Empowering the Information Warrior

Unlocking the Latent Value of this Strategic Asset

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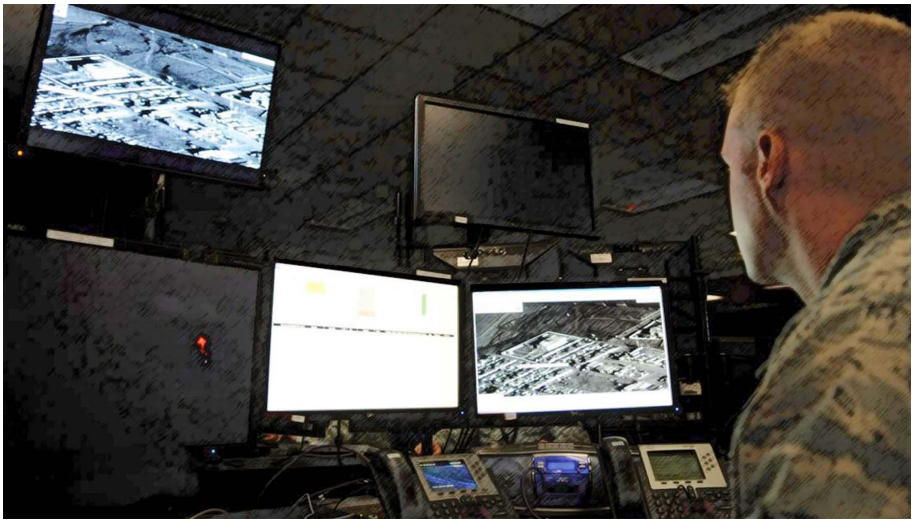

Purpose

Understanding one's adversary and generating deep insights about their intentions, capabilities, and actions is foundational for success in warfare.[1] As such, it is essential that the information warriors responsible for producing and acting on such intelligence have the necessary higher-order cognitive and critical thinking capabilities that will reliably generate the requisite understanding and insights. However, because of under-investment in the development of higher-order thinking and not having a structural means for systematically infusing these skills in intelligence operations, the Air Force is losing significant value that is essential for information warfare effectiveness.

This article will highlight a strategic opportunity, presently available, that will empower the Air Force to more effectively compete now by: (1) enhancing the higher-order and critical thinking capabilities of airmen, (2) infusing more robust insight generation capacity into information warfare processes, (3) better informing the war fighter to achieve desired outcomes, and (4) enabling the Air Force to

converge the appropriate resources for managing escalation and solving problems in a timely fashion.[2] Toward these objectives, this article will describe a specific platform that leverages human-machine teaming to enhance the higher-order cognitive capabilities of information warriors, unleashing their locked-up latent value and increasing their effectiveness. After introducing the issue, this article will address the following:

- Under-performance in higher-order thinking skills and processes (which includes critical thinking)
- Defining higher-order thinking skills and processes
- A strategic approach to developing, exercising, and assessing higher-order thinking
- A structural means for supporting and enhancing higher-order thinking by information warriors throughout their work activities

Introduction

A nation's ability to impose its will and achieve its desired objectives stems from its diplomatic, information, military, and economic instruments of national power (DIME).[3] While aspects of these four instruments of power are constantly in flux, information is increasingly important in the digital age.[4] Given information's ubiquity and growing importance, information warfare has also become omnipresent and prominent. Thus, information warfare has an essential role in serving to support and converge all instruments of power into a cohesive multidomain campaign.[5] And in doing so, it supports the *National Defense Strategy* goal of increasing the competitive space within which the US can shape the battlespace to the disadvantage of its adversaries.[6]

Accordingly, the Air Force is reinvesting in information warfare, after its initial attempt approximately 20 years ago. The Air Force recently restructured its separate Numbered Air Forces (NAF), the Twenty-Fourth Air Force (AF) and Twenty-Fifth AF respectively, into a single information warfare NAF, the Sixteenth AF, to unite its previously disparate efforts of cyber operations; electronic warfare (EW); information operations (IO); and intelligence, surveillance, and reconnaissance (ISR) into an integrated whole to influence its competitors' behaviors and deliver other desired outcomes throughout the entire spectrum of conflict.[7]

Due to the indispensable nature of information, intelligence, and decision-making to the success of warfare, it is essential to make intentional investments to not only develop the higher-order cognitive skills of information warriors but also to provide the structural means for systematically infusing these skills into intelli-

gence operations. This is an immediate common-sense action that is possible with current technology and can yield a significant impact on information warfare.

