UNITED STATES ARMY
SPECIAL OPERATIONS COMMAND

White Paper

Operationalizing Deep Knowledge

15 April 2016

"Mendel's concept of the laws of genetics was lost to the world for a generation because his publication did not reach the few who were capable of grasping and extending it; and this sort of catastrophe is undoubtedly being repeated all about us, as truly significant attainments become lost in the mass of the inconsequential."[1] *Vannevar Bush, 1945*

Overview

One of the key findings that emerged from the recent SILENT QUEST (SQ) 15-1 exercise venue, sponsored by the U.S. Army Special Operations Command, was the need to identify potential problems on the international stage before they became crises.[2] The premise underlying this research effort is that somehow, somewhere knowledge exists that could potentially indicate a burgeoning crisis or conflict situation. The question is, where is that knowledge and how does the U.S. military exploit this knowledge?

The basis for this concept is derived from senior leader guidance to consider "methods to sustain deep knowledge" and "what to consider in order to warehouse data and keep knowledge beyond the length of the assignment cycle/POM cycle." This focused effort has been a recurring theme since SILENT QUEST (SQ) 13-2 exercise two years prior. In order to address this recurring theme, one aim during the SQ 15-2 event is to use "deep knowledge" as part of the exercise framework, to guide decision-making. Key leaders will determine how this will be done based on outputs from working group discussions during SQ 15-2 Enabling Event #1 and Enabling Event #2.

The U.S. military needs to analyze two factors in order to begin testing this concept. First, what does "deep knowledge" mean, and more generally, what forms of knowledge does the U.S. military currently employ? Second, in what way could units store or access information that leads to deep knowledge? In a broader sense, where does knowledge currently reside? What mechanisms and methods could the force use to reframe the use of information and data as enterprise assets?

The following figure depicts a framework to guide deep knowledge discussions. It is a design feature to frame our knowledge environment. The goal of framing the environment is to uncover key areas where the U.S. military can take better advantage of its existing knowledge base. Additionally, we want to reveal advanced ways that information and data could inform decisions. Those revelations will lead to new approaches to harvesting deep knowledge, which will be tested as mission command solutions during SQ15-2.

Figure 1: Deep Knowledge Discussion Framework

"How do we have a conversation with the data?"[3] *SGM Houston, USASOC G9*

Purpose

This paper frames a discussion on how the U.S. military can use vast amounts of information to achieve decisive situational advantage. Moreover, this paper aims to elevate that discussion to consider options for using that information in more integrated ways. By doing so, the U.S. military will create a synthesized understanding of the operational environment by leveraging *deep knowledge*. **Deep knowledge can be defined as "a new perspective of the operational environment derived from acquiring, sifting, integrating, and interpreting diverse tacit and explicit data**."[4] International security trends of disorder, scarcity of resources, ecological challenges, toxic ideologies, game-changing technologies, emerging resistance movements and opportunistic competitors employing hybrid warfare capabilities are creating new challenges in the operational environment.[5] This demands new approaches to managing shared knowledge. The U.S. military must maintain a competitive advantage against adaptive threats by using deep knowledge to understand how the human domain overlaps with other physical and virtual domains. Doing so will enable the U.S. military to seize the cognitive initiative in a complex environment.

Rapidly evolving integrated technologies enable organizations to look deeply into areas of the world and see billions of disparate data as an aggregated picture. *The ability to see through those data and create meaning is the "deep knowledge" this paper seeks to explore*. How then does the U.S. military operationalize deep knowledge and understand the operational environment at an entirely new level? The information challenge the community faces is to move beyond our "know-what" and "know-how" and shift the paradigm of information management to become "professionals with know-why [that] can anticipate subtle interactions and unintended consequences" in our operating environments.[6] At the core of Mission Command lie the human experience and systems technologies, along with the organization's culture of learning to collect and analyze data relevant to operational decisions.[7] One of the primary tasks of mission command is to conduct knowledge management and information management; therefore, an opportunity exists to capitalize on the intersection of advanced computing capacity and myriad institutional information to achieve greater situational understanding than previously attainable.[8]

