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**NDIA FORCEnet STUDY – OVERVIEW OF THE HUMAN
ELEMENT GROUP'S FINDINGS: Implications for C2 and Other
Aspects of NCW**

Christine A.R. MacNulty
President & CEO
Applied Futures, Inc.
2101 Crystal Plaza Arcade, #233
Arlington, VA 22202

John A. Poirier
Director, Program Integration and Outreach
Senior Policy Analyst
Scientific Applications International Corporation
4001 N. Fairfax Drive
Arlington, VA 22203

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Abstract

The National Defense Industrial Association, in a study sponsored by the Deputy Chief of Naval Operations for Warfighting Requirements & Programs and the Commanding General of the Marine Corps Combat Development Command, spent a year investigating the critical technical, programmatic, organizational, and acquisition aspects of FORCEnet in order to develop a road map. One of the five study groups was focused on the Human Element. This paper provides an overview of that subgroup’s findings – covering everything from recruitment, selection, education, training and development of future warriors to changing ways of developing and assessing operational concepts, changing business processes and organizational structures, systems design and experimentation. This paper discusses the transformational aspects of FORCEnet and its contribution to Sea Power 21’s enabling concepts, especially Sea Warrior, Sea Trial and Sea Enterprise, all from the Human Element perspective. Three key themes resulted from this investigation:

- Equip the man, don’t man the equipment
- Humans decide, machines calculate
- We are moving from the human-in-the-loop to the human-*as*-the-loop

FORCEnet: Challenges, Implications & Recommendations

What is FORCEnet? What characteristics make FORCEnet transformational? *What* changes and why are these changes valuable? Answers to these questions are central to realizing FORCEnet’s potential to meet the operational challenges comprising Sea Power 21 – today and into the future. Yet, answering these questions in a network centric

environment requires articulation of a complex set of relationships that cross function, hierarchy, perspectives, time, and space.

The Chief of Naval Operation's definition of FORCEnet is: "...the operational construct and architectural framework for Naval Warfare in the Information Age which integrates Warriors, sensors, networks, command and control, platforms and weapons into a networked, distributed combat force, scalable across a spectrum of conflict from seabed to space and sea to land".

FORCEnet is about enabling the Warfighter – the most significant and important element of FORCEnet – through Network Centric Warfare¹. It is one of the prime means by which the Navy is achieving its transformation to Sea Power 21. Our work in the Human Element Group focused on the implications for Sea Power 21 and its main components: Sea Warrior, Sea Enterprise and Sea Trial.

Challenges Driving Naval Transformation

The nature of current and future military operations is changing. We must dominate in an unprecedented clash of wills involving military and / or non-military, political, economic, social, cultural and religious organizations. We must adapt rapidly, and in novel circumstances to asymmetric threats in asynchronous environments, and with distributed and virtual forces across the full spectrum from war to peace. For most of the 20th Century, the focus has been on the science of war as practiced through the application of primarily technological capabilities. Evolving circumstances require warriors at *all* levels who are adept in both the *art* and the science of war. In a globally connected environment, they will gain and share situation awareness through a melding of human and technological systems. Decision makers at all levels will have unprecedented access to information and the means to tailor it to their preferences. However, in the process, information and knowledge will be filtered through subjective human perceptions that are based on previous experience, values, beliefs and cultures. These perceptions will define both the actions taken and the means and patterns of information exchange and visualization of unfolding events. This is part of the art of war.

The tempo of the operating environment is constantly accelerating and the propagation of second and third order effects in civilian populations will drive operational processes. Rapid decisions will be made increasingly in situations of uncertainty, ambiguity and risk, requiring people capable of assimilating sufficient information to act. At the center of the transformation of the operating environment is the fact that Sailor / Marine performance must be considered an element of system performance – if the warfighter can't do his job, it is a system failure. Measures of performance and effectiveness must be reconsidered. As an example, the "probability of kill" P_{Kill} is no longer a sufficient measure of performance; an emerging notion of "probability of desired outcome" $P_{Outcome}$, especially in effects based operations (EBO), becomes a critical new measure that takes into account human cognitive performance.

¹ NDIA SLAAD Division Study: "FORCEnet, the Naval Component of the GIG" slide 5

Determining and deciding effects is an inherently human process driving, the move away from attrition warfare to effects-based operations. EBO are complex, often occurring in ambiguous and non-linear circumstances that require increased knowledge of potential adversaries, as well as understanding of the capabilities and limitations of one's own forces.

