
Distribution Statement A: Approved for Public Release
DCN#43-2536-17

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# EXECUTIVE SUMMARY

The Future Naval Capabilities (FNC) program, initiated by the Department of the Navy in 2002, is a science and technology (S&T) program designed to develop and transition cutting-edge technologies to acquisition program managers within a five-year timeframe. The program delivers these technologies as products for integration into platforms, weapons, sensors or specifications to improve Navy and Marine Corps warfighting and support capabilities.

FNC products typically begin at a point where analytical and experimental proof-of-concept has been established (Technology Readiness Level, or TRL 3). The products are subsequently matured to the point that a model or prototype can be demonstrated in a relevant environment (TRL 6). Once the technology is demonstrated, the acquisition sponsor takes responsibility for conducting any additional research, development, test and evaluation (RDT&E) necessary to engineer and integrate the product into an acquisition program of record, or other program, that will ultimately deploy the new technological capability into the fleet or force.

The FNC program is governed by formal business rules, which define the oversight, management and execution of FNC investments and strengthens coordination between the fleet/force, S&T, acquisition and resources/requirements communities. For all products, funding is contingent upon having a signed and negotiated agreement to transition and deploy the technology. Products that are unable to meet this requirement are subject to potential termination.

The FNC program plays an important role within the Office of Naval Research's (ONR) investment strategy. As the largest part of the Technology Maturation portfolio, depicted in Figure 1, the program fills the niche between Leap Ahead Innovations, which are high-risk, game-changing investments without transition paths, and Quick Reaction projects that respond to specified needs within a two-year period. The structure of the program ensures that FNCs respond to acquisition needs validated by stakeholder communities and allows FNC program managers to leverage groundbreaking research to meet those needs. In essence, the FNC program is structured to create a healthy balance of S&T "push" and acquisition "pull."

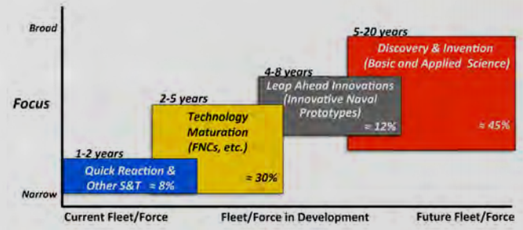



Figure 1 – ONR Investment Portfolio

The technologies in the FNC Program are functionally organized into eight areas of development, called pillars.

## WARFARE ENTERPRISE PILLARS

- **Air Warfare (AW)**
  Anti-Air Warfare (AAW); Anti-Surface Warfare (ASuW); Anti-Submarine Warfare (ASW); Aircraft, Power Projection; Cyber
- **Information Warfare (IW)**
  Sensors; Cyber; Space; Electromagnetic Maneuver Warfare; Military Deception; Command and Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR); Positioning, Navigation and Timing; Meteorology; Oceanography; Hydrography; Man-Machine Teaming in support of Information Warfare
- **Expeditionary Maneuver Warfare (EMW)**
  Special Operations Forces; Amphibious Warfare; Mine Counter-Measures; Mine Warfare; Humanitarian Assistance/Disaster Relief; Anti-Terrorism Force Protection; Explosive Ordinance Disposal; C4ISR; Cyber
- **Surface Warfare (SW)**
  Anti-Air Warfare (AAW); ASW; ASuW; Defensive Submarine Warfare (SUW); Theater Air and Missile Defense; Power Projection; Cyber; HM&E
- **Undersea Warfare (UW)**
  ASW; Power Projection; Strategic Deterrence; Cyber

## WARFIGHTING SUPPORT PILLARS

- **Capable Manpower (CMP)**
  Manpower, Personnel, Training and Education
- **Energy, Logistics and Platform Enablers (ELP)**
  Ashore energy; logistics; maintainability; sustainability; efficiency improvements
- **Force Health Protection (FHP)**
  Medical Equipment and Supplies; Health Care and Protection; Reduction of Morbidity/Mortality

All IPTs must consider power and energy issues related to weapons and platform development initiatives, as well as other cross-cutting issues that are relevent to their warfighting areas.

### FUNDAMENTAL PROCESSES OF THE FNC PROGRAM

Each pillar is managed by a two-star integrated product team (IPT). Each IPT has an IPT working group (IPT WG), which also consists of representatives from the S&T, acquisition, resource/requirements and fleet/force communities. IPTs identify the S&T capability gaps, which are detailed requirements that address technology needs in their respective areas.

S&T capability gaps are approved by the Technology Oversight Group (TOG), the three-star board tasked with FNC program oversight by the vice chief of naval operations (VCNO), assistant commandant of the Marine Corps, and assistant secretary of the Navy for Research, Development and Acquisition (ASN-RDA).

ONR proposes new technology investments, called FNCs, in response to the approved S&T capability gaps. An FNC consists of one or more interrelated products, which together provide a distinct capability to address one or more gaps. FNC investments are subjected to an extensive vetting process within ONR, and subsequently by the IPTs, before reaching the TOG for prioritization and approval.

The TOG considers the priorities of each IPT before establishing a comprehensive, balanced ranking of FNC proposals. FNCs are funded in accordance with the TOG's approved list, as constrained by the program's budget.

Once an FNC and its associated products begin execution, a series of reviews ensure continued collaboration among the S&T, acquisition and resource communities:

- Bimonthly: ONR's Office of Technology (ONR 03T) reviews the cost, schedule, technical progress and transition status.
- Annual: Transition assessments by all stakeholders formally review each product's transition status.

Additionally, all products require a signed technology transition agreement (TTA). These negotiated agreements document the commitment of the resource sponsor, acquisition program manager and S&T manager to complete development of the product and pursue its integration into an acquisition Program of Record (POR) targeted to deliver the new capability to the fleet/force. TTAs are renewed annually to ensure continued stakeholder consensus that the development status and transition path remain viable.

Products may be terminated for the following reasons:

- Cost, schedule or technical objectives become unachievable.
- A viable transition path is no longer valid.
- Funding cannot be made available for transition.

Funds recovered from a product's early termination may be used to address issues with existing investments, or to fund new FNCs in accordance with the TOG's established ranking.

Upon completion of S&T development and delivery to an acquisition program of record, products are assessed by an independent transition review board (TRB) to determine their final status. Each completed product is reviewed annually until it has either deployed to the fleet/force, or been determined to not deploy. TRB results serve as a beneficial report card on the program's success and are used to inform process improvements.

# FNC MANAGEMENT: STRUCTURE, ROLES AND RESPONSIBILITIES

### STRUCTURE

The TOG is co-chaired by the deputy chief of naval operations (DCNO) for Integration of Capabilities and Resources (OPNAV N8) and the deputy commandant for Combat Development and Integration (CD&I). Permanent TOG members also include the DCNO for Warfare Systems (OPNAV N9), the deputy commander of U.S. Fleet Forces (USFF) Command, the commander of U.S. Marine Corps Forces Command (MARFORCOM), the principal military deputy to ASN-RDA and the chief of naval research (CNR). Additionally, DCNOs and deputy commandants outside the purview of TOG member organizations may participate on issues that address their equities. Figure 2 shows the FNC management hierarchy.

