Section 3

PEO LS FUTURES

> *"We must innovate and adapt to a fast, unpredictable moving future to remain ahead of our adversaries."*
> **—LtGen Robert S. Walsh, Force Development Strategic Plan 2015**

The Marine Corps vision, in part, is focused on **capitalizing on innovation, experimentation and technology to accomplish its mission**. The 2015 Force Development Strategic Plan states that the **Marine Corps must innovate and adapt to a fast, unpredictable moving future to remain ahead of our adversaries**. Both of these statements demonstrate the Marine Corps' desire to innovate and to be technologically ahead of its adversaries and competitors. To do this, the Marine Corps has to innovate across the range of military operations (ROMO) and the full spectrum of domain capabilities, to include maritime, land, air, space and cyber, along with the human domain.

PEO LS uses technology investment focus areas to concentrate resources on the critical needs of warfighters. By identifying these focus areas in the ATIP, PEO LS has been able to align available resources within the Naval Research Enterprise, address the warfighter's needs expeditiously, and ultimately transition technologies into programs of record in a timely manner.

These focus areas serve as the primary means for identifying critical technology enablers and resolving critical capability challenges. They also incorporate natural supporting technologies that align to PEO LS programs such as fuel efficiency, intelligent power and thermal management, autonomy, corrosion resistance, crew visibility, fuel containment and fire suppression, safety, and weight reduction.

The PEO LS S&T Directorate monitors Marine Corps, Navy, other Service, and Joint efforts in the areas of futures assessment, concept development and innovation to articulate the potential impacts and influences across the PEO LS portfolio. This process supports the identification and prioritization of the PEO LS Top Program Issues and associated technology needs to inform, influence, and align S&T investment.

Two recent guidance documents have proven to be especially impactful in this effort. In November 2014, the Secretary of Defense published the Defense Innovation Initiative, which included guidance "to pursue innovative ways to sustain and advance our military superiority for the 21st century and improve business operations throughout the Department." Using references to advancements in stealth, networked precision strike, and surveillance in the 1970s and 1980s, he directed the identification of a "third offset strategy that puts the competitive advantage firmly in the hands of American power projection over the coming decades." The Secretary of Defense further noted his intention for innovation to be accelerated throughout the Department in several linked areas, to include new operational concepts for employing resources to greater strategic effect and for addressing emerging threats in more innovative ways. He proposed a new long-range research and development planning program to identify, develop and field breakthrough technologies and systems that will sustain and advance our military capabilities.

He also offered a reinvigorated wargaming effort to develop and test alternative ways of assessing the future security environment and achieving our strategic objectives.

The Secretary's Defense Innovation Initiative memo was followed up in February 2015 by a Deputy Secretary of Defense memo addressing the subject of "Wargaming and Innovation." The Deputy directed that, "To most effectively pursue an innovative third offset strategy, avoid operational and technological surprise, and make the best use of our limited resources, we need to reinvigorate, institutionalize, and systematize wargaming across the Department."

PEO LS is pursuing the goals outlined in these two important directives as part of its Concept-to-Capability approach. This approach is executed in conjunction with the Deputy Commandant for Combat Development and Integration, Marine Corps Warfighting Laboratory/Futures Directorate (MCWL/FD) and the Capabilities Development Directorate (CDD). Ultimately this collaboration is conducted within the overarching Planning Programming, Budget and Execution and Service force development processes. The PEO LS approach also has benefitted from the series of recently conducted wargames designed to examine aspects of the Marine Corps' new Expeditionary Force 21 (EF 21) capstone concept, to include the Ground Warrior 2015 and Expeditionary Advanced Base Operations 2015 wargames. PEO LS's Concept-to-Capability approach, depicted in Figure 2-1 in section 2 (S&T Collaboration and Engagement), provides a validated, repeatable process for addressing an uncertain future within the context of the Service's current force development system—the Marine Corps Capabilities Based Assessment (MC CBA). Future risks are mitigated by selecting well-researched areas of focused investment based on technical issues that share common warfighting connections to multiple programs within the PEO. Focusing S&T funding on these key areas enables the Marine Corps to maximize its Return on Investment (ROI) and to better prepare for the future.

