2021-12

Evaluation of Leadership Traits for Future Warfare

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https://hdl.handle.net/10945/68623

NPS-IS-21-002

NAVAL POSTGRADUATE SCHOOL

MONTEREY, CALIFORNIA

EVALUATION OF LEADERSHIP TRAITS FOR FUTURE WARFARE

by

Dr. Mark E Nissen and Dr. Simona L Tick

December 2021

Distribution Unlimited

Prepared for: Naval Leadership and Ethics Center
This research is supported by funding from the Naval Postgraduate School, Naval Research Program (PE 0605853N/2098). NRP Project ID: NPS-21-N333-A

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REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE ***(DD-MM-YYYY)*** December 2021	**2. REPORT TYPE** Technical Report	**3. DATES COVERED** ***(From-To)*** 01/02/2021 – 12/31/2021
4. TITLE AND SUBTITLE Evaluation of Leadership Traits for Future Warfare		**5a. CONTRACT NUMBER** **5b. GRANT NUMBER** **5c. PROGRAM ELEMENT NUMBER** 0605853N/2098
6. AUTHOR(S) Dr. Mark E Nissen and Dr. Simona L Tick		**5d. PROJECT NUMBER** NPS-21-N333-A; W1122 **5e. TASK NUMBER** **5f. WORK UNIT NUMBER**
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) AND ADDRESS(ES) Naval Postgraduate School		**8. PERFORMING ORGANIZATION REPORT NUMBER** NPS-IS-21-002
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Naval Postgraduate School, Naval Research Program / Naval Leadership and Ethics Center		**10. SPONSOR/MONITOR'S ACRONYM(S)** NRP / NLEC **11. SPONSOR/MONITOR'S REPORT NUMBER(S)** NPS-21-N333-A

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release: Distribution Unlimited

13. SUPPLEMENTARY NOTES

14. ABSTRACT

The Navy recognizes the continuing need to develop warfighters able to lead using critical problem solving skills while fostering an environment of trust throughout the command. Recent research suggests that leaders must be fluent in skills like humility, empathy and perspective taking. However, there are very few tools available to help leaders improve their effectiveness in these areas. This study focuses on understanding the elements of *humility* and how they interrelate with, complement and supplant other important leadership traits required for future warfare. We examine in particular the Navy Desired Leadership Attributes and Division Officer training for correspondence and coherence. Results highlight opportunities for alignment and improvement.

15. SUBJECT TERMS

Humility, soft skills, leadership, training

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT U	**b. ABSTRACT** U	**c. THIS PAGE** U	UU	64	Mark Nissen **19b. TELEPHONE NUMBER *(include area code)*** 831-656-3570

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std. Z39.18

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The report entitled "Evaluation of Leadership Traits for Future Warfare" was prepared for the Naval Leadership and Ethics Center, OPNAV N1, and funded by the Naval Postgraduate School, Naval Research Program (PE 0605853N/2098).

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ABSTRACT

The Navy recognizes the continuing need to develop warfighters able to lead using critical problem solving skills while fostering an environment of trust throughout the command. Recent research suggests that leaders must be fluent in skills like humility, empathy and perspective taking. However, there are very few tools available to help leaders improve their effectiveness in these areas. This study focuses on understanding the elements of *humility* and how they interrelate with, complement and supplant other important leadership traits required for future warfare. We examine in particular the Navy Desired Leadership Attributes and Division Officer training for correspondence and coherence. Results highlight opportunities for alignment and improvement.

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I. INTRODUCTION

The 2018 National Military Strategy emphasizes the importance of people, noted as “the Joint Force’s primary source of competitive advantage” (NMS, 2018, p. 5), and indicates that they must adapt continuously and innovate repeatedly to maintain their competitive edge. In concert, the 2020 Education for Seapower Strategy (E4SS, 2020) places the Navy’s investment in learning at the same level of importance as weapon systems; and the Education for Seapower Final Report reinforces the importance of education, calling it “vital … [to] producing leaders highly proficient in strategic thinking and analysis, the technologies they will employ, as well as professional warfighting competence” (E4S, 2018, p. 2). This applies in particular to the Officer Corps, asserting that an officer’s principal weapon is his or her mind.

These important leadership traits build in turn on the Navy Leadership Development Framework, which characterizes leadership as a “privilege” (NLDF, 2019, p. 1). Four principles listed at the heart of command include *authority, responsibility, accountability,* and *expertise*; and Navy leaders are expected to exhibit virtue, honor, patriotism and subordination. They are expected further to grow, both personally and professionally, throughout their careers; to “work from a foundation of humility, embracing the core values *honor, courage* and *commitment*; and pursuing “excellence in accordance with … core attributes of integrity, accountability, initiative and toughness” (p. 2).

Further along this line we find the Navy Desired Leader Attributes (NDLAs), which differ across the enlisted, warrant and officer corps, and which vary with rank and experience. Continuing to focus on the officer corps, the foundational elements include *core values, moral character, judgment* and *leadership*; which vary across the progression from Trusted Leader (O1 – O2), through Motivational Leader (O3 – O4) and Inspirational Leader (O5 – O6), to Visionary Leader (Flag); and which combine to form a 4x4 (16 cell) matrix as depicted in Figure 1 (NLDF, 2017).

Navy Desired Leader Attributes
Officers

Foundational Elements	O-1 to O-2 *Trusted Leader*	O-3 to O-4 *Motivational Leader*	O-5 to O-6 *Inspirational Leader*	Flag *Visionary Leader*
Core Values	Understands and lives relationship of Oath to Navy Core Values	Instills Navy Core Values in others	Infuses Navy Core Values in command culture	Guardian of Navy Core Values
Moral Character	Personal values consistent with Navy Core Values	Fosters ethical behavior in others	Moral arbiter for the command	Exemplar for the Navy
Judgment	Practices sound judgment; enforces rules, regulations, and procedures	Anticipates requirements and acts independently	Exercises discernment and acts both boldly and prudently	Embraces forward-thinking, strategic perspective
Leadership	Valued team leader Fosters loyalty up and down chain of command	Adaptive leader and team builder Exercises morally responsible, credible leadership	Command leader Embraces authority, responsibility, and accountability of command	Steward of the naval profession of arms Conveys highest standards of the Service with strength, determination, and dignity

Figure 1 Officer NDLAs (adapted from NLDF, 2017)

One can identify additional traits, attributes and characteristics associated with or expected of Navy leaders, but even the relatively small set summarized in this section reflects a plethora of factors to consider, much less to emphasize. This raises the important question of which leadership attributes are most important in Today's and Tomorrow's Navy, and how can the Navy best select people with and help people to develop them?

The balance of this report begins with important background regarding leadership. It continues then with an overview of our research method; followed in turn by key findings, results and recommendations. The report closes with high level conclusions and suggestions for further research.

II. BACKGROUND

We begin this section by noting that the myriad books, articles, magazines and shows addressing leadership make a comprehensive review of the literature impractical. Further, for our purposes, such comprehensive review is also unnecessary, as we look principally toward emerging attributes that may not have found their way into established Navy leadership training (yet). We organize this background section into two parts: We begin by summarizing some important points about leadership in general and humility in particular. We then follow by summarizing key aspects regarding the dynamics of knowledge.

A. LEADERSHIP AND HUMILITY

Recent research suggests that leaders must be fluent in skills like *humility, empathy* and *perspective taking* (Ou et al., 2014; 2018). Indeed, *humility* stands out for many researchers as a particularly effective leadership trait (Hyman, 2018; Hu et al., 2018), one that is suited ideally for leadership in the current age of intelligent, autonomous systems integrating persistently into our professional lives (Hess & Ludwig, 2017).

Not everyone agrees, however, and humility alone—although seeming necessary—is unlikely to be sufficient for leadership excellence (Lipkin, 2020); but in conjunction with emotional intelligence (Salovey, & Mayer, 1990; Goleman, 1995) and other factors, research to understand, measure and apply humility appears to offer excellent promise to enhance leadership (Mattis & West, 2019) and help the Navy continue to progress from good to great (Collins, 2001).

Moreover, recall from above that *humility* is noted as a leadership foundation in the Navy Leadership Development Framework (NLDF, 2019). Hogan (2018) notes three elements of humility: 1) self-awareness, 2) appreciating others' strengths and contributions, and 3) openness to new ideas and feedback regarding one's performance.

Hess and Ludwig (2017) address humility in great depth. By way of motivation, they note how artificial intelligence and machine learning (AIML) are powering "smart machines" with potential to take over many professional jobs and how the future belongs to individuals that have made an active lifelong commitment to learning (p. 20). As such, they assert that organizations will need people who can adapt to rapidly changing environments.

They assert further that agility, adaptability, and responsiveness also will be required for most, and thus organization efficiency will be necessary but no longer sufficient. This implies that people will need to learn continuously and iteratively, challenging their beliefs repeatedly against changing phenomena (p. 21):

> … humans will need to excel at the kinds of jobs and skills that either complement technology or are those that technology cannot do well—at least not yet. That list includes critical thinking, innovative thinking, creativity, and high emotional engagement with others that fosters relationship building and collaboration. Collectively we refer to these as the SMA [Smart Machine Age] Skills (pp. 21-22).

In order to develop and refine such SMA Skills, people will need to engage in four key behaviors: Quieting Ego; Managing Self (one's thinking and emotions); Reflective Listening; and Otherness (emotionally connecting and relating to others; p. 33).

This leads to five principles of what they term the NewSmart: "1) I'm defined not by what I know or how much I know, but by the quality of my thinking, listening, relating, and collaborating. 2) My mental models are not reality—they are only my generalized stories of how my world works. 3) I'm not my ideas, and I must decouple my beliefs (not values) from my ego. 4) I must be open-minded and treat my beliefs (not values) as hypotheses to be constantly tested and subject to modification by better data. 5) My mistakes and failures are opportunities to learn" (p. 38).

They continue to define humility as a mindset about oneself that is open-minded, self-accurate, and "not all about me" and that enables one to embrace the world as it "is" in the pursuit of human excellence. Clarifying, they note that it doesn't mean thinking less *of yourself*, but it does mean thinking *about yourself* less. This requires in turn that people balance their competitive spirit with collaborative spirit, because critical thinking, innovative thinking, and high emotional engagement are all team sports (pp. 59-60).