Traditional approaches are increasingly inadequate as we move further into these new forms of operations. The need for changing roles, responsibilities, organizational structures, command and control, competencies and cultures is increasingly evident, particularly in a resource constrained environment that requires Services to leverage capabilities across one another in joint, coalition and interagency environments. Dynamic restructuring in the face of high flux and tempo in operations reveal that flexibility, adaptability and agility are the keys to prevailing in "clashes of will."

FORCEnet is transformational not because it brings new technologies and processes. It is transformational because it provides flexible combinations of forces to enable adaptive action. It enables increasingly rapid linking, dispersing and re-linking of people, platforms, systems, technologies and processes in dynamic "capabilities packages." It is the "glue" linking Sea Strike (projection of power), Sea Shield (projection of defensive and deterrent capabilities), and Sea Basing (projection of naval presence and forward basing independent of national borders). It is enabled through new business processes that empower the warrior and improve access to needed resources, when needed (Sea Enterprise); new approaches to concept development and experimentation to ensure needed capabilities reflect operational needs (Sea Trial); and most importantly through new ways of looking at the future warrior in terms of selection, development and retention (Sea Warrior). The latter also requires a fundamental reassessment of the knowledge, skills, abilities, and function of the human in an intertwined system.

A new notion of "mobilized knowledge," via networked collaboration provides a forcing function that will drive naval operations. It represents a capability to provide timely, relevant access to the information needed to generate knowledge manifested as dynamic shared situation awareness and the ability to act in concert. What we envision is almost a melding of man and machine – one and inseparable – where each plays the part he / it does best.

The properly empowered warrior who is resourceful and willing to take initiative is the key to FORCEnet's success. We envision active command functions with strong, clear, unambiguous commanders' intents that include operational purpose, mission, desired effects, risk considerations and boundaries for tactical behavior. We anticipate that the warriors will be educated and trained individuals selected for their abilities in Network-Centric Warfare, and capable of relevant tactical operational and accomplishments and impacts.

Transformational Capabilities

Implementing Sea Power 21 will require agility in adaptation and appropriate understanding of context, derived from shared situation awareness (SSA) throughout the naval problem space. These become key drivers of FORCEnet conceptualization and assessment.

This means that naval capabilities must be defined in both operational and other contexts. Mission Capabilities Packages (MCPs) emphasize effects in an operational domain, with critical focus on the warfighter. Yet, another capabilities packaging reflecting the human element in its broadest sense is needed to facilitate definition of the MCPs, to provide input to organizational and business process environments and ensure the right force (human, systems, and platforms) is acquired and developed.

The form and function of the human element must be looked at differently. Traditional acquisition and other DOTMLPF² elements have focused largely on *manning* equipment. The new paradigm must incorporate design principles that *equip* the man with more than technology. A common lexicon is also needed that reflects a blended joint/interagency culture.

In this new environment, complexity becomes a necessary evil – both a challenge and a tool. Operational concept development must recognize that the human being is capable of dealing with complexity without articulating all of its underlying components. However, in a network centric environment with the number of nodal interactions exceeding the ability of individuals to assimilate information, “augmented cognition” is required to gain, maintain, and share situation awareness. This involves a range of sensing, collating, visualization, knowledge management, course of action analysis, and decision support tools.

Keeping it simple in this environment requires the ability to embed calculations reflecting defined *contexts* in the technological infrastructure and to embed decision making reflecting poorly defined contexts in the human element. Here the differentiation is between circumstances where clear relationships and decision criteria can be developed and those circumstances that are inherently unclear, yet subject to human ability to apply decision processes that incorporate non-linear elements including experience, emotion, and physical state. An essential factor is also the netted ability to access information from both military and non-military resources and to recognize and deal with cultural variance to assimilate those resources as input to an individual’s cognitive processes. Context management then becomes the focus of activities, tactics, techniques and procedures (TTPs).

Context management at a minimum involves two critical levels: perspectives and processes. The perspectives that must be accommodated are the individual, the group, and a systems level that includes a dynamic blend of human, artificial intelligence, and technological infrastructure. Several processes determine these perspectives: cognitive,

² Doctrine, Organization, Training, Materiel, Leadership, Personnel, Facilities.

collaborative, and integrative. A number of potential relationships may be identified to explore how these perspectives and processes combine and drive decision making in various contexts as represented in Figure 1. Primary relationships are represented with asterisks. Secondary relationships are represented by “+”.

	Cognitive	Collaborative	Integrative
Individual	*		+
Group	+	*	+
Systems	+	+	*

FIGURE 1. Perspective and Process Links.