IPTs are co-chaired by flag-officer or senior executive service (SES) representatives of the Navy and Marine Corps resources and requirements communities. Membership includes representatives from ONR, ASN-RDA, U.S. Fleet Forces Command and U.S. Marine Corps Forces Command.

The TOG and the IPTs operate as consensus bodies under the leadership of their co-chairs. As the resources and requirements voting representatives, the co-chairs are responsible for representing the interests of all Navy/Marine Corps requirements offices that have a role in transitioning FNC products. Similarly, the TOG's acquisition, S&T and fleet/force voting members represent the collective interests of their respective communities.

The senior managers of the IPTs and the TOG rely on working group (WG) representatives who are responsible for the day-to-day management of their organization's responsibilities. The TOG executive secretary works closely with the IPT principals and the TOG, while the TOG WG members deal extensively with their IPT WG counterparts.

### ROLES AND RESPONSIBILITIES

ONR functions as the S&T program execution manager responsible for the development of all technology products. ONR FNC managers are responsible for the performance, schedule and execution of each product. ONR SES-level managers serve as the senior S&T representatives on each IPT.

The acquisition community—consisting of the program executive offices (PEOs), direct-reporting program managers (DRPMs) and system commands (SYSCOMs)—is responsible for integrating and fielding successfully completed products into operational systems scheduled for delivery to the fleet/force.

The resource sponsors are responsible for planning and programming the funds required for successfully integrating and delivering products into their targeted acquisition programs of record.

Fleet/Force personnel, the ultimate end users of the delivered capabilities, engage throughout the process to identify and define requirements, and to advocate for new operational capabilities. They ensure planned product transitions are suited to warfighting needs.

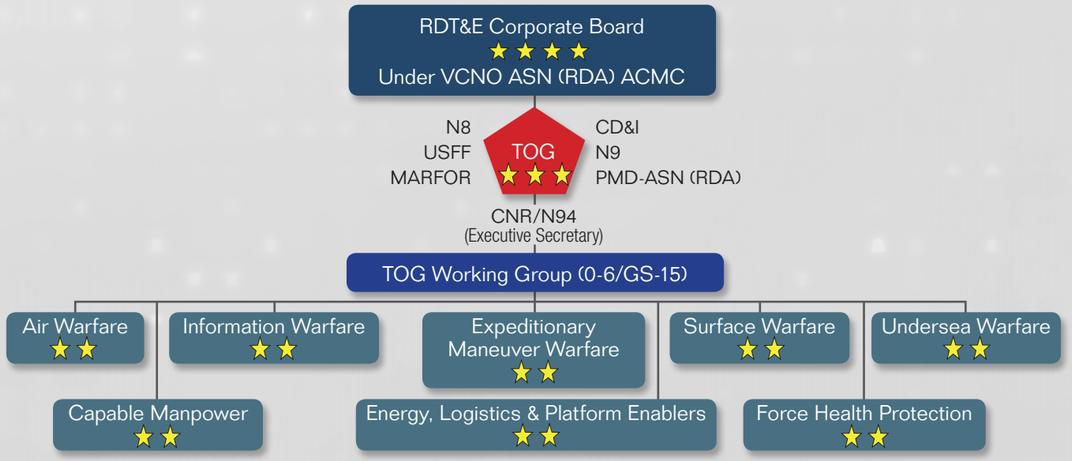



Figure 2 – FNC Management Hierarchy

NEW INVESTMENTS

# NEW INVESTMENTS: THE SELECTION PROCESS

FNCs are selected annually by a structured process that involves all of the FNC stakeholders. The process begins when the IPTs, representing the eight FNC pillars, initiate development of the annual S&T capability gaps.

Beginning in January, the IPTs coordinate closely with Navy and Marine Corps headquarters—as well as the fleet and force—to identify S&T capability gaps that cannot be addressed with the current platforms, weapons systems, science, technology, doctrines, organizational structure, training, material, leadership, personnel and facilities. In order to close the specified gaps, new technology investments are required. IPTs define gap requirements, but do not specify the technology approach necessary to address the need. Existing studies, analyses and capability assessments, such as the N81 Mission Area Assessment and the Naval Enterprise Science & Technology Objectives, are incorporated into this process and used by the IPTs as references.

Gap requirements can define a very specific lack of capability or an important area of focus that senior naval leadership has identified as a priority. Metrics are developed for each gap to provide the required detail and specificity to help focus technology development, as well as determine the extent to which proposed FNCs and products address naval needs.

Each February, IPTs conduct roundtable meetings with all stakeholders. These meetings are critical to the FNC process as the IPTs present draft requirements and solicit feedback. They serve as the main forum for ensuring the gaps accurately represent fleet/force requirements. Each IPT revises and finalizes their gaps in April based on insights gained from the roundtables. The TOG typically approves the final gaps in June.

Each gap is assigned to a lead ONR technical department responsible for assessing potential S&T solutions. While the development of FNC proposals typically starts early in the calendar year, the pace accelerates once the gaps are formally released.

The goal of each FNC is to significantly address one or more gaps within a four to five year S&T development timeframe. ONR and the IPTs work closely to ensure FNC proposals properly address the gaps and the individual products have support for transition.

An FNC proposal clearly describes the capability it will deliver and the metrics that will be used to measure success. Each product has detailed metrics, called exit criteria, which are negotiated as part of the TTA and become the key criteria for measuring the success or failure of the product. Exit criteria are used to define the product's specific contribution towards addressing the gaps. Each proposal contains specific cost and schedule information, as well as significant detail about other S&T efforts where leverage or collaboration is planned as part of the development process. ONR strives to consider at least one potential FNC proposal against every gap, which is possible due to the breadth of its basic research program.

## ONR FNC PROPOSAL REVIEWS

Consulting heavily with fleet/force, as well as acquisition and resource sponsor stakeholders, ONR's technical departments review and select a subset of the candidate solutions to go forward for further review. Each department may submit a specified number of FNC proposals, which are assessed by subject matter experts. ONR uses these assessments so advocates can address noted issues when the proposals are formally presented.

In the October/November timeframe, ONR convenes a technical review panel consisting of senior technical leaders, including department heads and portfolio directors, to assess the proposed FNCs. The panel approves FNCs and then releases them to their respective IPTs. If an FNC is not technologically mature enough, or if its proposed S&T content is not considered appropriate for the FNC program, it is removed from further consideration.

The panel considers the following questions, among others:

- Does the proposed FNC deliver a distinct, quantifiable capability that addresses an identified S&T capability gap?
- Do the technical metrics adequately quantify and define the capability the proposed FNC will deliver?
- Does the technical approach for each individual product have merit?
- Are the budgets for each individual product justified?
- Do the individual products have appropriate S&T content?
- Military utility versus cost?
- Do the individual products have a manageable degree of technical risk?
- Is the transition path of the proposed FNC reasonably aligned to acquisition program milestones?
- Are the target acquisition and resource sponsors supportive of the transition of each product?