The Information Warrior's Required Cognitive Abilities

Those responsible for conducting cyber operations, EW, IO, and ISR missions are the information warriors of this new era.[8] Though their expertise is varied, their effectiveness similarly depends upon the same foundation of higher-order thinking.[9] Specifically, these warriors should be able to:

- Identify the relevant aspects and elements of a problem
- Analyze the issue's scope, structure, elements, and dynamics
- Establish objectives
- Find connections and relationships between elements
- Construct meaning and understanding of the parts and the whole
- Find patterns and apply models
- Accurately infer all that is implied from what is known
- Uncover unknowns, ambiguities, and questions
- Reveal assumptions, biases, and falsehoods
- Formulate points of view and hypothesize alternatives
- Assess, evaluate, and judge the importance and probabilities of factors, criteria and points of view
- Reason logically and create well-reasoned fact-based arguments supporting the points of view
- Make decisions based upon the best available information, reasoning, and judgments

These skills are among the most important "elements of thought and reasoning" that are relevant to the information warrior.

Investing in Thought and Reason

While the US is advancing its information warfare capabilities, it is far from achieving information dominance. Much more can and must be achieved to increase the competitive space and maintain decision advantage. Although the Air Force invests significantly in generating, storing, and sharing information, it is not making adequate investments to ensure the systematic, comprehensive, accurate, and reliable creation of the "relevant elements of thought and reasoning" about

the information. Surely, the "relevant elements of thought and reasoning" are as important as the underlying information in information warfare, if not more so, and as such, are worthy of serious investment.

Under-Performance in Higher-Order Thinking Skills

Only 6 percent of college graduates are proficient in critical thinking, according to the Educational Testing Service.[10] Seventy-five percent of employers find recent graduates deficient in critical thinking and problem solving, according to the American Association of Colleges and Universities.[11] These figures are just two of the many consistent statistics that indicate young people entering the workforce are poorly prepared for employment in areas requiring critical-thinking and problem-solving skills.

In the event the reader believes that the workforce within the Air Force fares better than the general population, the work completed by Col Adam "MEZ" Stone should dispel that illusion. Colonel Stone was able to measure the critical thinking ability of Airmen using a standardized exam, the Watson-Glaser Critical Thinking Appraisal (WGCTA). The test was comprised of 40 questions measuring five critical-thinking skills and compared the critical thinking ability within the Air Force to a general population.[12] His results were published in the fall of 2008 and exposed the lack of critical thinking skills within the workforce of the Air Force.[13] The 180 Air Force officers who were tested scored well below average when compared to the graduate degree norm group.

While studying at the Air War College (AWC) in 2015, Colonel Stone conducted a similar study of officers' critical thinking skills at Air Command and Staff College (ACSC), AWC, and the School of Advanced Air and Space Studies (SAASS). In this study, SAASS students scored in the 61st percentile, while ACSC and AWC students scored in the 36th percentile.[14] The 2015 study criticized the Air Force's failure to educate and train its personnel to develop adequate critical-thinking skills in professional military education programs. Despite Colonel Stone's indictments of the Air Force's demonstrated lack of critical-thinking capability and repeated call-outs from others in the workforce, there are no significant and sustained efforts to measure, develop, and assess these essential cognitive skills within the workforce.[15]

In addition, periodically measuring critical thinking alone is insufficient. For instance, one may score well on the WGCTA or some similar test indicating they possess the ability to critically think but due to time constraints and other demands and distractions, there is no guarantee that information warriors will consistently produce analytical products, provide recommendations, and make decisions that are the result of and demonstrate higher-order thinking. Since these

"higher-order" thinking capabilities are central to effective information warrior activities, there is a compelling need for a systematic means to address this "higher-order" thinking skills deficit. Therefore, a need exists to not only train the Air Force's information warriors on these skills but also to "operationalize" this capability with the assistance of technology by leveraging human-machine teaming that ensures critical and higher-order thinking is integrated into their daily work.