Thus, Hess and Ludwig provide several insights into workplace requirements. For one, the work environment needs to be humanistic, implying that it must be designed to reduce fears, insecurities, and other negative emotions (p. 160). For another, such work environment should promote intrinsic motivation, which requires three support factors: 1) autonomy, 2) relatedness and 3) competence (p. 162). For a third, the environment where people work should be psychologically safe; have cultures of candor; permission to speak freely; permission to make learning mistakes (within financial risk parameters); and offer all employees a voice by devaluing elitism, hierarchy, and rank (other than with respect to compensation; p. 166).

Returning to our emphasis on Navy learning above, Hess and Ludwig impose an overarching requirement for the NewSmart organization: "irrespective of what it does or sells, will be a human development organization in the business of learning" (p. 170).

These important points about leadership in general and humility in particular are summarized in Table 1 below.

Table 1 Key Leadership & Humility Points

Point
Humility is an important leadership trait
Humility is necessary but not sufficient
Humility is a foundational leadership element in the NLDF
Self-awareness, appreciating others & openness to new ideas are important
Continuous learning is essential
People need critical & innovative thinking, creativity, & emotional engagement
SMA Skills: Quieting Ego, Managing Self, Reflective Listening & Otherness
Humility is a mindset
Balance competition with collaboration
A humanistic, psychologically safe work environment can promote humility

B. KNOWLEDGE DYNAMICS

Because learning plays such a prominent role in new thinking about leadership and humility, it is important to consider the dynamics of knowledge, for learning can be viewed as knowledge moving from where, when and how it is located to where, when and how it is needed (Nissen, 2014).

Instead of trying to define *knowledge*—over which philosophers have been arguing for millennia—we find it useful to operationalize it instead: knowledge enables action (Nissen, 2006). Thus, as opposed to arguing over what exactly knowledge is, we need only to discern when (i.e., someone can perform an action) and how much of (i.e., how well an action is performed) it is present in a particular person, team or organization.

Indeed, one can think of knowledge in terms of *chunks*[1], where one chunk can enable the performance of one atomic action. More precisely, following Herbst (1993), the fundamental knowledge based action involves making a distinction. Hence in our organization context, where knowledge enables action, its most fundamental aspect centers on distinction to address organization needs and goals.

Building upon this powerful view, we consider further the dynamics of knowledge. Nissen (2005) describes the concept *knowledge flow* in terms of dynamic knowledge and indicates that it subsumes similar concepts such as *knowledge conversion, transfer, sharing, integration, reuse* and others that depict changes, movements and applications of knowledge over time. Knowledge Flow Theory (Nissen, 2006; 2014) describes the dynamics of knowledge flows phenomenologically, and it includes multidimensional, analytic and graphic techniques for understanding, interpreting, measuring and comparing a diversity of flows.

Drawing directly from Nissen (2007), we organize this brief overview of Knowledge Flow Theory (KFT) into five parts: 1) knowledge uniqueness, 2) knowledge flows, 3) knowledge visualization, 4) knowledge patterns, and 5) knowledge measurement. Interested readers are directed to Nissen (2014) for details.

1. Knowledge Uniqueness

In this characterization, *knowledge* is conceptually distinct from *information, data* and *signals*: knowledge enables action (e.g., decisions, behaviors, work); information provides meaning and context for action (e.g., decision criteria, behavior stimuli, work settings); data answer context-specific questions (e.g., How much profit is expected by selecting Alternative A? Who says that we should honor our commitments to the workers? How many industrial accidents have occurred so far this year?); and signals transmit detectable events across physical space (e.g., light patterns from pages in a book, sound waves from voices in a room, voltage differences across cables in a computer network).

[1] *Chunk* (C) is a longstanding technical term, derived from psychology and used in the artificial intelligence literature, which describes a unit of knowledge that has become familiarized and can be recognized in one's field of expertise (Simon, 1996). A recognized expert in some domain is estimated to have command of at least 10,000 knowledge chunks in that domain and to require at least ten years to acquire such knowledge. We use chunk as a proxy for the mass or amount of knowledge possessed or moved.

Many scholars (e.g., Davenport and Prusak, 1998; Nissen et al., 2000; von Krogh et al., 2000) conceptualize a hierarchy of knowledge, information and data. As illustrated in Figure 2, each level of the hierarchy builds upon the one below. (Each is also fed from the one above.) For example, data are required to produce information, but information involves more than just data (e.g., need to have the data in context). Similarly, information is required to produce knowledge, but knowledge involves more than just information (e.g., it enables action). We expand this hierarchy using two dimensions—*abundance* and *actionability*—to differentiate further among the three constructs.

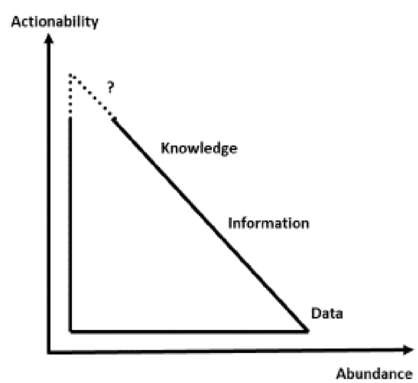

Figure 2 Knowledge Hierarchy (adapted from Nissen, 2014)

Briefly, data lie at the bottom level, with information in the middle and knowledge at the top. The broad base of the triangle reflects the abundance of data, with exponentially less information available than data, and even fewer chunks of knowledge in any particular domain. Thus, the width of the shape at each level reflects decreasing abundance in the progress from data to knowledge. The height of the shape at each level reflects actionability (i.e., the ability to take effective action, such as informed decisions, appropriate behaviors or productive work). Converse to their abundance, data are not particularly powerful for supporting action, and information is more powerful than data, but knowledge supports action directly, hence its position at the top of the shape.

Notice the question mark ("?") in the region "above" knowledge in this figure. A number of scholars and practitioners include *wisdom* and other terms (e.g., *enlightenment*) as something greater than knowledge in the hierarchy. With our operationalization of *knowledge* as enabling action, however, it remains unclear what, if any, actions can be taken via wisdom, enlightenment or the like that are not simply enabled through greater accumulations or higher levels of knowledge. Hence we maintain space in the hierarchy to accommodate any future insights into this question, yet we retain *knowledge* at the top of our hierarchy.

2. Knowledge Flows

In terms of knowledge flows (e.g., movements of knowledge across people, organizations, places and times; from where, when and how it is located to where, when and how it needs to be), the two connected knowledge hierarchies depicted in Figure 3 illustrate some key concepts. On the left side, we see a knowledge producer's hierarchy, and on the right side, we see a knowledge consumer's hierarchy. Both of these knowledge hierarchies conform to the characterization above (e.g., abundance vs. actionability, layers building upon one another, distinct concepts). The producer hierarchy includes a vector arrow pointed downward (i.e., from knowledge, through information, to data; each level feeds the one below), and the consumer hierarchy includes an arrow pointed upward (e.g., each level builds upon the one below). This depicts the relative direction of knowledge as it flows from producer to consumer.

Specifically, following Tuomi (1999), the producer utilizes existing knowledge to create information, which is used in turn to produce data, which are transmitted via signals across some physical space. Then, following von Krogh et al. (2000), the consumer interprets the data from signals, develops information through incorporation of meaning and context, and then develops actionable knowledge through some learning mechanism. Of course, the directionality of arrows can reverse (i.e., a "producer" can become a "consumer," and vice versa), and multiple knowledge hierarchies can participate simultaneously, but this provides a phenomenological description of how knowledge flows. Notice that only signals (e.g., via light, sound, electricity, magnetism) are involved with flows across physical space.

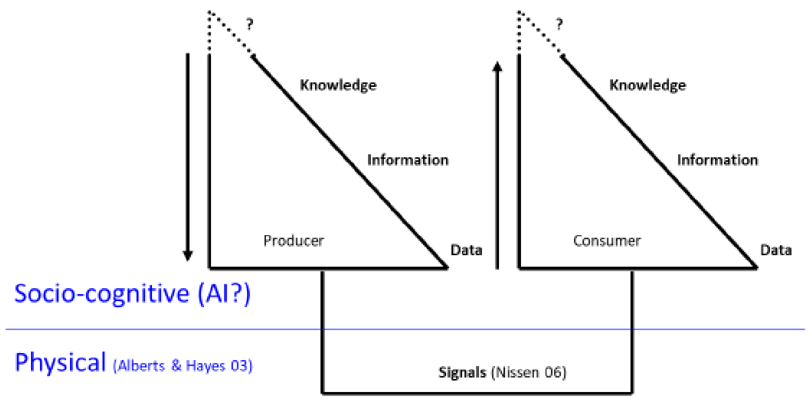

Figure 3 Knowledge Flows (adapted from Nissen, 2014)

Indeed, following Alberts and Hayes (2003), flows of data, information and knowledge take place in the socio-cognitive domain (e.g., associated with people, teams, organizations and tools). As people and machines continue to interact and work together ever more closely (esp. via artificial intelligence [AI]), however, this raises some question regarding the appropriateness of *socio-cognitive* as a term to describe the corresponding knowledge flows (e.g., human to machine, machine to machine, machine to human). Perhaps *computational* or like term would be more appropriate on the machine side of such flows. We leave this for future research and specification.

Another way to conceptualize and visualize the interaction between signals in the physical domain and the higher layers (i.e., data, information and knowledge) in its socio-cognitive counterpart is to overlay the Open Systems Interconnection (OSI) Seven Layer Reference Model. This model characterizes networking between two (or more) computers through a stack of seven distinct layers: 1) Physical, 2) Datalink, 3) Network, 4) Transport, 5) Session, 6) Presentation and 7) Application. Briefly, when sending an email message, for example, a user employs some email system (e.g., Gmail, Outlook, Yahoo) to compose the message. After hitting Send, the OSI stack initiates and processes the message down through the stack from Layer 7 (which interacts directly with the email application) to Layer 1 (which transmits bits via physical media [e.g., voltage on a copper cable, light on fiberoptic cable]) to the receiving machine. The receiving machine then processes this message in reverse order (i.e., from Layer 1 through 7) to deliver the message to some other email system on a different computer.

