generate [and] fusing it quickly into decision-quality information."[62] Today's DCGS and its thousands of analysts are not sufficiently prepared to flourish in this future environment.

Notes

[1] Jeff Goodell, "Steve Jobs in 1994: The Rolling Stone Interview," *Rolling Stone*, 17 January 2011, http://www.rollingstone.com/culture/news/steve-jobs-in-1994-the-rolling-stone-interview-20110117

[2] David Alan Grier, "The Human Computer and the Birth of the Information Age," *Endeavor*, Vol. 25, No. 1 (March 2001), 28-32.

[3] "The Thinking Machine," *Time*, 23 January 1950, http://content.time.com/time/subscriber/article/0,33009,858601,00.html.

[4] Malcolm Frank, Paul Roehrig, and Ben Pring, *What to Do When Machines Do Everything: How to Get Ahead in a World of AI, Algorithms, Bots, and Big Data* (Hoboken, NJ: John Wiley & Sons, 2017), 63.

[5] David Autor, "Why Are There Still So Many Jobs? The History and Future of Workplace Automation," *The Journal of Economic Perspectives*, Vol. 29, No. 3 (Summer 2015), 5.

[6] Robert K. Ackerman, "Seeing is Believing for Artificial Intelligence," *Signal* (blog), 21 August 2017, https://www.afcea.org/content/seeing-believing-artificial-intelligence.

[7] Cheryl Pellerin, "Project Maven to Deploy Computer Algorithms to War Zone by Year's End," *Department of Defense*, 21 July 2017, https://www.defense.gov/News/Article/Article/1254719/project-maven-to-deploy-computer-algorithms-to-war-zone-by-years-end/.

[8] Catherine Johnston, Elmo C. Wright, Jr., Jessica Bice, Jennifer Almendarez, and Linwood Creekmore, "Transforming Defense Analysis," *Joint Force Quarterly* 79 (1 October 2015), 18.

[9] Robert P. Otto, "Revolutionizing Air Force Intelligence Analysis," January 2014, 4.

[10] Mark Twain and Charles Dudley Warner, *The Gilded Age* (New York: Oxford University Press, 1996), 161.

[11] General John E. Hyten, *Statement before the House Armed Services Strategic Forces Subcommittee*, 115th Cong., 2d sess., 7 March 2018, 3.

[12] Department of the Air Force, *Air Force Future Operating Concept: A View of the Air Force in 2035*, (Washington, DC: Office of the Secretary of the Air Force, September 2015), 6.

[13] Deputy Secretary of Defense Robert Work, memorandum, April 26, 2017, Office of the Deputy Secretary of Defense, "Establishment of an Algorithmic Warfare Cross-Functional Team (Project Maven)."

[14] In this paper, data conditioning refers to AI's ability to quickly evaluate large amounts of data and provide an initial assessment that helps a human make sense of the data. For example, full motion video analysis augmented by AI may identify objects on the screen that an analyst then simply needs to validate. Data conditioning serves to organize data in a way that enables humans to accomplish the task more quickly and accurately.

[15] Col Jason Brown, USAF, "Bullet Background Paper on Creating the Optimal Airpower Neural Net," (13 November 2017).

[16] Ackerman, "Seeing is Believing."

[17] Gen David Goldfein, USAF, "War in the Information Age," *Defense One*, 16 November 2016, http://www.defenseone.com/ideas/2016/11/war-information-age/133193/.

[18] John R. Boyd, "The Essence of Winning and Losing," http://dnipogo.org/john-r-boyd/. The OODA Loop, originated by John Boyd, is a theory of decision-making comprised of the following elements: observe, orient, decide, act. The goal of the observe phase is to collect as much information as possible regarding a specific situation. During the orient phase, the goal is to add meaning to all of those observations. The decide phase represents the decision based on the meaning of the observations. The act phase is the end product of the previous three phases. Boyd argues that warfare favors those who complete this loop faster.

[19] Maj Gen VeraLinn "Dash" Jamieson, USAF, and Lt Col Maurizio "Mo" Calabrese, USAF, "An ISR Perspective on Fusion Warfare," *The Mitchell Forum - Mitchell Institute for Aerospace Studies*, No 1 (October 2015): 2, http://docs.wixstatic.com/ugd/a2dd91_df2f54c534b34ac1bac674b7379aa788.pdf.

[20] Jamieson and Calabrese, "An ISR Perspective," 2.

[21] "USAF Strategic Master Plan," May 2015, 5, http://www.af.mil/Portals/1/documents/Force%20Management/Strategic_Master_Plan.pdf.

[22] DAF, *Air Force Future Operating Concept*, 2.

[23] Joint Publication 2-0, Joint Intelligence, Joint Staff, 22 October 2013, II-10.

[24] Calum McLelland, "The Difference Between Artificial Intelligence, Machine Learning, and Deep Learning," Leverege Blog, https://www.leverege.com/blogpost/the-difference-between-artificial-intelligence-machine-learning-and-deep-learning.

[25] Brown, "Bullet Background Paper."

[26] DAF, *Air Force Future Operating Concept*, 23 & 37.

[27] Jamieson and Calabrese, "An ISR Perspective," 4.

[28] Valerie Insinna, "Air Force Transitioning Key Intelligence Systems to Open Architecture," Defense News, 18 September 2017, https://www.defensenews.com/digital-show-dailies/air-force-association/2017/09/18/air-force-transitioning-key-intelligence-system-to-open-architecture/.

[29] Brien Alkire, et al., "Leveraging the Past to Prepare for the Future of Air Force Intelligence Analysis," (Santa Monica, CA: RAND Corporation, RR-1330, 2016), 31.

