Lightening the Information Load

Naval Research Advisory Committee

30 Aug 2012

Leveraging Information Technology to Enhance the Marine

"Critical Information in Context"

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Terms of Reference (TOR)

- **Objective:**

  Assess the *information requirements at all echelons* in modern-day battlespace, evaluate the current level of effectiveness and efficiency being attained, and *recommend technological directions* for optimizing the delivery and assimilation of available *information to/from the warfighter*. While emphasis will be placed squarely on the Marine in the battlespace, the essential connection of Marine Corps fighting elements to supporting Naval forces afloat and in the air will be addressed as well.

- **Specific Taskings:**
  - ***Frame the information requirements of each echelon* in the battlespace, and establish the shortfalls in availability, access, and presentation of essential information at all levels.**
  - **Review any relevant human factors studies related to the ease of assimilation (by the human intellect) of information provided through technology available today and projected into the future.**
  - ***Identify and evaluate Naval S&T initiatives* as well as the direction *of commercial development* in guided information search/discovery/filtering that are being or could be pursued to optimize the information form and flow to the warfighter. Consideration must be given to speed of delivery and ease of assimilation, including the flexibility and adaptability of information presentation to suit a variety of individual recipients.**
  - **Finally, *recommend the direction of S&T* to support the needs of *future warfighters* as they engage more diverse forces than ever before imagined in the air, on the ground, at sea, and in cyberspace.**

Who We Met With

Key Take-Aways

1. Exponential IT and sensor growth *can enable* greater Marine effectiveness
2. Humans are *better than computers* at pattern recognition & decisions in high ambiguity environments
3. Computers are *better than humans* at filtering big data and tracking details
4. Future *end user devices can provide real-time* critical information in context to the individual Marine
5. IT systems can supply *critical information in context* even in the face of rapid situation changes and *intelligent adversaries*
6. User-centered *design is difficult, but essential*
7. Horizontal IT – *cloud-architectures* - and powerful *end-user devices* are key to supplying info in context
8. Designing for info in context requires *information architecture* and agile application acquisition (which DoD 5000 policy supports)

Presentation Flow

- Current State
- Future Environment
- Critical Information in Context
- Guiding Principles
- Findings & Recommendations

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Current State

Based on more than 10 years of operations in Southwest Asia

- **Forward Operating Bases (High bandwidth; intermittent availability)**
- **Marines as sensors**
  - **Collection & Reporting is labor- and bandwidth-intensive**
  - **Feedback to the collectors is not timely, and reason for RFIs not understood**
  - **Information overload especially pronounced at Battalion & Company levels**

We found persistent questions regarding the *priority*, *value* and *timeliness* of RFIs

Information Across Echelons

MEF Division	Insatiable requests for information from above (including ISAF)
Regiment Battalion Company	Overloaded by higher HQ RFIs, lots of powerpoint-based reports requiring data from large servers; they get and synthesize significant info from below; pattern analysis across a large battle space
Platoon	Little info flows downhill; High density of disparate systems that require extensive training; some reliance on commercial products (e.g., Garmins, Ipads, Google Maps, etc.)
Squad	Protected from higher HQ info request. Didn't necessarily get a lot of info and hence didn't expect it. Primarily worked voice.

We observed the problem is NOT too much information delivered to company and below, but rather complex reporting requirements imposed by higher echelons ("insatiable"; "feed the beast")

Current State Observations

- **Specific issues with reporting requirements:**
  - **Unstructured data formats (PowerPoint, email, …)**
  - **Reporting system requirements & procedures were developed with little input from tactical units**
  - **Inconsistent network architectures (SIPRNET, CENTRIX, email)**
  - **Equipment is NOT a system, and is expensive to support**
- **Other observations**
  - **Information Management Officers (IMOs) not well prepared**
  - **Information Exchange Requirements (IER) good but not sufficient**
  - **Little significant involvement of lower echelon Marines in the development cycle**
  - **Information Systems Architecture has been focus but not Information Architecture**

Capabilities Development and Implementation

- **MCWL Comprehensive Long Range Plan through FY17:**
  - Experimentation
  - Wargaming
  - Modeling & Simulation

  } Informed by concept development activities
  - Enhanced MAGTF Operations through FY14; Future Maritime Operations FY15 – FY17
- **Requires:**
  - Realistic environments
  - Red Teams
  - New technologies (e.g., ONR, Army, commercial)

Experimentation can support the development of future information systems capabilities