The Concept to Capability process outlined in this plan is initiated by the Combat Developer, specifically by DC CD&I's MCWL/FD, depicted in Figure 3-1. PEO LS engages with the MCWL/FD to

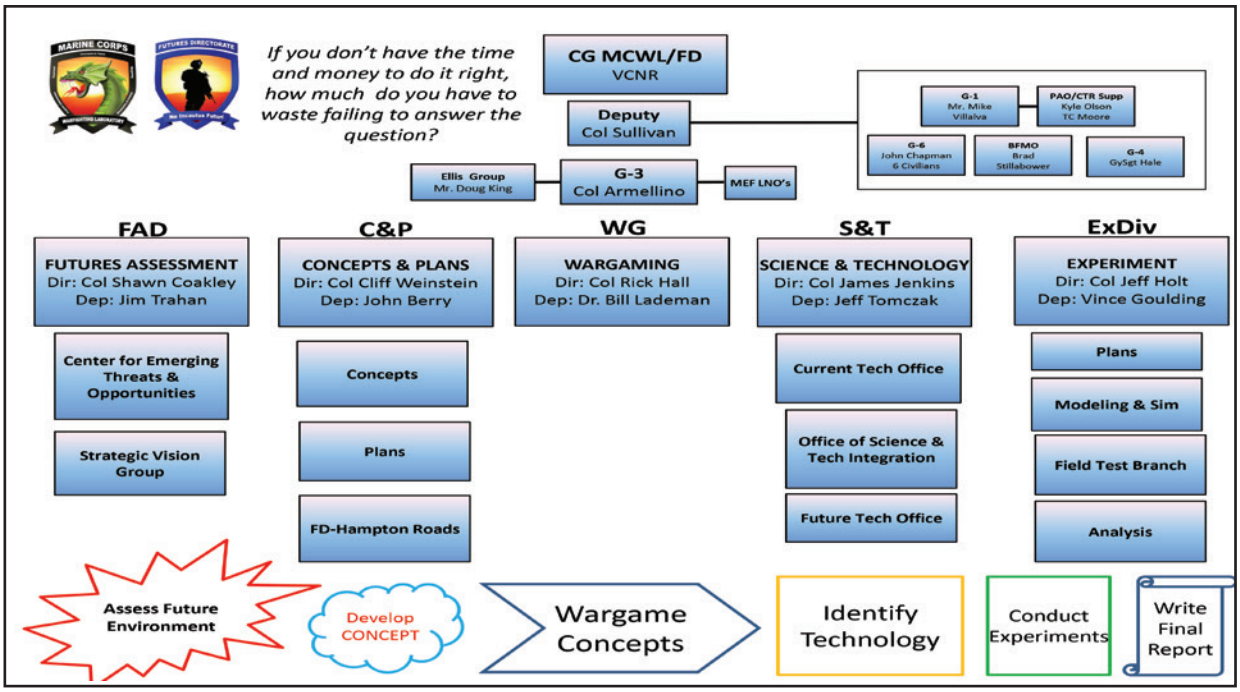


Figure 3-1. Futures Directorate Organizational Chart

understand and contribute to futures assessments, concept development, and other force development actions to include experimentation and wargaming. This engagement and communication helps inform future required capabilities. Those concepts, and the process that follows to produce the capabilities needed, are driven by wide-ranging assessments of the future that include everything from adversary capabilities to fiscal constraints.

PEO LS S&T must access a wide variety of sources and perspectives to develop and validate future threats and opportunities as they apply to the PEO LS portfolio. To get a tailored perspective of the future, the S&T Director uses the Assessment of Plausible Future Security Environments (Figure 3-2), which examines the wide range of possible futures preferable, probable, and alternative futures. The assessment of the plausible future helps to augment existing concepts as part of the initial steps of the Concept-to-Capability process.

This methodology of examining current and future capability gaps to inform the ATIP provides relevant context to understanding the most likely future security environment and the capabilities required to address it. The process references and responds to Department of Defense, Joint, and Service assessments and guidance relative to what the future is expected to hold. It also considers other likely and plausible futures (as well as less probable scenarios) from industry, academia, and international community experts.

These probable futures are derived from baseline forecasts that project existing trends into the out years. Trends and forecasts used to support PEO LS' examination of the most likely future security