The above statistics and Air Force practices bring focus to the three prominent causes of why information warriors are not realizing their potential nor fully exploiting the full range of their cognitive capabilities:

- Inadequate higher-order thinking skills upon leaving formal education
- Insufficient training and assessment focused on developing higher-order thinking skills
- The lack of a structural means for supporting and enhancing higher-order thinking and associated activities while creating work products

Defining Higher-Order Thinking Skills and Processes

One can find many ways for defining and characterizing "higher-order thinking" in the published literature and this article makes use of and combines concepts expressed across several widely accepted sources. Disambiguating the various terms and describing a useful "higher-order thinking taxonomy" is the starting point.

What is "higher-order thinking?" The 1987 National Research Council report *Education and Learning to Think* provided an excellent concise summary: Higher order thinking involves a cluster of elaborative mental activities requiring nuanced judgment and analysis of complex situations according to multiple criteria. Higher order thinking is effortful and depends on self-regulation. The path of action or correct answers are not fully specified in advance. The thinker's task is to construct meaning and impose structure on situations rather than to expect to find them already apparent.[16]

While informative, concise, and potentially familiar sounding to many information warriors, this National Research Council definition is not sufficiently detailed to serve as the basis for actionable specifications of a "higher-order thinking learning or support system." As such, it is useful to further disaggregate "higher-order thinking" into more discrete skills and thinking processes that enable a more systematic actionable approach.

Higher-Order Thinking Skills

The list of discrete "higher-order thinking skills" in the table below is largely categorized as per B. S. Bloom and David R. Krathwohl.[17] It is further augmented

with those higher-order skills expressed by R. H. Ennis, P. Facione, J. D. Bransford, the National Research Council, and Ross D. Arnold.[18]

Table. Higher-order thinking skills

1. Investigating and Observing Keenly	
• the situation • entirety of context • system and overarching structure • distinguishable details within the context • objects, behaviors, and forces	• elements and components • characteristics and attributes • magnitudes and measures • boundaries • statics and dynamics
2. Understanding	
• questioning • defining/clarifying • contextualizing/framing/scoping	• determining objectives • relating cause and effect • comprehending concepts, models, knowledge
3. Applying/Transferring	
• applying concepts and/or models to new circumstances • using concepts and/or models to derive insights • modifying concepts and/or models to meet new needs	• extending understandings to new contexts/situations • applying general principles to specific circumstances • applying lessons from analogous situations • testing/experimenting
4. Analyzing	
• identifying, characterizing, interpreting, organizing • defining dimensions of differentiation and homogeneity • distinguishing/differentiating • ranking/prioritizing • grouping/categorizing • comparing • quantifying/calculating • dissecting/disaggregating	• revealing individual parts and attributes • describing the context, its parts and functions • relating the full set of parts to the whole • uncovering patterns and relationships • uncovering factors that impact • uncovering issues • revealing assumptions • determining relevance & applicability • clarifying and making sense
5. Synthesizing	
• deducing • inducing • inferring/deriving • generalizing from specifics • abstracting • analogizing • connecting disparate elements into something of meaning • seeing relationships between elements • creating a concept or model • incorporating time, sequence, and dynamics	• planning • estimating/approximating • imagining/inventing • designing/creating • anticipating • theorizing • predicting • generating alternatives • hypothesizing/positing/explaining • constructing arguments/reasoning • creating meaning
6. Evaluating	
• establishing criteria • weighing/judging • criticizing • appraising/assessing • reflecting/reviewing • deciding/selecting/choosing	• recommending • supporting • concluding • uncovering biases • self-evaluating thought processes and dispositions (metacognition and self-regulation)

While this "skills" list is extensive and reflects a robust aggregation from the literature on higher-order thinking skills and processes, the list is not exhaustive. However, an "exhaustive" list is not needed here. The point of this list is to convey, in large measure, those discrete thinking skills and abilities that (1) sufficiently indicate what is meant by higher-order thinking skills, (2) are useful for empowering individuals to succeed in those contexts that require higher-order cognitive competencies, (3) are illustrative of the discrete measurable skills that should be developed, exercised and assessed by training technologies, and (4) should be integral to any structural method for supporting and enhancing information warrior higher-order thinking while on the job.

Higher-Order Thinking Processes

There are many different contexts for applying the previously listed higher-order thinking skills, and each different context may call upon individuals to use a subset of these skills toward a desired end. As used in this paper, a higher-order thinking "process" is the application of some subset of the higher-order thinking "skills" to achieve a particular end in a given context.

