Naval Research Advisory Committee Report

Life Cycle Technology Insertion

July 2002

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14. ABSTRACT
It is critical for the Navy to exploit technology to create war-fighting capabilities as quickly and efficiently as possible. The NRAC was tasked to review the processes for identifying and exploiting new technology, identify any related problem areas and deficiencies, and make recommendations to improve these processes.

The study examined: processes for early identification of promising new technology, application and feasibility demonstrations, systems engineering and technology integration, and the operational use and life-cycle support of technology as used in fielded systems. The panel also addressed management and acquisition practice issues that impact the effective insertion and operational use of technology.

The panel interviewed major "stakeholders" responsible for developing, integrating or using new technology. As a result, they identified: barriers that limit the effectiveness of technology insertion, "best" or "enabling" practices that promote technology insertion, and recommendations to improve the process for DON to efficiently harvest and transition new technologies.

These recommendations included strengthening the systems engineering processes and developing "gain sharing" incentives for program managers to insert technology. Further, Future Naval Capabilities should be reviewed to improve focus and prioritization. Finally, the panel recommended establishing a Naval Technology Insertion Executive Office to oversee and promote all facets of technology insertion.

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life cycle, technology insertion, technology development, new technology, demonstration, technology transition, interoperability, technology refresh

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Naval Research Advisory
Committee Report

Life Cycle
Technology Insertion

JULY 2002

OFFICE OF THE ASSISTANT SECRETARY OF THE NAVY
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Executive Summary

United States defense strategy is critically dependent on its ability to exploit advanced technology. History has shown that technology can act as a major force multiplier and provide operational superiority against adversaries and the threats they present to the American way of life. It is critical for the Department of the Navy (DON) to exploit technology to create war-fighting capabilities as quickly and efficiently as possible. To that end, senior Navy and Marine Corps leadership is concerned that the processes for both identifying and exploiting new technology be operating at maximum efficiency.

What is desired is timely delivery of cost effective war-fighting capabilities to our Fleet and Fleet Marine Forces. This study was undertaken at the request of the Assistant Secretary of the Navy for Research Development and Acquisition ASN(RD&A) to:

The Problem

- Review the current process for technology exploitation,
- Identify problem areas and deficiencies if any, and
- Make recommendations to achieve improvements in these processes.

Scope of Study

The study included identifying problem areas and making recommendations for improvement in all phases of technology development from early discovery through development to operational use. This included examining processes for:

- Early identification of promising new technology,
- Application and feasibility demonstration of technology,
- Systems engineering and integration of technology into war-fighting systems, and
- Operational use and life-cycle support of technology as used in fielded systems.

The study was intended to address transition processes for both naval and commercially developed technologies. The study was not however limited to just examining technical issues. It also addressed management and acquisition practice issues which impact the effective insertion and operational use of technology. Some of the questions to be addressed included:

- How can early awareness of promising new technologies be ensured?
- Are technology transitions tightly coordinated with real operational requirements?
- Are technologies and the associated system concepts proposed cost effective and has a quantifiable business case been conducted?
- Are we ensuring that technology transitions are really providing useful capability improvements for the warfighter?
- Are capability improvements supportable in the field from a cost perspective?

- Does the technology transition process ensure that technology transition is occurring at a pace which provides capability when needed?

Process for Identifying Barriers to Technology Insertion, Best Practices and Making Recommendations

The study was heavily oriented around "fact finding." The process focused on interviewing major "stakeholders" in the technology insertion process at various stages of technology development. The stakeholders included representatives from:

- The Office of Naval Research (ONR),
- Acquisition Program Managers,
- Fleet and Fleet Marine Force (FMF) users,
- Defense industry prime contractors,
- Navy Warfare Laboratories,
- Operational Test and Evaluation Force (OPTEVFOR),
- Navy Comptroller,
- Office of the Chief of Naval Operations (OPNAV), and
- Systems Commands.

The Life Cycle Technology Insertion (LCTI) Panel was also fortunate to benefit from having a set of members with a wide range of hands-on experience pertinent to this topic. Panel members included senior operations managers from industry, technologists from both government and academia, former flag-level operations and staff officers from both the Navy and Marine Corps, and several members with previous experience in OPNAV and Office of the Secretary of Defense (OSD). All panel members have been or are currently stakeholders in the technology insertion process.

Based on the results of extensive fact-finding, and the diverse experience of its panel members, the LCTI Panel made a number of key observations and identified key recommendations for improvement.

Principal Observations

The study panel made a number of key observations. These fall into two categories. "Barriers" which the panel felt currently limit the effectiveness of technology insertion and "enabling practices" which equate to "best practices" which the panel felt should be actively encouraged and emulated.

Some of the principal problem areas or barriers that were observed include:

- In the interest of schedule and cost, technology insertion programs often "short cut" good systems engineering practice particularly with regard to human factors and systems interoperability.

- The DON lacks corporate wide management focus in planning resources, creating and fostering the use of enabling tools, and facilitating management incentives to promote technology insertion.
- Naval technology insertion programs inadequately exploit modern systems modeling and simulation (M&S) tools to better facilitate technology insertion.
- DON's Future Naval Capabilities (FNC) programs are structured with neither the focus or critical mass necessary for success.

The panel also observed that several programs have developed and are exploiting practices which are enhancing technology insertion. These should be replicated where possible. Some of these "best practices" are:

- The use of "open architectures" and commercial standards particularly as regards information technology (IT) insertion,
- The use of innovative competitive acquisition strategies to encourage collaboration and incentivize industry for technology insertion,
- The initial development of some core capabilities as regards generic modeling and simulation tools which could be expanded and more broadly applied to better enable technology insertion.

In particular several programs exemplified best practices. They were:

- The submarine Acoustic Rapid Commercial Off-The-Shelf (COTS) Insertion (ARCI) program whose goal is to improve the U.S. Submarine Force's ability to detect hostile submarines at greater ranges, is using open software architectures and innovative competitive procurement strategies.
- The Navy and Marine Corps Intranet (NMCI) program whose goal is to improve computing and communications capabilities via a private intranet has developed innovative acquisition strategies which incentivize contractors to utilize new technology.
- Finally, the Integrated Command Environment (ICE) lab facility at the Naval Surface Warfare Center (NSWC) in Dahlgren and the Distributed Engineering Plant (DEP), represent the beginnings of some potentially powerful and generic tools sets which exploit M&S in a distributed test-bed environment to better address human factors and systems interoperability issues.

Recommendations

Four major recommendations are made to improve DON process for efficiently harvesting and more effectively transitioning new technologies into operational capabilities. The recommendations are:

1. Strengthen the systems engineering process for technology insertion by developing and using generic sets of systems modeling and simulation enabling tools. The tools are particularly needed to address human factors engineering and system interoperability issues.
2. Develop "gain sharing" incentives for both DON program managers and contractors. In the case of program managers, allow programs to retain a portion of the savings generated through new technology insertion. Additionally, when contractors successfully utilize new technology which results in savings to the government, allow them to maintain their previously negotiated profit and a portion of the savings. Such incentives could greatly offset the natural risks which are inherent in incorporating new technologies and would encourage managed risk-taking.
3. Current FNC programs should be critically reviewed in order to: (a) provide better focus in terms of their measurable objectives, and (b) prioritize to ensure that a sufficient "critical mass" of resources is applied to high priority initiatives.
4. The most important "enabling" recommendation which the panel makes is that the ASN(RD&A) establish a Naval Technology Insertion Executive Office (NTIEO) which: promotes “best practices” and “end-to-end” strategies for LCTI, develops and maintains corporate M&S tools, develops and promotes “gain sharing” incentive strategies, possesses technology exploitation planning, programming and budget authority, promotes harvesting and integrating of technology from all sources, and reviews, prioritizes and funds FNC programs. The specific responsibilities and duties of the office are further detailed later in this report.

Report Outline

- **Tasking**
- **Takeaways**
- **Approach**
- **Background**
- **Findings**
  - **Barriers**
  - **Successes / “Best Practices”**
- **Recommendations**

Outline

This report is broken down into several topic areas. The first area contains a description of the LCTI Panel's tasking. The second area contains a summary of the principal "take-away" observations developed in the study. The third area describes the approach the panel took in conducting the study and the means by which it arrived at its observations and recommendations. The fourth area describes background information which relates to assumptions that were made. The report then describes findings that were made by the panel. Findings are broken into two main categories: "barriers" and "best practices" associated with technology insertion. Finally, the report discusses specific "action-oriented" recommendations developed by the panel.