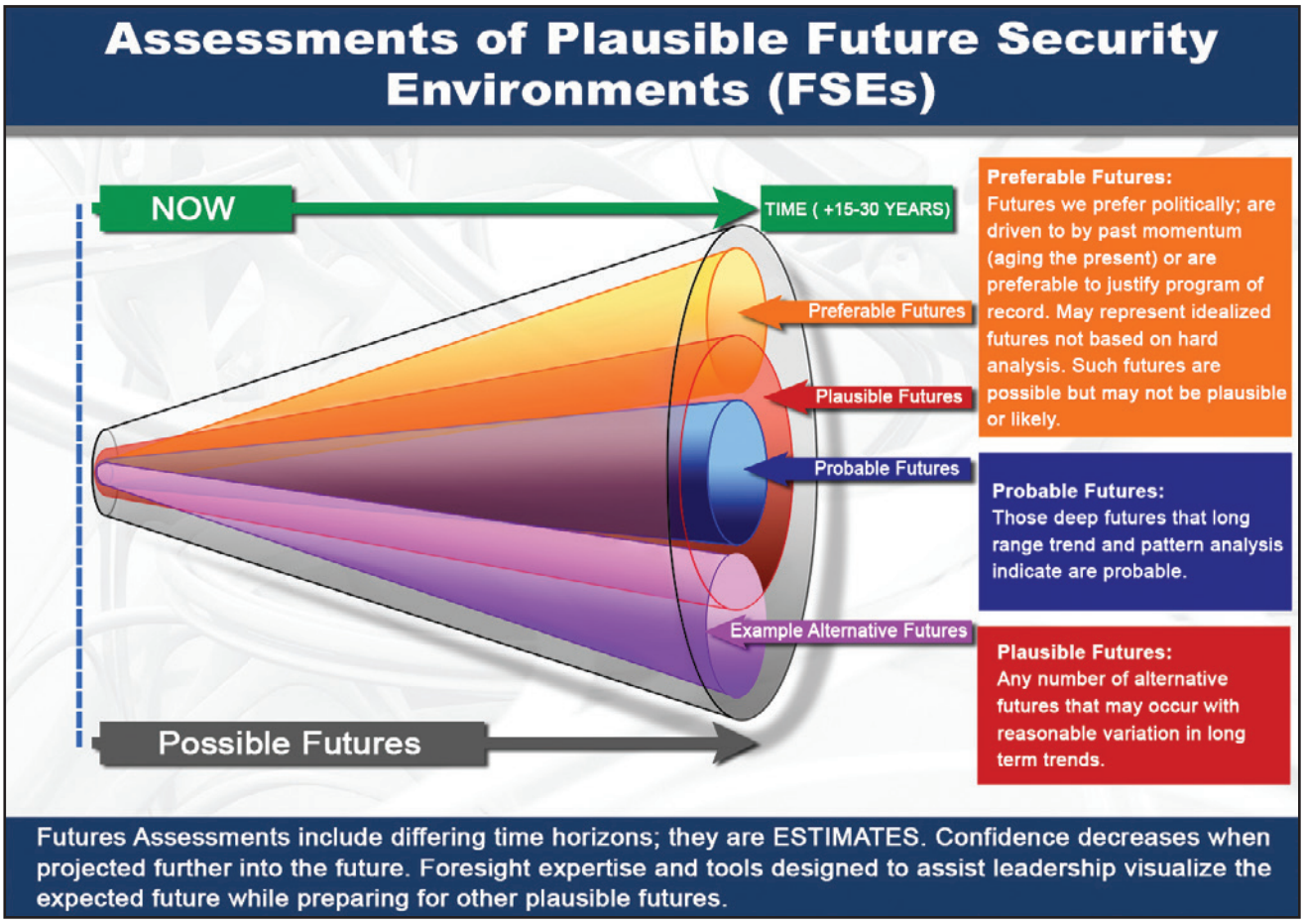


Figure 3-2. Assessments of Plausible Future Security Environments (FSEs)

environments are outlined in the following key U.S. defense-related publications:

- *Sustaining U.S. Global Leadership: Priorities for 21st Century Defense (DoD 2012).*
- *Capstone Concepts for Joint Operations: Joint Force 2020 (CCJO 2012).*
- *Joint Operational Access Concept (JOAC 2012).*
- *Mission Command White Paper (CJCS 2012).*
- *2012 U.S. Marine Corps S&T Strategic Plan.*
- *Gaining and Maintaining Access: An Army - Marine Corps Concept (ARCIC/MCCDC 2012).*
- *The Marine Corps Service Campaign Plan 2014 - 2022 (2014).*
- *Quadrennial Defense Review 2014 (QDR).*
- *Expeditionary Force 21 (HQMC 2014).*
- *The Defense Innovation Initiative (Secretary of Defense Memo, 2014).*
- *36th Commandant's Planning Guidance 2015.*
- *FRAGO 01/2016: Advance to Contact.*
- *Wargaming and Innovation (Deputy Secretary of Defense Memo, 2015).*
- *The National Military Strategy of the United States of America 2015 (NMS).*
- *Naval S&T Strategy: Innovations for the Future Force (ONR 2015).*
- *A Cooperative Strategy for 21st Century Seapower (SecNav 2015).*
- *National Security Strategy (NSS 2015).*
- *2015 Marine Corps Security Environment Forecast (MCSEF).*
- *Joint Concept for Rapid Aggregation (CJCS 2015).*
- *Force Development Strategic Plan (CG, MCCDC, DC CD&I 2015).*