Some higher-order thinking processes are broadly applicable across many disparate contexts and others are more narrowly focused on specific contexts. For example, "critical thinking," "creative problem solving," and "rational decision-making" are all higher-order thinking processes that are broadly applicable across many contexts. On the other hand, "scientific thinking," and "strategic thinking" are often referenced in slightly more "specialized" contexts. While these five examples of "higher-order thinking processes" have different names and may be applied in different contexts, they often call upon individuals to exercise very similar subsets of higher-order thinking skills from the table as there is a good deal of overlap. For example, scientists often refer to "scientific thinking" as "critical thinking" being applied to a scientific context. Business executives often describe the process of decision-making as a combination of critical thinking and creative problem-solving. So, while investigating scientific phenomena or making corporate decisions are very different contexts, those processes often share many (though not all) of the same higher-order thinking skills.

What follows are the widely cited definitions of the five aforementioned processes that are closely aligned with "higher-order thinking."

Critical thinking. "Critical thinking is reasonable reflective thinking focused on deciding what to believe or do."[19] In describing this elegant and expansive definition, Ennis also extensively details the rich set of underlying higher-order thinking skills (which he calls "abilities"), which characterize the critical thinking process. His set of "abilities" are encompassed by the higher-order thinking skills

in the table. In addition to the very broad scope of higher-order thinking skills that comprise critical thinking, the wide applicability of the critical thinking process is highlighted by its defined purposes: "deciding what to believe" as well as "deciding what to do." This wide applicability encompasses many other "higher-order thinking processes."

Creative problem solving. Creative problem solving is finding the ways for resolving the "discrepancy between an initial state and a goal state, when there is no ready-made solution."[20] It is worthy to note that "Improving Critical Thinking" is a subtitle of Bransford's 1993 book and with good reason. Identifying the "initial state," the "goal state," and deciding on "ways for resolving the discrepancy" between the two states will necessitate the use of many of the higher-order skills from the table that are shared in common with critical thinking.

Rational decision-making. Peter Drucker defines decision-making as a judgment; it is a choice between alternatives.[21] R. L. Trewatha defines decision-making with a bit more information: "Decision-making is the selection from among possible alternatives in order to arrive at a solution for a given problem."[22] In both Drucker's and Trewatha's definitions, decision-making is a particular category of problem-solving. Like problem-solving, identifying alternatives, analyzing the relevant information, and deciding the best among them will necessitate the use of many of the higher-order skills from the table. It is also interesting to note that decision-making is a fundamental element of the critical thinking definition, in other words, "reasonable reflective thinking focused on *deciding* what to believe or do." Thus, higher-order thinking skills relevant to critical thinking are similarly relevant to decision making.

Scientific thinking. Scientific thinking is the pursuit of understanding and explanations, based upon inquiry, experimenting, investigating, fact-gathering, analyzing, theorizing, modeling, hypothesizing, reasoning, evaluating, and arguing.[23] Not only are all these "thinking practices" also "higher-order thinking skills" but so too are the many thinking skills which these particular "scientific practices" encompass. For example, the term *reasoning* as a scientific practice includes deducing, inducing, deriving, inferring, generalizing, and so forth, all of which are "higher-order thinking skills" (per the table). Any survey of the literature on scientific thinking will see close alignment between the higher-order thinking skills of the table and those associated with scientific thinking. Scientific thinking is also highly consonant and consistent with critical thinking (i.e., the "reasonable reflective thinking focused on deciding what to *believe*").

Strategic thinking. Strategic thinking is the thoughtful process of configuring ends, ways, and means to achieve an objective, given a set of (often dynamic) circumstances.[24] This definition is well-aligned and consonant with the defini-

tions of critical thinking, creative problem solving, and decision-making. As such, the higher-order thinking skills applicable to strategic thinking are the same as those of critical thinking, problem-solving, and decision-making, albeit in a strategic context.

To summarize, "higher-order thinking skills" are those complex cognitive skills and abilities as broadly characterized by the National Research Council and as more discretely identified in the table.[25] A "higher-order thinking process" is a collection of those higher-order thinking skills that are used to achieve an end in a particular context. Helping information warriors to more fully develop and systematically employ these higher-order thinking skills and processes will greatly enhance our information warfare capabilities.