All of the processing between Layers 1 and 7 occurs within and between computational and network machines (e.g., computers, modems, routers), but the sender and receiver (esp. as humans) perceive, read and interpret the associated email messages via text in the socio-cognitive domain. Hence, as depicted in Figure 4, the data, information and knowledge hierarchy can be conceptualized as Layers 8-10 sitting atop the OSI Reference Model Layers 1-7. This may facilitate our interest in using one model to characterize knowledge flows involving people and machines as described above.

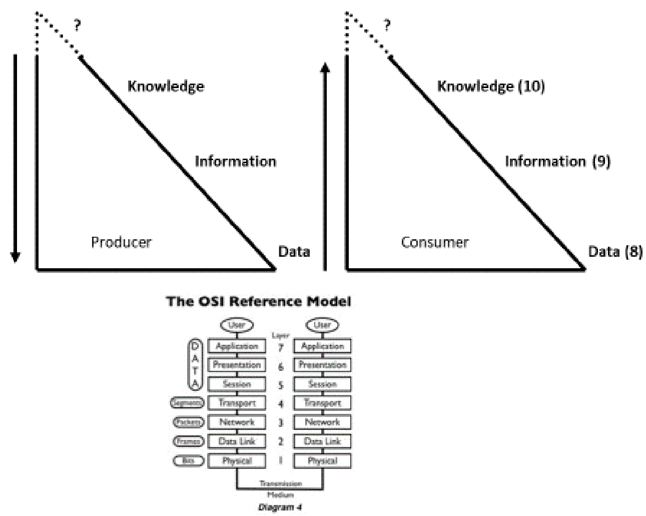

Figure 4 Hierarchy Conceptualization as OSI Layers 8-10

3. Knowledge Visualization

Figure 5 depicts a multidimensional space to visualize dynamic knowledge. Because knowledge is inherently intangible, invisible, indefinite and resistant to quantification, understanding its dynamics through graphic representation remains a challenge. Alternatively, multidimensional representation and visualization is straightforward and commonplace in Physics, so we borrow some of its fundamental concepts and techniques, and we begin to adapt them for our purpose in the knowledge domain.

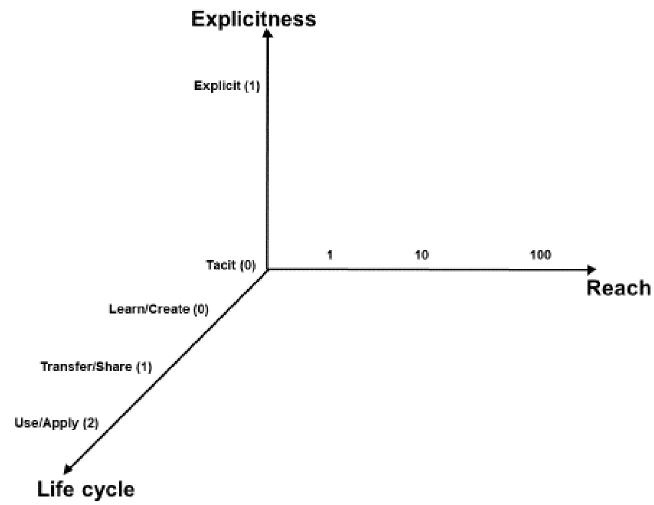

Figure 5 Basic Knowledge Flow Space (adapted from Nissen, 2014)

We are far from the first to borrow and adapt such concepts and techniques from other disciplines. Economics research, for instance, has borrowed concepts from Physics (e.g., *equilibrium, elasticity, differential*) for many years, and the Econophysics field (Gangopadhyay, 2013; Ghosh, 2013) employs both concepts and techniques from Physics (e.g., vectors, systems of dynamic equations, simulation) directly for use in addressing complex (esp. dynamic) economic problems. Hence our approach has abundant and relevant precedent, one that we continue to exploit for knowledge measurement below.

Briefly, the vertical axis represents the dimension *explicitness*, which characterizes the degree to which knowledge has been articulated in explicit form. This dimension draws from the Spiral Model (Nonaka, 1994) and includes a ratio scale between tacit and explicit knowledge. The horizontal axis represents the dimension *reach*, which characterizes the level of social aggregation associated with knowledge flows. This dimension draws from the Spiral Model also and is operationalized by the number of people associated with any particular chunk of knowledge. The third axis represents the dimension *life cycle*, which characterizes the kind of activity associated with knowledge flows. This dimension represents an extension to the Spiral Model (Nissen, 2002) and includes several ordinal categories of life cycle activity (e.g., create, share, apply). Together, these axes combine to form a three dimensional space.

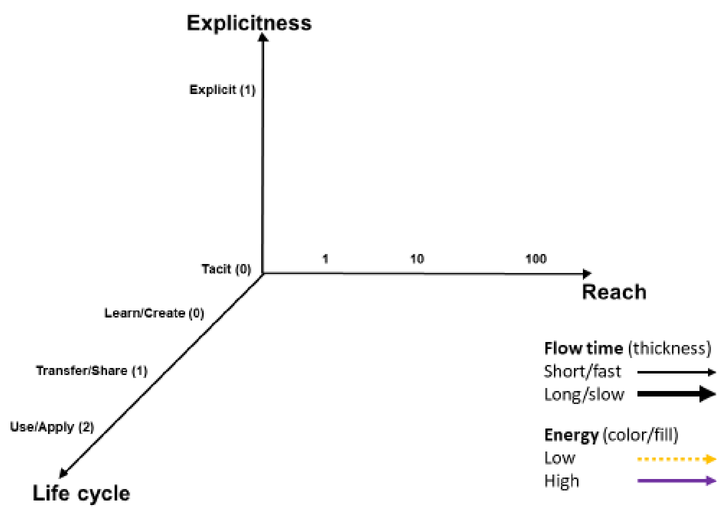

Figure 6 Extended Knowledge Flow Space (adapted from Nissen, 2014)

To represent important knowledge dynamics, through Figure 6 we continue to extend the Spiral Model by integrating the dimension *flow time,* which pertains to the length of time required for knowledge to move from one coordinate point in this three dimensional space to another, and *energy*, which depicts the performance level of action enabled by a particular knowledge chunk. Because visualization in five dimensions does not come naturally to most people, we use arrows of different thickness (e.g., thick for slow flows, thin for fast flows) when delineating knowledge flowing at different speeds, and we use different color patterns (e.g., dotted-orange for low energy flows, solid-purple for high energy flows) to represent the energy dimension.

4. Knowledge Patterns

A wide variety of knowledge patterns emerge from the multidimensional visualization space from above. In Figure 7, for instance, we illustrate a basic knowledge sharing problem. Someone at Point A learns how to do something important. Notice that the corresponding knowledge is tacit (e.g., experience based): The person at Point A knows how to perform the knowledge enabled action, but he or she has not written it down or articulated it into explicit form otherwise. Nonetheless, we want this knowledge to flow organization wide so that everyone is able to apply it *at the same efficacy level* (i.e., energy level) as the person at Point A.

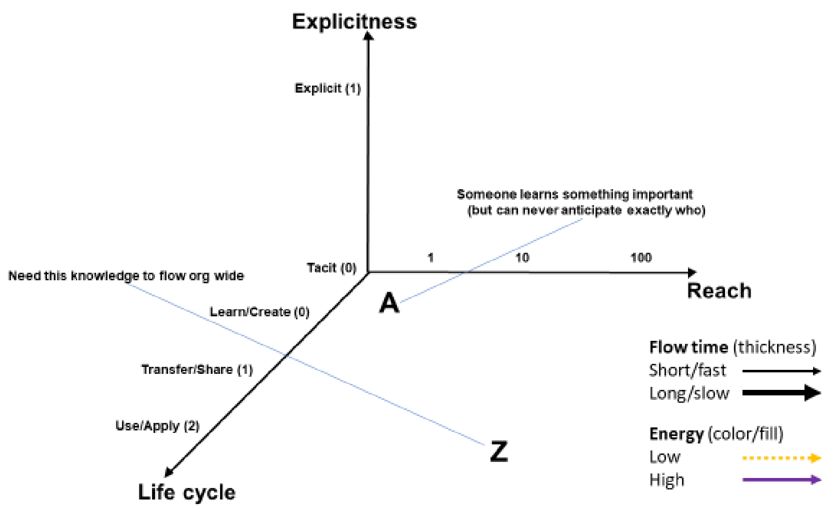

Figure 7 Basic Knowledge Sharing Problem

The shortest distance between two points is a straight line, hence we would like for such knowledge to flow quickly and energetically from the one individual to all 100 of his or her colleagues. Unfortunately, the organization does not possess a process for tacit knowledge to flow both quickly and energetically. (Few, if any, organizations do: some kind of sharing process would be required.) Indeed, much of the rich, experience based tacit knowledge in an organization can take weeks, months or even years to learn.

We illustrate this effect in Figure 8, which includes a thin, solid-purple vector extending from Point A toward Z. This delineates the kind of rapid, energetic flow that would be ideal. Because such ideal flow is infeasible, however, it cannot extend directly to Point Z, so we annotate the figure with a RIDGE blocking the ideal flow. This indicates that the corresponding knowledge must flow either over or around the RIDGE in order to reach Z.

