# Data-Enabled Decision-Making

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*"Universally, the one thing that jumps out continuously is the need for data. It's all types of data: logistics, operational, intelligence. All of that data has to be able to aggregate into a single pane of glass for the commander to make a decision."*

LTG Donohue, CG, XVIII Airborne Corps
13 October 2021, Fort Bragg, NC

## Data-Enabled Decision-Making

The U.S. Army must exceed the pace of our adversaries at our ability to exploit and process data to drive decision-making; decision-making then becomes the focal point for why data is critical. The decisions that need to be made should be used to determine the warfighter's data needs and not the reverse. A gap exists in achieving shared understanding between data collectors, data presentation, and the warfighters who leverage the data to enable decision-making. This gap creates a mismatch between the quantity and relevance of the data made available. Data acquisition and presentation without an understanding of the decision-making process and the commander's information requirements fails to prioritize relevant data over quantity. The negative impact of the mismatch hampers the warfighter's ability to process, analyze, and exploit data for decision-making. Today, we receive more data than is humanly possible to process into information or analyze into knowledge. Closing the gap optimizes the solutions developed to improve the Army's data culture to enable decision-making. While significant efforts are currently underway that are making rapid progress in developing the technologies required to enhance the Army's data analytics and data science capabilities and capacities, these efforts must be consistently guided by the following questions:

1. What decisions need to be made and by whom?
2. At what echelon and type of unit?
3. Where does the information originate, where does it need to go, and how will it get there?
4. What is the Latest Time of Information is of Value (LTIOV) to support a decision?
5. What are the risks if the information does not get to the right people, at the right time, in a useful format?

**Background:** "Commanders make decisions and order actions through command[i]." The decision-making authority is inherent within, and the commander bears the responsibility for their decisions. While the authority to make decisions may be delegated, Commanders are never absolved of their responsibility for what happens or fails to happen under their command.

The commander uses control to monitor and influence actions they ordered. Control is the regulation of forces and warfighting functions to accomplish the mission in accordance with the commander's intent[ii]. Staffs support the commander in exercising control by supporting the commander's decision making. Commanders and staffs must employ information and knowledge management techniques to add clarity to information received, turn it into effective decisions, speed its dissemination, and support situational awareness. In short, staffs provide the commander with analysis and assessments of their functional areas in an integrated fashion enabling the commander to make decisions.

Decision-making is a balance of the commander applying both the art and science of war. The science of war is represented by quantifiable and verifiable facts and figures, conveyed as numbers, calculations, and tables. The art of war is visible in such things as the impact of leadership, complexity of operations, and uncertainty about the enemy. Staffs provide the commander with the science of war, and the commander provides the art of war during decision-making. Under the Military Decision-Making Process (MDMP), the Commander's Critical Information Requirements (CCIR) are established in relation to the mission. The two sub-elements of CCIR are Priority Intelligence Requirements (PIR) and Essential Elements of Friendly Information (EEFI) which represent information requirements about enemy and friendly forces respectively. CCIR represent information that is critical to the commander to enable decision-making; the staff are responsible for providing the commander answers or insights to the CCIR as rapidly and frequently as possible. This established structure assists in the identification of relevant data sources that will assist the staff with generating information, knowledge, and understanding. Commanders and staffs will be referred to as "warfighters" throughout this paper.