To articulate the tradespace that FORCEnet must accommodate, the following perspectives and processes may be linked as focal points that ultimately constitute a “Human Capabilities Package” (HCP):

- Individual-Cognitive – addressing issues associated with perception, comprehension, insights, and proficiency
- Group-collaborative – addressing issues associated with organizational structures, types of relationships, cultural dynamics, communications and trust
- Systems-Integrative – producing the “*human-computer warfighter integral*” to achieve augmented cognition with blurred physical/virtual distinctions and semi-autonomous manipulation of operational state to achieve effects.

The human capabilities package may be described as an ontology³ articulating these dimensions and related to mission types that drive cognitive-collaborative-integrative requirements. This further may provide the basis for a taxonomy to decompose the context as it relates to the elements which the human capabilities package affects and is affected by. These would reveal linkages that describe how various organizational and technical systems combine to achieve a desired outcome.

Central to the HCP is recognition that a critical network in FORCEnet is the network of thinking humans connected by technological and other means. In this sense, individuals throughout the naval enterprise are nodes in NCW—thinking nodes that subjectively recognize, interpret, and act upon understanding of their environment (the cognitive pieces) through a combination of their preferences, experience, and contextual recognition. SSA and derived context reflects individual priorities and subjective view of the overall situation, which will differ from each other.

All of the linkages must be addressed to develop an HCP. But to illustrate one set of implications, let us look at the "Individual-Cognitive" link with emphasis on gaining and maintaining situation awareness (SA). SA, to a large degree, is dependent upon an individual’s knowledge of the location and means to access resources needed to obtain it

³ An explicit formal specification of how to represent the objects, concepts and other entities that are assumed to exist in some area of interest and the relationships that hold among them. (source: <http://www.dictionary.com>)

as well as other filters such as experience, emotion, and physical. This in turn requires understanding and deriving implications for decision making. Lastly, individually determined assessment criteria are needed to build confidence in decisions. These are often intuitive and radically different between people. Some of the resources needed include:

- Information,
- Systems from which to draw
- Knowledge of relevant TTPs⁴ and doctrine
- Knowledge of when TTPs and doctrine DO NOT apply
- Trust in information, people, and systems
- Experience / familiarity with others, and many more

These cognitive requirements at the individual level result in significant implications across many areas. Mission needs statement (MNS) and operational requirements documents (ORD) affecting future naval capabilities therefore must include a human element point of view.

Finally, transformation does not mean that traditional conflict goes away; it will likely always constitute the “worst case.” However, Sea Power 21 reflects the need to accommodate asymmetric and asynchronous warfare, increasingly characteristic of high probability encounters. It is also a means to vet and assess the utility of capabilities to meet anticipated and unanticipated operational requirements. In this case, assessment involves at least two dimensions: outcome and process. Outcome should reflect the Sea Strike / Sea Shield / Sea Basing elements with FORCEnet described in terms of its contribution to power projection, force protection, presence and forward basing. Process issues are addressed through the enabling concepts of Sea Trial / Sea Enterprise / Sea Warrior. Here, FORCEnet must include processes, tools, systems, and assessment criteria to develop, understand, and apply operational and other concepts. Among these other concepts are business process aspects of Sea Enterprise as well as the selection, development, and retention issues embedded in Sea Warrior.

FORCEnet Design Principles

Robustness and flexibility in systems design should be the primary focus in all FORCEnet systems and organizational development. Given the complex, high flux, often unarticulated and uncertain future global operational environment that FORCEnet comprises, optimization is neither possible nor desirable. Humans must have an unprecedented ability to access, and combine, information and other resources to meet novel requirements in their own way.

⁴ Tactics, Techniques and Procedures

Situation Awareness is not a picture, it is a cognitive state. Visualization, decision support, and information exchange systems must provide the ability for individuals to tailor information in the way(s) they choose. At the same time SSA requires a common set of anchors to ensure different perspectives are appropriately linked and expanded upon.

Tools are needed that provide models (Capabilities and Maturity Model(CMM)-like) as a common frame of reference to determine which measures / metrics of performance / effectiveness are relevant at a given time. Assessment measures and metrics are critically dependent upon knowledge of own roles / responsibilities, others roles / responsibilities, trends in the operational space, and adaptability to changing circumstance.

Human nodes are irrelevant in NCW if they are not connected and working towards a common purpose with different individual contributions. Therefore the human network is the organizational structure and shared awareness is the object upon which collaboration is based. Knowledge management as instantiated in purely technology based systems and databases is insufficient.