S&T Investment

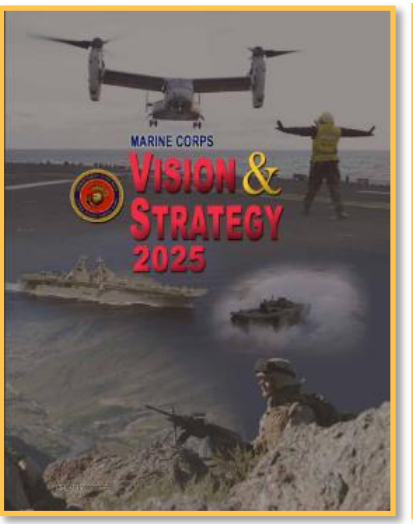
- ONR IT investment strategy generally well conceived to leverage much larger commercial and Army IT initiatives
- ONR funding excellent work in human-machine integration
- ONR IT investments and human factors investments insufficiently coordinated to achieve the appropriate user-centered design

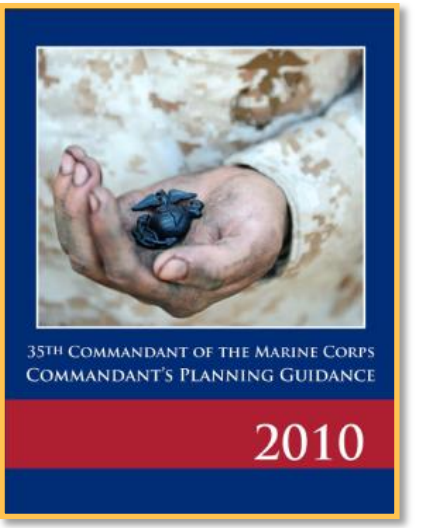
The Future Environment

Force Implications for 2025

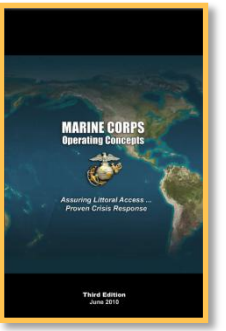
"To remain the Nation's force in readiness, the Marine Corps must continuously innovate. This requires that we look across the entire institution and identify areas that need improvement and effect positive change."

-Marine Corps Vision and Strategy 2025
-Commandant's Planning Guidance 2010





21st Century Marine Corps



Marine Corps Operating Concepts: Third Edition

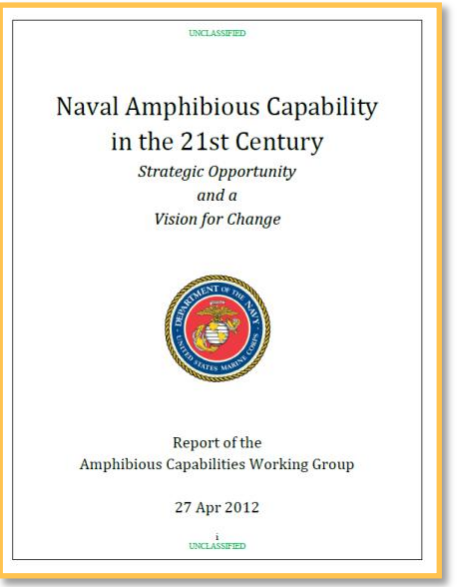
- **USMC Core Missions**
  - Military Engagement
  - Crisis Response
  - Power Projection
  - Small wars

- **USMC Operating Concepts**
  - Mission Command and Enhanced MAGTF Ops
  - USMC flexibility and effectiveness across the ROMO

Single Naval Battle

- **Marines at the edge**
  - **High value complex tasks**
  - **Decision making with high ambiguity**
- **Integration with the Navy will be key**
- **Applications on mobile devices will be the primary interface between the information and the Marine**

  Designed:
  - **to support critical information in context**
  - **to support expeditionary operations with intermittent connectivity**
  - **minimize information/bits transported**
  - **for human cognition**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Naval Amphibious Capability in the 21st Century

Strategic Opportunity and a Vision for Change

Report of the Amphibious Capabilities Working Group

27 Apr 2012

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Design information systems to support the forward Marine

Intelligent Adversary

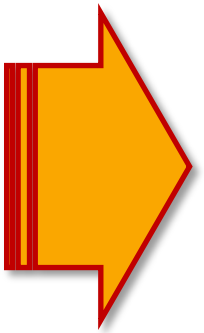
- Electronic opposition to sensors, networks, GPS
  - Cyber attack
  - Signal exploitation
  - Jamming
  - Electronic attack
  - Electronic decoys & deception
- Information systems need to identify and develop near real-time counters to evolving electronic threats
  - Rapid identification of emerging electronic threats
  - Agile systems architectures
  - Rapid system upgrade cycles
  - Graceful system degradation in presence of countermeasures
  - Integration of offensive & defensive electronic countermeasures