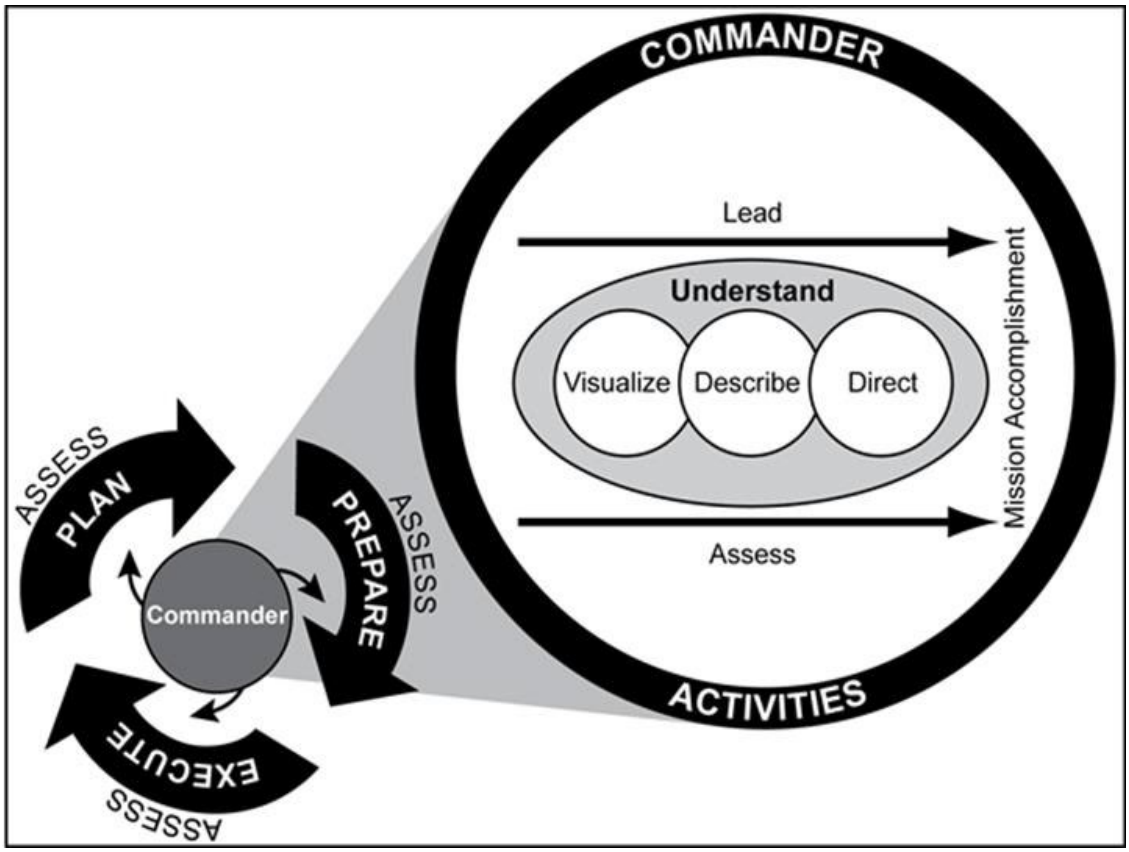


**Figure 1. The operations process**[iii]

**Discussion:** Data, as an enabler for making decisions, goes through a sequence of transitions between data, information, knowledge, and understanding to use in decision making. It is critical to understand the transitions between data, information, knowledge, and understanding to enable decision-making.

- Data is, in the context of decision-making, unprocessed observations detected by a collector of any kind (human, mechanical, or electronic).
- Information is data that has been processed and organized to provide context for further analysis.
- Knowledge is information that has been analyzed and evaluated for operational implications.
- In the context of decision-making, understanding is knowledge that has been synthesized and had judgment applied to comprehend the situation's inner relationships, enable decision-making, and drive action[iv].

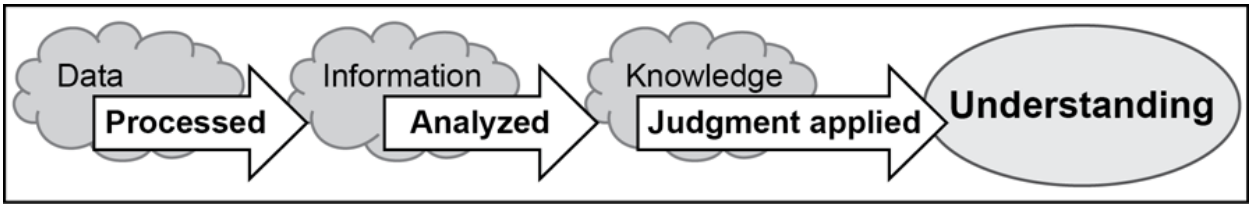


**Figure 2. Achieving Understanding**[v]

Given these definitions, data is unusable for decision-making due to the absence of contextual analysis. For example, the digital signal and images displayed from an unmanned aerial system (UAS) feed represent data; while the description of the images subjected to the processing, exploitation, and dissemination (PED) process coupled with location, represent information. This information, next analyzed determining facts and assumptions relative to the operational context renders the information as knowledge. When next, judgement is applied knowledge gained becomes understanding. For example, images from a UAS showed threat actors observed establishing a mortar firing point likely to provide indirect fire support to enemy forces movement and maneuver assessed to be the most likely course of action. The relevance of the original data provided is only apparent after several iterations of processing and contextual analysis.

While an artificial intelligence/machine learning (AI/ML) solution may be developed to analyze data rapidly, it will likely always require a human-in-the-loop (HITL)[vi] to verify its results. Data analytics attempts to shorten the time and resource requirements to advance data along the above life cycle.

- Descriptive analytics describe what happened over a given period.
- Diagnostic analytics focus more on why something happened.
- Predictive analytics supposes what is likely to happen in the near term.
- Prescriptive analytics provide recommended courses of action.