Organizational structures in NCW must be dynamic in response to broader context and changing circumstances in a distributed environment. The span of interaction includes numerous human organizational "systems" as well as supporting technological infrastructure representing a range of technical systems. Operational outcome is determined by the ability of these systems to integrate to provide the right resources as determined by the individual in group-collaborative context.

The Human Capabilities Package is the combination of these elements applied in specific mission focused circumstances. Understanding and putting together human capabilities packages has great implications for individual development, formal/informal organizational function, and cultural dynamics in each of, and across, the services.

Major Recommendations

Sea Warrior

Future warriors will need new knowledge, skills and abilities to deal with complexity, to operate in distributed, networked organizations, and to succeed in effects based operations. They will need to be able to lead, fight and innovate in this new environment. We must select, train and continuously educate our warriors to ensure that they have the understanding and resourcefulness to carry out their commander's intent in a way that is appropriate, and which draws on both military and non-military resources. This will require establishing criteria for selection, development and adaptation of individuals capable of operating in complex adaptive environments. These in turn will determine a range of cultural, educational, training, and career progression factors. Many people are thinking that the young people of today will be better able to operate in this

highly technology-oriented world than those of previous generations – to some degree that may be the case. But we should not ignore older people with great experience and expertise, who can be called upon as the situation arises. It may be useful to have a cadre of such older people available through the Reserves, for instance, or via some means of reachback.

We will need to provide the physical and virtual infrastructure to mobilize knowledge, to ensure that everyone has access to information and knowledge as needed, and access to education and training, through distance learning, virtual tutors, embedded training and, especially, through tailored programs and delivery. There is much research going on into multiple intelligences, accelerated learning and other approaches to ensure that the individual learns as speedily and effectively as possible. Augmented cognition and other new developments will provide improved capabilities for absorbing information and knowledge, whether in school or in the battlespace.

Finally, we see “human capability packages” involving combinations of individuals, groups and technology systems being developed to provide rapid response to changing circumstances, as described in an earlier section.

Sea Enterprise

Perhaps the most critical recommendation, in our view, is to co-evolve the human, organizational and technological elements of FORCENet in an intertwined process right from the start. This means that whenever a new system or technology is conceived, that conception includes human and organizational aspects. The US Navy’s Manning Affordability program has determined that 40-60% of lifecycle costs for current systems result from not having including human performance and human systems integration issues at the beginning of the systems engineering process. For instance, training and instructional systems development on any new system should begin as soon as the system is conceived. We will need to define the organizational, technological and systems relationships whenever anything new is introduced, so that we keep the understanding of the total system capabilities as the most strategic level for that total system. This intertwined concept has some significant implications for both acquisition and budgeting.

Naval-Government-Industry partnerships should be established aggressively to pursue the development of particular FORCENet initiatives, such as: performance-based training for FORCENet / Sea Power 21 that would involve new IT environments for teaching and learning; for design of distributed systems, and to determine how to achieve tactical, operational and strategic effects in complex operations.

Finally, we would like to see each Battle Group Commander provided with a budget, incentives and intra-deployment time (as regional operations allow) to experiment, to be innovative, not just with technology, but with new ways of doing things and new organizational structures. They would then provide feedback on the human,

organizational and technology experiments / innovations to the next Battle Group in the D-30 process⁵ (or similar).

Sea Trial

The most critical recommendation here is to link the Sea Warrior efforts to Sea Enterprise and Sea Trial in a higher-order, co-evolutionary development process, similar to that which we described for Sea Enterprise itself. Human performance, in particular, should be part of performance evaluation in every experiment and exercise. This means that it is imperative to develop measures of human proficiency and performance in complex, distributed networked environments. We would also recommend that seasoned warfighters vet new capabilities for operational utility – especially in the D-30 context.

There is a wide range of experiments that should be conducted, including warfighter visualization, decision-support, course of action analysis and other tools and procedures, especially at the tactical level. We should conceptualize, experiment with and evaluate TTP⁶s involving innovative use of “human capability packages”. We should experiment with adaptive C2 processes in a disciplined manner, while developing and validating new metrics. We should evaluate processes, drivers and impediments that affect the ability of warriors to re-configure and adapt – individually, organizationally, and technologically. In addition, we should test and evaluate aggressively all the enhanced new, human-oriented proposals in Fleet Battle Experiments, exercises, R&D institutions and education incubators.