Preparation for the Electronic Battlefield was not a focus of this study

Information Technology Trends

From

- Technology-centered design
- Managed innovation, largely DoD driven
- Information stored on privately-controlled local "silos"
- Securing transport
- Information scarcity



To

- User-centered design
- Open innovation, rapid iteration, commercially driven
- Information stored in ubiquitous infrastructure ("the cloud")
- Securing data elements
- Information abundance

Designing for Humans is Complex

- Most information systems are poorly designed for humans
- There is huge leverage in good user-centered design: Apple has excelled by addressing the challenge of designing for users
- Challenges
  - Large variations in how humans understand information
  - Mental capability varies by stress, competing activities
  - Information addiction – desire for unnecessary information
  - Propensity to trust and/or not-trust automated information systems
  - Erosion of skills and "common sense"
- Large body of untapped research addressing designs for human effectiveness
- Combat operations are more complex than most human activity

User-centered design facilitates accurately and timely decisions

Human – Machine Synergy

Human

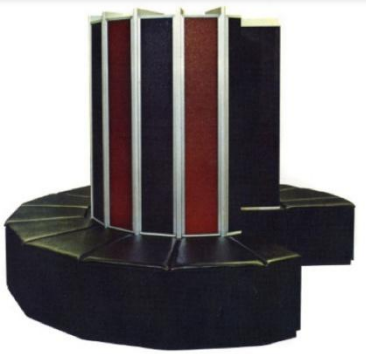
- Human brain slowly evolving
- Big picture
- Superior pattern recognition
- Good at decision-making in ambiguous, complex, high-risk mission environments
- Can make use of fused computer information to overcome ambiguity
- Endurance limited

Machine

- Capability growing exponentially
- Handles detail
- Limited pattern recognition
- Limited, rule-based decision-making
- Can fuse and merge data to support human operations
- Can operate on large data sets, doing tedious tasks
  - Repeatable & consistent

Era of The End-User App

- End-user-device capability will continue to grow exponentially
- Recruits will enter with info-tech knowledge and a smart phone
- Default interoperability and "there is an app for that" enabled by horizontal cloud architectures (platform as a service)



CRAY-1 Supercomputer; 1979

- 100MFLOPS
- $29M (2012 equivalent)
- 11,000 pounds w Freon Cooling
- 8 MB RAM
- 32 GB storage
- 230 KW of Power
- Fastest in the world then

Common smartphone; 2012

- 100 MFLOPS
- $600
- 0.25 pounds
- 1000 MB RAM
- 64GB storage
- 21 hr talk time on one battery charge
- GPS, 8 M camera, HD video, 3 radios

Need For Agility

- **Some trends – like ever-increasing processing power – are predictable**
- **But other trends – like the evolution of networking infrastructures and applications – are largely unpredictable**
- **Threat technologies will also continue to evolve in response to our innovations**
- **Agile development involving end users is required to exploit advances in capabilities while remaining ahead of potential adversaries**

Key attributes of applications: *agility* and *adaptation*

Information & Technology Imperatives

Deliver critical information in context

- Environment that tolerates Reduced Bandwidth & Intermittent Connectivity
- Technology permitting staff to focus on analysis to support the forward Marine
- Applications tailored to support the forward Marine

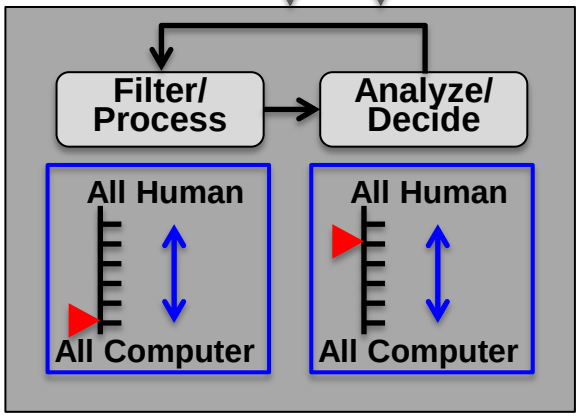
Critical Information in Context

- **Marines are always the most valuable combat-system element**
- **Vast amounts of "relevant information" have *no decision value***
- **It is critical to ensure that Marines are supplied with high-value information *in context***
- **Computers should filter out low-value information and forward only high-value information**
  - **Information that doesn't *reduce human uncertainty* has low-value**
  - **Information that *challenges human assumptions*, especially operational plans, has high-value**