The trends and forecasts outlined in these seminal documents that are relevant to PEO LS include:

- An Era of Fiscal Austerity and National Debt.Force Development Strategic Plan.
- Cyber Threats from Governments and Non-government Actors.
- Technological Diffusion / Weapons of Mass Destruction Proliferation.
- Increased Urbanization, Particularly in the Littorals.
- The Traditional View of the Three Primary Domains (Air, Land and Sea) within the "Global Commons," with the Increasingly Important Addition of the Space, Cyberspace and Human Domains.
- The Demand for Critical Resources is Likely to Continue to Exceed Supply, even with Advanced Conservation and Efficiency Measures Coupled with Alternative Sources.
- Transnational Crime, Regional Instability and Violent Extremism.
- An Increased Emphasis on a Forward-Postured Crisis Response Force in Readiness to Address an Unstable and Uncertain Operating Environment, with an Emphasis on Phase 0 through Phase 2 (Shape, Deter, Seize Initiative).

Influences within the Marine Corps on Future Development

The Commandant of the Marine Corps has said that the Marine Corps must be able to innovate, adapt and win with the equipment that we currently have in our inventory. The ATIP is designed to leverage efforts throughout the S&T Enterprise, to find solutions to the current technology needs of the PEO LS Programs of Record, and to look into the future to see what is in the "Realm of the Possible." This future section is set to inform where the Marine Corps could go with its investment funding and suggest technology trends that may influence the way the Marine Corps will fight in the future. The concepts/technologies on the following page will help shape this year's theme of **Innovate, Adapt and Win**.

"What we do here is the future of the Marine Corps."
—LtGen Robert S. Walsh, Force Development Strategic Plan 2015

3.1 Modernization through Modularity

Modularity, specifically modular approaches in design, engineering, manufacturing, and sustainment, has been used in the commercial sector for many years. These approaches have not only shown they can reduce production costs, but also show they can positively impact life-cycle costs, as well as, improve a company's ability to adapt and respond to the ever-changing market demands. While the Marine Corps is not faced with ever-changing market demands, they are faced with the ever-evolving technology-driven threats that must be managed while operating within a fiscally constrained environment. Consequently, modularity holds a promising pathway forward.

A modular approach also offers a potential pathway to modernize our force, affordably providing the flexibility and increased tactical agility from the sea base. Modernization and upgrade of critical systems is an essential element of a system's life cycle; it is imperative that our legacy systems remain relevant. More importantly, the systems must maintain their technological advantage over our nation's adversaries and staying ahead of ever-present and rapidly evolving threats is critical. Unfortunately, there are a number of underlying forces that affect the Marine Corps, as well as, all of the services' ability to modernize their force. These include more than a decade of continuous land-based warfighting operations, strategic uncertainty regarding the future operational environment, and the ever-increasing cost of labor and materials - particularly in a fiscally constrained environment (a condition that will likely exist for the foreseeable future). Given the many challenges associated with modernizing the force, it will be necessary to identify affordable solutions that will provide the Marine Corps and the Navy with systems that are scalable, interoperable, and adaptable, which a holistic modular approach has the potential of providing.

A Holistic Modular Approach (HMA) is not just a technology concept or strategy for the design and development of new systems; it also holds the potential of providing a pathway for the modernization of existing systems. The concept relies on a set of standard interfaces, a key component of modular design that provides the opportunity to obtain required future capabilities in a cost-effective manner. Where feasible, modular design concepts can provide the means for DoD to take advantage of widely supported commercial interface standards to ease the Services' burden and then move forward in developing required capabilities. Additionally, designing systems that support affordable change will require a modular approach - a concept that is capable of delivering combat systems that are effective, upgradable, affordable, and supportable throughout their planned life cycle. There are several examples where modularity use exists in products we use every day. Computers (hardware and software) rely on modular components, while the auto industry is trending toward fewer chassis designs that are capable of accommodating multiple models enabling companies to quickly adapt to customer needs and tastes. For the Marine Corp's needs, a HMA provides the means to meet existing requirements, while establishing the foundation needed to meet rapidly evolving threats.

What is Modularity and Why is it Important?