A mixed-methods approach was used to study how the DoD could interpret and envision using deep knowledge. Research on current business and government trends related to maximizing corporate knowledge occurred through surveys of various academic, businesses, organizational, and international publications. There are vast references to knowledge, knowledge management, data, big data, data analytics, global mapping, social networking, and other similarly related technology and social science disciplines. Additionally, the USASOC sponsored SILENT QUEST Wargaming venue fielded much of the grassroots conversation throughout the ARSOF enterprise as participants in associated enabling events debated and discussed interpretations and implications of deep knowledge. Incidentally, the topic of deep knowledge emerged from the SILENT QUEST enabling events as one of the key topics for senior leader to discuss during SILENT QUEST 15-2. Separately, the research team convened key stakeholders, including functional staff and subordinate organizations through one-on-one interviews and collaboration meetings to share perspectives of similar ongoing initiatives throughout the enterprise. The

research team was also able to leverage the reach-back capability of contracted concept development teams to collaborate with colleagues engaged in similar knowledge utilization initiatives in commercial business sectors. This broad study approach revealed that the time is right to advance the concept of deep knowledge beyond conversation to operationalization.

Deep Knowledge

Operating based on a profound, evolving understanding of the operating environment is at the core of Mission Command and Operational Art. The Army recognizes two forms of knowledge: tacit and explicit.[9] Essentially knowledge consists of what one knows and what an organization records. These are "gained through study, experience, practice, and human interaction and [are] the basis for expertise and skilled judgment."[10] Although these two forms of knowledge represent a foundation for what one might know, this paper raises the question: Is there another aspect of associating disparate information to include the digitized data to reveal new knowledge?

Deep knowledge needs to encompass a broad range of considerations relative to an area of operation, with granularity focused to operational echelons. It could account for stores of information within existing repositories internal to the organization. It could also account for information from data sources external to the organization. Examples of these domain topics include:

- Cultures
- Religions
- Ideologies
- Histories
- Infrastructure
- Economics
- Militaries and defenses
- Language
- Environment
- Geography
- Expertise
- Education

Along with these considerations, deep knowledge should be functionally unique by linking and dynamically relating numerous sources and diverse categories of information about an operating environment. This is an expansion of intelligence analysis to combine intelligence disciplines with operations experience. Employing “big data” capacities and methodologies, deep knowledge could thus extract interpretation from data. Mission Command could therefore assess the direction and implications of trends and events, perceived in near real time. In effect, operations planners could map the human domain with the geographic fractals of data.[11] At a minimum, this could include:

- Networked relationships
- Personal experiences
- Human transactions
- Ongoing or emerging trends
- Nuanced anomalies
- Virtual conversation trends
- Georeferenced metadata
- Multimodal societal sentiment analysis[12]
- Opinion mining (polarity classification and detection)[13]
- “Culturomics”[14]

Problem Statement

As the U.S. military confronts an increasingly complex operational environment, rapidly evolving computing technologies will advance information control in a globally connected world. How then do commanders and staff leverage massive amounts of data and information to make better, more rapid decisions? Moreover, how does the U.S. military use an information capability to derive deep knowledge of operational environments to gain a decisive advantage in situational awareness? Through better implementation of technology systems, streamlined information processes, and mission command emphasis, in essence, "How do we have a conversation with the data?"[15]