The value of information can only be determined in context, which is highly situational, dynamic, and temporal

Information in Context to the Marine

Sensors, HUMINT, SIGINT, Open Source, …



- Big Data
- Analysis & support tools (e.g., Palantir)
- NSA Cloud architecture
- DoD and commercial infrastructure

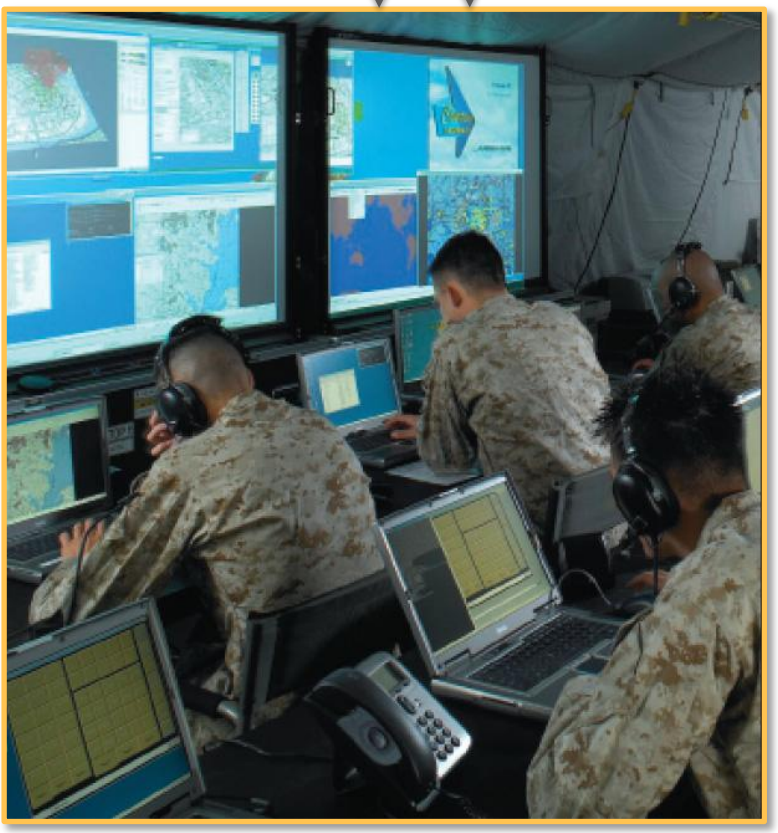
Significant ongoing development

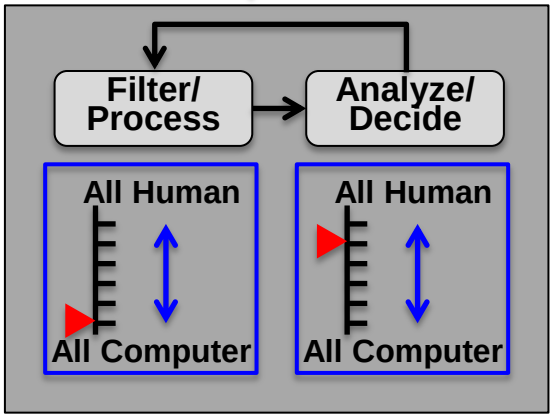
MIL SPEC 810G certified

Short bursts of information to reduce uncertainty

COC Support to the Edge