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Tasking

- **Review / assess appropriate refresh intervals for various technologies critical to Naval weapons & platforms**
- **Perform studies of successful / unsuccessful attempts to provide for life cycle technology insertion (LCTI)**
- **Recommend a design philosophy and strategy for ensuring and optimizing life cycle technology insertion**
- **Assess Navy acquisition practice regarding technology insertion and recommend strategies for improvement**

<u>Tasking</u>

The objectives of this study were:

- First, examine the refresh intervals of various technologies which are critical to naval platforms and weapon systems. This included examining technology categories that were most critical to the future of naval weapons systems.
- Second, examine successful and unsuccessful attempts at life cycle technology insertion by examining all phases of the technology insertion process from early identification of promising technology through final application. This included identifying "barriers" limiting the technology insertion process as well as identifying "best practices".
- Third, recommend a design philosophy and strategy for ensuring and optimizing life cycle technology insertion.
- Finally, recommend strategies for improving the technology insertion process. The study was not limited to only technical issues but also addressed management and acquisition practice issues which impact the effective insertion and operational use of new technology in naval platforms and weapon systems.

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LCTI Study Take-Away

- **LCTI is not happening efficiently - -**
  Problems are more Management than Technical

- **Tech Insertion lacks effective Systems Engineering**
  - **Human Factors / Human Performance Considerations**
  - **System Interoperability**
  - **Spiral development / changing baselines / OT&E**

- **Expand the Use of Modeling/Simulation Enabling Tools**

- **The FNC Process to Transition S&T is Not Working as Planned**

LCTI Needs "End-to-End" Focused Management
"Create a Technology Insertion Executive Office"

LCTI Study Take-Aways

The chart above summarizes several key observations or "take-aways" developed by the panel.

The first was that the technology insertion process does not always happen efficiently as a well managed, institutionalized process. Moreover, problems with the current process are more managerial than technical in nature. As an example, collaboration between technology developers and end-users either does not occur at all or does not occur early enough in the technology insertion process. This leads to the two fold problem of the user not knowing what technology can provide to solve a particular problem and the technologist not knowing the specifics of the problems to be solved and what courses of action to take in developing a particular solution . We also observed that technology insertion is "over-seen" or "managed" by part-time committees which can diffuse decision responsibilities and result in discontinuities in resource application.

Secondly, although a number of programs have certainly developed some "best practices" for technology insertion, many programs tend to treat technology insertion projects as "add-ons" to their main program objectives. The result is that good system engineering practice is often "short cut" in order to save schedule and cost. We found that this is often particularly true as regards human factors engineering and also as regards interoperability considerations between the developed system and existing systems. Additionally it was found that "spiral development", when not conducted properly, often leads to a proliferation of multiple baseline configurations in the fleet. Multiple baselines are problematic from both a training and support standpoint.

Thirdly, the panel found that much greater use could be made of modeling and simulation (M&S) tools to help address early systems engineering issues. This is particularly true in the area of human factors engineering where human performance should be addressed as an integral piece of overall system design. Commercial industry is making productive use of such tools. They have also developed standardized mechanisms for integrating different M&S applications to operate together in a virtually seamless environment. These tools can become an effective enabler for technology insertion by shortening development and integration time and by providing earlier insight into potential technical risk areas. Several new-start programs like DD21 and Joint Strike Fighter (JSF) have, in fact, developed some important core M&S tools which should be expanded and made generally available as a resource for other programs.

Fourth, the panel looked carefully at the processes by which new technology solutions are identified, matured and transitioned to acquisition programs. In this area, the panel found that the FNC process for exploiting naval S&T is not currently working as planned. The primary issues with the FNC process relate to a lack of proper planning, lack of review, lack of involvement by integrators and end-users, and a lack of critical mass in terms of funding. The latter problem is largely due to the large number of FNC programs and attempting to fund too many efforts.

Finally, the panel observed that the current technology insertion process lacks the "end-to-end" focused management necessary to provide the tools, corporate strategies, and incentives to efficiently enable technology insertion through all of its stages. The panel believes that such focus can only be achieved by the creation of a "technology insertion executive office" to develop corporate strategies and facilitate all phases of the technology insertion process in support of naval war-fighting systems. The authority and responsibilities of this office will be detailed later in this report.

NRAC

Study Approach

- **Consider all Phases of LCTI Process**
  Discovery --- Application --- EMD --- Production --- Operations

- **"Fact finding" focused on Major "Stakeholders"**
  S&T ---- PEOs & PMs ---- Fleet & FMF Users
  -- Warfare Labs --- OPTEVFOR
  ---- OPNAV & Comptroller ----
  --- Prime Integrators ------

- **Identify Barriers, "Best Practices", Key Technologies and Recommend Improvements**

Study Approach

In conducting this study the panel tried to consider and address issues in all phases of the lifecycle technology insertion process, from initial technology awareness through its final transition to operational use. The study was heavily oriented around a "fact finding" process which interviewed major "stakeholders" in the technology insertion process. The "stakeholders" included a variety of representatives from the naval S&T community, acquisition program offices, Fleet and Fleet Marine Force (FMF) users, defense industry prime contractors, and commercial industry. Support organizations critical to enabling efficient technology insertion were also interviewed. These included Warfare Centers, OPTEVFOR, the Navy Comptroller and representatives of OPNAV.

The objectives of the fact-finding effort were to identify barriers which limit the efficient utilization of new technology, identify any "best practices" which have been or are being used that might be emulated by others, and recommend actions to be undertaken to improve and facilitate more effective transition of new technology into naval weapons systems and platforms.

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Sources of Information

Industry
- 3M
- Gartner Group
- Boeing Phantom Works
- General Dynamics
- Lockheed Martin
- Micro Analysis & Design
- Mitre
- Newport News Shipbuilding
- Potomac Institute
- Raytheon

Fleet CINC & Navy Staffs
- CNO Strategic Studies Group
- CINCLANTFLT
- SUBLANT
- Navy Comptroller (Nemfakos)
- NWDC
- OPNAV (N125, N43, N6, N76, N77, N78)

Operational Testing
- OPTEVFOR

Acquisition Community
- COMNAVSEA
- DMSO
- DSMC
- PEO IT (NMCI)
- PEO S (DD21)
- PEO Subs (ARCI)
- PEO T (F/A-18)
- PEO TSC (AEGIS)
- PM (JSF)
- PM NTCSS

Government S&T
- AFRL
- CNR
- DARPA
- Marine Corps Warfighting Lab
- Navy-Industry R&D Partnership Conference
- NRL
- NSWC Dahlgren
- NUWC
- ONR Dept Heads / Managers
- Navair STO & Aerospace Mtls Div

Sources of Information

The chart above details the wide range of sources of information that were drawn upon as part of the fact-finding effort. While it was not possible to meet with every possible stakeholder, the sources contacted above were deemed to be important stakeholders through various stages of the technology exploitation and insertion process. These included representatives from government S&T program offices, the naval acquisition program community, fleet users, the Navy Comptroller, OPTEVFOR, OPNAV Requirements and Plans Staff, and industry representatives from both the defense and commercial sectors.

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Panel Membership

Chairperson	
Dr. George Webber	Technical Consultant, Getronics Government Solutions
Vice Chairperson	
Dr. Jerry Smith	Private Consultant
Members	
MajGen Joseph Anderson, USMC (Ret.)	VP Bus Dev, Advanced Navigation & Positioning Corporation
Mr. Jack Bachkosky	Chief Operating Officer, Systems Planning Corporation
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Mr. Joseph Rodriguez	Advanced Program Manager, Raytheon C4I
Mr. Dick Rumpf	President, Rumpf Associates International
Mr. Jim Sinnett	Private Consultant
Dr. Bob Spindel	Director, APL, University of Washington
Mr. George Windsor	Sr. Engineer, Phantom Works, Boeing Company
Executive Secretary	
Mr. William Slowik	Program Manager, Product Innovation Division-ONR

Panel Membership

The LCTI Study was fortunate to be able to benefit from having a set of panel members with a wide range of practical, hands-on experiences pertinent to this topic. The panel members included senior operations managers from industry, technologists from both government and academia, former flag-level operations officers from both the Navy and Marine Corps who have been on the user/receiving end of technology insertion programs, and finally several members with previous experience in OPNAV and OSD plans and programs. All of the panel members have been stakeholders in the technology insertion process at one time or another in their careers.

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Background –
Technology Insertion Objectives

- **Superior force capabilities**
- **Reduced costs**
- **Ability to harvest & integrate technologies in a timely manner from all possible sources**
- **Efficient transition to operational use**
- **Achieve reduced workload/manning & improved quality of service**

We want to deploy/integrate new technology wherever it comes from!

Background— Technology Insertion Objectives

DON's philosophy for technology development, insertion and transition should be based on the need to prepare naval forces for the future. In so doing S&T investments should aim to:

- Create superior force capabilities,
- Reduce the costs of operating forces and weapon systems,
- Reduce workload and manning requirements, and
- Improve quality of service.

Additionally, industry and foreign investment in R&D is now far outpacing U.S. Government spending, particularly in the areas of communications, computers, and power sources. This suggests that examining, appropriating and integrating non-DON technologies which are relevant to naval needs should be emphasized within DON S&T. In this process it is paramount that technology be exploited for operational use in as efficient a fashion as possible. What is desired is to deploy and integrate technology from all sources, including both naval and industry sponsored efforts.