These analytic types may be conducted purely by a human, or through technical means, or a combination of the two referred to as “human-machine teaming”. There are currently ongoing efforts to synthesize data analytics into AI/ML solutions to rapidly enable decision-making. These efforts require that data quality and quantity reach a minimum threshold so that the algorithms supporting AI/ML are accurate and informed to a sufficient extent to expedite information analysis. AI/ML solutions cannot run either contrary or beyond the parameters by which they were built. The static nature of AI/ML solutions requires persistent maintenance of AI/ML solutions and a human-in-the-loop (HITL) to verify their outputs. AI/ML solutions that reduce the time taken to transition data to information to knowledge will inherently be based on the understanding of the data and information at the time the original algorithm supporting the AI/ML was developed; AI/ML solutions will be highly unlikely to be able to identify changes that run either contrary or beyond the parameters by which they were built. The static nature of AI/ML solutions requires persistent maintenance of AI/ML solutions and a human-in-the-loop (HITL) to verify their outputs.

The HITL must always be knowledgeable not only on the parameters by which the AI/ML solution was developed and how it processes incoming data but also knowledgeable about any changes to the operating environment that impact how the AI/ML solution processes data. Future AI/ML solutions require constant feedback to update based on the operating environment and must be flexible and simple; flexible enough to account for the ever-changing character of conflict but also simple enough that operational tempo is not lost due to laborious modifications. A potential solution currently is the practice of employing a “digital delivery model”, like software patches on a computer, which can

dynamically update existing AI/ML solutions if network connectivity is available. This process represents the attempt of AI/ML solutions to replicate a human's ability to apply tacit and explicit knowledge. However, this process will always be challenged due to a human's ability to rapidly assimilate new data and information to modify transitions to knowledge and understanding in response to constant changes in the operating environment.

Data professionals consider the availability of data to be an end-state if they are without significant awareness and/or training in precisely how warfighters ultimately use data. Warfighters expect data to be available at the right place, at the right time, with the right level of detail to enable decision-making as an end-state. There are currently two distinct groups of experts attempting to improve the use of data science to enable decision-making: data professionals and warfighters. Data professionals include the personnel associated with identifying data sources, engineering, management, and analytic capabilities while warfighters are the group associated with leveraging the results of available, processed, and relevant data to enable decision-making.

This dichotomy creates risks because the group of data professionals is not ultimately responsible for decisions made with the data as provided to the warfighter to use nor are they necessarily aware of how the data will ultimately be used. Data professionals without operational or decision-making experience may also provide the improper amount of data, irrelevant data, or untimely data that does not enable military decision-making. Comparatively, warfighters that are not trained and educated in data science and analytic principles create challenges for the data professionals that support them; therefore, there is an increased need in training and educating Warfighters on data science and analytics principles. Warfighters bear responsibility in identifying timely, authoritative, and available sources of data that support their ability to enable decision-making. Warfighters must also carefully manage the tacit and explicit knowledge they generate throughout operations to ensure information and knowledge are adequately managed across the formation. Data professionals must have detailed knowledge and understanding of the warfighter’s data requirements, engineering, and management strategies to develop strategies for the processing and dissemination of data that best enables the warfighter’s decision-making processes.

For data to be operationally relevant, the data must be accurate, available, timely, transmittable, and processible (A2T2P). Accurate data is distinguished from inaccurate data by its representative fidelity at the time of collection. Accuracy is also subject to the collection platforms capabilities and limitations as well; full-motion video feeds without audio may indicate that observed personnel are speaking but cannot determine whether what was spoken was operationally relevant or not. Data may become inaccurate if sufficient time passes by the time the data is accessed. Data may be accurate at the time it is processed but if it is not reliably available, it may become inaccurate. Data availability refers to how easily data can be accessed by those that are authorized to access it and those who need to access it. Data availability is likely to be subject to laws, policies, procedures, and other administrative and technical restrictions that protect data from specific sources or of a specific nature. Timely data is capable of being collected and processed at a speed to enable decision-making. The timeliness of data may also be

affected by how data is collected, collection windows, transmission of the data across physical distances, networks, time between data collections, and how often the data is either updated or sent. Transmittable data refers to the mechanisms, policies, procedures, and technical infrastructure that supports moving data between locations. Unless data is being processed and used to enable decision-making from a single location, the ability to transmit data between locations based on requirements must be factored into planning. Processible data is data that can be interpreted and analyzed for transition towards understanding. Data that cannot be processed may be the result of insufficient capability, insufficiency capacity, and/or insufficient time to enable decision-making. This also includes the capacity and capability to store data; network architecture and organic capabilities may necessitate data to be stored and processed off-site and eventually transmitted to the warfighter in a form that can be received based on operational and mission variables.