In general, modularity can be described as the development of interchangeable system components, for use within a larger complex system, that are linked together through a set of common or standard interfaces, designed to perform a specific

mission or task. A common example of modularity is the Legos® toy set, which is composed of blocks of varying shapes and sizes that can be linked together through a common structural interface to build a complex item. In 2005 the Naval Research Advisory Committee (NRAC) defined modularity as an architecture where system functions are partitioned into elements consisting of various components that have standard/defined interfaces and minimal interdependencies in the overall system (NRAC, p. 19). NRAC further defines four types of modularity: capability swapping modularity (mission-package modularity), component sharing modularity, bus modularity, and construction/design modularity (NRAC, 2005).

Since the early 1990s, many people within the DoD, who previously gave little credence to the benefits of a modularity concept, began to shift their thinking and started viewing modularity as a concept holding significant potential. As shown in Figure 3-2, when a system is "modularized," it is decomposed into manageable components that operate independently and interface with other system components through a set of standardized interfaces. From a functional perspective, modularity has three purposes: to make complexity manageable, to enable parallel work, and to accommodate future uncertainty (Baldwin and Clark, 2006). "Modularity accommodates uncertainty because the particular elements of a modular design may be changed after the fact and in unforeseen ways as long as the design rules are obeyed. Thus, within a modular architecture, new module designs may be substituted for older ones easily and at low cost".

Modularity, while not a new concept, continues to grow in its importance to industry. Examples of modularity date back to 1939, when Baldwin Locomotive Works patented a 4000-horsepower diesel engine with six generator modules (an example of functional modularity), and during World War II with the German shipbuilding industry designing and manufacturing the Type XXI Submarine in sections at various locations and shipping these modules to the Hamburg and Danzig shipyards for assembly (production modularity). A more recent example, one that has transformed logistics within the global business community, is the standard 20-foot cargo container. These containers, with their standard structural interfaces and specifically designed handling equipment, can move easily between "container ships," which are designed specifically to carry these containers, and various semi-trucks with trailers that are specifically designed to haul them. The broad use of modular systems in industry and within some military systems, such as air platforms, has increased interest in how to apply modularity to naval systems.

Introducing a modular concept into the DoD acquisition model can potentially provide valuable advantages in the design and acquisition of weapons systems and platforms. These advantages can range "from ease of technology refresh to decreased total ownership cost and increased readiness on the battlefield" (The Naval Strike Forum, 2005, p.6). Numerous studies, including several that are ongoing, have been conducted to analyze modularity for military purposes. PEO LS also has supported studies conducted by ONR and Naval Surface Warfare Center Dahlgren Division (NSWCDD) - both indicating that there are potential benefits for introducing a HMA. The success of this new modular approach is predicated on standardized interfaces, an open architecture, and an acquisition system that encourages open innovation.

Open innovation requires modification of the existing acquisition model to one in which proprietary software/system interfaces are no longer standard. While it has many benefits, modularity's key feature is that it enables plug-and- play capabilities that will provide the expeditionary warfighter of the future the flexibility to adapt to the dynamic battlefield by enabling rapid reconfiguration of forces to ensure they are optimally configured for current missions. An ongoing ONR study indicates some

potential advantages and disadvantages to Holistic Modularity:

Potential Advantages

- Total Structure is more comprehensible.
- Modules can be easily replaced.
- Work division is possible without all participants needing an understanding of the complete system.
- Effects of changes to one part of a system are minimized on others.
- Many different configurations of the system are possible.
- Standardized interfaces prevent vendor lock-in.
- Open innovation — enabling external entity innovation input.

Potential Disadvantages

- For very specific modules, the cost of developing interfaces can be high.
- For assemblers (integrators), it can be difficult to assess the quality and interation of different modules.
- It can be difficult to assemble (integrate) the modules.
- The design creativity of a module can be limited because the needs conform to standard interfaces.
- Less variation in products because of overuse of the same modules.
- Total system performance may be suboptimal.
- Total module replacement costs when a cheaper sub-component has failed.

A modular design enables a system to be expanded or functionally reconfigured by incorporating new modules or replacing others with greater functionality or differing functions. A useful way to think of this concept is to visualize a desktop computer that provides basic functions such as a word processing capability, a graphics application, and spreadsheet software. In this example, a modular upgrade could include the addition of a new software module such as database management software. Similarly, expanding a system's functionality can be easily achieved by installing new hardware modules such as a printer or scanner.

Applying the principles of modularity — i.e., maximum cohesiveness; grouping modules by function; low inter-modular coupling, and low intra-modular connectivity — to convert functional architectures to modular system design architectures can result in the same low-cost flexibility and reliability that we have come to expect from our computers. Adding functionality is possible because the corresponding system interfaces are clearly defined, which enables designers to develop their individual modules independently.