[30] Mark Pomerleau, "DoD Has More Intel Than It Can Process," *C4ISRNET*, 20 March 2017, https://www.c4isrnet.com/intel-geoint/isr/2017/03/20/dod-has-more-intel-than-it-can-process/.

[31] "Air Force Distributed Common Ground System," U.S. Air Force, accessed 24 April 2018, http://www.af.mil/About-Us/Fact-Sheets/Display/Article/104525/air-force-distributed-common-ground-system/.

[32] Air Force Intelligence, Surveillance and Reconnaissance Agency Instruction (AFISRAI) 14-153 Vol. 3, *Air Force Distributed Common Ground System (AF DCGS) Operations Procedures*, 15 March 2013, 14

[33] Air Force Distributed Common Ground System Job Qualification Standard, IA, SCR, and IMS MQT, 7 October 2016; Air Force Intelligence, Surveillance and Reconnaissance Agency Instruction 14-153, Vol. 2, *Air Force Distributed Common Ground System (DCGS) Evaluation Criteria*, 15 March 2013.

[34] 480 ISRW, Interviews by Maj Ricardo D. Colón, October/November 2017.

[35] Department of the Air Force, *AFSC 1NX Intelligence Fundamental Core Career Field Education and Training Plan*, Washington, D.C., Career Field Education and Training Plan 1NX, 24 August 2016, 1-5.

[36] Department of the Air Force, *AFSC 1N1X1X Geospatial Intelligence Career Field Education and Training Plan*, Washington, D.C., Career Field Education and Training Plan 1N1X1X, 26 September 2016, 29-47.

[37] GEOINT Course Director, Goodellow AFB, TX, to the author, e-mail, 28 November 2017.

[38] Both of these items refer to target research. In the AF DCGS IA IQT Course Training Standard (CTS) / Training Task List (TTL), CTS 21 reads as follows: "Perform research, exploitation and analysis on assigned target." In the Geospatial Analyst (GA) Joint Qualification Standard (JQS) item 3.1 reads as follows: "Perform research, exploitation and analysis on assigned target." These task are generally interpreted in a very narrow sense and trained accordingly, expanding beyond the imagery intelligence realm only by exception.

[39] "Air Force Distributed Common Ground System."

[40] Graham T. Allison and Philip Zelikow, *Essence of Decision: Explaining the Cuban Missile Crisis* (New York: Longman, 2010), 145.

[41] Allison and Zelikow, *Essence of Decision*, 145.

[42] Barry R. Posen, "Explaining Military Doctrine," in Robert J. Art and Kelly M. Greenhill, *The Use of Force: Military Power in International Politics, 8th ed.* (Lanham, Maryland: Roman and Littlefield, 2015), 28.

[43] 480 ISRW, Interviews by Maj Ricardo D. Colón, October/November 2017.

[44] Edgar H. Schein, *Organizational Culture and Leadership*, (San Francisco, CA: Jossey-Bass, 2010), 18.

[45] Metrics of this nature have been a part of DCGS for a long time. Recently, the DCGS has engaged in efforts to move away from these metrics and is searching for ways to more accurately measure effectiveness. 480 ISRW, Interview by Maj Ricardo D. Colón, May 2018.

[46] Thomas E. Ricks, *The Generals: American Military Command from World War II to Today* (New York, NY: Penguin Books, 2013), 354.

[47] Ibid, 355.

[48] Ibid, 355.

[49] Lt Col Michael D. Holmes, USAF, "Fusion Intelligence: Establishing a Reliable Capability," (ISR Task Force research paper, Air University, 2017), 8.

[50] Abdul Razack, "How to Prepare Employees to Work with AI," *Entrepreneur*, 15 June 2017, https://www.entrepreneur.com/article/295520#.

[51] Ibid.

[52] Peter Roberts and Andrew Payne, "Intelligence, Surveillance and Reconnaissance in 2035 and Beyond," *Royal United Services Institute for Defence and Security Studies* (February 2016), 18.

[53] Frank, Roehrig, Pring, *What to Do*, 28.

[54] John E. Adair, *Strategic Leadership: How to Think and Plan Strategically and Provide Direction*, (London: Kogan Page, 2010), 88.

[55] Colonel Jason Brown, current 480 ISRW Commander, has spoken extensively about the concept of problem-centric PED, and the ideas within this paper referencing this concept are heavily influenced by the author's personal recollections of those talks from 2016 to 2017.

[56] The DCGS is already making progress on this front, sponsoring a pilot program to evaluate a problem-centric crew construct at Distributed Ground Station-1 in May 2018. The intent is to bring together analysts from various intelligence disciplines to solve warfighrer problems. Preliminary feedback suggests that the increased cognitive activity required by analysts in this construct also increases motivation. 480 ISRW, Interview by Maj Ricardo D. Colón, May 2018.

[57] Frank, Roehrig, Pring, *What to Do*, 37.

[58] Schein, *Organizational Culture*, 236. This is an adaptation of Schein's six embedding mechanisms, focusing on the three that the author consider most applicable to Air Force DCGS.

[59] Ibid, 247.

[60] S. L. A. Marshall quoted in Conrad C. Crane, *American Airpower Strategy in World War II: Bombs, Cities, Civilians, and Oil*, (Lawrence, KS: University Press of Kansas, 2016), 85.

[61] Daniel Akst, "Automation Anxiety: Where Have All the Jobs Gone," *The Wilson Quarterly* (1976-), Vol. 37, No. 3 (Summer 2013).

[62] Goldfein, "War in the Information Age."

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