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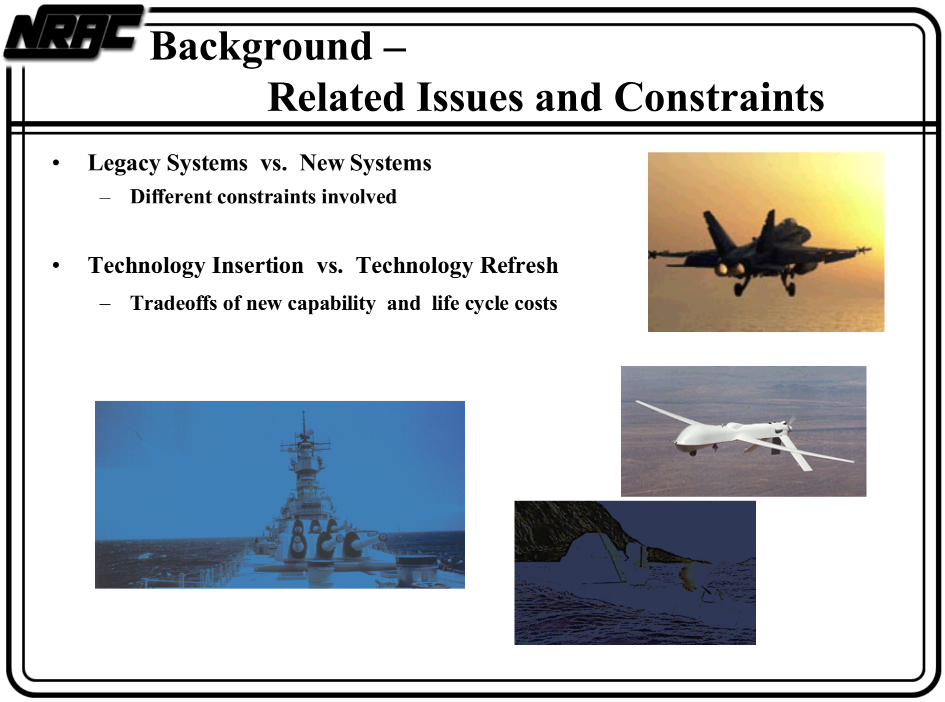

<u>Background — Related Issues And Constraints</u>

In conducting this study, the panel found that there are important differences in the constraints and options for technology insertion. Technology insertion is dependant on whether the system being addressed is an older "legacy" system, or a new system.

New systems have the advantage of presenting a clean slate in terms of options for open systems architectures, physical configurations and innovative new acquisition strategies.

Technology insertion into older legacy systems, on the other hand, is often constrained by existing software architectures, proprietary interfaces, physical space, power provisions and existing acquisition practices.

The panel also found it useful to define the terms "technology insertion" and "technology refresh" to avoid confusion. The term "technology insertion" is generally used when new technology is being applied to develop a new functional capability. The term "technology refresh" generally applies to new technology being used to replace an existing function usually because the previous implementation has either become obsolete or prohibitively expensive to maintain. This study addressed both technology insertion and refresh as a single topic under the general heading of technology insertion.

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Background - Future Acquisition Environment

	New	Legacy
• Number of Systems	Few	Many
• Tech Insertion Potential	High	Low
• Budget (POM-02 FYDP)		
• R&D	6%	4%
• Procurement	16%	23%
• O&S	____	51%
Totals	22%	78%

Tech Insertion Important for both New and Legacy Systems

Background — Future Acquisition Environment

As previously discussed, it is generally much easier to address issues associated with technology insertion for new systems where the freedom exists to utilize systems architectures and generalized solutions that can be optimized to enable future technology upgrades. Unfortunately, one cannot overlook the need to provide for technology enhancements and upgrades for existing legacy systems already deployed.

The chart above illustrates the number of new systems planned versus existing legacy systems and the allocation of budget resources over the next five years in order to maintain required naval force levels. Approximately 78% of the total Naval R&D, Procurement, and Operations budget is allocated for existing legacy systems. Clearly a substantial element of the projected force structure for at least the next decade will have to be made up of current legacy systems. There simply isn't enough money available to make wholesale replacements with new systems. For this reason the panel concluded that we have to be able to facilitate life cycle technology insertion and address the particular issues and constraints associated with legacy systems.

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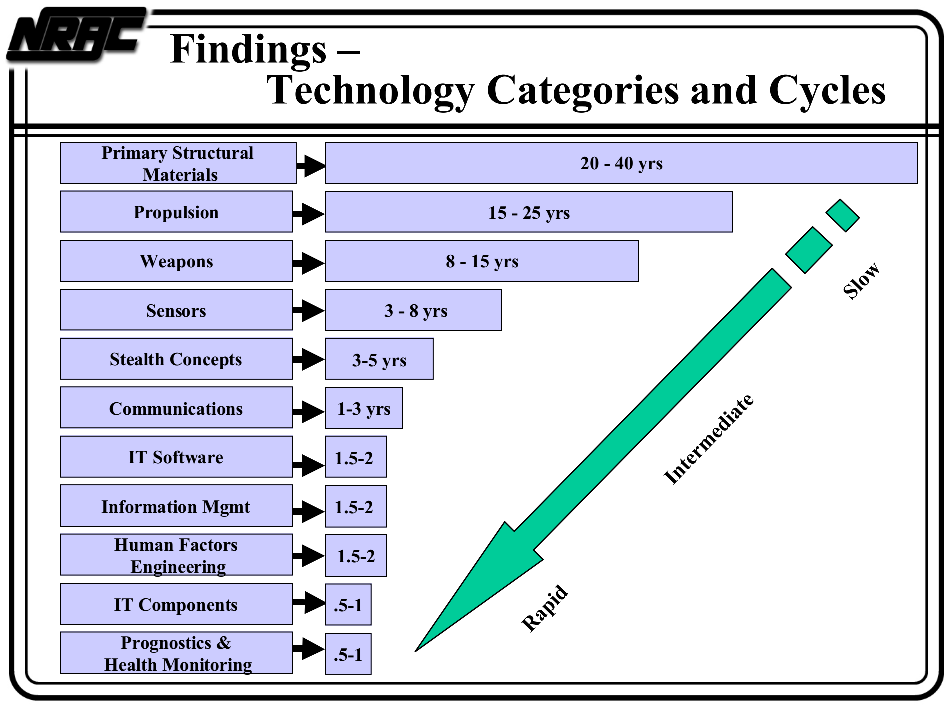

Findings — Technology Categories And Cycles

As part of it's tasking, the panel requested information from each of our fact-finding sources as to their assessment of various technology categories which they thought might be critical to their future missions. Also developed was information relating to the anticipated refresh cycle times for the various technology categories to provide an idea as to how often new capabilities might become available and how frequently naval systems might be required to upgrade due to obsolescence issues.

As illustrated above, some of the fastest cycling and highest payoff technologies relate to information processing hardware and software. The cycle times for these technologies are on the order of 1-2 years and are driven by the commercial marketplace. In contrast to IT, the cycle times for sensor technologies are 3-8 years. At the long end of the spectrum are propulsion and structural materials which cycle every 15-25 years and 20-40 years respectively.

Although naval systems do not have to accommodate every new iteration of IT hardware and software technology, the panel found that after about 3-4 cycles of the technology, issues of obsolescence come into play which can make maintenance and support prohibitively expensive. Clearly technology insertion and refresh is a fact of life in naval weapon systems. For this reason, it is important to be able to utilize open systems architectures, incentivized contracting and other techniques to better facilitate future upgrades.

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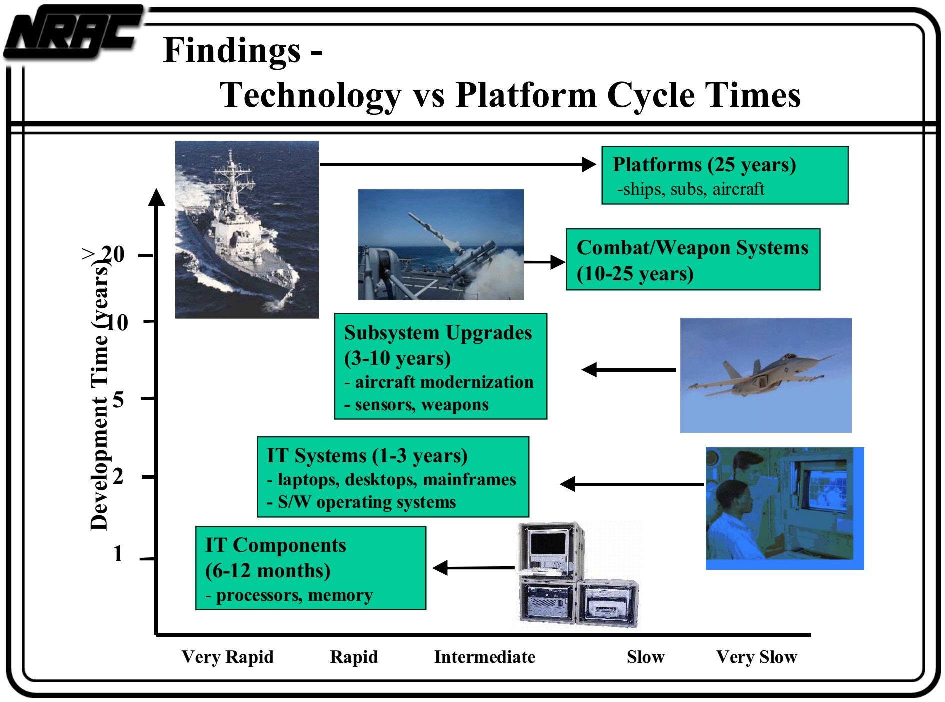

Findings — Technology VS Platform Cycles Times

The figure above further illustrates the differences between the typical lifetimes of major platforms/systems and the cycle times of some of the highest payoff technologies. It is typical for example, for ships to last 25-40 years, aircraft 20-25 years and major weapon systems 20 years. Given these lifetimes, it is not inconceivable that a weapons platform or ship might may have to accommodate 15-20 technology upgrades in its signal processing and IT systems to either avoid obsolescence issues or improve in terms of capability.