Developing a modular design for a new system begins with the partitioning of the system into functions and identifying which elements must be designed as modules. For legacy systems, the initial steps focus on gathering information associated with the system's existing design and performing the modular partitioning and interface mapping to known functions and capabilities. Once the system design is established, the system, subsystems, and components should be prototyped to demonstrate the integration of the system using the proposed modular decomposition. There are several advantages to producing a prototype: it allows the design team to see the product assembled (an important aspect of a modular design); it enables early design issues to be identified; it allows for the test of structure and function; and it can be used to generate interest in and discussion of the modularized system.

An HMA will provide the acquisition community with the tools and flexibility needed to maintain

the capacity to field capabilities to meet the intent of EF 21 in this era of fiscal constraint. While an HMA concept with standard interfaces is closely related to the concept of designing for technology insert, the decoupled interfaces lead to independent and parallel development of modules. With an HMA, individual module independence supports an environment of open innovation, which facilitates incremental improvement. A new or upgraded module can be added to a system without affecting the system architecture. Frequently, capability and flexibility in system design are either traded away because of competing requirements (cost), or lost because of the government's inability to cope with schedule slips associated with design challenges. In this current acquisition approach, capability that does not make it into the initial design may wait until a mid-life upgrade, which sometimes occurs ten years after the original system is delivered to the fleet. A modular design allows the program to move forward, while the challenging modules are worked in parallel and delivered when ready without a major setback to the system's delivery schedule.

Modernizing through a modular approach can potentially provide significant benefits. However, a sizable effort will be required up front, beginning with identification or development of standardized interfaces (e.g., power, structural and data), similar to the standardized interfaces, that are found in most computers, such as USB, FireWire, or simple headphone jacks. After standardized interfaces are developed, systems undergoing modernization will require physical modification, such as adding a data bus or a power distribution bus. Once the modular design is adapted to the system, new modules can be procured or developed to ensure that the system maintains its technological advantage or that it adequately addresses the emergent threat.

The challenge will be to partition the modules correctly. Applying the appropriate interfaces, as well as holistically partitioning the system, will allow the Marine Corps to realize the maximum benefits of a modular design. A Holistic Modular Approach that is focused on desired operational mission capabilities has the best potential of achieving these results.

3.2 High Water Speed

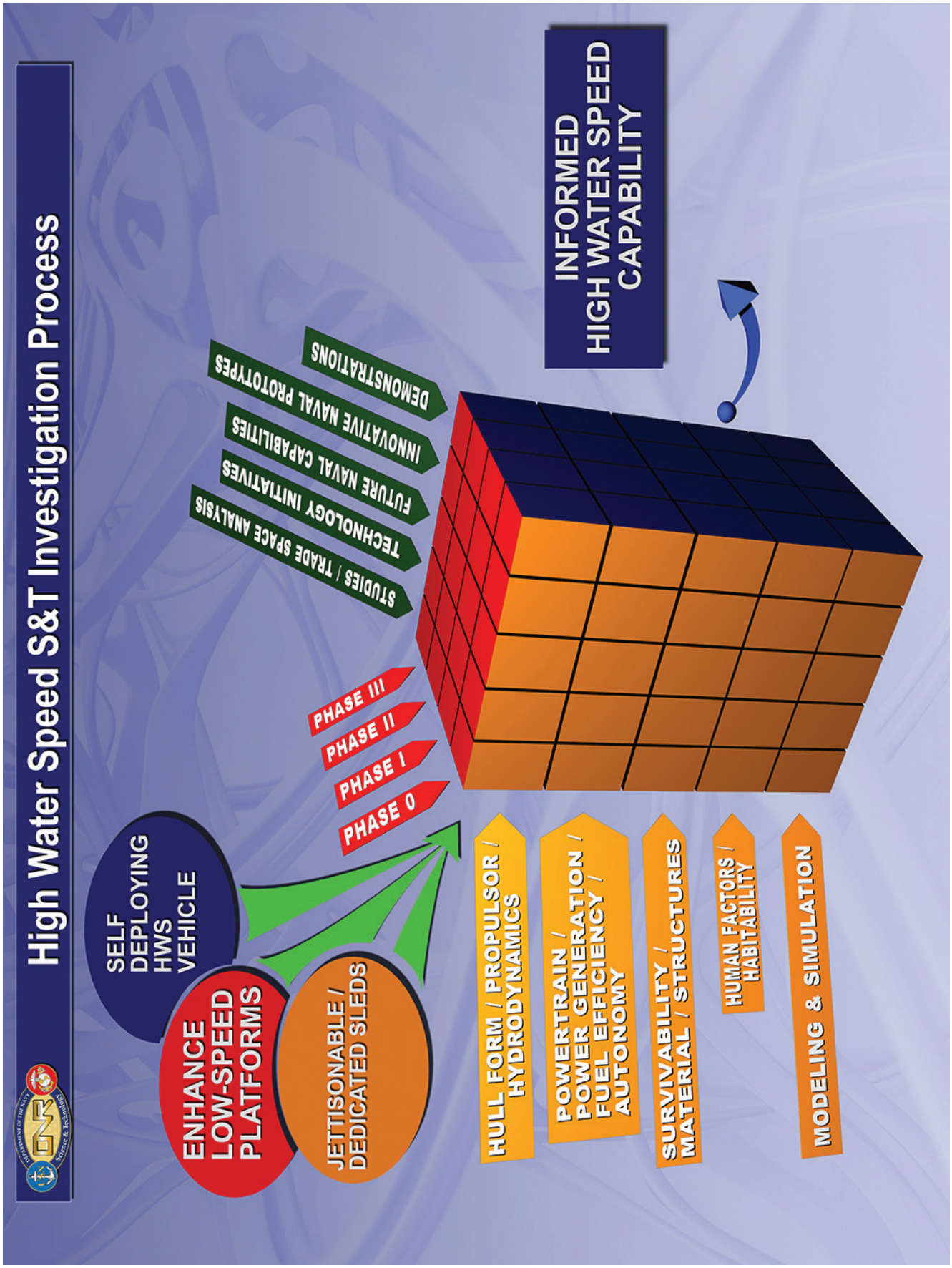
While the future is unknown the *US National Security Policy (2014, 2015), Expeditionary Force 21 (2014), Gaining and Maintaining Access: An Army-Marine Corps Concept (2012)* and a multitude of other strategic and doctrinal documents suggest that a High Water Speed (HWS) amphibious vehicle, capable of assaulting across defended beaches to the objective will be necessary. The Marine Corps in response to the cancellation of the Expeditionary Fighting Vehicle program, and armed with the understanding that a high-speed amphibian will be needed to support the future force, has requested that the Naval S&T Enterprise investigate the viability of a HWS solution that is as effective on land as it is on the sea.