## PRIORITIZATION OF FNC PROPOSALS

All proposals approved by ONR's technical review board are further assessed by the appropriate IPTs, which evaluate and prioritize them based on a range of criteria, including:

- Alignment with prioritized warfighting and supporting needs
- The impact of the FNC on its S&T capability gaps
- Support for transition

IPTs review all products within the proposed FNCs and make recommendations to delay or drop technologies—or whole FNCs—when appropriate. Each IPT forwards a single prioritized list of proposed FNCs, and any recommended changes to associated products, to the TOG working group.

## REVIEW OF PROPOSALS AND APPROVAL PROCESS

In December, proposed FNC's are briefed to the TOG WG, which consolidates the IPT lists into a single prioritized list of FNC proposals balancing Navy and Marine Corps needs. In February, this list is presented to the TOG for final review and approval. The goal is to maximize the investment in the naval S&T portfolio, while considering each IPT's priorities in its respective functional area. FNC proposals within the Capable Manpower pillar are prioritized separately, as OPNAV N1 resources the S&T funding for this pillar.

ONR funds new FNCs in strict compliance with the TOG-approved priorities list, consistent with Navy and Marine Corps programmed and budgeted resources. Typically, fewer than half of the proposed FNCs are funded in any given year due to budgetary constraints of approximately $460 million per annum over the future years defense program (FYDP). Typically, between 12 and 15 new FNCs are approved each year. The FNC program is resourced by a complementary set of budget activity (BA) 2 and 3 research, development, test and engineering (RDT&E) lines in both the Navy and Marine Corps. Figure 3 shows the timeline of the FNC approval process for products begining execution in fiscal year 2019.

The FNC budget is often subjected to naval and congressional budget cuts. In such cases, FNCs or individual products may be delayed until funding can be properly realigned or terminated. In most cases, these actions follow the TOG's priority list. The TOG must approve any deviations to its approved priority list when dealing with budget-related issues.

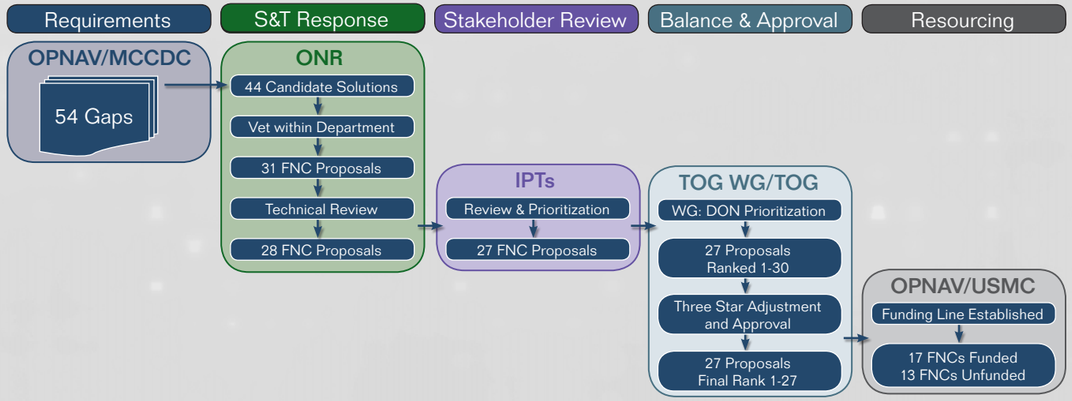



Figure 3 – FNC Proposal Approval Process (POM-19 Example)

ONGOING FNCS

# ONGOING FNCs – EXECUTION MANAGEMENT AND TRANSITION OVERSIGHT

As the execution agent, ONR has implemented an organizational structure for a centrally managed, monitored and controlled FNC program. The key to success lies in the leverage realized by managing the S&T funding. Each year, FNC managers submit annual business plans and updated TTAs for every active product. Compliance with this guidance is required before funding is released for the upcoming fiscal year.

Once the execution year begins, ONR's FNC management team schedules bimonthly status meetings with the technical managers in each department. These meetings review S&T accomplishments and upcoming events, and discuss transition and financial issues. ONR's technical departments submit a technical progress report for each product bimonthly, which addresses S&T development issues for the performers participating in the development. The reports are used to identify S&T execution issues early so corrective actions can be taken.

## TECHNOLOGY TRANSITION AGREEMENTS (TTAs)

The TTA is the fundamental document used to manage FNC product transition. The TTA is a signed document that articulates the commitment of each stakeholder to develop, transition and deploy a product to the fleet/force. It is a negotiated, good-faith agreement of intent between the stakeholders, and is critical to the program. TTAs are required on an annual basis for every product receiving S&T funding in the upcoming fiscal year, as well as products completing S&T development in the current fiscal year.

TTAs are not legally binding contracts; they serve to document intent. Each agreement requires stakeholders to clearly describe the product being developed, specify the threshold and objective performance attributes to be met (e.g., exit criteria), describe the integration strategy used to bring the technology into an acquisition program of record, estimate the funding required for the integration strategy, identify the acquisition funding lines to be used to pay for the product's integration, and describe the plan for securing the funding required to complete the post-S&T maturation. Products are required to have transition funding available prior to the final year of S&T development. ONR provides a TTA template that identifies all of the information required for compliance.

ONR product managers typically prepare draft TTAs and submit them to their transition partners by May 1 for review and update. Fully signed TTAs are due to ONR 03T by July 1, allowing a negotiation period of at least two months. ONR product managers and their transition stakeholders maintain regular contact and keep each other informed of important developments throughout the year to prevent issues from arising during the TTA negotiation period.

TTAs must address the following points:

- What is the product being developed?
- How will it be developed?
- How will success be determined?
- Who will receive the completed product?
- How will the technology be integrated into the fleet/force?
- How much will the transition cost?
- Who will fund the transition, and how will it be funded?
- How and when will the capability be deployed?

TTAs are reviewed by ONR's FNC management team to ensure compliance with the TTA template and to identify issues that will become topics of discussion during the annual transition assessments.

## TRANSITION ASSESSMENT REVIEWS

Each August, resource sponsors convene meetings to review products under their purview and assess the status of their transition paths. Held at ONR and attended by all transition stakeholders, these assessments ensure:

- The S&T development is on track with manageable risk.
- The transition strategy is viable.
- Transition planning is on track per the TTA.
- Transition funding is appropriately aligned to ensure successful S&T integration and eventual deployment to the fleet/force.

During these assessments, ONR managers brief the resource sponsors regarding information contained in the signed TTAs. Issues identified during the TTA process, and any other known concerns (e.g., an unsigned TTA), are discussed to determine the best strategy for resolution. Resource sponsors are required to provide a recommendation to the TOG on whether to continue or terminate S&T development for each product.

## TOG MEETINGS

In addition to approving the S&T capability gaps, the TOG approves FNC investments across the IPT managed capability areas. The TOG meets biannually:

- Each winter, the TOG receives a budget update from the CNR, reviews the recommended FNC refresh list, adjusts the list as required and approves a final set of FNC priorities for the upcoming program objectives memorandum (POM) year.
- Each fall, the TOG reviews the results of the transition assessments. It receives an FNC budget update from the CNR; makes a final decision on products with unresolved transition issues; and approves adjustments to the FNC program based on product terminations, adjustments or other S&T development issues.

The TOG adjudicates all major FNC program issues and approves any changes to the program as required to facilitate the transition of products to acquisition programs.