A Strategic Approach to Developing, Exercising, and Assessing Higher-Order Thinking Skills and Processes

The strategic approach entails two elements: (1) understanding the higher-order thinking skills and processes important for the information warrior, and (2) designing a scalable, automated, web-based interactive technology that enables one to efficiently learn these cognitive skills using a methodology that is aligned and consonant with widely accepted expert learning theory. The previous section provided a clear description of the higher-order thinking skills and processes that are desired and necessary. This section discusses the expert learning theory that will enable the efficient and effective learning of these essential skills.

In his widely cited work, *How People Learn*,[26] Bransford makes clear that "learning with understanding" and achieving the ability to "transfer" those understandings to different contexts is developed and enhanced by several factors, beginning with Piaget's theory that learners construct understanding by actively engaging with a domain, and, construct their conceptual scaffolding in response to their findings from the interactions.[27] That is, individuals develop understanding and their cognitive capabilities by accommodating preexisting conceptions and assimilating new learnings from active exploring and experiencing.[28] However, Bransford makes clear that having learners construct understanding completely independent of guidance can in many instances be less than optimal; that without some guidance, new constructions of understanding can potentially be misdirected. Therefore, the dual combination of constructing one's understanding through independent cognitive effort being followed-up with a dose of guidance is very powerful. As Bransford states: "usually after people have first grappled with issues on their own, "teaching by telling" can work extremely well."[29]

In addition to the important dual process of having learners independently actively construct their conceptual scaffolds in combination with assistance from

expert guidance, Bransford describes other factors affecting the ability to learn with understanding and transfer, including metacognition, time-on-task, learner motivation, context, and engaging with authentic problems.

Metacognition

Learning is enhanced when individuals take responsibility and recognize what they understand and when they need more information.[30] Metacognition refers to an individual's ability to predict their own performances and to monitor their current levels of mastery and understanding.[31] Instructional practices congruent with this approach include enabling sense-making, self-assessment, and reflection on what worked and what needs improving. These practices have been shown to increase the degree to which learners transfer their learning to new settings and events.[32]

For learners to "self-assess" and gain insight into their learning and their understanding, frequent feedback is critical. Feedback is most valuable when students can use it to revise their thinking as they are working. Responsive formative assessment increases students' learning and transfer, and they learn to value opportunities to revise.[33]

Time-On-Task

In all domains of learning, the development of expertise occurs only with major investments of time, and the amount of time it takes to learn the material is roughly proportional to the amount of material being learned.[34]

Learner Motivation

Motivation affects the time and effort that people are willing to devote to learning. Students are motivated to spend the time needed to learn complex subjects and to solve problems that they find interesting. Humans are motivated to develop competence and to solve problems; they have, as R. W. White put it, "competence motivation."[35] Although extrinsic rewards and punishments affect behavior, people work hard for intrinsic reasons, as well. Challenges, however, must be at the proper level of difficulty to be and to remain motivating; tasks that are too easy become boring; tasks that are too difficult cause frustration.

Context

Transfer is also affected by the context of original learning; people can learn in one context yet fail to transfer to other contexts. Research has indicated that

transfer across contexts is especially difficult when a subject is taught only in a single context rather than in multiple contexts.[36] The issue is how to promote a wide transfer of learning. One way to deal with a lack of flexibility is to ask learners to solve a specific case and then provide them with an additional, similar case; the goal is to help them abstract general principles that lead to more flexible transfer.[37]

Transferring Beyond the Classroom—Employing Authentic Problems

A primary goal of learning is to be able to access and apply information where it is needed, and to be able to transfer what is learned to relevant circumstances. There is much value to the idea that learning should be organized around authentic problems that are frequently encountered in non-school settings: in John Dewey's vision, "School should be less about preparation for life and more like life itself."[38] The use of problem-based learning in medical schools is an excellent example of the benefits of looking at what people need to do once they graduate and then crafting educational experiences that best prepare them for these competencies.[39] For this reason, case-based learning is often employed where relevance to the workplace is important.

A Systematic Means for Developing & Measuring Higher-Order Thinking Skills

The above theories and principles are foundational for successful learning. As such, they were incorporated as the central elements in the design of a new online platform that measures, develops, exercises and assesses higher-order thinking skills and processes. This innovative platform was created by findingQED, a company focused on providing a systematic, scalable, and effective means for significantly improving higher-order thinking capabilities.