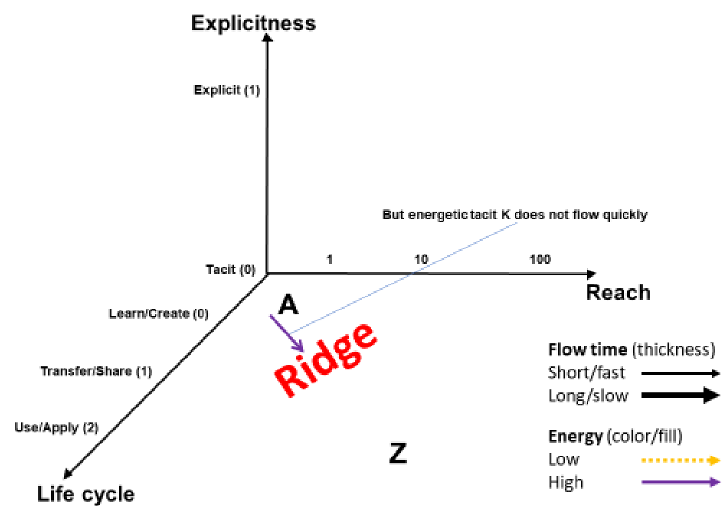

Figure 8 RIDGE Blocking Ideal Knowledge Flow

These two flows are depicted in Figure 9. The organization possesses two, archetypical knowledge flow processes, to which we refer as 1) the Jump Shot, and 2) the River. The Jump Shot is delineated by a dotted-orange line that rises up out of the tacit plane, whereas the River flow moves back and forth within this plane. With the former flow, the person at Point A expends both time and effort to articulate his or her knowledge in explicit form (e.g., written document, training material, SOP/TTP), who can then share it very quickly across the organization via network. Once shared as such, all 100 people in the organization are able to access and apply the new knowledge. This explicit knowledge flow pattern is exceedingly common in the modern organization.

The problem is, once articulated, explicit knowledge rarely flows at the same energy level as the corresponding tacit knowledge used to articulate it. Reading a book, for instance, about how to fly an airplane is not the same as direct experience flying airplanes. Simply reading a document, as another instance, about leading people rarely equips a leadership novice to be an effective leader without considerable experience and practice. Even the best training course on computer network defense, as a third instance, is rarely adequate for a novice computer security person to defend a complex network well without working defensively with that network. Thus, the Jump Shot archetype is known well for knowledge flowing very quickly and broadly through the organization, but it is known also for such knowledge to be comparatively attenuated in terms of energy.

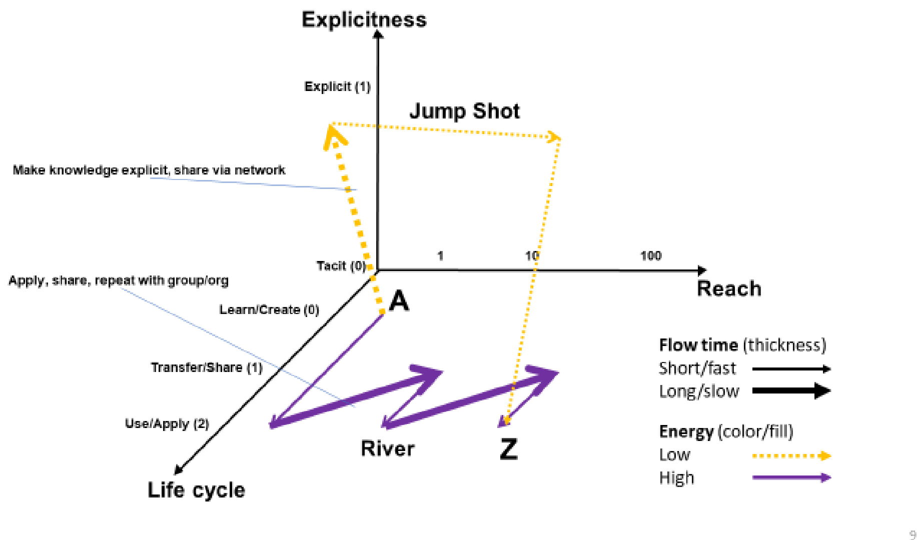

Figure 9 Archetypical Knowledge Flow Processes

Alternatively, with the latter flow, the person at Point A applies his or her knowledge directly via demonstration and then shares it with a group of (say ten) people using tacit knowledge flow techniques (e.g., mentoring, coaching, observation, practice). Once all ten people in this group are able to apply the knowledge *at roughly the same efficacy level* as the knowledge creator, each of them shares it in turn with another group of ten—in something of an evangelic or viral model—using the same kinds of tacit knowledge flow techniques. Over considerable time, all 100 people in the organization are able to apply the knowledge at roughly the same energy level. This latter energy level—and hence the efficacy level of performance—is generally much higher than that achieved through the Jump Shot.

Nonetheless, despite the high energy knowledge flow, the River has its own limitations. In particular, tacit knowledge flows comparatively very slowly and narrowly. It can take weeks, months or even years for someone to teach others to perform some knowledge enabled actions proficiently, and the kinds of tacit knowledge flow techniques noted above (e.g., mentoring, coaching, observation, practice) limit the number of people that knowledge can be shared with at any point in time. Effective mentoring, for instance, is limited to only one, two or perhaps a few people at a time. Thus, the River archetype is known well for knowledge flowing very slowly and narrowly through the organization, but it is known also for such knowledge to be comparatively very energetic.

This does not imply that one archetype is necessarily "better" than another. Rather, it explains that the two archetypes differ qualitatively and exhibit unique dynamic properties and behaviors. When circumstances necessitate rapid and broad knowledge flows, and when such flows do not require high energy, the Jump Shot represents the superior approach. Alternatively, when high energy flows are critical, and when the organization can wait for it to flow slowly from individuals through small groups, the River represents the better choice. With this as background, we have the ability to examine knowledge flows and needs within any operational organization and to determine—analytically—which approach to employ.

5. Knowledge Measurement

Finally, we summarize and extend recent research (Nissen, 2017) that enables the measurement of dynamic knowledge. Such recent research builds upon our understanding of dynamic physical systems to outline a simple set of equations that characterize the dynamics of motion in physical space and time (e.g., including constructs *force, work, friction, energy, time, power*). This recent work then draws from Measurement Theory (Krantz, Luce, Suppes & Tversky, 1971) and leverages KFT to develop an analogic set of equations to characterize the dynamics of knowledge as it flows through the organization (e.g., including constructs *knowledge force, knowledge work, knowledge friction, knowledge energy, flow time, knowledge power*). We link the dynamic knowledge measurement system that emerges with the visualization techniques from above to illustrate how such system is consistent with theoretic predictions.

This is done with full understanding and upfront admission regarding the limitations of analogic reasoning: In no way do we assert that the dynamics of knowledge follow or mirror the dynamics of physical systems precisely. Every analogy breaks down when stretched too far, and even some of the most basic physical concepts may have little meaning in terms of dynamic knowledge. Notwithstanding such limitations, however, we gain considerable insight from the deep understanding and mathematic representation of dynamic physical systems, which are adapted analogically to enable the measurement of dynamic knowledge.

a. Physical System

To recapitulate the approach, which is described in detail through research by Nissen (2017), a simple physical system is represented mathematically through the basic Newtonian equations summarized in Table 2. Such equations can be found in any introductory Physics textbook, yet they enable quantitative measurement, analysis, prediction and simulation of dynamic physical systems. Here we interrelate *force* (mass x acceleration; expressed in Newtons), *work* (force x distance; expressed in Joules) and *power* (work / time; expressed in Watts). We include three variations of Equation (3) to interrelate *time, distance* and *acceleration.*

We note also (beyond the table) how *work* and *energy* are exchangeable and expressed in the same units (Joules): energy is required to perform work, and work performance involves the expenditure of energy. We leverage such exchangeability below through analogic reasoning for knowledge systems.

Table 2 Physical System Equations

Construct	Description	Equation
Force (F)	Effort required to accelerate mass	(1) $F = m \times a$
Work (W)	Force applied through distance	(2) $W = F \times d$
Time (t)	Time for a mass to move its distance	(3a) $t = \sqrt{(2d/a)}$
Distance (d)	Distance that a mass moves	(3b) $d = \frac{1}{2} at^2$
Acceleration (a)	Change in velocity	(3c) $a = 2d/t^2$
Power (P)	Work done per unit time	(4) $P = W / t$

We note further how friction affects many physical systems by opposing motion and acceleration. An ordinary shopping cart, for instance, requires greater effort (i.e., more force) to push along a store aisle with a rough floor than a smooth one: the greater friction associated with the rough floor opposes motion and acceleration of the cart, hence it requires more force to push.

Considering friction in support of our analogic reasoning, a simple, linear, negative relationship between *force*—including that required to overcome friction (F_{Fr})—and floor *smoothness* (fs) is delineated in Figure 10. Here force can be measured in Newtons, and smoothness is expressed on a [0,1] continuum between rough (fs=0) and smooth (fs=1) endpoints.

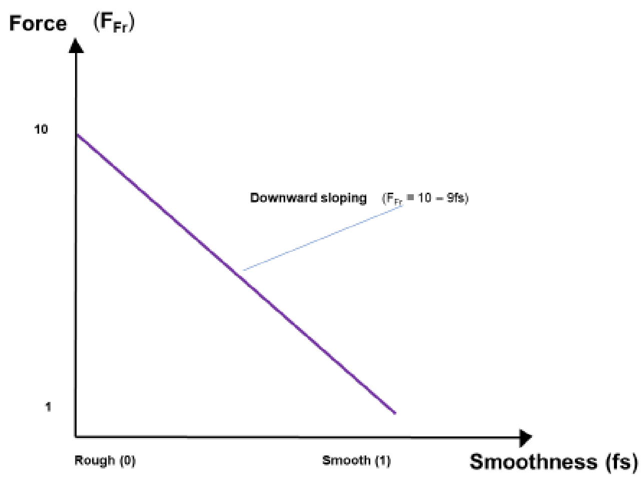

Figure 10 Force and Smoothness

Specifically as depicted in the figure, a rough floor is characterized here as requiring ten times the force to push a shopping cart as that needed on a smooth floor (F_{Fr} = 10 - 9fs). This downward sloping relationship between force and smoothness is representative, with specific slopes, intercepts and functions highly likely to differ across various carts, stores, aisles and floors. Nonetheless, the relationship makes intuitive sense and is consistent with many physical observations and measurements.

For illustration, say that some researchers go into a store and take three measurements: They observe a cart laden with 10 kg of groceries that takes 20 s to be pushed to the end of a 10 m aisle. The researchers use a scale to weigh the groceries, a stop watch to time the cart, and a tape measure to gauge the aisle length. This simple system of equations enables one to calculate all of the other parameters.