# COMPLETED FNCs

## TRANSITION REVIEW BOARD (TRB)

Following the successful completion and subsequent delivery to the acquisition community of a product at a technology readiness level (TRL) of 6 (i.e., system/subsystem model or prototype demonstration in a relevant environment), additional engineering, development and testing are required to mature the technology, so the new capability can be deployed into the fleet/force.

To track the FNC program's effectiveness in deploying technologies to the warfighter, a transition review board (TRB) conducts an independent and objective annual status assessment of all products delivered by ONR to its acquisition partners.

The definitions of transition and deployment are critical to understanding how the success of the FNC process is determined. Transition requires a shift in development and funding responsibility from ONR to the acquisition program manager. Deployment involves the acquisition manager's delivery of a fully supported product or capability into the fleet/force. The TRB's objective is to determine if transitioned products have been successfully integrated into programs of record and deployed.

The TRB consists of senior Navy and Marine Corps Reserve officers with relevant experience and expertise across the requirements, acquisition, S&T and/or test and evaluation communities. Convening annually at ONR in July, the board contacts and engages the acquisition program offices (or other transition offices) as documented in each TTA.

The TRB assesses the transition status of completed products and the status of transition as follows:

- Deployed into the fleet/force
- Fully funded and being integrated into the target transition program
- Under consideration to be integrated without a fully funded or committed plan
- Failed transition

All products are evaluated annually until they either "deploy" or "fail to deploy." The TRB further assesses failed products to determine the cause of the failure, and determines if value is derived from the failed transition. If the failed transition is determined to have value, the TRB categorizes the value as:

- Reduced acquisition program risk (didn't transition, but helped the acquisition program make an important acquisition decision)
- Technology leveraged for follow-on S&T efforts
- Available for future transitions

The TRB issues an annual report, which is reviewed with the CNR, who in turn, presents the results to the TOG. The report also is made available to FNC stakeholders via a collaborative website. As seen in Figure 4, 60 percent of all transitioned products are assessed as either deployed or still being further engineered and integrated within an acquisition program of record (i.e., with acquisition). Of the 40 percent of products that did not deploy, 52 percent were found to have provided significant value to the Department of the Navy. Others (48%) remain "on the shelf," where the product may be leveraged in future technology development proposals or in acquisition programs if appropriate. The recent trend has shown an increase in the success rates of transitioned products—likely due to process improvements, which added rigor to the proposal and transition assessment processes.

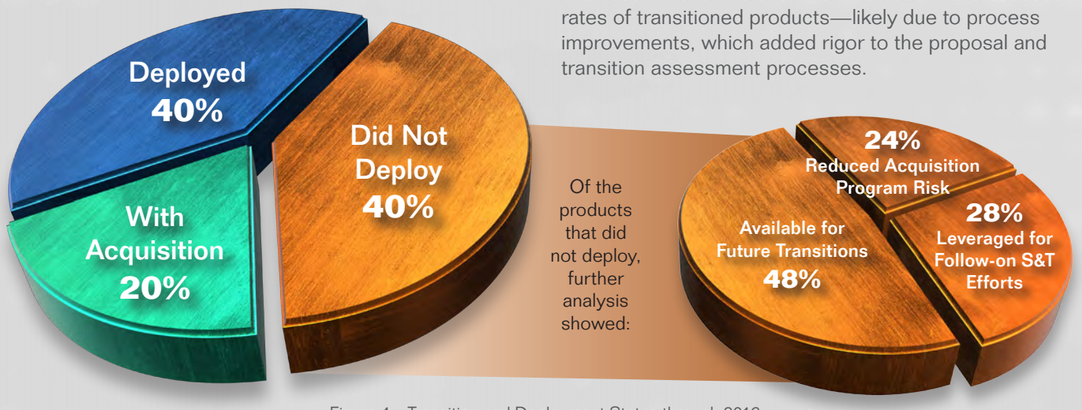



Figure 4 – Transition and Deployment Status through 2016





# TRAINING, OUTREACH AND DOCUMENTATION

## TRAINING

ONR 03T provides training courses for stakeholders, both internal and external to ONR, emphasizing their roles and responsibilities within the FNC program. The courses are:

- FNC Program Overview and Refresh Process—A highlight of the structure, oversight, requirements, investment strategy, program reviews and major events of the FNC program, including a review of the FNC proposal process from requirements development through approval, focusing on engagement points and collaboration within the Department of the Navy.
- Transition Management—A deeper look into TTAs, transition assessments and the mechanisms that ensure FNCs have a viable path to the fleet/force.
- Managing FNCs at ONR—The training course for ONR program managers and their support personnel, focuses on budget and financial management, organizations and processes, and manager responsibilities.

The training modules each last about an hour, with the exception of "Managing FNCs at ONR," which is a two-hour course. ONR's training courses are available to all Navy and Marine Corps stakeholders who participate in the FNC program, including support contractors, and can be scheduled with ONR 03T upon request. Training is conducted at ONR, the Pentagon and other stakeholder locations, as well as online via Defense Collaboration Services.

## STAKEHOLDER OUTREACH

In addition to training, ONR has an active outreach program to inform and solicit inputs from external stakeholders who have a role or interest in the FNC program. Annually, ONR publishes a report on transition programs, which is aimed at fostering collaboration and coordination among stakeholders. This report, available only to stakeholders with access to the classified network, provides situational awareness of transition-related technology development programs. It provides descriptions, time frames, transition alignment and other information concerning various S&T programs. Its availability is announced to a broad audience, including the Navy and Marine Corps acquisition and resource sponsor organizations. It includes, but is not limited to, the following programs:

- Future Naval Capabilities
- Foreign Comparative Testing
- Innovative Naval Prototypes
- Defense Advanced Research Projects Agency
- SwampWorks
- TechSolutions
- Manufacturing Technology
- Small Business Innovative Research

In the spirit of transparency, the FNC program provides access to a large amount of current and archived documentation about FNC investments via its collaborative website. New-start proposals, program review briefs, TTAs, ONR reports on transition programs, S&T capability gaps, business rules, IPT charters and additional resources are available for download to users with classified network accounts.

## INDUSTRY OUTREACH

In addition to its annual transition reports, the FNC program participates in two large ONR-sponsored events: the biennial Naval Future Force Science & Technology Expo and the annual Navy Opportunity Forum.

The Naval Future Force Science & Technology Expo introduces and advances the awareness of ONR's S&T strategy and program initiatives, including potential business opportunities regarding FNC products. Current S&T focus areas are discussed in order to broaden ONR's partnership base and explore new ideas.

The Navy Opportunity Forum showcases technologies developed by small businesses funded by the Navy's Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) programs. These programs involve technologies that address naval needs across the S&T spectrum. FNC and product managers review SBIR projects of interest to identify new, complementary or alternate technology development paths. They attend the forum to discuss technologies of interest with small businesses.