*Data professionals and warfighters need to understand the A2T2P characteristics of any ADS they use to enable decision-making*.

Authoritative data sources (ADS) are systems or programs of record designated as the official sources of specific data sets. Their intended purpose is to reduce data acquisition time, serve as a trusted source for specific data sets, and maintain a standard for the specific data they house. When a data source or a data system is awarded an ADS status, the data populated after the ADS designation continues to undergo assessment as a trusted source. Data professionals can build trust in the ADS through transparency of the A2T2P characteristics for each system. Data professionals must be transparent in their understanding of data's A2T2P characteristics and warfighters must continuously evaluate how they use such data to enable decision-making. The need to consistently evaluate data is critical to managing risk and making informed decisions. Data, without evaluation, is subject to misinterpretation, misidentification, tampering, and/or inaccuracy. While the humans analyzing data are equally as likely to be affected by biases, heuristics, and various other cognitive challenges to objective judgement, humans can more rapidly recognize and correct for these challenges, especially as part of a staff, than an AI/ML solution built on a static algorithm based on the best interpretation of data at a given point in time.

The first challenge to optimize data for decision dominance is using data and engineering solutions to improve the A2T2P characteristics of data. As part of the MDMP process, warfighters identify early how data will be used to enable decision-making to accomplish the mission. Warfighters must evaluate how their organic capabilities and capacity is able to process the requisite data needed to enable decision-making. The staff should identify the intended use of data transitioned into knowledge, before or during the act of updating their running estimates. The staff is careful to include an estimate on the unit's capability to process in coming data. e.g.

| WHAT | SO WHAT | THEREFORE |
|---|---|---|
| Process Incoming Data | Too Much Data or Slow Processing Prevents the System from Functioning at an Operationally Relevant Rate and Prevent Relevant and Reliable Information from Reaching the Decision Maker | This unit requests additional analyst(s). This unit will accept risk and use only data from a specified list of authoritative data sources. This unit will use AI/ML to sort or filter through data looking for the following CCIR...<br><br>The staff in turn relays the refinement of their data request/search back to the data professionals to build a shared understanding of what data should be pushed to or pulled by the unit. |

After the staff have evaluated the availability and veracity of the data available to them, and carefully considered their capability and capacity to process said data, they may relay the gaps or requests for support to the data professionals supporting them.

Agreement between the unit and the ADS or data professionals should include:

- Procedures for transmitting and sharing data, including format and frequency – shared understanding must be achieved on available networks, transport capabilities, and knowledge of the operational environment as it pertains to the permissibility of electromagnetic activities.
- Procedures regarding classifications – as data traverse from specific sources, across various networks, and becomes enriched with more data how do these processing iterations affect the final classification and availability.
- Procedures for archiving data - informed by the data's time of relevance and how it is used to develop knowledge and understanding; some data may become irrelevant after a period of minutes or hours while other data may remain relevant for weeks, months, or even years.
- Procedures for disposal of irrelevant data – using previously identified requirements (EEFI, PIRs, etc.) to filter the delta between available data and relevant data while maintaining the flexibility to redefine these parameters based on changes to the operational environment.
- Procedures or protocols for revisiting data - the rates at which the archived data is revisited or refreshed must also be considered when evaluating its credibility; data that is not regularly or predictably refreshed carries the risk of being irrelevant and/or erroneous in the moment of need.

Data professionals would seek to enable the warfighter's access to data based on requirements; this means the two groups must achieve shared understanding on what data best meets the A2T2P data characteristics that enables the warfighter's decision-

making processes at echelon. This is not a binary scenario; Commanders can make decisions with little or incomplete information available as they acknowledge and accept the risk of such decisions. However, in the event more data is required to be processed to enable operations, additional support and/or engineering options to employ data in novel ways may need to be explored. For example, if the warfighter does not expect to have the capacity to process the data they anticipate receiving, there may be options for developing or leveraging an off-site capability that is able to alleviate latency or processing-time burdens at a given echelon.

For example, a Battalion level Commander and Staff operating in a large-scale combat operation (LSCO) will likely not have the time or access to large volumes of data, especially in denied, degraded, intermittent, or limited (DDIL) environments. In this scenario, data professionals and warfighters must understand how data requirements and the dissemination of knowledge occurs as operational and mission variables change. In more permissive environments, data processing and exploitation may occur predominantly digitally while less permissive environments lend themselves towards more analog means. The personnel and equipment capabilities at the Battalion level would likely not be sufficient to process the amount of data able to be collected from the operating environment. Conversely, the Divisions or Corps could have the personnel and equipment necessary to not only collect, process, exploit, and analyze large volumes of data but they would likely also have reach-back or external support that would further supplement their data exploitation processes. Echelons above Brigade are also generally advantaged by less operational need to displace frequently, greater access to upper tactical internet (TI) capabilities, and larger staff numbers.