Using Equation (1) to find the force: The mass (10 kg) is known; and acceleration is calculated from Equation (3c), knowing distance (10 m) and time (20 s), at 0.05 m/s^2. Hence the corresponding force is 0.5 N. From Equation (2), work and energy are 5 J, and from Equation (4), the average power exhibited is 0.25 W. Thus, the researchers are able to discover much about this system from only three measurements. Figure 11 delineates velocity (v), acceleration (a) and distance (d) over the first five seconds of movement down the aisle.

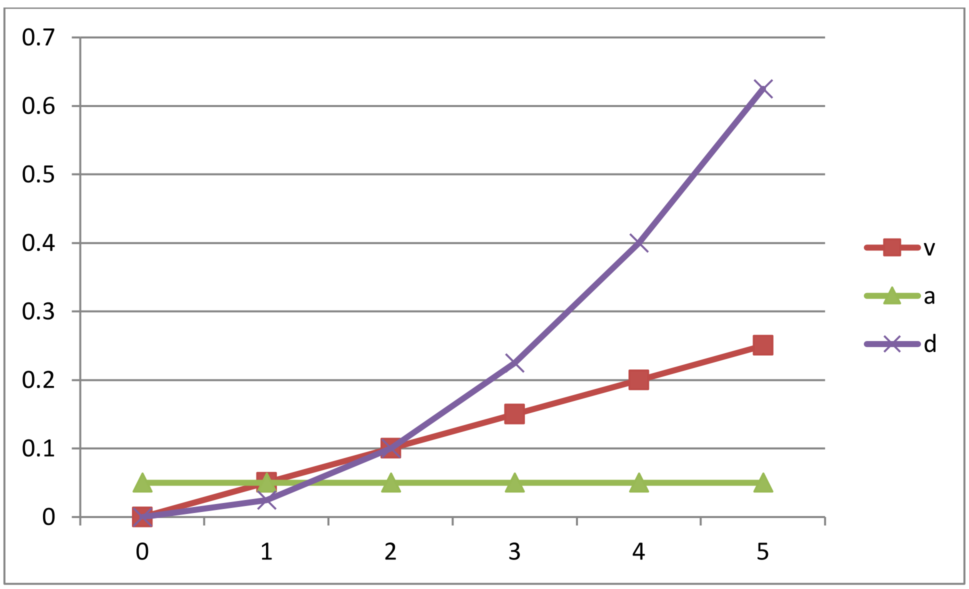

Figure 11 Physical System Dynamics

Moreover, now that this system of equations has been parameterized with measured and calculated values, one can understand and predict myriad changes and variations to the system without having to observe and measure it again physically. Say, for several instances, that researchers want to know what would happen if someone were to double or halve the mass of groceries on the cart (i.e., 20 kg, 5 kg), if the aisle were to double or halve in length (i.e., 20 m, 5 m), or if the cart were pushed to the end in double or half the time (i.e., 40 s, 10 s). Calculating such changes is straightforward with our parameterized system of equations: different values are substituted simply, and additional measurements in the field are not required.

b. *Basic Knowledge System*

In this section we recapitulate development of a basic knowledge system via analogic reasoning with respect to the simple physical system summarized above. Details of such knowledge system are found in Nissen (2017). As summarized in Table 3, we outline an analogic knowledge system. Briefly, *knowledge force* (K-Force or KF) is analogous to physical force and represents the effort required to accelerate knowledge in an organization. From KFT, it is expressed as a function of the knowledge *chunks* (C) being accelerated and the *explicitness* (E) of such knowledge.

Table 3 Analogic Knowledge System

Construct	Description	Analogy
K-Force (KF)	Effort required to accelerate knowledge	f(C, E, **o**)
K-Work (KW)	K-Force applied through reach	KF x R
Flow Time (FT)	Time required for knowledge to flow	FT
K-Power (KP)	K-Work done per unit flow time	KW / FT

In this conceptualization, each chunk (see Simon, 1996) of knowledge can enable the performance of one atomic action (e.g., making one distinction) in the organization. As noted above in terms of knowledge visualization, *explicitness* derives from Nonaka's (1994) epistemological dimension and represents the degree to which a knowledge chunk has been articulated in explicit form. The greater the number of chunks being accelerated (analogous to physical mass), and the more tacit the corresponding knowledge (analogous to physical friction), the greater the K-Force required. Notice also the **o** vector representing a number of other, unspecified factors (e.g., experience, communication skill, motivation, stress, organization climate, IT support), which are likely to play a role, but which have yet to be integrated explicitly or analogically.

As noted above also, *reach* (R) derives from Nonaka's (1994) ontological dimension and represents the number of people associated with the knowledge chunks from above (analogous to physical distance). Reach combines with KF to specify *knowledge work* (K-Work or KW) accomplished in the organization (analogous to physical work). Analogous to the exchange between and common units of *work* and *energy* in physical systems, we also conceptualize a correspondence between *knowledge work* and *knowledge energy* (K-Energy or KE): KE is required to perform KW, and KW performance involves the expenditure of KE. Indeed, without exploring complexities of efficiency (Nissen, 2020), we equate KE and KW for our present purposes.

In turn, *flow time* (FT) represents the time required for such knowledge chunks to flow from one person (e.g., an expert), group (e.g., a sales team), place (e.g., West Coast office), form (e.g., tacit) or time (e.g., night shift) to another. As a time measure, it combines with KW to specify *knowledge power* (K-Power or KP), which represents the knowledge work accomplished (and knowledge energy expended) per unit time (analogous to physical power).

Continuing to draw analogically from the dynamics of physical systems; and considering friction, which opposes motion and acceleration; a simple, linear, negative relationship between *knowledge force* (KF) and *explicitness* (E) is delineated in Figure 12. Consistent with KFT, this relationship indicates that tacit knowledge, which is notably "sticky" (Szulanski, 2000) and difficult to move through the organization, requires more effort (i.e., greater KF) to accelerate than its explicit counterpart.

Alternatively, tacit knowledge, in the context of which Polanyi (1967) explains that we know more than we can say, can enable knowledge work at higher performance levels than explicit. As noted above, to recapitulate the instance, reading a book (i.e., explicit knowledge) about how to fly an airplane is not the same as direct experience (i.e., tacit knowledge) flying airplanes, hence it is unlikely to enable performance at the same level.

Specifically as depicted in the figure, a chunk of tacit knowledge is characterized here as requiring (analogously) ten times (10x) the K-Force needed to get a chunk of explicit knowledge flowing (KF = 10 - 9E). Space prohibits a long discussion of sensitivity analysis, but results are highly robust to differences in slope (e.g., 2x, 100x), linearity (e.g., x^2, $x^{1/2}$) and other factors. Indeed, this downward sloping relationship between K-force and explicitness is representative, with specific slopes, intercepts and functions highly likely to differ across various organizations, people, processes, technologies and kinds of knowledge. Nonetheless, the relationship makes intuitive sense and is analogous to physical friction.

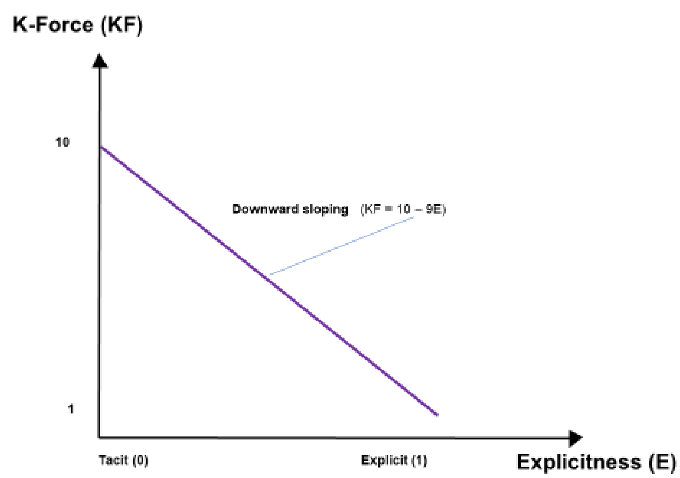

Figure 12 Knowledge Force and Explicitness

Further, we can use this representative relationship to specify the set of dynamic knowledge equations summarized in Table 4. In Equation (5) we specify K-Force as a multiplicative function of knowledge chunks (C), explicitness (10 - 9E), and vector of unspecified other factors (**o**). We refer to units of K-Force as "Nonakas" (N), acknowledging the seminal knowledge flow research done by Nonaka (1994). K-Work (and K-Energy) then follows in Equation (6) as the product of K-Force and reach (R). We refer to units of K-Work as "Polanyis" (P), for the keen insight into tacit knowledge provided by Polanyi (1967). K-Power is specified in turn through Equation (7) by dividing K-Work (or K-Energy) by flow time, the latter of which must be measured (e.g., using a stopwatch or calendar, measured in seconds). We refer to units of K-Power as "Bacons" (B), acknowledging Sir Francis Bacon, to whom many scholars attribute the aphorism, "knowledge is power."

Table 4 Knowledge System Equations

Construct	Equation
K-Force	(5) KF = C x (10 - 9E) x **o**
K-Work	(6) KW = KF x R (= KE)
Flow Time	Measure
K-Power	(7) KP = KW / FT

To reiterate from above, this analogic reasoning is not strict, and we recognize its limitations. Nonetheless, we gain insight from the deep understanding and mathematic representation of dynamic physical systems, which are adapted here to address the measurement of dynamic knowledge. Even this simple set of equations enables us to begin measuring knowledge as it flows through the organization. This represents a substantial step forward in terms of knowledge management and measurement.

c. Measurement Example

Recall from Figure 9 above how the Explicit Path delineates knowledge flowing *over* the RIDGE via the Jump Shot pattern. As illustrated in Figure 13[2], one can visualize such flow via three vectors (i.e., A-X, X-Y, Y-Z). This is the archetype associated most closely with technologic implementations, as it centers on making knowledge explicit and using technology for sharing. In contrast, the Tacit Path delineates knowledge flowing *around* the RIDGE via the River pattern. Through this same figure, one can visualize such flow via two vectors (i.e., A-W, W-Z). This is the archetype associated least closely with technologic implementations, as it centers on sharing tacit knowledge through interpersonal interaction.