## FNC PILLARS

AIR WARFARE

INFORMATION WARFARE

EXPEDITIONARY MANEUVER WARFARE

SURFACE WARFARE

UNDERSEA WARFARE

CAPABLE MANPOWER

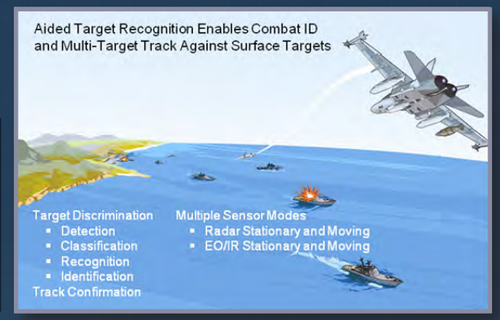
ENERGY LOGISTICS AND PLATFORM ENABLERS

FORCE HEALTH PROTECTION

The air warfare pillar focuses on developing new technologies that align to acquisition programs of record principally under the purview of the director of Air Warfare (OPNAV N98). Focus areas of interest include extended-range targeting; rotor-craft advanced protection from infrared and electro-optic threats; radar electronic attack protection; intelligent collaborative engagements; multifunction capabilities for missile warning sensors; advanced threat aircraft countermeasures; technologies that discriminate and provide terminal guidance for weapons that engage moving targets; numerous advanced weapons technologies; high-altitude anti-submarine warfare (ASW); placement and operation of active ASW distributed systems; data exfiltration and networked platform interaction; advanced topcoat systems for air vehicles; air platforms safety and affordability technologies; virtual-constructive representations on live avionics displays for training; and dynamic adaptive and modular training for unmanned aerial systems. An example of a successful air warfare FNC is provided on the next page.








# Strike Accelerator

### SYNOPSIS

Strike Accelerator reduces pilot workload by automating the recognition and identification of surface targets in high-density littoral environments. The software, targeted for the F/A-18E/F Super Hornet and the EA-18G Growler, aims to accelerate the kill chain by providing real-time, hierarchical Aided Target Recognition (AiTR).

### OVERVIEW

Target recognition and identification is a difficult and time-consuming task still performed manually by pilots and aircrew. In littoral waters with high shipping density and the presence of other noncombatants, it becomes even harder. With Strike Accelerator's AiTR software, combat identification and multi-target tracking functions will be performed up to one-hundred times faster than before—a difference between minutes and seconds. This will allow for the targeting of precision weapons against multiple stationary or moving targets in a single pass by one platform. By reducing the data search and decision-making the aircrew must complete, Strike Accelerator will enable a faster traversal of the kill chain and improve the success rates of engagements.

Strike Accelerator's design allows for an optimal balance of automation and aircrew control. Stationary and moving maritime target data are provided to the system by the aircrafts' radar and optics pod. The advanced AiTR algorithms and multi-look, adaptive and hierarchical architecture then process the raw data inputs and produce outputs at four levels of fidelity for the pilot and aircrew. At the lowest fidelity level—target detection—targets are distinguished from non-targets in the sensor data. Target discrimination outputs then increase in fidelity from classification to recognition and finally to the highest-fidelity level of identification. Discrimination at all levels must pass a quality test in order to be promoted to the air crew. If they pass, the high-confidence outputs are quickly delivered to the air crew, who make the final target determination and engagement decision.

Strike Accelerator is targeted for the F/A-18E/F Super Hornet and the EA-18G Growler, though its algorithms will function on any platform that has adequate processing capabilities, such as the Distributed Targeting Processor (DTP) and Active Electronically Scanned Array (AESA) radar (APG-79). Inputs to stationary and moving maritime target data will be provided to Strike Accelerator by the AESA radar and Advanced Targeting Forward Looking InfraRed (ATFLIR (ASQ-228).

### BENEFITS TO THE WARFIGHTER

- Reduces in-cockpit workload through hierarchical, adaptive target discrimination
- Improves speed and accuracy of in-cockpit combat identification and multi-target tracking
- Improves success of engagement by direct-attack and stand-off weapon systems

## FNC PILLARS

AIR WARFARE

INFORMATION WARFARE

EXPEDITIONARY MANEUVER WARFARE

SURFACE WARFARE

UNDERSEA WARFARE

CAPABLE MANPOWER

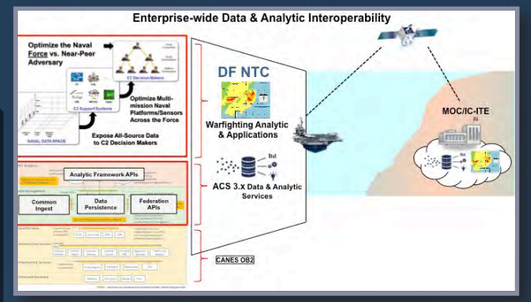
ENERGY LOGISTICS AND PLATFORM ENABLERS

FORCE HEALTH PROTECTION

The information warfare pillar focuses on developing new technologies that align to acquisition programs of record principally under the purview of the deputy dhief of Naval Operations (OPNAV N2N6). Focus areas of interest include next-generation command, control-and-decision support services; force-level integrated fires, real-time engagement coordination and performance estimation; next-generation countermeasure technologies for ship missile defense; extended-distributed weapons coordination; cross-field processing and smart use of distributed systems; network-collaborative precision navigation and timekeeping; communications and interoperability for integrated fires; a shipboard panoramic infrared and electro-optic cueing and surveillance system; a tactical cloud that exploits cross-warfare area data sources; electronic warfare battle management for surface defense; autonomous-persistent tactical surveillance; mission-based waveform controls and networking; satellite vulnerability mitigation; and comprehensive maritime operational and navigational planning via decision-support services. An example of a successful information warfare FNC is provided on the next page.








## Data-Focused Naval Tactical Cloud

### SYNOPSIS

Today's Navy intelligence analysts are drowning in data. Data-Focused Naval Tactical Cloud (DF NTC) is being developed to address this issue. The big data analytic framework developed by ONR-funded investigators will automatically ingest, index and process multi-source intelligence data to feed adaptive analytics supporting warfighter decision-makers.

### OVERVIEW

Intelligence, surveillance and reconnaissance (ISR) functions are critical to the warfighter's success across all maritime mission areas. ISR data is required to establish situational awareness, allowing the fleet to effectively target enemy combatants and perform several other mission-critical tasks. However, this growing demand for ISR data within the fleet from tactical and National Technical Means (NTM) sources has resulted in big data repositories that are overwhelming intelligence analysts and their ability to process them.

To bridge this gap, ONR is developing a set of specifications, support tools and advanced analytics, which will provide analytic capabilities for the Distributed Common Ground System-Navy Increment 2, enhancing ISR support to warfighter decision-making in challenging and complex warfighting scenarios. The overall objective of this effort is to achieve unprecedented access to data; to extract new and deeper insights by exploiting data in new and innovative ways.

Data-Focused Naval Tactical Cloud will field a set of all-source analytics to automate "human in/on the loop" Operational Intelligence (OPINTEL) across echelons supporting Anti-Submarine Warfare (ASW), Expeditionary Warfare (EXW), Integrated Air Missile Defense (IAMD) and Integrated Fires missions. These analytics aim to achieve Joint Directors of Laboratories (JDL) Level 3/4 fusion with predictive enemy course of action (ECOA) and intent supporting OPINTEL, and improve the ability of Naval Warfare Area commanders to more effectively and rapidly plan, assess and execute operations.