A scenario of "paralysis by analysis" manifests when a unit receives more data than it can process and/or analyze. Prioritization of information requirements drive the type of data, and, if overwhelmed by required information, the staff adjusts either by reducing/refining the requirements or by requesting more resources. "Paralysis by analysis" would occur in the event the warfighter is exposed to so much data that it creates hesitancy to make recommendations and/or decisions based on the premise that more data may quickly become available that will lead to a better decision. Data that is beyond the warfighter's ability to effectively process becomes a distraction. De-synchronized staff processing of data would occur when all data is completely available to all staff proponents equally. While this scenario may sound advantageous, it circumvents some of the data processing that is required by certain staff functions before it is more widely available for planning. For example, data regarding enemy composition and disposition may be enough for the Fires section to plan and prepare for lethal effects. However, without the necessary intelligence analysis on the composition and disposition of enemy forces in time and space, how it confirms or denies courses of action (COAs), and the predictive analysis of effects on the enemy given current and future mission and operational variables may lead to a decision or action that is uninformed by the science available from the staff proponent responsible for it. While it is advantageous for functional staffs to be closely integrated, this is not synonymous with functional staff sections performing the functions of other staff sections without the requisite training and expertise.

Classification of data, information, and knowledge informs many of the practices and procedures between Information Management/Knowledge Management entities, such as the data professional who catalogs and files data or attaches meta data, and the end user of these products. Data classification is dictated by a series of overlapping laws, policies, and regulatory guidance. The most frequent references that dictate how data is classified are data owners' guides (DOGs) and security classification guides (SCGs). While data storage and ownership are interdependent, impact to data accessibility must be considered to preserve the operational relevance of the data. Data storage and access controls directly impact planning for how to share data across classified systems. Near automatic classification using DOGs and SCGs places tremendous responsibility on data professionals and warfighters to collaboratively understand how and what to release and to whom. For example, the practice of "tear lines" ensures that the relevant data elements of an intelligence report are shared while preserving the more sensitive elements that directly implicate sources and methods. Without detailed understanding of how the data is generated, classified, and stored it is highly likely that data will be either stove-piped or otherwise unavailable at the time and point of need.

The final data management and engineering solution for warfighters will optimally represent data products in relation to each other. The commander’s visualization of processed and analyzed data directly affects the application of operational art and decision-making. The tool, application, or software use to help the commander visualize knowledge before application of judgement dramatically affects understanding of the situation. It must be clearly defined how often and from which sources data displayed is updated to ensure inclusion of the most timely and accurate information available thus enabling the commander’s ability to make informed decisions. The commander cannot properly assume risk if it is not clear what factors are contributing to said risk.

Information and Knowledge management considers all the above across echelon, classification, and full range of military operations. Initial planning regarding data approaches must be informed by how organic capabilities and capacities affect data requirements and vice versa. As data is processed, it is critical for data professionals and warfighters to understand how the people, systems, processes, and networks interact with said data along its life cycle. For example, intelligence data may initially only be available to the Intelligence Section. However, if a requirement exists for said intelligence data to also be shared across networks at different classifications, then an engineering solution must be identified to ensure the data is available at the point and time of need. Pursuant of knowledge management, there will be a need to ensure as knowledge is generated, based on data provided, that it is proliferated across Commanders and Staffs effectively and efficiently. This will be dependent upon accurate determination of when and where data in what form must become accessible. Data that is available too early may still require too much time to process while data that is available too late will not effectively enable timely decision making.

Information advantage is described as a position of relative advantage in which U.S. Army forces preserve their ability to command, control, and preserve friendly forces' ability to access and disseminate information while simultaneously seeking to reduce enemy's

forces' ability to do the same. Decision dominance is a desired state in which a force generates decisions, counters threat information warfare capabilities, strengthens friendly morale and will, and affects threat decision making more effectively than the opponent. Decision dominance requires developing a variety of information advantages relative to that of the threat and then exploiting those advantages to achieve objectives. Commanders employ relevant military capabilities from all warfighting functions to create and exploit decision dominance.