[2] To simplify this figure, we omit the knowledge pattern names (i.e., Jump Shot and River) from the diagram, and we show the two archetypical flows extending only to a Reach of 10.

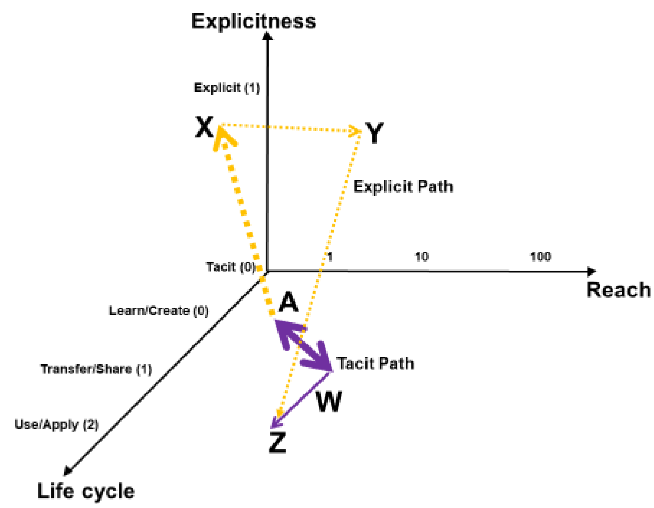

Figure 13 Archetypical Knowledge Flow Processes

Measurements corresponding to the Explicit Path for, say, 100 knowledge chunks are summarized in Table 5. Notice that we divide the measurements into three parts corresponding to each of the flow vectors. Walking across columns in the table, for the 100 chunks moving through the first flow vector (A-X), one can see explicitness is listed as a fractional value (0.5) in Column 2. This denotes that knowledge associated with the flow begins as tacit (E = 0) and ends as explicit (E = 1), as an individual worker articulates tacit knowledge into explicit form. Using Equation (5), this results in K-Force of 550 N (KF, KW and FT are expressed in thousands in the table), and with unitary reach (i.e., the individual), Equation (6) indicates K-Work (and K-Energy) of 550 P. The worker's time records indicate that just over four hours are invested in articulating the knowledge in explicit form and making it available on the computer network, which corresponds to 15,000 s flow time.

Calculations for the other two flow vectors (X-Y, Y-Z) involve the same 100 knowledge chunks and follow the same logic and procedure. Notice that knowledge is purely explicit (E = 1) for these latter flow segments[3] and that both involve the same reach (10) across the team. In the first of these vectors (X-Y), explicit knowledge flows very quickly (100 s) and simultaneously to all ten people via computer network. In the second (Y-Z), all ten coworkers apply such explicit knowledge directly and in parallel, through actions requiring nearly 17 minutes (1000 s) to complete. K-Work (and K-Energy) is nearly double (i.e., 1000 P) for these purely explicit flows because of the greater reach (10 vs. 1). Summing K-Work (2550 P) and flow time (16,100 s) for the process as a whole, (average) K-Power of 0.16 B obtains from Equation (7).

Table 5 Explicit Path Measurement

Flow	E	KF	R	KW	FT	KP
A-X	0.5	0.55	1	0.55	15.0	
X-Y	1.0	0.10	10	1.00	0.1	
Y-Z	1.0	0.10	10	1.00	1.0	
Sum				2.55	16.1	0.16

Measurements corresponding to the Tacit Path are summarized in Table 6. They involve the same 100 knowledge chunks and follow the same logic and procedure described above. Notice that knowledge for both flow vectors (i.e., A-W, W-Z) comprising this latter process is purely tacit (E = 0). This reflects the kind of interpersonal, iterative, experiential interaction that is associated widely with tacit knowledge sharing. As such, and as above, the system of equations is used to obtain the measurement values in this table for the tacit knowledge flow path, and flow time from coworkers' time records is included.

Notice further that a relatively long time (i.e., roughly 15 hours; FT = 55,000 s) is required for this tacit knowledge to be shared (A-W). This is consistent with the "sticky" nature of such knowledge. Alternatively, once

[3] Although the A-X-Y-Z vectors complete a loop through (tacit) application at Point Z, without incorporating some kind of learning process, the corresponding knowledge remains explicit (accessible by the team at Point N). This differs from the A-W-Z flow vectors, through which knowledge persists in both tacit (the individual at Point A) and explicit (the team at Point W) form.

learned, application of tacit knowledge is comparatively very quick (i.e., FT = 100 s) for the group of coworkers (W-Z).

Table 6 Tacit Path Measurement

Flow	E	KF	R	KW	FT	KP
A-W	0.0	1.0	10	10.0	55.0	
W-Z	0.0	1.0	10	10.0	0.1	
Sum				20.0	55.1	0.36

Comparing measurements for the Explicit and Tacit Path archetypes, K-Work performance through the tacit flow is nearly eight times that of its explicit counterpart (20,000 vs. 2550 P), but flow time is more than three times as long (55,100 vs. 16,100 s). The K-Power metric reveals that the Tacit Path completes the knowledge flow at over double the power level (0.36 vs. 0.16 B) of its Explicit counterpart. Thus, the Explicit Path, leveraging technologic implementations for explicit knowledge sharing, accomplishes substantially less knowledge work—at lower energy levels—in the organization, but the corresponding knowledge flows much more quickly. The opposite applies to the Tacit Path, which relies more on interpersonal interaction than technology for knowledge sharing.

6. Summary

To summarize, because learning plays such a prominent role in new thinking about leadership and humility, it is important to consider the dynamics of knowledge, for learning can be viewed as knowledge moving from where, when and how it is located to where, when and how it is needed. Further, instead of arguing over an exact definition of *knowledge*, we operationalize it instead: knowledge enables action. Moreover, one can think of knowledge in terms of *chunks*, where one chunk can enable the performance of one atomic action, which centers on distinction to address organization needs and goals.

Considering further the dynamics of knowledge, we learn the basics of KFT, which addresses its uniqueness, flow, visualization, pattern and measurement. The key idea is to focus on learning in the organization—

particularly as it applies to leadership with humility—and to examine its constituent knowledge flows.

III. RESEARCH METHOD

We describe the research method in this brief section. In addition to the focused literature review summarized above, we employ comparative analysis to understand humility in Navy leadership better. More specifically, this involves assessing key leadership traits within the NDLAs as well as new traits such as *humility*, which we compare to the material being taught to prepare junior officers for Division Officer leadership (esp. the Division Officer Leadership Course or DIVOLC). This provides the grist for knowledge flow analysis via KFT concepts, tools and techniques.

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IV. RESULTS

We describe the key research findings and results in this section. We begin by recapitulating the NDLAs and comparing them to the DIVOLC material, looking in particular for coverage of current and emerging leadership traits such as *humility*. We follow then with knowledge flow analysis, which leads to recommendations for addressing any shortfalls.

A. CURRENT EMPHASIS AND TRAINING

Here we use the NDLAs as a proxy for current leadership emphasis and the DIVOLC for corresponding training. We summarize each briefly in turn and then examine their correspondence.

1. NDLAs

Recapitulating from above, we repeat the 4x4 matrix presented as Figure 1 above here as Figure 14.

Navy Desired Leader Attributes
Officers

Foundational Elements	O-1 to O-2 *Trusted Leader*	O-3 to O-4 *Motivational Leader*	O-5 to O-6 *Inspirational Leader*	Flag *Visionary Leader*
Core Values	Understands and lives relationship of Oath to Navy Core Values	Instills Navy Core Values in others	Infuses Navy Core Values in command culture	Guardian of Navy Core Values
Moral Character	Personal values consistent with Navy Core Values	Fosters ethical behavior in others	Moral arbiter for the command	Exemplar for the Navy
Judgment	Practices sound judgment; enforces rules, regulations, and procedures	Anticipates requirements and acts independently	Exercises discernment and acts both boldly and prudently	Embraces forward-thinking, strategic perspective
Leadership	Valued team leader Fosters loyalty up and down chain of command	Adaptive leader and team builder Exercises morally responsible, credible leadership	Command leader Embraces authority, responsibility, and accountability of command	Steward of the naval profession of arms Conveys highest standards of the Service with strength, determination, and dignity

Figure 14 Officer NDLAs (adapted from NDLA, 2017)

As noted, this particular matrix is for the Officer Corps. It includes the four foundational elements (i.e. *core values, moral character, judgment,* *leadership*) and four levels of leadership progression (i.e., Trusted Leader, Motivational Leader, Inspirational Leader, Visionary Leader).

Because most naval officers complete the DIVOLC before their first tours aboard ship, the Trusted Leader column applies most directly. Drawing heavily from NDLA (2017), along with Caldwell and Auliveld (2021), the Core Values (i.e., *honor, courage, commitment*) represent the first foundational element listed in the figure. With our focus on the Division Officer level, a trusted leader is expected to comprehend the meaning of the Oath of Office and Core Values and to exhibit them through both personal and professional behavior. Moreover, with Moral Character, such leader is expected to have personal values that align with and reinforce the Core Values. One would expect such officer to exhibit truthful, ethical and principled behavior, along with great military bearing, both on and off duty.

A Trusted Leader should also demonstrate sound judgment, imagination and analytic ability in leading a division. This involves enforcing rules, regulations and procedures, along with managing equipment, personnel and programs. Such Trusted Leader should also be results oriented, who can make good decisions due to skills in hazard awareness and both the assessment and management of risk. One would expect the Division Officer to further display coolness and courage in stressful situations and to place the needs of the team and the Navy above his or her own. Integrity, accountability, initiative and toughness represent important behaviors at this level, and of course he or she must understand the nature and purpose of war.

Finally, the Trusted Leader is expected to exhibit enthusiastic leadership, along with effective time management and planning skills, and to achieve both technical and tactical qualifications in a timely manner. Such leader should also understand the value of taking care of Sailors, exhibiting a strong sense of duty to subordinates, and proactively take responsibility for the welfare and character development of others. He or she is expected further to invest considerable time in Sailors' wellbeing; earning their trust, respect and confidence; and to value the diversity of all team members. Finally, the effective Division Officer needs to inspire commitment in others by developing a sense of ownership in subordinates for the command's mission and its successful accomplishment. This includes fostering loyalty up and down the chain of command, sharpening written and oral communication skills, and actively taking steps to strengthen the chain of command by fostering effective two-way communications as a good listener.