The Chief of Naval Research has tasked ONR Code 30 to lead the investigation of a HWS amphibious vehicle. To focus their effort, ONR Code 30 has developed a strategic approach that aligns with the Marine Corps' desires and allows for three lanes of investigation:

- Enhancement of legacy vehicles
- Development of novel technology associated with a self-deploying HWS vehicle
- The exploration of jettisonable/dedicated sled solutions and High Water Speed connectors

As depicted in Figure 3-3, the approach is phased with a connected timeline that covers a 10-year research and development timeframe. It provides a comprehensive three-lane methodology that supports scientific investigation across multiple research areas while incorporating multiple funding venues.

Right Page: Figure 3-3. HWS Investigation Process


High Water Speed S&T Investigation Process
SELF DEPLOYING HWS VEHICLE
ENHANCE LOW-SPEED PLATFORMS
JETTISONABLE / DEDICATED SLEDS
PHASE III
PHASE II
PHASE I
PHASE 0
STUDIES / TRADE SPACE ANALYSIS
TECHNOLOGY INITIATIVES
FUTURE NAVAL CAPABILITIES
INNOVATIVE NAVAL PROTOTYPES
DEMONSTRATIONS
HULL FORM / PROPULSOR / HYDRODYNAMICS
POWERTRAIN / POWER GENERATION / FUEL EFFICIENCY / AUTONOMY
SURVIVABILITY / MATERIAL / STRUCTURES
HUMAN FACTORS / HABITABILITY
MODELING & SIMULATION
INFORMED HIGH WATER SPEED CAPABILITY

The overarching HWS Amphibious Vehicle Strategy will explore the three technology lanes across five ACV 2.0 Sub-Integrated Product Team (IPT) technology areas. ONR Code 30 will use the ACV 2.0 Sub-IPT structure to discover and recommend technologies in the following areas:

- Hull Form and Propulsor Hydrodynamics
- Powertrain, Power Generation, Fuel Efficiency and Autonomy
- Survivability, Materials and Structures
- Human Factors and Habitability
- Operational Modeling and Simulation

As a unified methodology, the HWS Vehicle Strategy will allow for open and systematic scientific investigation. By executing the ONR Code 30 HWS S&T Amphibious Vehicle Strategy and keeping the community of interest aligned, the Department of Navy's leadership will be provided with the necessary information to make a fully informed HWS amphibious vehicle decision within the designated time line.