Embodied within findingQED's unique online platform is a powerful framework that calls upon learners to investigate, analyze, and resolve issues arising in scenarios of relevance to the learner, and for learners to support their perspectives by constructing explicit well-reasoned fact-based arguments. Higher-order thinking skills are developed, exercised, and measured during the learner's interactive investigations, sense-making, fact gathering, analyzing, finding connections, applying methods and models, deriving inferences, judging and assessing, specifying perspectives, and constructing supporting arguments. Probabilities, levels of certainty, and the number of reasonable resolutions can vary from scenario to scenario as can the quantity and types of digital media to be evaluated. Importantly, instructive automated descriptive feedback is combined with detailed quantitative

measures to provide immediate rich personalized guidance that empowers each learner to reflect upon and improve their higher-order thinking.

Custom scenarios that incorporate any type of digital media (video, photos, graphics, PDFs, audio, etc.) can be efficiently created by anyone using the platform's scenario creator interface and can pertain to any context, subject matter and issues deemed relevant by the scenario creator for their particular set of learners. Having subject matter experts create scenarios on the platform with the aim of measuring, exercising, developing, and assessing analyst higher-order thinking skills as applied to resolving issues arising in situations that are directly relevant to the analysts' domain is exactly the type of use envisioned for the platform. The platform framework ensures that, regardless of the scenario context, the learner's higher-order thinking, critical thinking, and problem-solving processes are systematically developed in accord with widely accepted cognitive theories and learning principles.

In addition to developing higher-order thinking skills in a training context, the findingQED platform and framework can also provide a structural means for infusing these important cognitive abilities into the information warrior's actual operational work activities.

A Structural Means for Supporting and Enhancing Higher-Order Thinking by Information Warriors in Their Work Activities

While higher-order thinking skills development is important and necessary in any information warrior training program, it is not sufficient. A platform that supports and enhances information warrior higher-order thinking in their actual operational work activities is also necessary for ensuring greater warrior effectiveness. That is, the information warrior needs a structural method to ensure that all "relevant elements of thought and reasoning" are applied to each work assignment; in other words that the requisite higher-order thinking skills and processes are brought to bear on the warrior's information production.

There are at least six areas of strategic gains that information warriors can achieve by employing a structural means for explicitly incorporating all "relevant elements of thought and reasoning" in their process and practice. Employing such a method in their work process will:

1. Systematically enhance information warrior cognitive capabilities.
2. Foster systematic continuous learning and improvement.
3. Enable more efficient collaboration and sharing of relevant elements of thought and reasoning across organizational divisions and stovepipes.

4. Enable a network of "inter-level" interactions about relevant elements of thought and reasoning, as an overlay to the existing information-flow hierarchy.
5. Provide a flexible dynamic means for rapidly modifying any aspect of underlying thoughts and reasoning to efficiently generate alternative scenarios and test sensitivities.
6. Enable more rapid and accurate assessment and management of workforce capabilities.

Systematically Enhance Information Warrior Cognitive Capabilities

As detailed in previous sections, effective information warrior work activities depend upon a wide array of cognitive capabilities. But much of the workforce does not consistently excel across all required cognitive skills. These shortfalls can and should be structurally and systematically remedied, with the result being a more insightful, consistent, comprehensive, accurate, reliable, and efficient information product. The findingQED platform is a cost-effective developmental technology that can structurally support and empower all information warriors to enhance their cognitive capabilities during their work process. While the platform can be effectively utilized in any context requiring higher-order thinking, the authors intend to prioritize the platform's configuration and use to empower intelligence analysts to advance the conduct of information warfare. Doing so will enable the Air Force to better employ the information element of power in pursuit of national interests. It will:

- Prevent emotion from overwhelming the ability to reason
- Foster higher-order and critical thinking
- Prevent assumptions and uncertain inferences from being treated as facts
- Enable more explicit and effective assessment of probabilities
- Foster more well-reasoned fact-based logical arguments
- Ensure a science-based, data-driven-process with the understanding that science is seldom 100 percent settled
- Remain objective, adjusting conclusions based on the latest evidence and testing

Foster Systematic Continuous Learning and Improvement

Creating a culture of continuous learning and improvement is a goal for any organization. This is essential for organizations involved in areas that are strategically consequential and experiencing dynamic change, as exemplified by the information warfare arena. A culture of learning will support individuals to systematically increase their capabilities and effectiveness, which is especially necessary when change brings new opportunities and threats. Aggregating gains in learning and improvement across the organization and over time will have a profound impact on information warfare readiness and effectiveness.