Of critical importance is optimizing weapon system and subsystem upgrade cycles to take advantage of the capabilities offered by new technology and to do so without imposing too many different configurations. At issue is a proliferation of baseline configurations all supporting various levels of technology, different software systems, etc., and the resultant burden on the support infrastructure. If one is not careful, the operations and maintenance (O&M) costs associated with too many weapon baseline configurations can spiral out of control.

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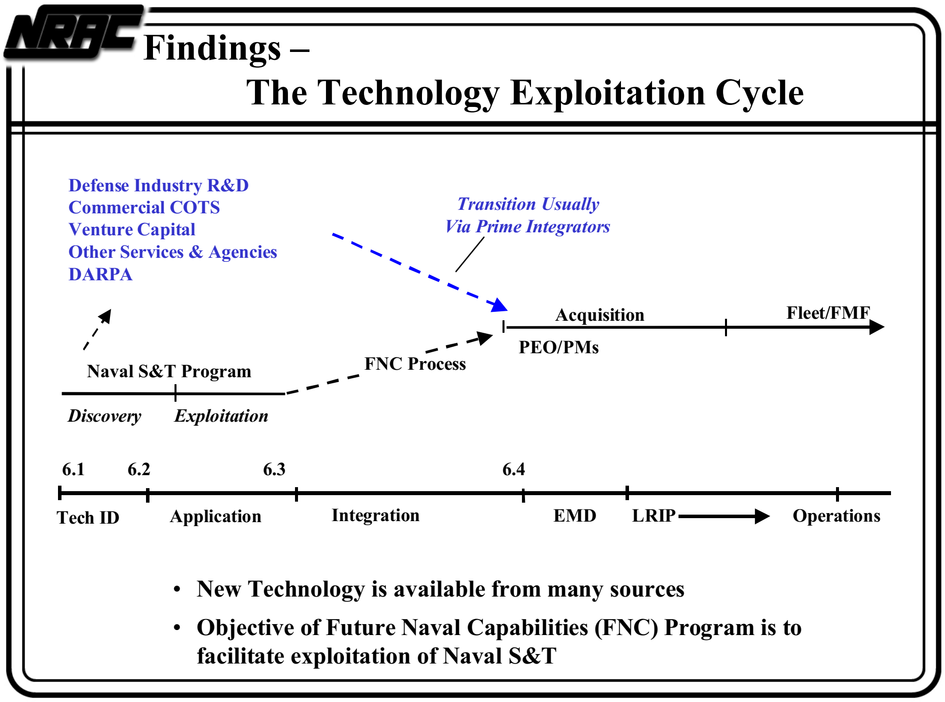

Findings — The Technology Exploitation Cycle

The above figure illustrates the various phases of the "technology exploitation cycle" from initial awareness of a new technology shown on the left side, continuing through development, application, risk reduction, and finally system integration and operational use. Ideally new technologies can come from a variety of sources. One of these is the naval S&T program which in FY 02 will direct nearly $2B toward the discovery and exploitation of new technologies for naval systems. In addition to ONR, outside sources of new technology are becoming increasingly important as candidates for naval systems exploitation. Some of these other sources are shown in the top left of the chart and include COTS technologies, technologies developed by defense industries using internal research and development (IR&D) funds, venture capital organizations, the Defense Advanced Research Projects Agency (DARPA), and other government organizations.

In examining the naval S&T process, once a promising technology is identified and an early application concept demonstration is performed, additional systems integration and risk reduction must be performed in order to allow an acquisition program to incorporate the new technology with acceptable levels of risk. The "handoff" of new technology from S&T to the acquisition community must be done well and is absolutely critical to the overall success of the technology insertion/transition initiative.

During the course of this study the panel found that this transition is often not accomplished well and as a result is a large impediment to the successful exploitation of new technologies. As an example, the panel found that technologies developed in ONR's naval S&T programs are often not matured sufficiently to provide for an acceptable level of risk to an acquisition program without requiring significantly more work by the acquisition program office. Typically the acquisition program office either will not pick up the technology because it is not ready for transition and not proven, or cannot undertake additional development without programming for additional funds. Because a "risk adverse" acquisition community must insure that a new technology has been matured, and due to the nature of DOD's planning, programming and budget system (PPBS) cycle, it can often take two years or more to get funding in place to transition a mature technology. During this time the candidate technology application often languishes and dies. The terminology often applied which describes this problem is called the "Valley of Death".

In an attempt to help solve this problem, ONR initiated the FNC program. The objective of the FNC program is to develop early agreements between the naval S&T community and the recipient acquisition program office so that priorities are established for technology development and transition programs, and funds are planned early on both sides of the "handoff" to achieve continuity of funding and development. Although its objectives are good, the panel believes that FNC programs today are neither properly structured or funded to be successful without changes in philosophy and a prioritization of initiatives.

For those technologies originating from other sources outside of naval S&T programs, the panel found that prime integration contractors typically play a significant role in facilitating the transition of new technology applications into acquisition programs. If a program is already ongoing, then the integration contractor is under contract to the acquisition program office and therefore is in a unique position to be able to facilitate the risk reduction and integration of new technical solutions. While this certainly has benefits, it can also lead to a situation where new technology options might be limited to only those that come from, or are of particular benefit to the prime contractor.

Unfortunately, it was found that there is minimal early collaboration between the naval S&T community and other outside sources (defense contractors, DARPA and other agencies). Too often this seems to result in unproductive competition between technologies from various "camps" rather than a pragmatic use of resources to develop an optimal solution.

Findings –
Current Naval S&T Profile

- **62% of S&T program in "Discovery & Invention" (6.1/6.2) + Other**
  - **Basic research**
  - **Work in Navy Core and "Grand Challenge" areas**
  - **Work in areas that industry will not work on or does not lead**
- **38% of S&T program in "Delivery & Exploitation" Via Future Naval Capabilities (FNC) Programs (6.2/6.3)**
  - **Applied Research & Advanced Technology Development focused on war-fighting shortfalls for systems in or going to acquisition**
  - **Harvest industry and DOD S&T and exploit it**
  - **Experimentation**
  - **Capabilities Options**

Future readiness dependent on ability to exploit/absorb new technology !

<u>Findings—Current Naval S&T Profile</u>

The chart above illustrates the current allocation of resources for ONR's naval S&T programs. In this chart we show the breakout of the S&T budget for FY 02 which includes 6.1, 6.2 and 6.3 resources. For FY02, Navy's S&T budget will total approximately $2B. In this budget, approximately 62% of the funds which include all of 6.1 and part of 6.2 are allocated to basic research and "technology discovery" , together with a small category of "other" special initiatives. Approximately 38% of the funds are allocated to "technology exploitation" as part of the FNC program.

The information is presented not to make a value judgment, but rather show the current emphasis of the naval S&T program. What this ratio should be is a decision that must be made by senior naval leadership in the context of operational requirements for new technology. Having said the aforementioned, the panel thought that it might be worthwhile to draw some comparisons with other industries. In interviews with Boeing Phantom Works, 3M Corp., and Lockheed-Martin, it was discovered that in general, "technology discovery" represents approximately 20-25% of their technology investment while "technology exploitation" made up the remaining 75-80%. If the primary emphasis of the naval S&T program is to foster university and naval laboratory research in the discovery of new technology as "seed corn" for future development and less on the near-term exploitation and transition of technology into operational use, then the ratio shown may be correct. If on the other hand, the primary emphasis of S&T should be to solve nearer term fleet and acquisition problems which lend themselves to technology solutions, then perhaps funding for FNC's should be increased.

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TOR Tasking

Analyze Lessons Learned from
Successful and Unsuccessful (Problematic) Attempts
To Provide for Life Cycle Technology Insertion

<u>TOR Tasking—Findings From Lessons Learned</u>

One of the objectives of this study was to conduct fact-finding and analyze lessons learned from both successful and unsuccessful, or at least problematic, attempts to provide for life cycle technology insertion into naval systems. The use of the word "unsuccessful" in the Terms of Reference (TOR) was a little unfortunate since most technology insertion programs were never "unsuccessful" to the point that they were cancelled. The complete TOR is found in Appendix A. What was found was that some of the programs were very "problematic" in terms of schedule delays, cost growth, and perhaps reduced performance expectations. The following charts summarize the findings.