### BENEFITS TO WARFIGHTER

- Increases the completeness and accuracy of the battle space picture through predictive analysis and ECOA development
- Provides the auto-determination of ECOA operational impacts to the plan due to enemy activities and blue force issues
- Reduces the decision-making timeline

## FNC PILLARS

AIR WARFARE

INFORMATION WARFARE

**EXPEDITIONARY MANEUVER WARFARE**

SURFACE WARFARE

UNDERSEA WARFARE

CAPABLE MANPOWER

ENERGY LOGISTICS AND PLATFORM ENABLERS

FORCE HEALTH PROTECTION

The expeditionary maneuver warfare pillar focuses on new technologies that align to acquisition programs of record principally under the purview of the deputy commandant for Combat Development and Integration (CD&I) and the Director of Expeditionary Warfare (OPNAV N95). These technologies are developing new capabilities that focus on areas such as autonomous unmanned surface vehicles for mine warfare, off-board refueling and data transfer for unmanned surface vehicles; automated data analysis for expeditionary mine-countermeasures; an advanced undersea weapon system; a ground-based, air defense, on-the-move, high-energy laser system; advanced sonar technology for high clearance-rate mine countermeasures; defense of harbor and near-shore naval infrastructure against asymmetric threats; a fuel-efficient medium tactical vehicle replacement; renewable and sustainable expeditionary power; exchange of actionable information at the tactical edge; actionable intelligence enabled by persistent surveillance; high-bandwidth free-space laser communications; advanced shipboard water desalination; a new densified propellant for fire from enclosed/confined spaces; spectral and reconnaissance imagery; a new azimuth and inertial navigation system; counter radio-controlled, improvised-explosive-device electronic warfare; a new precision universal mortar; and individual warfighter lightweight protective armor. An example of an expeditionary maneuver warfare FNC success is highlighted on the next page.



EXPEDITIONARY MANEUVER WARFARE



## Advanced Power Generation

### SYNOPSIS

The Ground Renewable Expeditionary Energy Network System, or GREENS, is a portable hybrid photovoltaic and battery power system ruggedized to provide power to Marines in remote locations and forward operating bases. GREENS saves fuel and money, reduces the frequency of resupply missions and supports the Marine Corps objective of generating more power in the field. GREENS is the main deliverable of the Advanced Power Generation product. Also delivered is a single-person-portable 750W generator capable of extending the mission endurance of squads in the field.

### OVERVIEW

With higher and higher energy usage accompanying the growth of battlefield technology, Marines have become critically dependent upon fuel logistics. By using renewable energy instead of consuming fossil fuels, GREENS reduces the burden on a difficult supply chain and lessens the need for costly, and often dangerous, resupplies of Marines in forward positions. The system consists of 1680-watt scalable solar arrays, a controller system and energy storage capabilities that provide 300 watts of continuous power for electrical equipment in forward operating bases. GREENS can also be hybridized with generators and vehicle power to provide intelligent, small-scale energy management, increasing the efficiency of fuel-based energy.

After successfully completing a demonstration through the Experimental Forward Operating Base (ExFOB) program at Quantico, GREENS was procured and fielded in Afghanistan in 2010. The systems were put to use immediately, powering the electrical equipment of Marines in the most remote areas of conflict. Some, such as India Company, from the 3rd Battalion, 5th Marine Regiment, were able to power their bases entirely through solar energy.

The GREENS program has continued to refine the system since its first deployment. Through the Department of the Navy's Small Business Innovation Research program, the development of GREENS 2.0 has focused on reducing the weight and size of the system while increasing the amount of energy harvested. The latest prototype reduced the size and weight of the original modular solar technology version by almost 75 percent.

### BENEFITS TO THE WARFIGHTER

- Increases the use of renewable energy sources
- Decreases the need for fuel-supply convoys
- Fills the energy gap between large power generators and batteries

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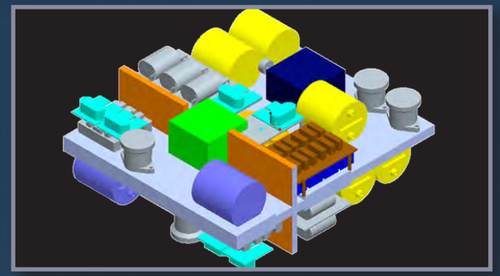
The surface warfare pillar focuses on developing new technologies that align to acquisition programs of record principally under the purview of the director of Surface Warfare (OPNAV N96). Focus areas of interest include a new hyper-velocity projectile; full-sector torpedo defense; anti-torpedo torpedo engagement timelines; cooperative networked radars; sonar automation; radar resource management for integrated air and missile defense; periscope detection and discrimination; high-fidelity, active-sonar training; anti-ship missile defense; long-range detection and tracking; naval interceptor improvements; unmanned systems common control; digital array radars; lightweight torpedoes; multifunction shipboard-energy storage and power distribution; high-power, solid-state circuit protection; compact power conversion for advanced surface machinery systems; resilient hull and infrastructure mechanical and electrical security; phased array antennas; human injury and treatment models; gas turbine upgrades that lower cost and improve reliability; aluminum-alloy corrosion control and prevention; affordable common radar architectures; total-ship-survivability damage tolerance and recoverability; adaptive training to enhance individual and team learning; and platform design and acquisition tools that reduce manpower. An example of a successful surface warfare FNC is provided on the next page.







## Bi-Directional Power Control Module (BPCM)

### SYNOPSIS

The BPCM increases the amount of power available for the computers and electronics required by Sailors and Marines to do their jobs. It also enables new configurations for shipboard energy storage and power distribution, and increases the options available for emergency or distributed generation and energy storage.

### OVERVIEW

As today's ships and submarines carry an increasing number of computers and electronics to help Sailors and Marines perform their jobs, more power is needed to run these systems. To meet this need, a Bi-Directional Power Converter (BDPC) is being developed under the Compact Power Conversion Technologies FNC. The FNC's overarching goal is to increase power density in naval shipboard electrical power conversion applications.

BPCM meets this objective by increasing the amount of power available by two to three times, while also creating new configurations for shipboard energy storage and power distribution. This creates a power system for vessels that is potentially more capable and efficient than current systems.

Unlike conventional systems, the BPCM is bi-directional, meaning that power can flow in either direction to supply or store it. The versatility of this design allows it to be employed in a multitude of applications and meet the requirements of different system interfaces. Specific near-term applications include operation as the source converter for the new Air and Missile Defense Radar and the energy storage management system for the USS Arleigh Burke (DDG 51). Other benefits include increasing options for generating emergency power and energy storage integration concepts. Present estimates indicate that the BDPC product will meet the threshold power density metric, which is twice the power density of similar equipment found on the Zumwalt-class destroyer (DDG-1000).

BPCM will align with the Navy's Next-Generation Integrated Power Systems product, which was created to support increasing power demands by maintaining system reliability even when a component or the whole system isn't working.