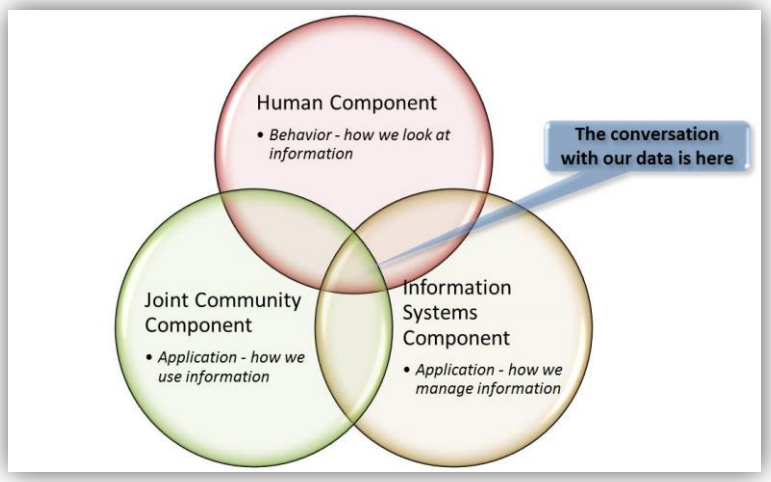


Figure 2: Conversation With the Data

The U.S. military has an opportunity to seize the initiative using knowledge as a weapon system by:

- collecting and retaining tacit forms of knowledge to include social and professional connections, operational experiences, civilian education, personal skills and abilities
- piecing together existing sources of tacit and explicit information
- integrating information from external sources
- leveraging advanced data systems to analyze content and synthesize data

Central Idea

Since one of DoD's roles is to maintain persistent presence throughout the world, day-to-day observations coupled with historic data should reveal nuances that otherwise would go unnoticed. The Joint Force is uniquely postured to take those inputs in aggregate and synthesize them into actionable knowledge. This factor is particularly true of future maneuver within the human domain. Collective interactions in the human domain should reveal potential security conditions when analyzed with aggregating data tools by both intelligence and operations experts. The hypothesis behind deep knowledge suggests that fusing multidisciplinary information practices ought to reveal situational insights that otherwise would go unnoticed. Much like the Ishihara Color test reveals hidden numbers embedded within a colored plate, new revelations in the human domain could be gleaned from digitized data that is pieced together by multidisciplinary efforts (Fig. 3). [16]

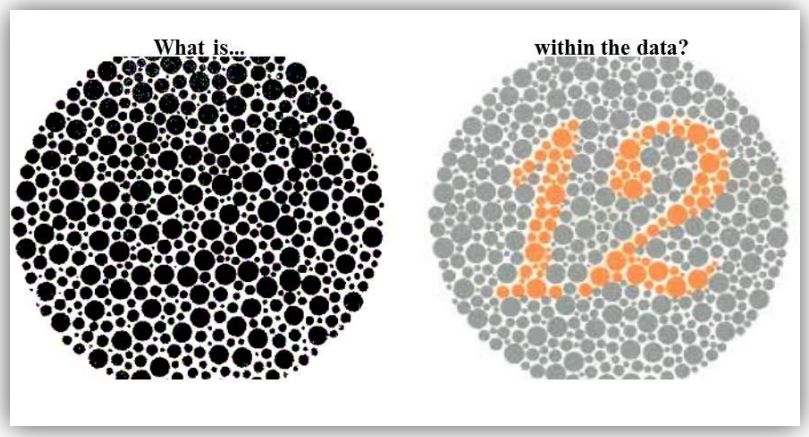


Figure 3: Information in Data

Components of a Solution

Managing People

As the U.S. military seeks comprehensive solutions to operationalizing knowledge, three key areas of emphasis will drive the thinking about leveraging information. The first area considers the operator. This is the human element. This human element consists of the management of information our operators knows explicitly and intuitively. The DoD personnel enterprise is both highly talented and highly aware of nuances within operational environments. Therefore, in order to extract the most from what operators know, an approach to gaining deep knowledge needs to account for managing the talent with the ranks and the personal knowledge developed through experiences, social connections, professional contacts, and individual competencies.

Data Repositories - Managing Information

Currently information exists throughout the force in a wide variety of information management systems (SharePoint), databases, shared drives, file documents, reports, etc. Some of that information is readily accessible to those within the enterprise network. However, access restrictions, systems constraints, and data storage practices limit collaboration of information thereby reducing the utility of it as useful knowledge. Therefore, through what repository methodology could operators exploit tacit and explicit knowledge buried within the data?