The development of the Army's data science culture and improvement of the people, processes, systems, and networks that support data analytics have the potential to facilitate information advantage and by extension decision dominance. However, data as an enabler must be consistently evaluated for costs and benefits as any other enabler; it is key to emphasize **relevance over volume**. Detailed planning for data requirements assists in emphasizing relevance over volume by placing limits on data received by establishing the CCIRs and openly sharing the CCIRs with the data professionals. Creating the CCIRs requires warfighters to understand the operational environment and situational impact on the use of processed and analyzed data. Warfighters should not allow a surplus of data to distract them from the mission, but instead, limit the flow to data necessary for decision-making. Data professionals might not have the level of situational awareness as the warfighter, and this is the gap that must be closed through the sharing of CCIRs and the operational understanding of the data science community. There is a requirement for detailed planning at echelon for how to manage and engineer data requirements that enable decision-making. Operational and mission variables will significantly impact how much, at what time, and to what extent data can enable decision-making. Data, as a raw commodity, will not automatically enable decision-making. Each echelon will have both limited capability and capacity to process data into understanding that enables decision-making. The availability of data alone is not an end-state; available data must consistently be evaluated for its veracity and operational relevance. The gap in understanding between data professionals enabling the availability of data and warfighters who will leverage the data to enable decision-making must be closed to optimize the solutions developed to improve the Army's data culture.

*Data procurement that is unrestrained by information and knowledge management practices ultimately creates the risk of inundating warfighters with more data than what can be processed and/or enough irrelevant data that the identification of relevant data causes the loss of operational tempo.*

**Recommendations:** The following recommendations are intended to initiate the process to close the gap in shared understanding between data professionals, data presentation, and the warfighters who leverage the data to enable decision-making. This is not an all-inclusive list, and many of these recommendations will be subject to the technical innovations and evolving character of modernized warfare; relevance will have a direct relationship with agility and flexibility to respond to changes in the operating environment.

1) **Doctrine:** Enhance the body of knowledge and doctrine to include and expand upon how the transitions between data, information, knowledge, and understanding enables decision-making during the full range of military operations at each echelon.

    a) ADP 6-0 is the best description yet, but it is inadequate to the need of data professionals to understand their products as enablers. Situational awareness, provided through CCIRs is a critical input for the data science community, but doctrine needs to provide a clear and concise model for data analytics enablers to understand and support.
    b) There are references across several doctrinal publications (FM 5-0, FM 6-0, ATP 5-0.2-1) that describe the relationships between commanders, staffs, information, and knowledge but there is not a model spanning across all doctrine outside of ADP 6-0 for how data becomes understanding.
    c) Updating doctrine is and should remain continuous. Updates at the speed of technological increases is unrealistic, however, the current cycle renders updates obsolete at publication. Use of immediate updates to doctrine can be pushed to the force using Memorandums for Record or All Army Activity messages.
    d) Videos produced by Combined Arms Doctrine Directorate (CADD) on how to conduct Military Decision-Making Process need updates to include considerations for selective data, information, knowledge products to drive cultural change with warfighters to be more sensitive to and aware of available data sources and how they support decision-making.
    e) Doctrinal references must detail how functional cells and integrating cells determine their data requirements, systems, and processes for generating information, knowledge, and understanding. Current doctrine identifies only 3 integrating cells: Current Operations, Future Operations, and Plans (FM 5-0). Functional cells are largely defined by the individual Staff sections organized approximately by warfighting function but the preponderance of integrating activities are described under the context of boards, bureaus, cells, councils, and working groups (B2C2WGs).