3.3 PEO LS Future Focus

Exponential Technologies

Exponential technologies are those technologies that fundamentally disrupt the 'balance of power'. These technologies typically have the following characteristics:

- Decentralization: The work is performed by a diverse network of individuals using mass collaboration in a virtual environment
- Transparency: The work is usually open-source

The impact of 'transparency' is further amplified when technologies coalesce into open platforms, thus enabling insertion and upgrades by rapidly building on previous versions. Furthermore, the ability to combine and recombine technologies lends itself to exponential innovation - where the combined capability is greater than the sum of its parts.

PEO Land Systems' future investments will focus heavily on exponential technologies to include:

- Condition Based Maintenance (CBM)
- Autonomy/Robotics
- Big Data Analytics
- Additive Manufacturing (3-D Printing)
- Active Protection Systems (APS)

Condition Based Maintenance (CBM)

Condition Based Maintenance is a central component of Total Productive Maintenance (TPM). CBM is the application and integration of processes, technologies, and knowledge-based capabilities to achieve target availability, reliability, and operation. CBM also supports costs of Marine Corps systems and components across their life cycles. TPM is a comprehensive approach to maintenance intended not only to prevent and correct equipment failures, but also to optimize equipment performance and extend equipment life cycles. Another key component of TPM is Reliability Centered Maintenance (RCM), which is a method of analysis that captures and assesses operational and maintenance data to enable decisions that improve equipment design, operational capability, and readiness. RCM is a logical decision process that provides the "evidence of need" for both reactive and proactive maintenance tasks that support CBM processes. RCM involves performing only those maintenance tasks that will reduce the probability of a failure or mitigate the consequences of failure, based on analysis of each failure mode and the consequence of failure.

Autonomy/Robotics

Autonomy and Robotics provide capabilities that effect operational and tactical maneuver in the littorals through the use of unmanned autonomous

systems with minimal human interaction and control. These capabilities include unmanned ground vehicles, robots, air vehicles, sensors, UxS swarms, and connectors that work side by side with the Warfighter. Ideally, these systems will be able to collaborate and share information to reduce the operator workload, relieving him or her of physical and cognitive burdens. The goal is to reduce risk to human life by using unmanned systems to accomplish potentially dangerous tasks.

Big Data Analytics

Big Data Analytics describes the exponential growth and availability of data, both structured and unstructured, so large or complex that traditional data processes applications are inadequate. Big data analytics will help the user gain insights from a massive amount of data, enabling more accurate analysis, modeling and predictions. It will also transform the ability to draw actionable intelligence from a myriad of sensors and nodes to the tactical edge. It can inform commanders at all levels from mundane tasks, like a vehicle needs an oil change, to the immediate threat of a roadside Improvised Explosive Device. The immediate transmitting, receiving, gathering and acting on this information can greatly benefit the Marine Corps.

Additive Manufacturing (3-D Printing)

Additive Manufacturing is the process of making a three-dimensional solid object of virtually any shape from a digital image. This is achieved by using an additive process, where successive layers of material are laid down in different shapes. 3-D printers could transform military logistics by allowing units to print equipment and spare parts in the field, greatly reducing response time. While there is a logistical burden associated with 3-D printing, it could be offset by its advantages. The Marine Corps wants to explore the potential for significantly increased efficiencies in logistics through reduction of inventories and determine other areas of military application.

Active Protection Systems (APS)

Active Protection Systems refers to a system that detects, classifies, receives warning cues, and actively uses countermeasures for safeguarding vehicles and personnel from incoming fire. The Department of the Army's recent push will encourage industry leaders to explore the possibility of developing a Modular Active Protection System (MAPS). The newly developed system will also include "soft-kill" and "hard-kill" defense mechanisms. Soft-kill is an electronic countermeasure used to confuse the incoming missiles targeting mechanism by way of electro-optical signals, infrared, or laser jamming.

Hard-kill countermeasures physically counteract incoming missiles and Rocket-Propelled Grenades by intercepting them at close range if needed.

In summary, what we invest in now is the future of the Marine Corps! Our ability to anticipate the mid to long term (3–5 year and 5–10 year) operating threat environment, align S&T resources, and quickly adjust to the ever-changing landscape will ensure the future Marine Corps is not only innovative but able to adapt and win.

Counter Unmanned Aircraft System (UAS)

Based on the proliferation of inexpensive Low and Small (LSS) Unmanned Aircraft System (UAS); a cost effective kinetic and/or non-kinetic counter UAS capability is required to negate the threat at the system's weapon keep out or sensor ranges. Counter UAS system should provide a low cost per shot system with a high probability of kill against a group 1 UAS, integrated detection, tracking, and identification sensors, and capable of being mounted and transported on a lightweight tactical vehicle.