Although *humility* does not appear expressly among the NDLAs, one can argue that it is implied at least. Being a good listener, for instance, could imply some level of humility. Nonetheless, humility does not appear to have a place of major emphasis.

2. Division Officer Leadership Course

Leadership is essential for efficacy as a naval officer. The Navy considers this essential skill to be so important that it mandates a continuum of leadership training at three different levels (MILPERSMAN 1301, 2021): 1) All officers must complete the Division Officer Leadership Course (DIVOLC) prior to or during their first tour following accession training. 2) The Intermediate Leadership Course is required of all officers advancing to Department Head. 3) The Senior Leadership Course is available to all officers promoted to Commander (O5). The Navy Leadership and Ethics Center (NLEC) is responsible for the curricula and both assists with and provides instruction.

The DIVOLC in particular can vary somewhat across Navy communities (e.g., Aviation, Surface Warfare, Supply Corps), but all course instances adhere to the NLEC curriculum as a baseline. This course prepares new officers to lead a division of Sailors aboard ship or elsewhere. Division is generally the lowest level organization led by an officer aboard ship, with multiple divisions reporting to each department, and multiple departments reporting to each command.

The DIVOLC involves one full week of classroom instruction and facilitation. The course equips junior officers with the knowledge to take charge of a division and to begin developing their individual leadership styles. Students complete assigned readings, attend lectures, analyze cases and practice leadership skills that align with the NDLAs and NLDF discussed above. One particular instance of this course (NLECSD, 2021) offers this overview:

The Division Officer Leadership Course is designed to resemble the first tour of a Division Officer. A major instructional theme of the course is teaching a junior officer the importance of building and maintaining an effective work climate while providing positive oversight and management of resources. The Division Officer Leadership Development Program consists of classroom attendance of the Division Officer Leadership Course (DIVOLC). DIVOLC provides junior officers the necessary tools to function as effective leaders at the Division Officer level. Previous completion of the Division Officer Capstone (CIN P-7C-0039) satisfies the requirements for the DIVOLC. The Navy Leader Development Strategy (NLDS) assigns the following outcomes for the average rank of a Division Officer (O-1 to O-2): Understands and lives relationship of Oath to Navy Core Values; Personal values consistent with Navy Core Values; Practices sound judgment; Enforces rules, regulations and procedures; Valued team leader; Fosters loyalty up and down the chain of command. The Navy Leadership Competency Model (NLCM) assigns the following competencies to the Division Officer development program: Accomplishing Mission; Leading People; Leading Change; Working with People; and Resource Stewardship. Students will be applying leadership skill sets based on the content derived from the NLDS and the NLCM.

Table 7 DIVOLC Concentrations (adapted from Caldwell & Auliveld, 2021)

Concentration Area	Course Coverage
Communication	Different means of communication Chain of Command communication Communication pitfalls and best practices Email and face-to-face communication Posted watchbills and schedules Plans of the Day and briefs Consistent leadership and subordinate messages Body language and tone
Moral Character	Ethics in the US Navy Navy Code of Ethics Former SECDEF Mattis' Ethics Memo Ethical principles and moral character Ethics in critical thinking and decision making Ethics case studies
Teamwork	Leading Chief Petty Officer (LCPO) relationship New officer development Wardroom teamwork Kilmann Conflict Modes Peer relationships Teamwork and mission impact

Drawing from recent analysis of the DIVOLC, the course appears to concentrate heavily upon communication, moral character and teamwork (Caldwell & Auliveld, 2021). Several examples of course coverage for each concentration area are summarized in Table 7. As with the NDLAs above, although *humility* does not appear expressly among the DIVOLC, one can argue that it is implied at least. Teamwork, for instance, could imply some level of humility. Nonetheless, humility does not appear to have a place of major emphasis.

3. NDLA-DIVOLC Correspondence

Comparing the NDLAs and DIVOLC, and reconsidering our discussion of *humility* from above, we summarize their correspondence via Table 8.

Table 8 NDLA-DIVOLC Correspondence (adapted from Caldwell & Auliveld, 2021)

Attribute	NDLA	DIVOLC
Core Values	Addressed	
Moral Character	Addressed	Addressed
Judgment	Addressed	
Leadership	Addressed	
Communication		Addressed
Teamwork		Addressed
Humility		

Clearly each of the four NDLA attributes are addressed as shown in the "NDLA" column. Likewise with the three DIVOLC attributes. Notice how *moral character* is addressed by both. Notice moreover how *humility* is addressed by neither. Hence we see an opportunity to update and expand both to address *humility* as part of NewSmart in the Navy.

B. HUMILITY KNOWLEDGE FLOW ANALYSIS

This knowledge flow analysis centers on the DIVOLC as the primary source of explicit leadership knowledge taught to Navy officers at the beginning of their careers, but we first address on the job training (OJT), which represents the primary source of their tacit knowledge, along with any mentoring, coaching or peer assistance they may receive. We first conduct a knowledge flow analysis using the visualization techniques summarized above. We then address *humility* as a topic of knowledge flow.

1. Knowledge Flow Analysis

Here we examine and delineate four knowledge flows: 1) DIVOLC training lessons, 2) DIVOLC curriculum, 3) OJT and 4) Coaching. The first pertains to explicit knowledge associated with each individual lesson learned by students via DIVOLC classroom training. The second represents the accumulation of explicit knowledge associated with all such lessons as taught through the whole DIVOLC curriculum. The third corresponds to tacit knowledge associated with trial and error learning accomplished by each Division Officer while working on the job. The fourth represents tacit knowledge associated with coaching by a more experienced person (e.g., Department Head).

Figure 15 delineates the knowledge flow pattern corresponding to DIVOLC training via classroom instruction. Here one knowledgeable and experienced Instructor (Point A) articulates his or her experience into explicit knowledge that can be shared through the course (Vector A-X). This flow is represented by a relatively thick, dotted, orange vector extending upward out of the tacit plane. This reflects the relatively slow process of articulating experiential knowledge into explicit form, along with the knowledge loss corresponding to such articulation (e.g., similar to the Explicit Path from above).

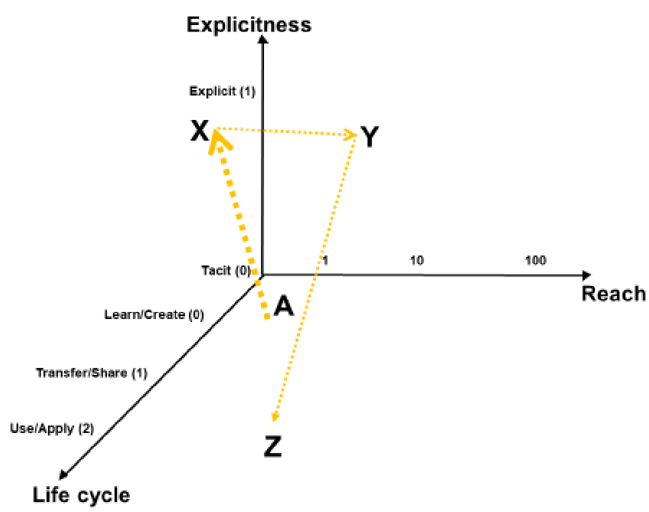

Figure 15 Leadership Knowledge Flow Processes – DIVOLC Lesson

Once articulated in explicit form, the knowledge can be shared with others. Here the Instructor shares explicit leadership knowledge with a group of (30 in this diagram) less experienced students (Vector X-Y), say in the form of course readings, each of which the students can access and then apply through classroom role playing and examinations (Vector Y-Z). Notice that these are depicted as thin, dotted, orange vectors. This reflects knowledge flowing quickly but with attenuated energy as above. Each DIVOLC lesson can be represented in this manner.

Figure 16 delineates the knowledge flow pattern corresponding to DIVOLC training via classroom instruction also. This diagram is nearly identical to its counterpart above: whereas the previous Figure 15 represents each individual DOVOLC lesson, the present Figure 16 represents the whole DIVOLC curriculum. The difference is shown through a thicker vector between Points X and Y.

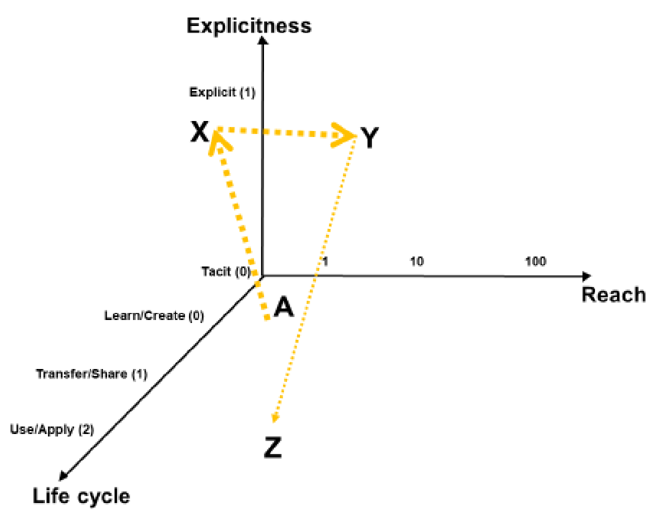

Figure 16 Leadership Knowledge Flow Processes – DIVOLC Curriculum

This reflects the same kind of explicit knowledge being shared with students in the classroom, but the thicker vector indicates a substantially longer amount of time required for all of the course knowledge to flow. The application vector (Y-Z) remains thin, nonetheless, as knowledge can be applied relatively quickly once learned. Such application vector retains the same dotted, orange pattern, however, reflecting the attenuated energy corresponding to such classroom knowledge. Clearly this DIVOLC classroom knowledge flow would be followed by its OJT (and possibly Coaching) counterpart(s) after the students report for duty and become Division Officers (DivOs). In order to avoid clutter, we do not overlay the OJT and coaching diagrams.