Sensors, HUMINT, SIGINT, Open Source, …

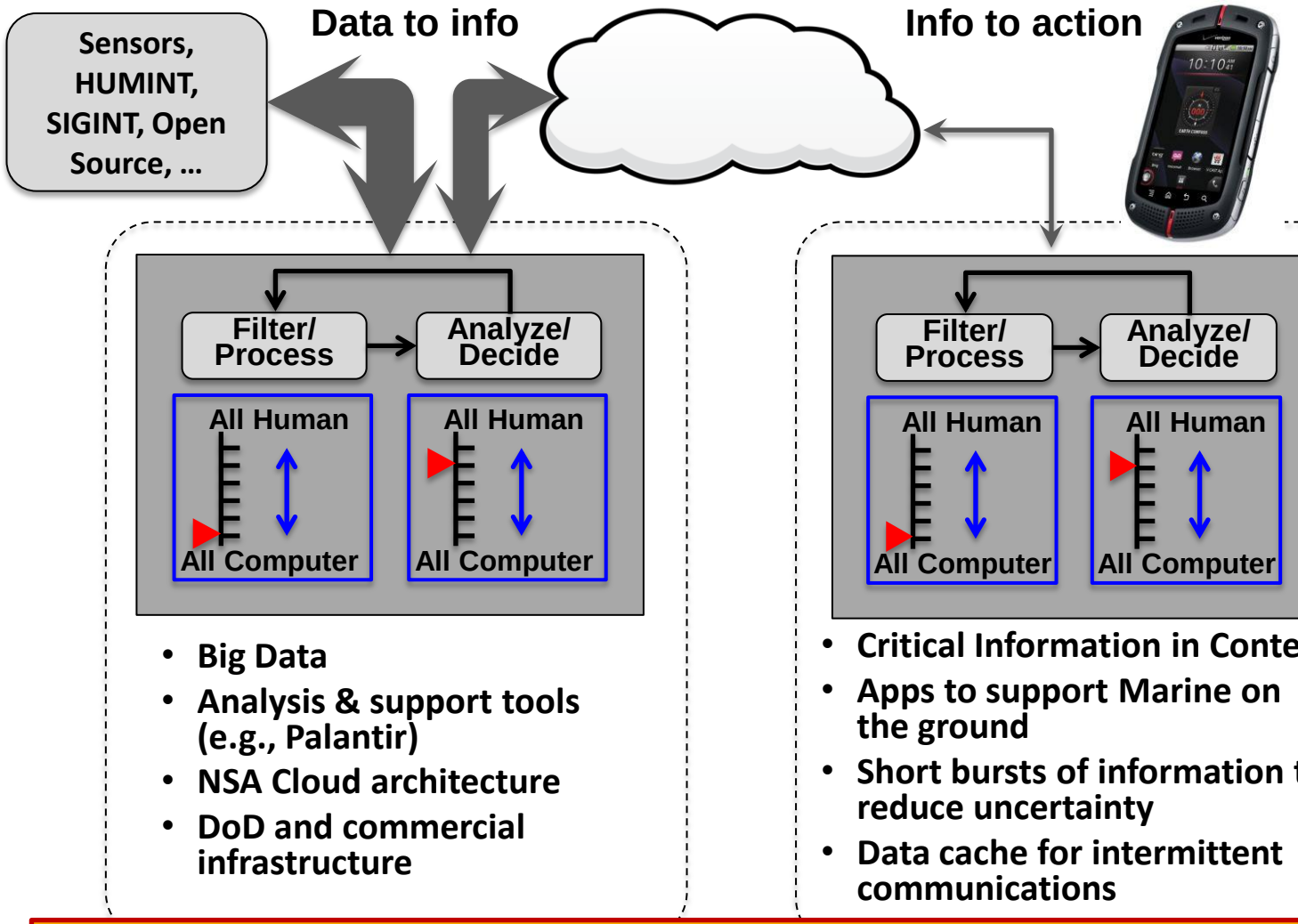




- Critical Information in Context
- Apps to support Marine on the ground
- Short bursts of information to reduce uncertainty
- Data cache for intermittent communications

Little to no ongoing development

Lightening the Information Load



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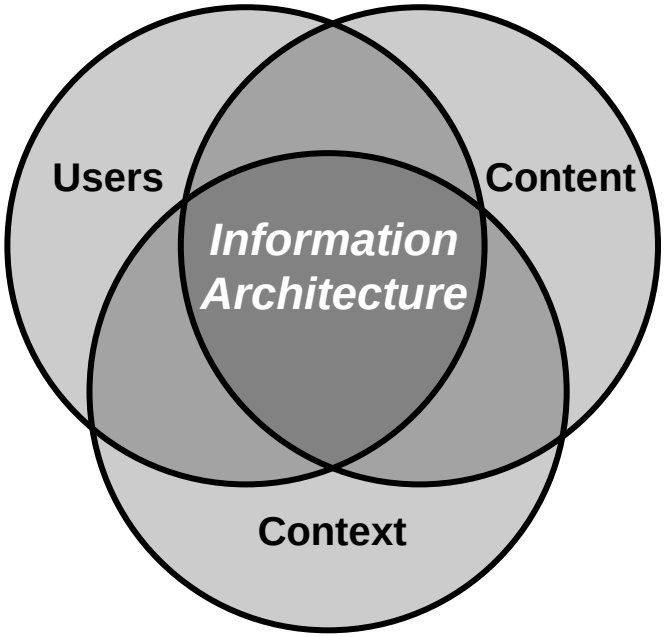
The data, core processing & end-user apps will be a critical future warfare discriminator