Solutions to data exploitation could consider new ways of storing and accessing information as well as new ways to associate bits of data. One way to think about solutions to a repository idea would be to compare card catalog libraries to digital encyclopedias, such as Wikipedia. In the former example, one would need to consult a physical cataloging index or librarian for directions to a particular book or subject of books. They would then need to manually sift through those books in hopes of finding relevant information - an inefficient and time-consuming process. The latter example virtually connects the information dots by providing summarized, user-defined information. Moreover, it digitally links to source references. The latter example could be taken

further through an automated mechanism that sifts through the referenced data and extracts associated information.

One critical observation is that a culture exists throughout the force that, unfortunately, is not fully maximizing an opportunity to put both tacit and explicit information into a collaborative data environment. The strongest case example of this behavior is the general tendency to forego the use of the enterprise collaboration tool, SharePoint, for more rudimentary and inefficient repository solutions, namely shared drives. This paper will not attempt to explain why there is a significant reluctance to use SharePoint; however, the SharePoint example illustrates an inherent behavior representative of the emphasis placed on how information is used to generate knowledge.

Information that is difficult to reach is difficult to use. Current business technology trends are seizing upon information management and data technology solutions to design agile learning organizations that maximize both tacit and explicit knowledge.[17] It is for this reason that this white paper suggests that deep knowledge is a form of a weapons system when Mission Command emphasizes its use to frame the operational environment.

Tools to Manage Knowledge

Finally, how does the U.S. military leverage analytical tools to piece together these key areas to develop deep knowledge? Many tools currently exist and could be models for off-the-shelf information systems to employ as a sort of dashboard that could be used within an operationalized CONUS base. One example, merely for illustration, is the GDELT Project platform that provides real-time monitoring of open-source information sources.[18] Through open access Application Program Interface (APIs), the service culls billions of available database information sets to visualize and explore data.[19]

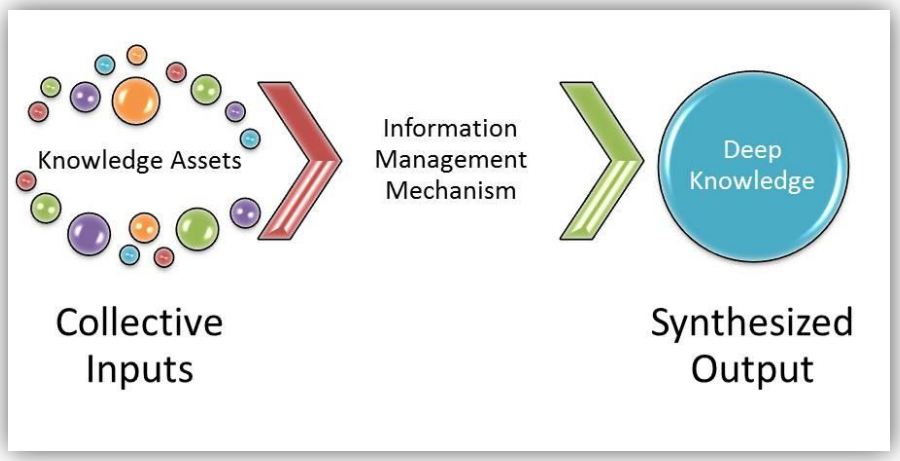


Figure 4: Inputs to Outputs

Other similar commercial services include IBM's Watson platform and Dataminr's real-time information engine.[20] Similarly intelligence and mission command systems such as Palantir, Distributed Common Ground System-Army (DCGS-A), and Command Post of the Future (CPOF) attempt to present visualizations of multi-variant information. Other information systems also exist to store lessons learned, operational observations, area studies, and even unit specific training and operations events. These can be found on both classified and unclassified networks. The problem with these few examples is that the data are often either difficult to transfer, or cannot be transferred between systems. Moreover,

the value of the data is a function of input and access. Information has to be added in a useful way, and the information must be accessible. If the information is not accessible because it is hard to find, or security classifications limit authorized access, or it exists in incompatible forms, then the information cannot be turned into knowledge.