### BENEFITS TO THE WARFIGHTER

- Allows power flow from any devices connected to the power supply back to the circuit power supply
- Increases the number of options available for emergency or distributed generation and energy storage

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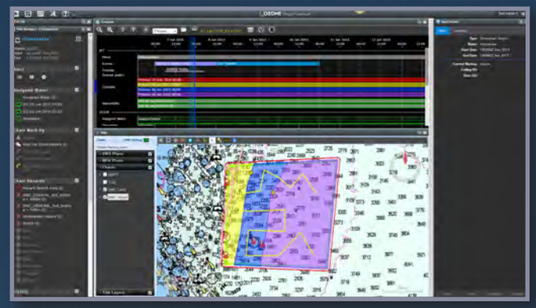
The undersea warfare pillar focuses on developing new technologies that align to acquisition programs of record principally under the purview of the director of Undersea Warfare (OPNAV N97). Focus areas of interest include extended-range, modular, undersea heavyweight vehicles for submarine-launched torpedoes; coherent electronic attack for submarines to increase survivability; torpedo common-hybrid fusing systems; a vector sensor towed array and signal processing; situational panoramic infrared sensors for protection in port and restricted waters; rapid and covert surveillance; electronic sensors for detection of low probability of intercept periscope detection radars; torpedo advanced propulsion systems; simultaneous transmit-and-receive capabilities for submarines; scalable integrated-radio-frequency systems for undersea platforms; electronic warfare tactical-decision aids; tools for predicting array-operational loading and distribution; acoustic damping systems; corrosion-mitigation technologies that increase operational availability; an affordable and modular panoramic photonics mast; a compact hyper-spectral scanning imager and low-light level video camera; an advanced material propeller; an unmanned aerial system control station; adaptive training for submarine navigation and piloting teams; and information architectures for improved decision-making. An example of a successful undersea warfare FNC is provided on the next page.







# Display Information with Uncertainty: Mission Planning Application

### SYNOPSIS

The Mission Planning Application (MPA) is an intuitive, easy-to-operate software toolset that supports comprehensive maritime mission planning through the use of algorithms and displays during the creation of submarine and surface ship navigation and tactical plans.

### OVERVIEW

Sailors used to spend days or even weeks planning a successful navigation route for a mission. They collected maps and charts, analyzed them, double-checked them and cross referenced information that came in various hard copy and digital forms. Any re-planning was equally time-consuming. Through the capable manpower pillar, ONR developed the MPA to improve this process.

Through partial automation and use of apps and widgets, the new software combines multiple chart data sources to produce an accurate picture of a submarine's intended transit path on one display. A navigation plan can be checked for quality and rule violations at any time using a one-click "easy" button that analyzes all chart and transit data relative to defined zones and hazards. The software can review thousands of chart markings in a fraction of the time required by the legacy process of manually zooming in and out of each chart, and visually searching for each and every marking.

Additionally, MPA includes a timeline and multiple tactical decision aids. Ship events (e.g., engineering, training, watch bill, etc.) populate the timeline to allow crewmembers to understand where and when each event will occur on the map and to de-conflict future events. The software allows the crew to plan, brief, execute, and assess the various aspects of a mission plan in a single software application, reducing the workload required by the legacy system by 2.5 orders of magnitude. This affords the crew more time for critical thinking to evaluate multiple courses of action and make informed decisions.

The submarine force has taken ownership of this capability and is investing significant resources to distribute it across all submarine platforms. The first MPA spiral software version, part of an Advanced Processor Build (APB), has been installed on several submarines. Submarine crews returning from deployment have rated the software favorably. A second spiral software version is adding significantly more capability to improve navigation planning. The APB MPA software will be installed on U.S. and Australian submarines after formal testing is completed.

### BENEFITS TO THE WARFIGHTER

- Increases navigation safety due to computer-assisted searches of digital chart information to ensure comprehensive hazard identification
- Significantly reduces the time needed to generate safe and effective navigation and operational plans
- Provides a better crew understanding of operational plans through the use of integrated geographic and temporal information displays
- Reduces the training burden through the use of streamlined visual workflows to guide complex task performance

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ENERGY LOGISTICS AND PLATFORM ENABLERS

FORCE HEALTH PROTECTION

The capable manpower pillar focuses on developing new technologies that align to acquisition programs of record principally under the purview of deputy CNO for Manpower, Personnel, Training and Education (OPNAV N1) and Marine Corps Training and Education Command (TECOM). Focus areas of interest includes the future integrated training environment for integrated air and ground operations of the marine air-ground task force; learning continuum and performance aids; manpower, personnel and training strategic planning; simulation tailored training and assessments; decision-making and learning management systems; an assessment process for the selection of unmanned aerial systems personnel; a simulation toolset for analysis of mission, personnel and systems that includes techniques to optimize manpower planning; next-generation perceptual-training systems and tools; augmented immersive-team training; behavioral and performance analysis for intelligent training; advanced technologies for automated performance assessment in games and tools for game-based training; and assessment of human performance. An example of a successful capable manpower FNC is provided on the next page.





## Augmented Immersive Team Training (AITT)

### SYNOPSIS

AITT is developing and demonstrating software, hardware and knowledge products to augment live squad training with visual and auditory representation of battlefield effects in support of the Squad Immersive Training Environment (SITE) and Force on Force Training System (FoFTS) programs. This technology product is in direct support of Force on Force (FoF) training capabilities in the Instrumented Tactical Engagement Simulation System (ITESS) under the purview of the program manager for Training Systems (PM TRASYS) under the Marine Corps Systems Command and the Training and Education Command (TECOM) Training and Education Capabilities Division (TECD).

### OVERVIEW

This augmented-reality simulation training system, when fielded, will provide improved infantry squad training with simulated battlefield effects that include call for fire, Type II Close Air Support and other training tasks. It addresses a SITE gap for battlefield effects in Force-on-Force training. The prototype system has been evaluated and engineering estimates have been completed to develop the technology and provide an initial schoolhouse capability during fiscal year 2018.

### BENEFITS TO THE WARFIGHTER

- Increases the effectiveness of pre-deployment training by providing enhanced and readily available training opportunities at the home station
- Provides increased training availability (e.g., sorties) when unavailable (e.g., weather), and has a great potential for reducing the costs of training (e.g., ammunition, gas, etc.)
- Enhances sustainment of pre-deployment training package skills by providing enhanced and readily available training opportunities at home station

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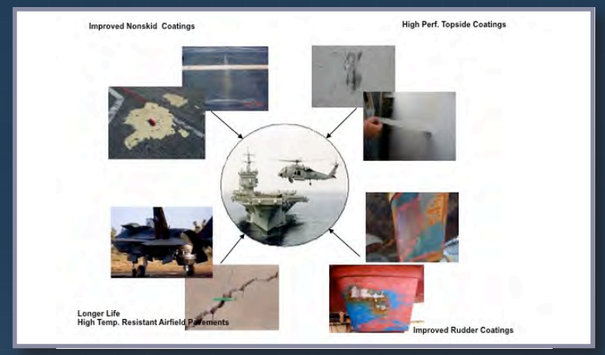
FORCE HEALTH PROTECTION

The energy, logistics and platform enablers pillar focuses on developing new technologies that align to acquisition programs of record principally under the purview of the deputy CNO for Fleet Readiness and Logistics (OPNAV N4). Focus areas of interest include vertical and horizontal movement of logistics resupply materials on ships; high-speed sea base-to-shore connectors for resupply; small-to-large-vessel at-sea transfer sea-base connector capabilities for personnel and material; lightweight, cost-effective and motion-accommodating ramp systems for vehicle transfer operations between ships and the shore; advanced mooring systems for automated mooring and positioning of ships during ship-to-ship transfer operations; an environmental ship motion-forecasting capability able to forecast and predict ship motions in order to determine windows of opportunity for inter- and intra-ship materials and personnel movements; new materials and designs for turbine engines that improve cost, fuel efficiency and performance; maintenance reduction technologies for topside, nonskid and ship rudder coatings that extend service life; and quality metal additive-manufacturing design tools and process controls. An example of a successful energy, logistics and platform enablers FNC is provided on the next page.