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NRAC

Problems Encountered in LCTI

- **Tech Insertion Programs "Short Cut" Good Systems Engineering**
  - **Human factors/performance design**
  - **System interoperability analysis**
  - **Conflicts with spiral development**
  - **Navy labs are losing system engineering skills**
- **Lack of Technology Insertion "Enabling" Tools (M&S)**
- **Lack of Collaboration with OPTEVFOR early on**
- **Lack of Discretionary Funds and Incentives for "Managed Risk-Taking" by Acquisition PMOs**
- **Lack of Navy Technology Readiness for Transition to Acquisition**

Result can be "Magic Junk"

<u>Problems Encountered In LCTI</u>

Based on fact-finding with developers, acquisition personnel and Fleet and FMF users, a number of problem areas leading to limited technology transition were identified.

Based largely on interactions with CINCLANTFLT, it became apparent that technology insertion programs often "short-cut" good systems engineering practice early in their development. This seems to particularly be an issue with regards to human factors engineering, systems interoperability, and systems sustainability. Too often, it was found that new systems requiring new technologies did not sufficiently consider human performance as part of system design. As a result, these systems tended to saturate an operator with complex displays and information which he/she was unable to effectively process and use.

LANTFLT users also identified a lack of adequate system analysis and testing which could lead to major interoperability issues. There was also a concern voiced regarding the adequacy and frequency of operational testing, spiral development and the concept of build-test-build often used in technology insertion programs and the tendency of these to create multiple system baselines. Multiple systems baselines can be cumbersome in terms of supportability, training and interoperability.

Another issue which was raised was that spiral development insertion increments are typically not well coordinated with requirements. The result is that interim requirements for operational test and evaluation are often waived. The term "Magic Junk" was coined by the Atlantic Fleet Deputy Commander in Chief to describe technology programs which promise magic, but in the end due to inadequate testing or interoperability issues, are all too often left on the dock as "junk."

The panel also found that better use should be made of M&S tools to address system integration risk issues earlier in the development of technology applications. The tools could also be used to predict technical risk areas so that better operational test strategies could be developed. New systems programs like DD 21 and JSF are developing a number of very useful M&S tools which should be extended and made available for use by other programs.

Finally a problem area which has already been discussed is the general lack of readiness of naval S&T for successful transition to acquisition programs. Basic philosophies for defining what S&T works on and how far it develops technology should be re-assessed to reflect the need to resolve system integration and operational issues earlier in the process. Also the general lack of discretionary resources and "incentives" to help the acquisition PMOs undertake technology initiatives and resolve problems as they arise has created a "risk adverse" environment which limits the acquisition community's ability to capitalize on the benefits of new technology.

Problems Encountered in LCTI (Cont.)

- **Contracting**
  - **Lack of incentives for Primes / PMs to insert technology**
  - **Long contract lead times vs. technology life cycle times**
- **Funding**
  - **Insufficient "Discretionary" funds for new initiatives**
  - **Diffused authority for resource expenditure, planning & execution**

Technology Exploitation is a Broader Management Issue Than Just S&T

<u>Problems Encountered in LCTI (Cont.)</u>

Additional problem areas which hamper technology transition were found to be related to contracting and funding issues.

<u>Contracting:</u>

The panel found that there are a lack of incentives for both the acquisition program managers and prime contractors to insert new technology. The introduction of new technology carries with it risks. These risks can affect cost, schedule and performance. Additionally, there is no incentive on the part of a contractor to insert new technology which reduces contract costs as profits are more often than not, tied directly to costs. On the program manager side the same holds true. If a program office reduces the cost of a program, the savings are generally taken by the comptroller to fund deficiencies elsewhere.

<u>Funding:</u>

The panel found that there is a lack of quick reaction, discretionary funds to fund new opportunities. More often than not, all funds are planned two years in advance and there is no room for either new technologies or emergent requirements to be funded.

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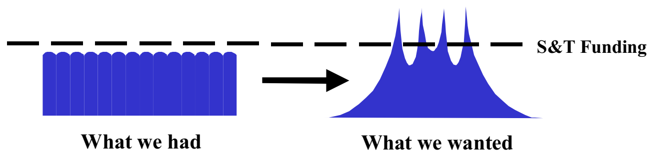
Problems Encountered in LCTI (Cont.)

- **FNC Programs not Structured for Success**
  - **Lack of top level objectives and metrics**
  - **Reviews lack detail for proper decision making**
  - **Limited participation of Fleet and FMF Users**
  - **Limited collaboration with Industry Primes to enable early tech exposure**
  - **Naval S&T often competes with Industry solutions as adversaries**
  - **Minimal "harvesting" of outside technology sources(DARPA, etc)**
  - **Lack of critical mass**



<u>Problems Encountered in LCTI (Cont.)</u>

The panel's fact-finding investigations led it to conclude that the "hand-off" process for transitioning technology applications from naval S&T development to acquisition programs is a serious problem and will limit the availability of new technology solutions. In FY02, the DON will spend approximately $2B on S&T and $11B overall on R&D (includes S&T). One of the most critical steps in capitalizing on this investment is the "hand-off" or transition of technology to acquisition. Based on our reviews, it is believed that the current FNC process is not being properly executed.

The panel felt strongly that FNC programs in general lacked sufficient detail in terms of top level objectives and performance metrics necessary to support good business decisions. Additionally, proper reviews are not always conducted. Some of the questions not being adequately addressed include the following:

- What problem is being solved?
- What is required in terms of capability?
- What product is being created?
- How will current Operational Concepts (OPCON) be affected?
- What technologies are being applied?
- What technical issues need to be resolved?
- What is the mitigation scheme for resolving technical issues?
- To which specific program(s) is the proposed effort transitioning?
- When does the effort <u>need</u> to transition?

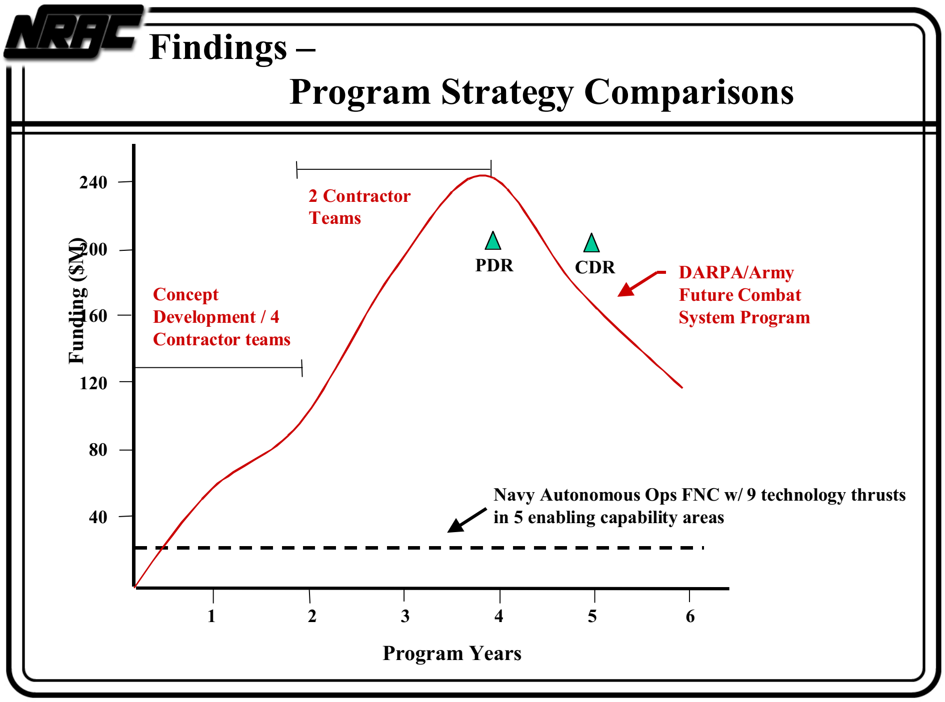
- What defines an acceptable transition product from S&T?
- When do major milestones/tests need to occur?
- What are the critical path items?
- Is funding as a function of time sufficient?
- How does the effort from a timing standpoint fit into the schedule of the program(s) to which it is transitioning?
- What funding will be used to fund the follow-on 6.4 efforts?

Additionally, it was found that testing and exit criteria are seldom defined, affordability issues are ignored, and comparison and contrast to other programs working similar technology and issues are not conducted.