Capabilities

What capabilities does the force need to operationalize deep knowledge? The following aspects should be considered as the U.S. military finds solutions to maximize available data.

- Searchable across classification systems
- Able to assess multi-source inputs for trends, tipping points, thresholds, anomalies with organization information and with non-standard indicators (e.g. independent metadata)
- Possibly new expertise to facilitate exploitation of data mined knowledge
- Able to tailor parameters for necessary levels of analysis from MACOM to operator
- Ability to associate multiple sources of information
- Develop predictive models of human behavior
- Negotiate access restrictions through institutional firewalls and systems
- Illuminate real and fabricated narratives from multi-source media analysis
- Intuitive interface that encourages participation
- Secured at relevant levels based on classification limitations
- Real-time and historic data analysis
- Battlefield networking to share information
- Tactical biometric matching

Context for Deep Knowledge

The Army initiated a series of challenges to orient the force's thinking about how future capabilities should address current problems. The first warfighting challenge looks at "[how] to develop and sustain a high degree of situational understanding while operating in complex environments against determined, adaptive enemy organizations."[21] The lead for this challenge has been the Intelligence Center of Excellence. Incidentally, the Intelligence community has specifically taken on certain aspects of broadening situational understanding. The effort that intelligence functions are doing to build better and more responsive threat understanding correspond with an underlying difficulty in operationalizing deep knowledge. Based on recent surveys of the force and iterative concept testing through SILENT QUEST 15-2 enabling events, we are coming to understand more fully the artificial and virtual walls that separate functions (such as operations and intelligence) and organizations from capitalizing on existing access to information.[22] A key takeaway from the SILENT QUEST events was that the force already has many mechanisms to generate knowledge, but the ability to consolidate the effect of those mechanisms collectively unfortunately keeps institutional knowledge disaggregated.

Aside from the Army's warfighting challenge, one consistent theme emerges from the variety of national strategy guidance; that is the demand for decisive situational awareness. Grasping the

complexities and nuances of the future operating environment requires collective efforts of intelligence disciplines and operations expertise. The lash up of those efforts, if managed in a synthesized manner, could more clearly portray the environment to scalable degrees of granularity from multiple narrative vantage points.

The 2015 National Security Strategy recognizes an interconnected global system of participants. Consequently, struggles for power are anticipated both among states and beyond state structures.[23] Deep knowledge could illuminate those tension points when they appear and as they increase in intensity. Doing so would inform policy considerations to shape the trajectory of power outcomes. *Moreover, the ability to identify particular indicators and warnings of security conditions early in an operational timeline would enable decision making that gets ahead of potential instability trajectories*.

Most recently, state-on-state challenges resurface in priority based on their risk potential. The 2015 National Military Strategy (NMS) identifies a global security context that requires a "competitive advantage…[in] early warning and precision strike."[24] Moreover the NMS notes the global nature of information and information technologies which both enable and empower people. The power of information and the power of access to information is changing the velocity of decision-making. Competition for control of resources and the social narratives that lead to political and economic stability are based in part on a competitive advantage to information.

Together these strategic policy frameworks point to a need for comprehensive approaches to establish international deterrence credibility. In part, the relative advantage of credibility favors the actor able to weigh the cost of benefits against associated and even unintended risks. Those measurable variables must be ascertained through deliberate and inadvertent capture means. In other words, data that reveal information about an operational environment provide the knowledge needed to guide mission command. This paper suggests that the Joint Force can achieve a level of situational awareness that is decisively more valuable to decision makers because of the fundamental understanding of the human domain.