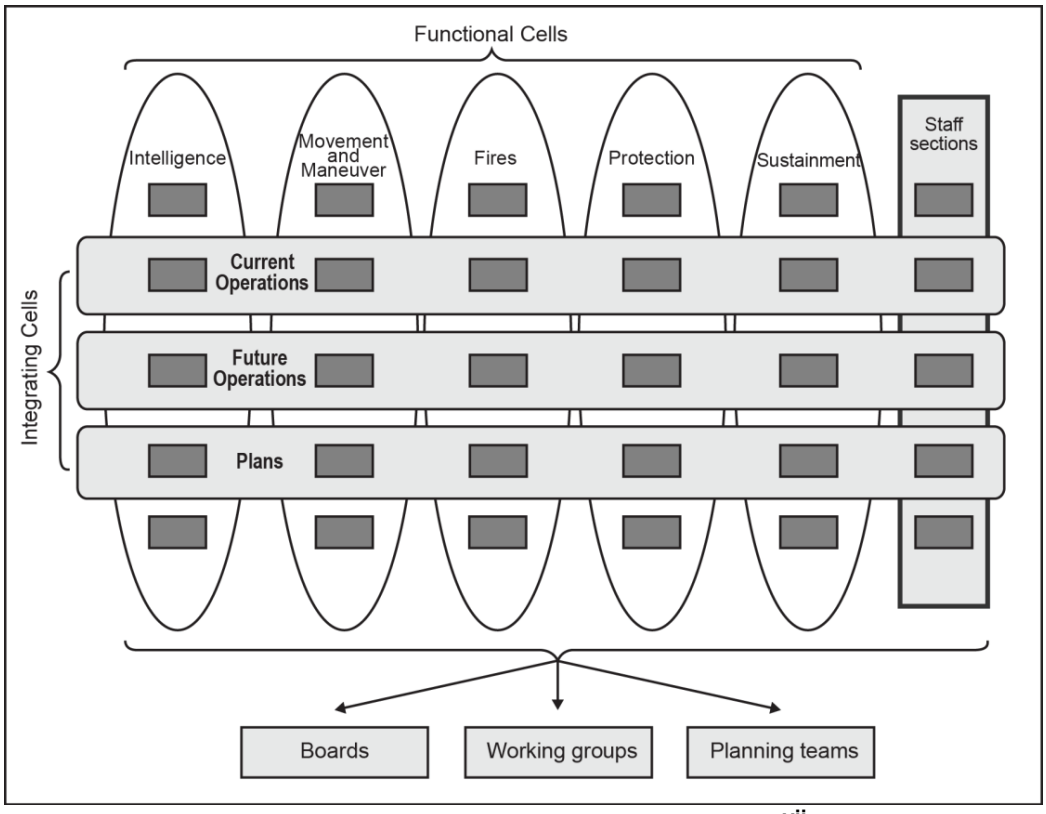


**Figure 3. Cross-functional staff integration**[vii]

2) **Organization:** The Information Advantage Task Force (IATF), if established by the commander, roles and responsibilities must be continuously evaluated for its roles, responsibilities, and authorities with respect to information advantage and decision dominance.

   a) Is this the correct force structure to monitor and conduct information advantage activities supporting decision dominance?
   b) Is this a permanent force structure: Troops to task assessment of operational risk vs. opportunity cost.
   c) Possible variations:

      i) Each functional staff section has a specified individual as the "Information Advantage Representative" in a similar model to how each functional staff has a "Foreign Disclosure Representative".
      ii) At a minimum, the IATF requires members knowledgeable in Open-Source Intelligence (OSINT), Information Operations (IO), military deception (MILDEC), military information support operations (MISO), network architecture (25A or 26A/B), electronic warfare (EW), cyberspace operations, intelligence, and operations.
      Under this model, the IATF is required to dedicate time and resources to integrate into plans and the scheme of maneuver to ensure information advantage planning is deliberately accounted for as opposed to dedicated IARs

embedded within functional staffs that can contribute to the established integrating staff cells and B2C2WGs organically.

3) **Training**: Add scenarios to training to develop practices of data, information, and knowledge processing, selection, and/or reduction of time and resources necessary for transition at echelon to achieve operational objectives.

   a) Training scenarios and objectives maximizing access and dissemination of relevant data at echelon in controlled training environments such as Combined Training Centers (CTCs), reinforces the gap contextual analysis of information supporting better decision making. Data professionals training alongside warfighters in these scenarios would also provide additional insight and appreciation for the challenges placed on warfighters in tactical scenarios.
   b) Assessments of training exercises with data-enhanced decision-making provides feedback to warfighters and data professionals on their abilities to select and improve the quality of data, information, and knowledge as an enabler for decision-making.

      i) Feedback given is modified according to capacity and capability by echelon
      ii) There should be an inherent understanding that operational and mission variables at echelon will impact how formations apply data science and analytics.
      iii) Emphasis on how data is employed to enable decision making assists in development of Commanders and Staffs.

4) **Leadership:** Create new Programs of Instruction in Primary Military Education (PME) with deliberate evaluation criteria for staff activities supporting the commander's decision-making process.

   a) This includes Senior Leader courses at the War College and Pre-Command Courses at the Battalion and Brigade level. Senior leaders educated in data science principles will teach, coach, and mentor their staffs on how to process data and information to support the commander’s decision-making.
   b) Reinforce at all leadership levels the importance of relevancy over volume. This lesson of quality over quantity, if learned early in a career improves the quality of staff work to include providing relevant data, information, knowledge for decision-making purposes.

5) **Materiel:** Innovations in applications, tools, and software must include relevant data standards, and messaging formats, shorten the speed at which users can analyze data faster and make data visualizations more tailorable. Rapid adoption of materiel solutions to changes in the operating environment impacts data management and engineering and should happen as soon as possible. To be operationally relevant, AI/ML solutions should develop at a concurrent pace to changes in technology. Materiel adaptations through the current programs of record and acquisition formalities are hindrances to achieving and maintaining information dominance.