The panel also found that FNC programs have had limited working level, end user participation from the fleet. With regard to participation in the FNC Integrated Product Teams (IPTs), CINCLANTFLT users told us that "they had attended a few times, there wasn't much of particular interest to them, they were short of travel funds, and so they have not been attending". We need to point out, however, that when we visited the Marine Corp War-fighting Center in Quantico, we did see users from the field who had been brought in to be involved in the new technology programs and in some cases were leading them. The Navy Submarine Modernization Program and specifically the ARCI Program was also found to do a good job of involving end-users early in their technology insertion initiatives. In our fact-finding at the AFRL in Dayton we found that they also strive to directly involve end-users into their technology transition programs.

The panel also found that there appears to be only limited collaboration with other outside sources of technology solutions and particularly with system integration contractors who could be important partners in successfully transitioning technology into acquisition. Currently, naval S&T technology programs tend to compete rather than collaborate with DARPA and industry solutions.

Finally, the panel found that the current FNC programs lack the "critical mass" of resources necessary to be successful. This point is illustrated on the next chart and in subsequent paragraphs.



Findings—Program Strategy Comparisons

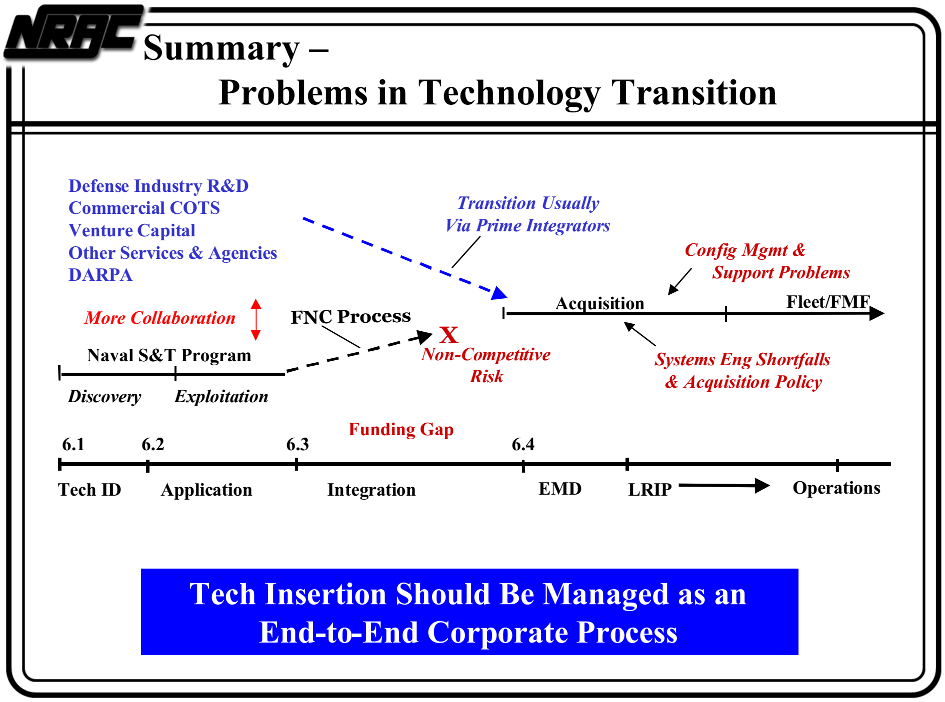
During the study the panel was briefed by Tony Tether (Director) and Jane Alexander (Deputy Director) of DARPA. They provided insight into DARPA's approach and strategies for the development of new technology. The chart above draws comparisons between a major DARPA program and the Navy's FNC approach to developing new technology. For comparison purposes two similar technology areas, both of which involve autonomous operations are illustrated. The DARPA program is the joint DARPA/Army Future Combat Systems Program. It involves developing autonomous warrior concepts. The Navy program is the Autonomous Operations FNC Program.

The first difference in the programs involves funding. While the DARPA program is split funded between DARPA and the Army and ramps up to $240M in year four, the FNC program is level funded at about $24M per year. Further, while the DARPA program is focused on various technologies all coming together with one single aim, the Navy program funds nine different technology thrusts in five different capability areas. The panel felt that in the Navy's case, a "peanut butter spread" of resources lacks the necessary critical mass to be able to adequately "flesh-out" systems level technology concepts and develop them to the point that integration risks will be acceptable to an acquisition program.

The DARPA program is also structured such that in phase I of the program, four contractor teams, each involving academia, industry and government are funded to detail their ideas in preliminary conceptual designs, conduct analyses and develop proposals for a phase II follow on effort. In this way, technology concepts are drawn from multiple sources. A down select then occurs with the best two teams being funded to develop detailed designs, to conduct system level risk reduction efforts and to develop prototypes for testing.

The DARPA approach is very beneficial in that it prioritizes its programs such that a "critical mass" of resources are applied to help insure success, it encourages early collaboration among a wide range of sources, and it leverages Army funding to achieve a partnership with and buy in from the Army.

Finally, as a general observation, there appears to be little collaboration in terms of joint programs between the Navy and DARPA. This is partly due to the fact that there are currently very few naval officers assigned to DARPA to help foster DARPA programs in support of naval requirements. On the latter issue, the panel noted that there is no incentive for a naval officer to do a tour at DARPA as the Navy no longer recognizes a DARPA tour as a joint assignment.



<u>Summary—Problems In Technology Transition</u>

The chart above is similar to an earlier chart in that it presents the total technology transition cycle. However, overlaid in red are places in the cycle where the panel found problems. The problems include:

- A lack of collaboration between ONR and other sources of technology,
- A funding gap from 6.3 to 6.4 efforts as previously described,
- Systems engineering process shortfalls as previously described, and
- Configuration management and support issues when having to deal with multiple baselines in the field.

Problems occur across the entire timeline of technology development. They are not solely S&T problems, solely acquisition problems, or solely funding problems. The panel believes that technology insertion must be planned and managed as an "end-to-end" process as part of an over-riding corporate strategy. In doing so, issues might be quickly addressed, resources allocated and benefits achieved in the shortest possible time. In the course of the panel's deliberations, we found that this is the way that many of the most prominent commercial corporations address new technology insertion.

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"Best Practices"
From Successful Attempts at LCTI

- **Use of "Open Architectures" to Enable Technology Insertion (Highest Payoffs in Software and IT Technologies)**
  - **Acoustic Rapid COTS Insertion (ARCI) Program, F/A18-E/F, JSF, DD 21**
- **Competitive Acquisition Strategies to Incentivise Technology Insertion**
  - **DD 21, NMCI**
  - **ARCI**
- **Systems Engineering Tools to Enable Technology Insertion**
  - **Integrated Command Environment(ICE) Lab (DD 21)**
  - **Distributed Engineering Plant (DEP)**
  - **Modeling & Simulation Tools (Boeing PhantomWorks)**
- **Collaborative Environment Tools for Tech Transition Mgmt**
  - **Web-based "Collaboration Portal" Tools (Boeing PhantomWorks, Navair AMTCE Program)**

"Best Practices" Should be Emulated

"Best Practices" From Successful Attempts At LCTI

The last five charts focused on problem areas and barriers to technology insertion. However, the panel also found many successful attempts at technology insertion. The chart above and text below describes successful attempts at LCTI. The practices used to achieve these successes are termed "best practices".

The panel observed that several programs have developed and are exploiting practices which are enhancing technology insertion. These should be replicated wherever possible. Some of the best practices are:

- The use of "open architectures" and commercial standards particularly as regards IT insertion,
- The use of innovative competitive acquisition strategies to encourage collaboration and incentivize industry for technology insertion,
- The initial development of some core capabilities as regards generic modeling and simulation tools which could be expanded and more broadly applied to better enable technology insertion, and
- The use of collaborative tools for technology transition management.

Open Architectures and use of COTS

The submarine ARCI program whose goal is to improve the U.S. Submarine Force's ability to detect hostile submarines at greater ranges, is using open software architectures and innovative competitive procurement strategies. The new JSF program and the DD 21 program are similarly making widespread use of "open architecture" strategies which should help enable these systems to more easily accommodate technology insertion and refresh in the future. As a legacy system the F/A-18E/F aircraft program is also making good attempts to partition avionics systems so that open architectures and more COTS technology can be used effectively in upgrading selected subsystems. The panel generally found that open architecture techniques have become widely recognized and are being embraced wherever possible in most naval programs. Important lessons which can be learned from legacy insertion programs like the ARCI Program and the F/A-18 Program have to do with the partitioning of major subsystems such that when one is considering targets for technology insertion the entire system does not need to be re-engineered.

Competitive Acquisition Strategies

The NMCI program whose goal is to improve computing and communications capabilities via a private intranet has developed innovative acquisition strategies which incentivize contractors to utilize new technology. The DD 21 and JSF programs have also developed some very innovative contractual approaches which incentivize technology insertion for both the program and the contractors. Some of these strategies should also be considered as potential "best practices" for use by other programs.