Knowledge Sharing Example from Crisis Mappers

One way to illustrate how tacit forms of knowledge, such as social connections, could provide deep knowledge is to look at how humanitarian practitioners leverage international networks to anticipate and respond to crises. An example of socially connected knowledge is seen through the work of international "crisis mappers."[25] Crisis mapping utilizes crowdsourcing concepts to leverage networked individuals participating in crisis response efforts through web-based and mobile applications. These interconnected digital ecosystems are able to move massive quantities of data about impending crises and virtually *ex nihilo* form rapid responses to those crises.[26]

Although technology tools are maximized to make the process of information sharing efficient, technology only serves as a secondary element that supports a cultural behavior of information sharing. One crisis mapping researching noted that, "grassroots organizations foster practical approaches that focus on relationship building, information analysis and *fusion*, rather than software development."[27] One critical lesson that the Joint Force can learn from the way crisis mappers have redefined international humanitarian responses is to embrace an inherent motivation to share information rather than store it.

Solution Options

Deep knowledge solutions should be comprehensive, addressing multiple factors simultaneously. No one-solution approach will solve any problems with the way the force uses its information. Incidentally, an approach will likely need to synthesize the relationships among human components, information systems components, and the broader joint community. The intersection of a data oriented mindset within the community, the expertise to manage and manipulate those data, and the data themselves is where DoD operationalizes deep knowledge (Fig. 2).[28]

What follows (Fig. 5) is a menu of options along the aforementioned lines of effort. These options are scalable within each dimension, so, collectively, they can be scoped to achieve required advantages. The way to engage with the data is to apply elements from each component to comprehensively leverage information and use knowledge as a weapon system.

Human Dimension	Develop organizational architecture of SME managers - "help desk" model or fusion cell centers of operational knowledge managers and technical knowledge managers
	Adopt new behaviors of information managment that integrates practitioners with technologists
	Combine Intelligence and Operations information functions through integrated organizational processes
Information Systems	Adopt new advanced information aggregating systems capable of extracting information across multiple platforms and domains
	Adapt current ARSOF information systems to use more collaborative and integrated protocols
	Broaden Intelligence data collaboration initiatives to fuse with operations information and personal information
Joint Force Community	Adopt new training and education practices that teach leveraging information
	Prioritize information management practices to instill a culture of knowledge specialists
	Design and enforce new business rules to capture, exploit, and use tacit and explicit forms of operational knowledge

Figure 5: Options to Comprehensive Solution

Implications

The implication of achieving deep knowledge at the individual operator and institutional level is clear: the U.S. military could derive a much more profound and proactive understanding of likely operational regions, along with a more attuned grasp of potential or emergent triggers to crises in these regions. Units would thus be able to focus on critical interpretive indicators in likely areas of operation, enabling much more rapid and responsive mission planning.

Through analysis of associated knowledge, the U.S. military could potentially get ahead of the crisis curve. The force could also determine the degree to which figurative "gray zones" are transitioning from stages of peace to war. Layered depths of knowledge management could reveal broader understanding across traditional information seams.