# Maintenance Reduction Technologies

### SYNOPSIS

The Maintenance Reduction Technologies FNC consists of four corrosion-control and prevention products that significantly improve operational readiness and service life. The products include new and improved topside coatings, airfield pavements, nonskid coatings and ship-rudder coatings.

### OVERVIEW

The Maintenance Reduction Technologies FNC was developed to significantly reduce maintenance and repair costs, improve readiness and safety, and enable recapitalization of fleet assets. The following four products were successfully developed and deployed to the fleet:

High performance topside coatings consist of low-solar-absorbing topside/freeboard coatings with enhanced color and gloss stability. The previous freeboard topside camouflage coating exhibited an 18- to 24-month service life before requiring repainting; this solvent-free solution doubles to triples the service life, reduces the cost of depot-level applications by 28 percent and increases camouflage retention by 50 percent. The coatings are expected to provide a net present value (NPV) of $153M over 30 years and a return on investment (ROI) factor of 39.

High performance airfield pavement is a heat-resistant concrete that provides a land-based airfield for the Joint Strike Fighter (JSF, F-35B) and other aircraft. The new materials increase the service life of airfield pavements by a factor of five over previous materials, which spall under the intense heat of vertical take-off and landing (VTOL) and short take-off and vertical landing (STOVL) operations. The new pavements are expected to provide a NPV of $126 million over 30 years and an ROI factor of 36.

Improved Nonskid Coatings enhance durability and thermal resistance in support of JSF operations. The thermal resistance of these new solutions allows for JSF operations that were not previously feasible under the Navy's limited base of approved nonskid coatings. The new coatings increase gloss and color stability by 50 percent, double the service life and are expected to provide a NPV of $208 million over 30 years and an ROI factor of 50.

Improved ship rudder coatings with enhanced cavitation and erosion resistance provide a minimum of 2-5 years of service life for DDG 51-class rudders. The Navy spends $25,000-200,000 per ship every six to 18 months for rudder and rudder coatings repair on DDG 51-class destroyers. By improving the service life of the coatings, this effort is expected to provide a NPV of $565 million over 30 years and an ROI factor of 112.

### BENEFITS TO THE WARFIGHTER

- Increases service life of coatings and pavements
- Decreases maintenance hours
- Increases operational availability of assets

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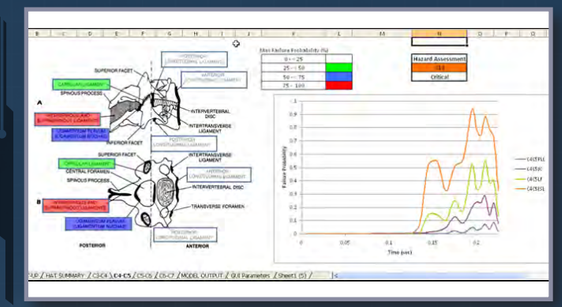
The force health protection pillar focuses on developing new technologies that align to acquisition programs under the purview of the Defense Health Agency and under the oversight of the surgeon general of the Navy (OPNAV N093). Focus areas of interest include technologies enabling new practices, procedures, medical devices and pharmaceuticals for the improvement of personnel performance, casualty prevention and combat casualty care. These technologies aim to decrease the logistical burden of forward medical operations; mitigate and prevent combat-related illness and injury; and provide cutting-edge medical applications for Navy and Marine Corps warfighters on land, at sea and in the air. The pillar addresses a broad range of diverse technology areas that include biological, physiological, computational, biomedical and engineering disciplines. The objective of the FHP pillar is to mature basic research concepts into prototype devices, treatments, protocols and software/hardware applications that can be transitioned to the fleet/force for the benefit of tomorrow's warfighter. Recent efforts have included injury prediction modeling and simulation tools; closed-loop systems for en route care and casualty monitoring; treatment of hypoxia through broadly applicable inhaled emergency medication; methods of pharmacologic resuscitation; the development of hemostatic agents; medical data prioritization and throttling in constrained environments; and the mitigation of traumatic brain injury through brain cooling treatment. An example of a successful force health protection FNC is provided on the next page.







## Models of Head and Cervical Spine (MHCS)

### SYNOPSIS

MHCS is an anatomically based probabilistic risk-prediction model used to mitigate head and spinal injury due to blast overpressure and acceleration forces, such as those caused by crash and ejection. The model enables physiologically based design guidelines for clothing, seating and head- or body-mounted equipment that lessen the severity of trauma to the head and body from exposure to these forces.

### OVERVIEW

With a finite-element modeling tool for personal protective equipment (PPE) based upon human physiological responses—not just those of a mannequin or crash test dummy—design criteria can now be optimized to protect aviators from blast and acceleration forces. MHCS provides the first quantitatively validated tool to develop life-support design criteria based on age- and size-appropriate human physiology that accounts for variability due to gender, anthropometry, posture and loading.

In order to create and then validate the model, numerous studies were conducted and consolidated. Such studies included the determination of physical parameters of body mass; the determination of the material constitutive properties of hard and soft tissue and their failure and sub-failure responses; and analyses of cervical loading due to ejection, wind blast and crash events. Through MHCS research, several advancements were made in the field, including a new back ejection-injury test procedure; a new methodology for determining tissue material properties; regional differences and force transmissibility; and a revision of an international standard (ISO-2631.5) on vibration exposure and measurement.

MHCS comes with a Hazard Assessment Tool, or HAT, that correlates predicted anatomic injury to occupational disability. The acquisition process uses hazard assessments in programmatic decision-making. Assignment of injury severity is a fundamental part of performing a hazard assessment on equipment fielded into the fleet. However, injury severity implies a probability of occurrence or risk that needs to be part of the design process and employed in the assessment of occupational injuries for longer-term exposures. The HAT is able to assess the forces on bodily tissue and structural elements and generate a localized, specific failure probability, thereby allowing for a more comprehensive health hazard assessment.

MHCS was delivered to NAVAIR PMA 202 in fiscal year 2014 and immediately assisted in making critical procurement decisions. In its first use, the model demonstrated its value by identifying the best choice of a helmet-mounted display for a particular aircraft. Of the five helmets modeled, four were determined to cause severe injury to the aviator upon ejection. The other, if modified based upon the model's output, provided a usable system. With the MHCS, program managers were able to avoid selecting a dangerously flawed helmet design for use by naval aviators.

### BENEFITS TO THE WARFIGHTER

- Provides physiologically relevant guidelines to develop PPE
- Determines engineering tradeoffs and potential hazards of PPE
- Reduces occupational hazards through better protection



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