The last major recommendation for Sea Trial, and perhaps the most controversial, is to designate and resource an experimental and deployable Battle Group, so that it could develop Doctrine and TTP “on the run”, but within legal and safety bounds. With the decrease in total number of ships in the Navy, this is unlikely, but this kind of thing has been done before by a Destroyer Squadron, and a similar experiment is being conducted by the Army’s 1st Digitized Division.

General Recommendations

Develop doctrine to empower, but guide informal organization functions in distributed, virtual environments. This will include articulation of the terms of appropriate commanders’ intents, TTPs, ROEs⁷ and tactical / organizational behaviors in FORCEnet system and operation. We shall need to ensure that there are formal organizational structures to provide operational underpinnings. While there has been much discussion of new organizational structures, hierarchies are clearly the most effective and, in the Armed Forces, are likely to be here to stay for the foreseeable future. However, within and between those hierarchies, we should define very clear policies and guidelines for

⁵ (Deployment time minus 30 months) has been established as a timeframe for installation of new capabilities and refitting of naval vessels.

⁶ Tactics, Techniques and Procedures

⁷ Rules of Engagement

effective cross-functional organizational relationships⁸. These will enable the articulation of appropriate methods and circumstances of coordinating across permeable organization boundaries, and the adaptive shifting of roles and resources. Our view is that the warriors “on the deckplates / ground” should determine and evolve the appropriate organizational structure to meet unplanned situations and unfamiliar contexts. They should also be permitted to innovate and develop new methods “on the fly” during actual operations. This may result in emergent, ad hoc and forming / dispersing informal organizations and functions, and it will certainly require new leadership approaches.

In all of this new form of warfare, we should develop, provide and expect flexible tools and environments. Individuals should be able to engage in effects-oriented collaboration using novel means of their choosing with a broad range of resources. This means that we should not specify the blend of process, technology or organization, but should let it emerge. “Bloatware” – providing a basket of tools from which to select the appropriate ones – might be a useful approach, although not one favored by the acquisition community. And another approach – also a controversial one – might be to drive accountability for acquisition support to the user level to ensure prioritization in resource constrained environments. We saw an excellent example of this during a recent, large scale experiment, Millennium Challenge 02, where the Special Operations Command element of the Joint Forces Command (SOC JFCOM) developed its own effective, highly customized web portal for a tiny fraction of the cost proposed by major contractors.

It has been stated that the warrior is 50% of FORCENet. We have seen clearly that we shall need individuals with very specific knowledge, skills and capabilities who will need to be recruited, selected, trained and educated throughout their careers. This suggests that now might be the time to develop a comprehensive FORCENet human resource strategy through Sea Warrior and Sea Enterprise. Such a strategy would involve integrating recruitment, selection, assignment, education, training and career development activities and organizations. We would need to attract individuals with the natural inclination and ability to operate in complex environments, to develop a range of new skills and types of relationships, and then develop them to meet the evolving warfighting requirements. This would require the evolution of the existing selection, training and education processes to meet the new FORCENet challenges. It will also require a new personnel incentive structure that reflects the changing requirements of these people. One thought in this direction is to reward innovation in some way, for instance, perhaps by offering a prize, or by having a special CNO’s list of innovators.

Many of these recommendations are for the longer term, and will require significant changes to the structure of the Naval Service, if they are to be realized. However, our “bottom line” for FORCENet for the shorter term are as follows:

⁸ Elliott Jaques in *Requisite Organization*, Cason Hall, 1989, 1998, has identified such relationships for industry. It may be possible to develop a “militarized” version of these.

Bottom Line Recommendations

Equip the man – don't man the equipment / Humans decide – machines calculate

- Equip the man with more than technology – empowered sense-making and decision-making, flexible organizational structures, new paradigms regarding complexity and distributed collaboration
- Co-evolve the human, organizational and technological elements in an intertwined development process
- Design for robustness and adaptability, rethink optimization criteria
- Identify leveraging points among others doing similar things, including other Services, Agencies, Academe and Industry
- Enable both formal and informal organization structures to emerge, function and disperse in the most appropriate form needed for a given situation or stage in the operation
- Maximize the use of machines for fast, complex calculations in order to free up people for making higher order decisions
- Articulate a commonly understood trade space among technology, people, doctrine, training and education
- Prepare the man – via equipment, education, TTP...etc. – with the ability rapidly to generate and share knowledge from the increasingly available data and information
- Ensure consideration of complexity, properties of distributed networks, and the propagation of second order effects