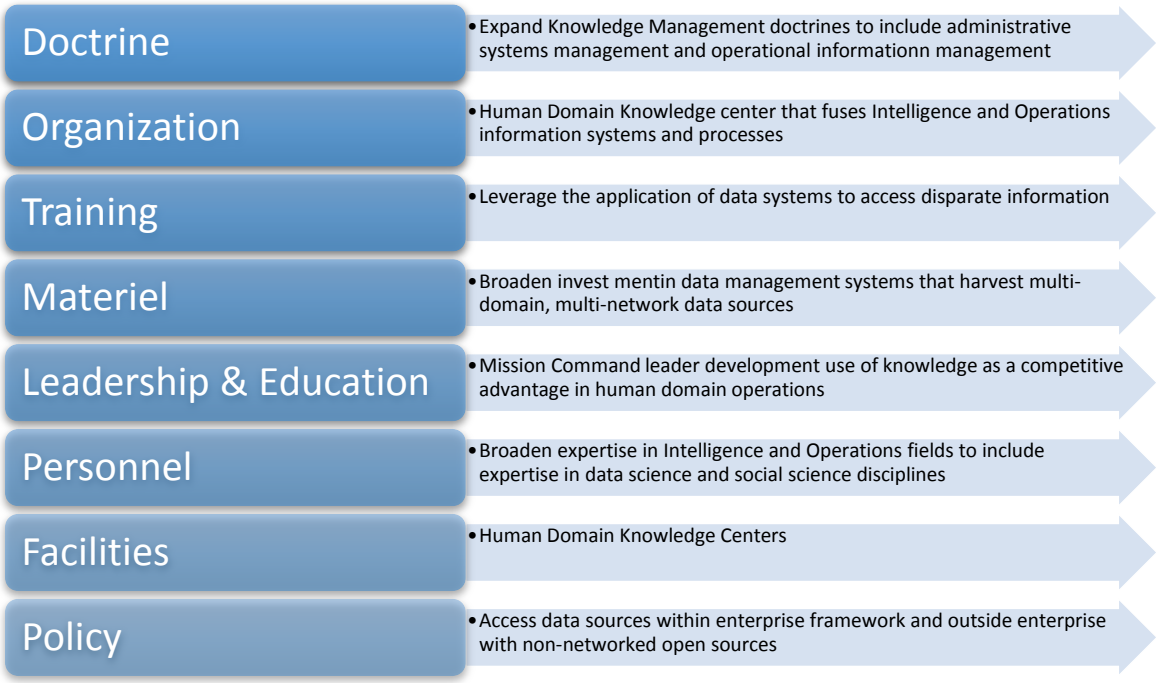
Conclusion

"[Man] has built a civilization so complex that he needs to mechanize his record more fully if he is to push his experiment to its logical conclusion and not merely become bogged down part way there by overtaxing his limited memory."[29] *Vannevar Bush, 1945*

Can the U.S. military arrive at new meaning from existing knowledge and synthesized data? By exploiting repositories of information, and collecting operationally relevant data with method-driven technology solutions, Joint forces can overcome the limitations of individual and institutional memory. To do that, we must better integrate personal and organizational knowledge with useful management, storage, and access to such information. However, if operators continue to rely on its current panoply of independent information systems and methods of managing information, then the organization runs the risk of falling behind other government agencies, joint partners, and potentially competitors in the arena of information dominance. This risk is further exacerbated by the rapid rate with which data technologies are advancing across the global information market, making the ability to acquire new knowledge both easy and relatively inexpensive – an advantage to adversaries and allies alike.

Appendix: DOTMLPF-P Considerations to Manage Adaption of Deep Knowledge

A DOTMLPF-P framework is one way to consider instituting long-term organizational change. The following considerations only illustrate themes of thought derived through collaboration with various ARSOF enterprise functions and organizations. These illustrations are intended to generate further discussion as to the use of Deep Knowledge during SILENT QUEST 15-2.