Recommend changes to acquisition processes within the programs of record which will allow the U.S Army to keep pace or pull ahead of changes and our opponents.

6) **Personnel:** New Data professionals have two imperatives to support military operations:

   a) Maintain their currency with civilian and commercial industry standards for data science and data analytics.
   b) Understand how the data is used in military decision-making across echelon and the full range of military operations.

      i) Data professionals should be regularly assigned to Center for Arms Lessons Learned (CALL) Collection and Analysis Teams (CAATs) and CTCs to collect observations during training exercises.

         (1) Data professionals in these environments are given the opportunity to immerse themselves in how warfighters plan, prepare, and execute operations. This exposure to warfighting provides perspective and creates shared understanding of requirements
         (2) Warfighters regularly engaging with the data professionals provide better ways to communicate and reinforce shared understanding with data professionals. Communicating data, information, and knowledge requirements is a skill necessary to warfighting today.

      ii) Continue regular attendance at non-military symposiums and expositions to maintain currency. These opportunities will enable data professionals to gain an appreciation how to apply industry solutions to military problems by observing them both firsthand.

**Conclusion.** The U.S. Army must exceed the pace of our adversaries at our ability to exploit and process data to drive decision-making. With the priority being decision-making, we will be more capable of identifying the right data, both in quantity and quality, to enable it. The decisions that need to be made should be used to determine the warfighter's data needs and not the reverse. Data professionals are an asset to the Army that should be given every opportunity available to understand the capabilities, limitations, and challenges at echelon. This becomes particularly relevant if data professionals do not have previous military experience. While previous military experience is not a prerequisite for data professionals providing relevant expertise as it pertains to data science, data professionals will become advantaged if they are able to gain an appreciation for the military decision-making process at multiple echelons. If data professionals are only able to view their contribution to warfighters through concepts and forums outside of the operational Army, they will likely find it difficult integrating feedback and planning considerations at the tactical and operational echelons. Experiential opportunities provide insight to the use of data/information/knowledge by warfighters during operations.

Synchronizing multidomain operations (MDO) will require significant access to data about the operational environment. The distinct challenges to data management and access at echelon will likely dictate the echelon at which convergence of MDO is possible. If significant data processing and exploitation capabilities are not possible or available at echelon due to operational or mission variables, the ability to achieve convergence or employ capabilities from multiple domains will likely elevate to the next higher echelon capable of processing the data necessary to synchronize MDO.

Due to current restrictions or limitations to current Programs of Record (PORs), there is increased reliance on commercial off-the-shelf (COTS) solutions to meet data management and visualization needs. These COTS solutions inevitably create intra and interoperability challenges with both U.S. Army forces and unified action partners (UAPs) as they inevitably lead to challenges at managing data standards, exchange mechanisms, and access to specific COTs due to costs. Limitations to PORs to meet the warfighters' operational needs for data management and visualization need to be documented and reconciled.

The risk of viewing data as a quantity-over-quality scenario is high without a coordinated campaign of learning, strategy, and training. Before meaningful changes to the Army's data culture can be implemented, the Army must first understand why these changes are necessary. It can be argued that the Army has always employed data science and data analytics; Commanders and Staff have always received data, processed it into information, analyzed information into knowledge, and applied judgement to turn it into understanding. There is tremendous potential for data analytics to take what has historically been a long and manual process and gain efficiencies in time. However, there must be shared understanding in the capabilities and limitations of having large volumes of data available and processed by AI/ML solutions. While humans conducting analysis are also likely to make errors in judgement, there are ethical concerns surrounding the reliance on AI/ML solutions to enable decision-making. A HITL will likely always be required to verify the outputs of AI/ML solutions but that HITL's ability to assess and analyze available data and information must not become diminished or apathetic due to reliance on technology. If personnel do not remain engaged in the consistent process of validating and verifying data analytics, the ability for personnel to conduct analysis and make assessments will rapidly be diminished. The evolution of data analytics must not become synonymous with compromising the commander's ability to make decisions; AI/ML solutions cannot be misconstrued as authoritative or a substitute for the commander's ability to employ the art and science of war.

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[i] FM 6-0, Commanders and Staff Organization
[ii] ADP 6-0, Mission Command
[iii] ADP 6-0
[iv] ADP 6-0
[v] ADP 6-0
[vi] Department of Defense Directive (DoDD) 3000.09, Autonomy in Weapon Systems
[vii] FM 6-0