Modeling and Simulation Tools

The panel found that a number of innovative systems engineering tools which can help enable technology insertion have been developed recently in support of specific programs. These should be expanded and enhanced and made more generally available to other programs as corporate assets. One of these is the ICE Lab. The ICE Lab is a very versatile M&S environment which provides capabilities for incorporating human performance as an integrated element of system design. Another powerful tool set which should be expanded and used in addressing a wider variety of system interoperability design issues is the Distributed Engineering Plant (DEP) Lab facilities which have been developed by NAVSEA. This is a distributed network environment that permits interoperability issues to be addressed amongst multiple interacting systems. Other instances where M&S tools have been developed and effectively used include the Air Combat Environment Test and Evaluation Facilities at Patuxent River, and the Navy's Network Centric Training Facility.

It was also found that a number of defense contractors, most notably Boeing Phantom Works, have developed and now use a powerful variety of M&S tools which allow them, as part of early system design, to model all aspects of aircraft structures including avionics systems. In this way, Boeing has been able to "fly" a virtual aircraft as part of their system design process to optimize performance and assess system interoperability issues early on.

According to Boeing, the use of this technology has resulted in major savings in schedule and cost. These types of systems engineering tools should be assessed and emulated wherever possible.

<u>Collaborative Tools</u>

Finally, to better facilitate the management of technology insertion programs, we found that commercial industry is now using powerful web-based collaboration tools including integrated desktop personal video teleconferencing (VTC) technology to achieve effective collaboration amongst developers and end-users without incurring time consuming and expensive travel. These practices and tools should also be more widely used. One version of such a web-based "collaboration portal" environment is now being used at Boeing's Phantom Works to help facilitate not only technology collaboration but also all aspects of their project management. Also, during our meetings and reviews with NAVAIR's Science and Technology Program Office at Patuxent River, the panel found that NAVAIR's Aerospace Materials Division has just initiated a new program jointly with DARPA to develop and deploy a web-based "collaboration portal" environment as part of the Aerospace Materials Technology Consortium program. This is an exciting new initiative which can become a powerful technology insertion enabling tool. As such it should be monitored, enhanced and made generally available for use on other programs.

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TOR Tasking

Recommend Strategy/Philosophy Changes
For
Ensuring and Optimizing LCTI

TOR Tasking—Recommendations

After conducting its fact finding which detailed problems/barriers and best practices/successes with technology insertion, the LCTI Panel was asked to develop recommendations. The recommendations detail strategies and philosophies to help enable LCTI in the future. The recommendations are summarized in the following charts.

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Recommendations

1. Strengthen Systems Engineering Process for LCTI

- **Adopt "Best Design Practices" for New and Legacy Systems**
  - **Open Systems Architecture / COTS**
- **Enhance / Expand M&S "Enabling" Tools as "Corporate Resources"**
  - **Distributed Engineering Plant (DEP) to address system interoperability**
  - **Integrated Command Environment (ICE) Lab to address human factors design**
  - **Use Warfare Labs as focal points**

Recommendations

The next four charts detail specific recommendations which the panel believes should be carried out. The fourth chart details a management strategy to implement the recommendations on the first three charts.

Recommendation # 1 - Strengthen the System Engineering Process for LCTI

The panel's first recommendation is to strengthen system engineering practices and tools in support of technology insertion programs particularly in the systems integration phases of applying new technology solutions. Specific actions which can be undertaken in the near term to help facilitate this is to develop a set of "best design practices" for technology insertion based upon the experiences of programs with demonstrated success. This information should be distributed to all programs of record as well as to S&T programs using interactive web-based technology. The information should include technical and management points of contact for programs which are cited for "best practices".

As a part of this recommendation the panel strongly recommends that under the authority of the ASN(R&D), specific funding and utilization strategies be developed to enhance and expand the use of systems M&S tools and to make them generally available as "corporate resources" to help enable technology insertion. As part of a corporate strategy to enable technology insertion the naval R&D community should assemble an assessment of high priority M&S requirements as well as an inventory of available capabilities. This should be updated periodically as a means of providing a strategic focus for the planned evolution of a comprehensive M&S tool environment as capabilities are improved and new tools acquired and integrated. Included amongst these initial tools should be the (ICE) Lab and the Multi-Modal Watch Station Environment (SPAWAR) tools for addressing human factors design, and the DEP tools to address system interoperability issues.

In support of enhancing awareness of new technology and in strengthening systems engineering practices the panel recommends that the naval S&T/R&D community under the authority of the ASN(R&D) develop specific near-term strategies to deploy and utilize a standardized web-based "collaboration portal" tool environment for use across all of its R&D and S&T programs. We would recommend that the pilot program in this area which has now been started at NAVAIR's Aerospace Materials Division at Patuxent River should be closely monitored and enhanced as necessary in order to provide a core capability from which these tools can be grown for wider use across the Navy in the near future.

Finally, DON needs to determine what it wants from the NAVSEA, NAVAIR and SPAWAR laboratories (Warfare Centers). These laboratories perform a tremendous amount of R&D work and act as intermediaries between the acquisition and R&D communities. Because of this role, the Warfare Centers can serve as smart buyers of technology. This in turn however requires the Warfare Centers to attract and grow scientists and engineers of a national caliber. This concept has and is presently being thwarted by the current allocation of independent S&T funds and senior scientist position allocations away from the Warfare Centers and to the Naval Research Laboratory (NRL), as well as current naval promotion policies which favor managers over scientists and engineers. DON might consider changing the policies detailed above to reinvigorate the Warfare Centers.

Recommendations (Cont.)

2. Develop "Gain Sharing" Incentives for PMs and Primes to Insert New Technology

- **Primes maintain negotiated profit and share in savings**
- **PMs share in portion of savings from technology insertion**

3. Prioritize FNCs to Achieve "Critical Mass" in Resources and Manage Them Like a Business

- **Demand top level objectives, KPPs, metrics and regular reviews**
- **Demand early involvement of Users, Integration Contractors and Outside Technology Sources**
- **Implement / use web-based "Collaborative Environment"**
- **Leverage DARPA Programs**
- **Terminate non-performing /non-relevant programs**
- **Free up funds for new starts (goal 20% per year)**

Recommendations (Cont.)

Recommendation # 2 - Develop Gain Sharing Incentives for PMs and Primes

Perhaps one of the most important recommendations from this study is to address some of the cultural issues of "risk adversity" as regards technology insertion. A big step towards improving this situation could be made by developing "gain sharing" strategies in which a portion of the savings resulting from technology insertion programs could be retained and shared by both the program office and by the contractor. In this way as actual savings occur a portion of these can be retained by the program office to address other problem areas, and the contractor can also maintain his original negotiated profit plus share in the generated savings for a net profit gain. Such incentives could greatly offset the natural risks which are inherent in incorporating new technologies and would encourage managed risk-taking.

Recommendation # 3 - Changes to FNCs

In order to facilitate the successful transition of technology from naval S&T programs to Acquisition Programs, the panel recommends that the current FNC programs should be reviewed, prioritized and probably reduced in number so that a "critical mass" of resources can be made available to selected programs. The technology applications can then be developed to a point where they can truly provide competitive, low risk solution options to the acquisition program manager.

FNC programs should also be structured and managed like a business with well defined objectives, key performance parameters, metrics and regular reviews. In conducting annual reviews of FNC programs, the following questions should be asked:

- What problem is being solved?
- What is required in terms of capability?
- What product is being created?
- How will current Operational Concepts (OPCON) be affected?
- What technologies are being applied?
- What technical issues need to be resolved?
- What is the mitigation scheme for resolving technical issues?
- To which specific program(s) is the proposed effort transitioning?
- When does the effort <u>need</u> to transition?
- What defines an acceptable transition product from S&T?
- When do major milestones/tests need to occur?
- What are the critical path items?
- Is funding as a function of time sufficient?
- How does the effort from a timing standpoint fit into the schedule of the program(s) to which it is transitioning?
- What funding will be used to fund the follow-on 6.4 efforts?

Additionally, for FNC programs, testing and exit criteria should be defined, affordability of the technology investigated, and comparison and contrast to other programs working similar technology should be investigated to either eliminate or leverage similar programs.

The panel also recommends the use of program strategies to encourage early collaboration of end-users, integration contractors and outside sources of technology. Strategies similar to those being used by DARPA's Future Combat System program, as an example of process, should be emulated. FNC programs also need to have working level, end-user participation from the fleet. In this regard, fleet users need to send appropriate working level representatives to FNC planning and review meetings to insure that end-user requirements are being met.

The panel also recommends that approximately 20% of annual FNC funding be set aside for new-start programs. The funds would be created by terminating non-performing or no longer needed programs.

Finally, as part of the FNC process, the DON should have as an objective, the development of several major joint programs with DARPA. To facilitate this, DON should consider reinstating the joint designation for Navy and Marine Corps officer tours at DARPA.