Figure 17 delineates the knowledge flow pattern corresponding to OJT. Here one person (Point A) performs in a leadership role and learns from experience. Notice that it is depicted as an oval shape in the tacit plane. This reflects the iterative, experiential aspect of OJT: largely through trial and error, a person applies his or her knowledge and learns through the experience corresponding to each iteration. This flow is represented by a thick, solid, purple, cyclical vector, which indicates that the corresponding OJT process is relatively slow, energetic and iterative.

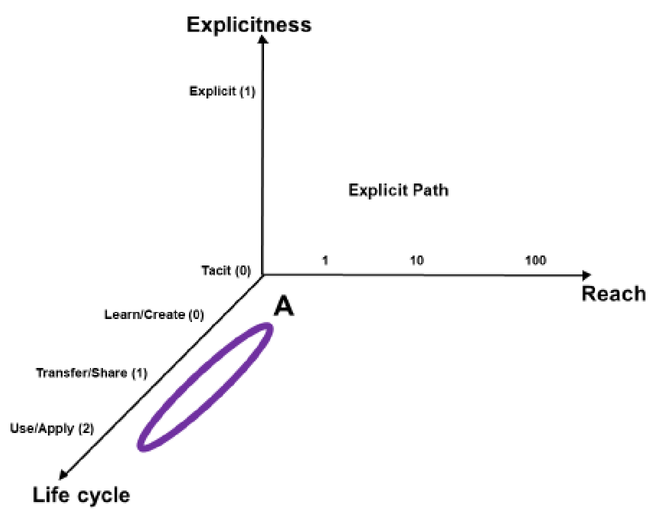

Figure 17 Leadership Knowledge Flow Processes - OJT

Figure 18 delineates the knowledge flow pattern corresponding to coaching. We could also delineate a dyadic pattern to represent mentoring or peer assistance, but the broader reach associated with coaching aligns better with the one to many nature of workplace supervision. Here one knowledgeable and experienced person (Point A) shares knowledge with a group of (10 in this diagram) less experienced people (Vector A-W). Notice that it is depicted as a two headed vector in the tacit plane. This reflects the kind of tacit path delineated via Figure 13 above: each of the multiple (e.g., 10 Division Officers in a Department) people learns from the one leader (e.g., Department Head) in a coaching model.

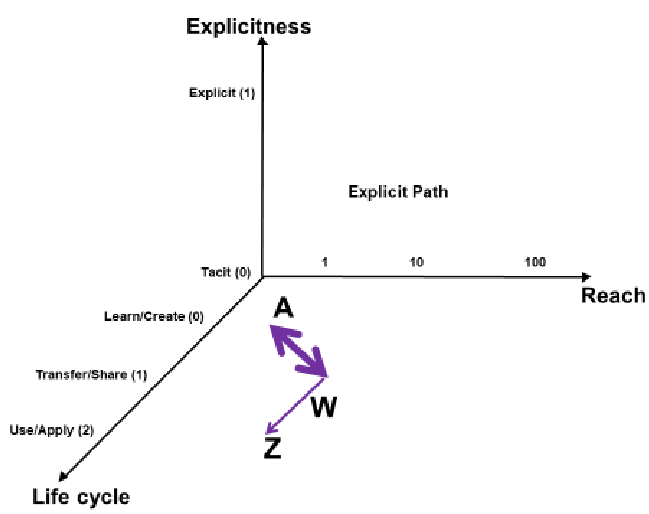

Figure 18 Leadership Knowledge Flow Processes - Coaching

This flow is represented by a thick, solid, purple, double headed vector, which indicates that the corresponding coaching process is relatively slow, energetic and bidirectional: in addition to the DivOs learning from the Coach, the latter can also learn from his or her subordinates (e.g., younger people may have greater social networking and technological skills). Once the DivOs have learned well from their Coach, they can apply such leadership knowledge collectively

(Vector W-Z). Clearly each DivO is learning via OJT also. As above, we do not overlay the OJT and coaching (or DIVOLC) diagrams.

From this analysis, we see how the OJT and Coaching processes are relatively slow but energetic in terms of knowledge flow, whereas knowledge flowing via the DIVOLC lessons proceeds quite quickly, even though the DIVOLC curriculum as a whole requires considerable time to complete.

2. Humility Knowledge Flow

From our discussion above, we understand much about how humility offers good potential to help the Navy prepare its current—but in particular its future—officers to lead in the NewSmart. Some people are born and raised to be humble and helpful, whereas others develop this attitude and trait later in life, many times only after being humbled by Life. Alternatively, other people are born and raised to be arrogant and self-centered, while still others learn arrogance and self-centeredness through work and other pursuits. In either case—but particularly the latter—humility can be learned and taught. Drawing from our analysis above, we address now how humility can be integrated into each of the delineated knowledge flows.

Starting with the DIVOLC and its emphasis on explicit classroom learning, it seems straightforward to integrate into the course one or more lessons on how to practice humility. At this point, *humility* would represent more of a skill to be learned than an attitude or trait, but this is consistent with *leadership*: some people are natural leaders, whereas leadership represents a learned skill for others. Through learning and practice, people can improve their leadership skill, and over time, leadership can become second nature: an attitude and trait.

Thus, the first step is to introduce humility training into the DIVOLC. Indeed, the book discussed above (Hess & Ludwig, 2017) could serve as the text, and this report could serve in conjunction as required reading. It should be up to the academic planners and instructors to develop and implement the specifics, but they may require some humility training first. Perhaps the authors could assist with this.

Moving now to OJT, DivOs will have abundant opportunity to practice humility while leading Divisions, but they should have continued access to humility course content in order to prevent their classroom knowledge from growing stale or even perishing. Online content has become much more readily available, even aboard ships at sea, but many officers—particularly those to whom humility does not come naturally—will require models, incentives and reinforcements for the newly learned skill to transform into attitude and trait. Leaders overseeing the DivOs (esp. Department Heads) represent the most direct and influential source of such models, incentives and reinforcements, but this highlights a dilemma: What if such leaders are not humble? How can we expect someone who is not humble to embrace—much less model, incentivize and reinforce—humility?

The Navy has addressed similar circumstances throughout its existence. Where certain deep seeded attitudes and behaviors become problematic and are deemed to be unacceptable (cf. Tailhook, racial prejudice, religious homophily, nepotism), stand down days, ongoing training, higher level leadership mandates and like techniques have proven—albeit slowly—to be effective. Thus, an emphasis on humility—if it is to diffuse throughout Navy leadership and become both widespread attitude and trait—will likely have to be mandated, modeled, incentivized and reinforced from Top Leadership. The Naval Education and Training Command (NETC) and Navy Personnel Command (OPNAV N1) represent the most likely proponents to convince the highest leadership levels of its importance.

Finally, coaching represents a practice that enables tacit knowledge to flow through organizations. With Top Leadership enforcing humility among its officers, organization leaders at all levels will have an opportunity to see the key role that they can play in terms of promoting and supporting humility in their organizations: model humility and help subordinates to do likewise for people under their charge. We summarize these recommendations in Table 9.

Table 9 Humility Recommendations

Knowledge Flow	Recommendation
DIVOLC	Introduce humility training into the DIVOLC Instructors may require assistance
OJT	Make humility course material available at work Mandate, model, incentivize & reinforce humility
Coaching	Encourage leaders to coach subordinates Use coaching to promote and support humility

V. CONCLUSION

One of Navy's critical efforts is to develop warfighters able to lead their teams using critical problem solving skills while fostering an environment of trust throughout the command. This need has taken on increased urgency with maritime operations become increasingly distributed and as autonomous systems integrate ever more densely into organizations and work processes. To develop trust, effectively manage teams of diverse Sailors, and continue to tackle the challenges of the modern Navy, leaders must be equipped with the leadership skills required to ensure success; and they must attain the corresponding leadership attributes and traits for success. This raises the important question of which leadership attributes are most important in Today's and Tomorrow's Navy, and how the Navy can best select people with and help people to develop them?

The objective of this project is to focus on understanding the elements of *humility* and how they interrelate with, complement and supplant other important leadership traits required for future warfare.

From the literature review on traits for successful leadership, *humility* emerges as an important attribute, in conjunction with emotional intelligence and other factors, especially in the context of organization agility, adaptability and responsiveness becoming more important objectives than efficiency. This leads to four key behaviors: Quieting Ego; Managing Self (one's thinking and emotions); Reflective Listening; and Otherness (emotionally connecting and relating to others).

Building on Knowledge Flow Theory, we understand that humility can be learned and taught, and that it offers good potential to help the Navy prepare its current and future officers to lead in the future warfare environment.

A comparative analysis—of key leadership traits within the Navy Desired Leadership Attributes (NDLAs) and of new traits such as *humility*—focuses on the material taught to prepare junior officers for Division Officer leadership (esp. the Division Officer Leadership Course or DIVOLC). This provides the grist for knowledge flow analysis via KFT concepts, tools and techniques. Indeed, we use the NDLAs as a proxy for current leadership emphasis and the DIVOLC for corresponding training.

Main findings indicate the opportunity to update and expand both to address *humility* as part of future warfare leaders in the Navy. While the NDLAs address core values, moral character, judgment and leadership; and the DIVOLC addresses communication, moral character and teamwork; neither appears to address humility directly.

To provide guidance in the new thinking about leadership and humility, we use a humility knowledge flow analysis to examine and delineate four knowledge flows: 1) DIVOLC training lessons, 2) DIVOLC curriculum, 3) on the job training (OJT) and 4) Coaching.

The analysis results in three recommendations: 1) Introduce humility training into the DIVOLC; course instructors will likely require assistance with this. 2) Division Officers should have continued access to humility course content in order to prevent their classroom knowledge from growing stale or even perishing; humility will likely have to be mandated, modeled, incentivized and reinforced from Top Leadership. 3) Encourage leaders to coach subordinates; such coaching can promote and support humility.

Recommended follow on studies could examine where and how well coaching occurs across the Fleet. Another study could work to assist DIVOLC instructors with integration of humility material into their coursework. This is likely to have the greatest immediate benefit and represent the highest return on investment.

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