Such a culture does not happen through words; it must be supported with a systematic approach, tools, and process. With the findingQED platform, individuals would not only have a tool to systematically support their thought processes in their work product creation, but such a structural interactive platform would also encourage consistent self-reflection about all their elements of thought and reasoning, and enable rapid and efficient sharing with more experienced personnel who can rapidly provide evaluation and feedback, which of course is a key element for continuous learning and improvement.

In addition to individual development, there are organization-wide gains available. One such gain is the storage of and reference to any professional's investigatory observations, understandings, analyses, interpretations, assumptions, inferences, insights, connections, relationships, evaluations, judgments, assessments, probabilities, alternative points of view, and entire reasoning chains. Having ongoing and historical access to all the relevant elements of thought and reason can be quite valuable to others in the organization.

Although there are multiple ways to incentivize regular use of the platform to improve higher-order thinking, fearless accountability for learning and improvement will most quickly instill a culture of excellence and superior performance. Having a structural capability for creating, storing and manipulating "relevant elements of thought and reasoning" is a valuable asset not only for (1) enhancing information warrior cognitive capability and work product effectiveness, (2) individual reflection, feedback and improvement and (3) use as a historical reference, but also (4) to provide input to prospective artificial intelligence system learning engines, when and where appropriate.

Enable More Efficient Collaboration and Sharing of Relevant Elements of Thought and Reasoning across Organizational Divisions and Stovepipes

Information is currently shared across organizational divisions and stovepipes where and when it is "needed." However, the "tough problems, the complex ones" often require multisource and/or specialized input that would be more useful if based on the full set of existing elements of thought and reason. Hence, it would be highly productive to have an efficient structural means to ask for and receive input from the most appropriate personnel across different organizational divisions, who can provide their analyses and perspectives based upon the full set of most current "work-in-process" elements of thought and reasoning, rather than just on the raw information or "final reviews." Such collaboration may even extend to persons providing unsolicited insights about relevant elements of thought and reasoning that they could view on the platform. The collaboration should be as broad as is permissible across the organization, subject to the necessary security constraints in certain circumstances. For tough problems, the more collaboration from invited eyes and minds on the relevant elements of thought and reasoning, the better the result is likely to be. The web-based findingQED platform can enable such efficient and effective collaboration.

Enable a Network of "Inter-Level" Interactions about Relevant Elements of Thought and Reasoning as an Overlay to the Existing Information-Flow Hierarchy

Currently, information product formulation is often the result of a hierarchical structure. That is, many information gatherers are feeding their (often highly focused) findings upward through additional levels of information filtering and aggregation, with the ultimate insight generation or point of view created by far fewer at the top of this filtering and aggregation pyramid. The question is not if this works; it has. The question is if this should be the only systematic process, exclusive to all others. Might there be other efficient and useful ways to augment this traditional process and further leverage the information warriors' capabilities?

A hierarchical information filtering and aggregation architecture most certainly does not always leverage the capabilities of the organization nor of the many highly capable warriors that exist "lower in the food chain." Certainly, less senior analysts could have an insightful impact on some issues that have already been filtered and aggregated at a higher level. But presently, not enough of this "lower-to-upper-level" iterative input is undertaken and is not sufficiently leveraging the

totality of the cognitive value of the entire workforce. As a result, the Air Force is, unnecessarily, leaving untapped information warrior value on the field.

Without disrupting the architecture of the existing hierarchical process, an efficient and impactful "network architecture approach" can be overlaid and enable efficient "inter-level" iterative interaction pertaining to the relevant to elements of thought and reasoning, and by so doing, unleash significant amounts of cognitive value into the existing processes.

If the information production process included an explicit means for creating, storing, and manipulating relevant elements of thought and reasoning, several others, regardless of level in the hierarchy could review and provide input, potentially yielding key insight value on an issue. For example, it is possible that a newly discovered or re-introduced relevant piece of information could change a point of view or reasoning chain if that piece of information was known by the decision-maker. It may be that the relevant information was filtered, or simply did not seem relevant until the aggregation process proceeded and led to a point of view. If the individual who knows this "now relevant information" is not privy to the full reasoning chain and resultant point of view, the decision-maker(s) are deprived of this potentially relevant insight. This example is just one of many scenarios where potentially useful information is not connected where and when it is needed because of the existing hierarchical process.