Notes

[1] In his seminal work, *As We May Think*, Vannevar Bush made a prescient argument for the exploitation of scientific advances to contain, record, and reuse man's vast base of knowledge.
[2] SILENT QUEST 15-1 Final Report (Draft)
[3] During the SILENT QUEST 15-2 Enabling Event #1, one of the most informative analyses that came out of small group collaboration sessions was a remark by USASOC G9 Sergeant Major, SGM Houston. He asked this prescient question, which elevates the deep knowledge discussion from one of just managing repositories to one of connecting the human dimension with information technology.
[4] This definition of deep knowledge is derived from iterative SILENT QUEST working group sessions. It is also derived from one-on-one interviews with various functional and subordinate USASOC elements.
[5] See USASOC White Paper "Redefining the Win"
[6] Quinn *et. al*. describe how organizations can maximize the inherent knowledge in people by managing professional intellect.
[7] Ibid.
[8] ADRP 6-0 Mission Command, p. 1-4. Knowledge is a central theme of Mission Command as information is analyzed and turned into knowledge through command discernment.
[9] ATP 6-01.1, p. 1-3.
[10] Ibid.
[11] For more human domain mapping see Raymond, Derek. *Human Domain Mapping in 21st Century Warfare*.
[12] For an overview of sentiment analysis and opinion mining see: Cambria, Erik, Bjorn Schuller, Yunqing Xia, and Catherine Havasi. "Knowledge-Based Approaches to Concept-Level Sentiment Analysis." *Intelligent Systems, IEEE* 28, no. 2 (March/April 2013): 15-21.
[13] Ibid.
[14] "Culturomics" is an emerging discipline that looks at "the application of high-throughput data collection and analysis to the study of human culture." For more see: Michel, Jean-Baptiste et. al. "Quantitative Analysis of Culture Using Millions of Digitized Books." *Science* 331, no. 6014 (January 2011): 176-182. See also Leetaru at http://firstmonday.org/ojs/index.php/fm/article/view/3663/3040.
[15] SGM Houston, SILENT QUEST 15-2 Enabling Event #1.
[16] These images are from the Ishihara Color test, Test Plate 12, used to test for colorblindness. The black and white plate represents a collection of data points that when filtered in color reveals the number 12.
[17] In a 1988 Harvard Business Review essay, Peter Drucker observed that "to remain competitive – maybe even to survive – businesses will have to convert themselves into organizations of knowledge specialists."
[18] For more on the GDELT Project see http://gdeltproject.org/ . Note that GDELT is one example of many platforms currently exploring the aggregation and analysis of "big data" information.
[19] Kalev Leetaru, the founder of the GDELT Project discusses "realtime [sic] programmatic access" to massive amounts data made possible through APIs. See more at: Leetaru, Kalev H., Shaowen Wang, Guofeng Cao, Anand Padmanabhan, and Eric Shook. "Mapping the global Twitter heartbeat: The geography of Twitter." *First Monday* . May 6, 2013. http://journals.uic.edu/ojs/index.php/fm/article/view/4366/3654 (accessed May 20, 2015)
[20] There are many commercial projects led by numerous technology companies that are trying to use complicated algorithms and API interfaces to extrapolate correlations that can be visualized. See: https://www.dataminr.com/technology/ ; http://www.ibm.com/smarterplanet/us/en/ibmwatson/explorer.html.
[21] For more on the Army's Warfighting Challenges, see http://www.arcic.army.mil/Initiatives/army-warfighting-challenges.aspx.
[22] During SILENT QUEST Enabling Events 1 and 2, participants discussed the difficulty their organizations have had sharing information with other ARSOF organizations as well as organizations external to ARSOF. These challenges are technical (e.g. classifications, system firewalls, permissions), cultural (e.g. perceived expertise difference between operators and analysts), administrative (including agency policies, formal and informal business rules), and technological (e.g. limits on data aggregating software, limits on access to open data sources, user understanding of technology capabilities).
[23] See 2015 National Security Strategy, pp. 3-5.
[24] See 2015 National Military Strategy, p. 1.
[25] One of the largest networks of humanitarian workers exists through crisismappers.net, which hosts a community of humanitarian practitioners and others interested in collaborating through open sourced crowdsources applications.
[26] For more on how government can learn from grassroots crisis responses see Crowley, pp. 21-23.

[27] Crowley, p. 28. *Emphasis added*. Crowley notes that "Large system integrators have perpetuated this confusion [preeminence of technologies]: it is far easier to sell a silver-bullet technology to the government than to build the combination of community, technology, and best practices…" p. 31.
[28] Mayer-Schonberger and Cukier discuss how the online corporation, Amazon, broke from institutional norms by approaching its business model as "the mindset, the expertise, and the data." See *Big Data* p. 132.
[29] Bush, p. 46.

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Please direct any questions to:

USASOC Commander's Initiative Group (CIG)
910-432-8954

or

USASOC Deputy Chief of Staff, G9
910-432-7743