Designing for "Critical Information in Context"

Users
+
Content
+
Context
=
Information Architecture



Users

Who are they, what are their information seeking behaviors and needs

Content

Volume, formats, metadata, structure, organization

Context

Mission model, mission value, politics, culture, resources and constraints

Information Architecture is NOT Information Systems Architecture

Acquisition Policy Not a Barrier

> **"…the Program Manager (PM) and the MDA shall exercise discretion and prudent business judgment to structure a tailored, responsive, and innovative program."**
>
> ***DoDI 5000.02, December 8, 2008, Defense System Acquisition Management***

- **Acquisition practices have historically *not been tailored* to address applications riding modern horizontal infrastructures (e.g., CANES in Navy)**
- **"Software only" application programs constrained by long 3-6 year acquisition timelines are *outdated when deployed***
- **Agile application developments with *user participation can* deliver effective upgrades in six month delivery cycles**
- **DoD *5000 does not preclude* such rapid delivery cycles**

Guiding Principles

- ***Use technology to Enhance Human Cognition*** **in the Battle space – "Use humans for what humans are good at; use machines for what machines are good at"**
- ***Plan for the future state of information technology*** **with flexibility for adaptation**
- ***Define Information Architecture*** **(critical information) first; before investing in better information transport infrastructure - (the right information architecture may actually reduce bandwidth requirements)**
- ***Treat the IT platform as a fungible asset*** **(hardware up through operating system is independent of the applications that run on it)**
- ***Use commercial developments in the area of human systems integration*** **– "ride the wave" while continuing to leverage the efforts of other services and Naval S&T**
- ***Iteratively adapt the application to the mission and user*** **(e.g., by use of apps)**
- ***Make effective use of lower echelons of the force*** **in development or testing of new information technology applications**

Finding 1: Information Architecture

Finding:

1. Marine Corps Information systems investments are not driven by an Information Architecture

Recommendations:

1-A. USMC should build on existing MAGTF C2 Information Exchange Requirements to establish a baseline definition of critical information at each echelon within the MAGTF and use the result to drive future plans for information systems acquisitions

1-B. USMC should establish a process to iterate on critical information in context, one that evolves as new sensors, communications links, tactical concepts and organizational constructs are introduced

1-C. Operating Forces Marines should be primary participants in information architecture design. This should not be a contractor-led activity

Finding 2: Concept Based Experimentation

Finding:

2. USMC has not been using concept-based experimentation in development of an Information Architecture

Recommendations:

2-A. USMC should integrate modeling and simulation, technology war gaming, intelligence analysis, and field experimentation to promote innovation in the development of a future MAGTF Information Architecture

2-B. USMC should develop a participatory design process built on iterative experimentation (e.g., using existing MCWL assets). Iterative interaction between the developer and operating forces is key

Finding 3: User-Centered Design

Finding:

3-a. Marine Corps IT infrastructure Investments do not currently make effective use of commercial user-centered design developments

3-b. ONR is supporting excellent work in Information Technology and Human Factors but these often are separate activities that are not well coordinated with each other

Recommendations:

3-A. USMC should designate a small group to experiment continually with current commercial IT offerings specific to user-centered design to see how force effectiveness can be improved quickly and incrementally

3-B. VCNR (CG MCWL) should facilitate improved coordination between ONR's Information Technology and Human Factors research with enhanced user-centered design and improved human cognition as the goals

Finding 4: Agility within Acquisitions

Finding:

4-a. IT infrastructure is becoming a fungible commodity

4-b. Current DoD 5000 flexible acquisition regulations allow agile development and procurement of low cost applications

Recommendations:

4-A. USMC should structure IT acquisition contracts to specify that commodity products are current at time of delivery (i.e., not specified at contract award)

4-B. USMC should develop and manage their own information needs and thus their own apps

4-C. USMC should reduce time and cost for application acquisition by tailoring its use of the DoD 5000 process to support rapid and continuous capability development in IT (goal should be six month cycles or less)

Finding 5: Information Management

Finding:

5. USMC lacks in-house professional military cadre with specific responsibility for information management across echelons (a collateral duty)

Recommendations:

5-A. USMC should establish a trained information management professional cadre – e.g., consider establishing a primary or secondary MOS as Information Management Officer with specified education/training to qualify

Key Take-Aways

1. Exponential IT and sensor growth *can enable* greater Marine effectiveness
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