This flaw of process and organizational structure is avoidable. By utilizing a structured means for producing information that makes visible all the detailed relevant elements of the thought and reasoning, and by inviting those who can provide feedback and input into the process, regardless of position in the hierarchy, one can unlock useful information and increase value in the process. Would it not be useful (of course, accounting for security considerations) to have all relevant information warriors to see, reflect on, and potentially provide input on the various discrete elements of observations, understandings, analyses, interpretations, assumptions, inferences, insights, connections, relationships, evaluations, judgments, assessments, probabilities, alternative points of view, entire reasoning chains, and other relevant elements of thought and reasoning that are pertinent to an important information product and resulting consequential point of view? Does one's level in the hierarchy matter if they have a valuable contribution to make? Utilizing the findingQED platform that structures information products into highly useful and reference-able discrete "elements of thought and reasoning" could help unlock the strategic untapped value that resides within our information warriors.

Providing a Flexible Dynamic Means for Rapidly Modifying Any Element of Underlying Thought and Reasoning to Efficiently Generate Alternative Scenarios and Test Sensitivities

Often, the objective of intelligence analysis is to create a point of view that: assesses, describes, explains, predicts, prescribes alternatives, or decides. Therefore, it is often the case that there are different alternatives and differing levels of probability or uncertainty. Given this, it can be very useful to examine and vary one or more of the underlying relevant elements of thought and reasoning, including the key facts, analysis, interpretations, inferences, assessments, probabilities, and judgments to determine how possible changes in one or more of these individual elements will impact the ultimate point of view. If all the underlying thought and reasoning elements are not entirely explicit and clear, then conducting a sensitivity or alternatives analysis could be dangerously flawed. Further, if it is difficult to roll-up probabilities across all the elements of the reasoning chain, such an analysis would be cumbersome. By having a structured means for creating, storing, and manipulating all the relevant elements of thought and reasoning supporting a particular point of view, including its entire reasoning chain, conducting such a sensitivity or alternatives analysis would be efficient, thorough, and comprehensive. This will be a very powerful tool for many uncertain situations.

Enable Rapid and Accurate Assessment and Management of Workforce Capabilities

Understanding who is best able to accomplish tasks accurately and reliably is of critical importance. Understanding who has the potential to advance, and who shows continual improvement, is also of great importance. So too is understanding who is not progressing appropriately. Knowing these facts with some certainty is key to making assignments that can have serious consequences.

By having a structural method that enables one to create, store, and manipulate all the relevant elements of thought and reasoning about any analytical project provides operational and talent managers with an objective, explicit, and transparent method for evaluating and assisting personnel. Such a system enables a clear and transparent view of everyone's higher-order thinking skills and provides the robust means to support and train them where the assessment of the thought and reasoning output shows need. Viewing and assessing each person's cognitive abilities becomes transparent for managers, thus enabling specific assistance, intervention, support, advice, and training. This can be accomplished in real-time, all while information warriors are on the front line performing their tasks and responsibilities; their work activities can be reviewed at any time by their supervi-

sors. As such, the findingQED platform configured to support analytical production can be a powerful talent management tool in addition to providing training and operational support for advancing the Air Force information warfare mission.

Summary

The Air Force is significantly and systematically under-utilizing a strategic asset, the mind of the information warrior. This is a result of under-investing and not providing consistent broad-based thorough development of higher-order thinking skills in information warrior training and not providing a structured means for ensuring the systematic use of these skills in operations. These shortfalls can be remedied by incorporating systematic training methods focused on developing higher-order thinking skills as well as employing a structural means for infusing these elements of thought and reason into the operational work practices of the warriors. The findingQED company's mission is to remedy these shortfalls and has a powerful online platform that measures, develops, exercises, and assesses higher-order thinking skills using interactive scenarios that are contextually relevant to the learner. As well, the platform's framework can be deployed as a tool to infuse higher-order thinking into the information warrior's analyses and work activities.

This human-machine teaming, for enhancing both training and work processes, will empower the information warfare workforce to achieve large-scale increases in capability and effectiveness. By incorporating such structural and systematic methods, the Air Force will add a powerful strategic means for outpacing competitors in the contest for information dominance. ✪

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Notes

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