Enabling Prior Recommendations

**** Most Important Recommendation ****

**** Establish "Naval Technology Insertion Executive Office"****

- **Promotes "best practices" and "end-to-end" strategies for LCTI**
- **Develops/maintains corporate M&S tools**
- **Promotes collaboration for concept development and early technology Identification**
- **Develops/Promotes "gain sharing" incentive strategies**
- **Promotes joint programs with DARPA**
- **Possesses tech exploitation planning, programming & budget authority**
- **Maintains RDA resource fund for new initiatives**
- **Promotes harvesting and integrating of technology from all sources**
- **Reviews, prioritizes and funds FNC programs**

Enabling Prior Recommendations

Recommendation # 4 - Establish a Naval Technology Insertion Executive Office

The panel's final recommendation is by far the most important! It is made as an "enabling" recommendation, which is believed necessary to facilitate changes in strategy and philosophy for establishing LCTI as a corporate-level process. To this end the panel believes that it is necessary to establish a "Naval Technology Insertion Executive Office (NTIEO)". The office would have a Senior Executive Service (SES) person at the helm with a small supporting staff. The head of the office should have the following attributes:

- Engineer first / scientist second;
- Laboratory, industry, Fleet/FMF, OPNAV, SYSCOM/Warfare Center experience;
- Ability to work with OPNAV, Fleet/FMF, Warfare Centers, SYSCOMs, academia and industry to focus efforts.

This office would be a facilitator of technology insertion and as such would emphasize the creation of products that the Fleet/FMF and acquisition community can use, rather than merely conducting scientific efforts and technology demonstrations as end products.

The NTIEO would also be the focal point for prioritization, funding and review of all FNC programs. FNC managers would report to the Technology Insertion Executive. These managers might come from Navy Warfare Centers, naval laboratories as well as ONR. FNC managers would possess the same attributes as the NTIEO Executive. An FNC Manager's duties would entail:

- Focusing on developing and demonstrating technologies in focused, Fleet/FMF approved applications with metrics;
- Focusing on appropriating technology from whatever source to solve relevant problems;
- Conducting systems integration efforts;
- Conducting technology demonstrations with metrics;
- Supporting Fleet Battle Experiments;
- Providing direct support to acquisition programs.

The NTIEO would also serve as a single focal point to detail the strategy and practices necessary to enable technology insertion initiatives in all phases of the technology transition cycle. The executive function would be responsible for promoting "best practices" and developing "end-to-end" strategies for LCTI including the development and maintenance of corporate M&S tools. The office would also be responsible for developing the gain sharing strategies previously described as well as creating joint strategies and programs with DARPA and other agencies.

The office would exist at a sufficiently high level and also possess planning, programming and budgeting authority for technology exploitation initiatives primarily encompassed in the 6.2 and 6.3 budget lines. It would also direct ASN(RD&A)'s resource fund for new initiatives. In short, the office would be responsible for harvesting technology from whatever source to solve critical naval problems.

What's at Stake

- Efficient transition of $11B+ Naval S&T / R&D
- Leveraging of other sources of R&D
- Future readiness and capability

Reinforced by 1986 NRAC Study Recommendations

What's at Stake—Conclusion

DON's S&T and R&D programs currently spend approximately $11B (FY02). Technology insertion is taking place within naval systems but it is currently not happening as efficiently and effectively as it could. The LCTI Panel believes that the $11B can be more efficiently used to provide needed operational capability more quickly by managing LCTI as a corporate business process. Without this kind of management focus, DON risks missing opportunities to leverage other sources of R&D and to pro-actively capitalize on totally new technologies which might enhance the future readiness and capabilities of our naval forces.

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Appendix A

Terms of Reference

NAVAL RESEARCH ADVISORY COMMITTEE
PANEL ON LIFE CYCLE TECHNOLOGY INSERTION
TERMS OF REFERENCE

BACKGROUND: The rapid evolution of supporting technologies relative to the acquisition cycle and service lifetime of naval weapons platforms makes it essential to design and acquire future naval systems in such a way that up-to-date technologies are affordably utilized throughout the service lifetime of the system. Today, new generations of technology become available as often as every two-to-three years, whereas the design-build cycle for a major naval platform may be as long as seven-to-ten years, and service lives of 25-40 years are typical. Future naval weapons platforms must be designed to facilitate affordable insertion of current-generation technologies throughout their service lifetimes with minimum impact on availability.

SPECIFIC TASKING:

- Perform case studies of successful and unsuccessful attempts to provide for life cycle technology insertion on recent naval platforms and extract lessons learned.

- Review and assess the appropriate refresh intervals for the various classes of technologies critical to naval weapons platforms.

- Recommend a design strategy for ensuring and optimizing life cycle technology insertion opportunities for future naval weapons platforms.

- Assess current U.S. Navy acquisition practice as regards technology insertion and system re-capitalization and recommend strategies for improvement.

Study Sponsor: Mr. Paul Schneider, Acting Assistant Secretary of the Navy (Research, Development and Acquisition)

Study Administrator: RADM Jay Cohen, USN, Chief of Naval Research and NRAC Executive Director

Study Coordinator: Mr. Thomas Tesch, Head, Industrial Programs Department, Office of Naval Research

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Appendix B

Panel Membership

Chairperson	
Dr. George Webber	Getronics Government Solutions, Inc
Vice Chairperson	
Dr. Jerome Smith	Private Consultant
Panel Members	
MajGen Joseph T. Anderson, USMC (Ret)	Advanced Navigation & Positioning Corporation
Mr. John “Jack “Bachkosky	System Planning Corporation
Mr. Duncan Brown	The Johns Hopkins University
MajGen Paul Fratarangelo, USMC (Ret)	Contrail Group, Inc.
Capt Robert Hogan, USN (Ret)	AEPTEC Microsystems, Inc.
Dr. Joseph Johnson, III	Florida A&M University
VADM Douglas Katz, USN (Ret)	Private Consultant
Dr. Frances Kelly	Private Consultant
Mr. Mark Lister	SARNOFF Corporation
VADM David Robinson, USN (Ret)	Booz-Allen and Hamilton
Mr. Joseph Rodriguez	Raytheon Command, Control, Communication and Information Systems
Mr. Richard Rumpf	Rumpf Associates International
Mr. James Sinnett	Private Consultant
Dr. Robert Spindel	University of Washington
Mr. George Windsor	The Boeing Company
Study Coordinator	
Mr. Thomas Tesch	Office of Naval Research
Executive Secretary	
Mr. William Slowik	Program Manager, Product Innovation Division-ONR

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Appendix C

Acronyms

A&M	Agricultural and Mechanical
AFRL	Air Force Research Laboratory
ASN (RD&A)	Assistant Secretary of the Navy For Research, Development & Acquisition
APL	Applied Physics Laboratory
ARCI	Acoustic Rapid COTS Insertion
AT	Advanced Technology
B	Billion
CDR	Critical Design Review/Commander
CINC	Commander in Chief
CINCLANTFLT	Commander in Chief Atlantic Fleet
CNO	Chief of Naval Operations
CNR	Chief of Naval Research
COMNAVSEASYSCOM	Commander, Naval Sea Systems Command
COTS	Commercial off the Shelf
DARPA	Defense Advanced Research Projects Agency
DD(21)	Next Generation Destroyer
DEP	Distributed Engineering Plant
DMSO	Defense Material Systems Office
DON	Department of the Navy
DSMC	Defense System Management College
DUSD	Deputy Under Secretary of Defense
EMD	Engineering, Manufacturing and Development
FMF	Fleet Marine Force
FNC	Future Naval Capabilities
FY	Fiscal Year
FYDP	Five Year Defense Plan
ICE	Integrated Command Environment
ID	Identification
IPT	Integrated Product Team
IT	Information Technology
JHU	Johns Hopkins University

JSF	Joint Strike fighter
KPP	Key Performance Parameter
LANTFLT	Atlantic Fleet
LCTI	Life Cycle Technical Insertion
LRIP	Low Rate Interim Production
M&S	Modeling and Simulation
N125	OPNAV Human Systems Integration Branch
N43	OPNAV Supportability, Maintenance & Modernization Division
N6	Director, Space Information Warfare Command & Control, OPNAV
N76	Director, Surface Warfare Division, OPNAV
N77	Director, Submarine Division, OPNAV
N78	Director, Air Warfare Division, OPNAV
NMCI	Navy and Marine Corps Internet
NSWC	Naval Surface Warfare Center
NTCSS	Navy Time Critical Strike System
NTIEO	Naval Technology Insertion Executive Office
NUWC	Naval Undersea Warfare Center
NWDC	Naval Warfare Development Command
O&M	Operations and Maintenance
O&S	Operations and Support
ONR	Office Of Naval Research
OPCON	Operational Concepts
OPNAV	Office of the Chief of Naval Operations
OPTEVFOR	Operational Test and Evaluation Force
OSD	Office of the Secretary of Defense
OT&E	Operational Test and Evaluation
PDASN	Principal Deputy Assistant Secretary of the Navy
PDR	Preliminary Design Review
PEO	Program Evaluation Office
PM	Project Manager
PMO	Program Management Office
POM	Program Objective Memorandum
PPBS	Planning, Programming, and Budget System
R&D	Research and Development
S&T	Science and Technology
SES	Senior Executive Service

SUBLANT	Submarine Forces, Atlantic
TOR	Terms of Reference
TSC	Theater Surface Combatant
U.S.	United States

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