Patuxent Policy Group
White Paper

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NASA-Navy Cooperation in the 21st Century

Produced by
The Center for the Study of Democracy
St. Mary's College of Maryland

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August 11, 2011
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I. Introduction

NASA and the Navy have a long and productive history of collaboration.This partnership includes problem solving, technological innovation, joint facilities use and personnel development. When NASA was created as an independent agency, the Navy organizational structure served as a blueprint for NASA operations in part because so many Navy personnel were employed there. NASA later developed specialized expertise and assets that proved valuable to the Navy on many defense related systems. Both organizations have benefited by leveraging shared technical capacity and by looking beyond specific organizational challenges to shared research goals.

Yet, despite their long history of collaborative efforts, productive interactions in recent years have diminished significantly. Shifting internal priorities and budget reductions have limited the benefits of collaborative work. Diminished opportunities for basic dialogue between NASA and the Navy have resulted in failures to share technical information and research products. Finally, recent closures of research facilities and reductions in aeronautics budgets have negatively influenced collaboration between NASA and the Navy.

There remain many unexplored opportunities for joint benefit. Looking to bring more projects "in house" and taking advantage of the smart buyer-honest broker relationship, Navy-NASA collaborations could be revitalized. Moreover, both the Navy and NASA have a shared interest in collaborating to fund and assist STEM programs and workforce development. Most importantly, the potential for future collaboration is strong, particularly in the area of unmanned aviation systems (UAS).

This paper reviews some of the more successful collaborative programs and practices between the Navy and NASA over the past several decades. The purpose of this review is to identify organizational practices and funding mechanisms that have resulted in improved and cost effective technological development. The review provides important perspectives on future needs of each organization and illustrates how joint organizational infrastructures can be more efficiently utilized to better achieve mutual technological goals important to programs within each organization. The paper ends with a discussion of promising areas for future collaboration at joint facilities.

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This paper was produced by Dr. Matthew Fehrs and
Dr. Michael Cain for the Patuxent Policy Group, a
collaboration of The Patuxent Partnership and
the Center for the Study of Democracy.

The Patuxent Policy Group, a collaboration of The Patuxent Partnership and the Center for the Study of Democracy, hosted a group of experts at St. Mary's College of Maryland to discuss opportunities for NASA and the Navy to renew collaborations and develop new opportunities for programs of mutual interest and benefit. The working group, facilitated by MG Joseph Anderson, USMC (ret.), former Deputy Director for the National Air and Space Museum, convened panelists and participants from academia, government and industry, with a broad range of perspectives and experience. The discussions focused on their views of how NASA and the Navy can re-energize their decades-long partnership for their mutual advantage and continue U.S. leadership in aviation, space operations and technologies.

This document reflects the perspectives of the panelists and participants, and identifies actions that address the question of how to improve collaboration in an era of tight funding, high stakes and critical needs. The views expressed in this paper reflect the output of a group discussion and are not intended to represent the views of any particular individual. This paper was produced by Dr. Matthew Fehrs, Ms. Bonnie Green and Dr. Michael Cain.

Participants

Leader/Facilitator

MG Joseph Anderson, USMC (ret.), former Deputy Director for the National Air and Space Museum

Panelists

Ms. Lesa Roe, Director, NASA Langley Research Center
COL Bryan O'Connor, USMC (ret.), Chief, Safety and Mission Assurance, NASA
Mr. Michael Deitchman, Deputy Chief of Naval Research, Naval Air Warfare and Weapons, Office of Naval Research (ONR)
Mr. Bruce Underwood, Chief, Advanced Projects Office, NASA/Goddard Space Flight Center (GSFC)/Wallops Flight Facility
Mr. Mark Croom, Senior Researcher, Flight Dynamics, NASA Langley Research Center
RDML Donald "BD" Gaddis, Program Executive Officer, Tactical Aircraft Programs, PEO(T)
Ms. Mary Lacey, Deputy Assistant Secretary of the Navy for Research, Development, Testing & Engineering (RDT&E)
Dr. Darryll Pines, Dean, Clark School of Engineering, University of Maryland
Dr. W. Neil Johnson, Space Science Division, Naval Research Laboratory (NRL)
Mr. Daniel Newman, Program Manager, Tactical Technologies Office, Defense Advanced Research Projects Agency (DARPA)

Participants

Mr. Raymond "Corky" Clinton, Deputy Manager, Science & Missions Systems, Marshall Space Flight Center, NASA
CAPT Bill Shepherd, USN (ret.), Science Advisor, United States Special Operations Command
RADM Tim Heely, USN (ret.), Vice President, Unmanned Aviation Systems (UAS) & Naval Air Programs, Cobham
RADM Craig Quigley, USN (ret.), Executive Director, Hampton Roads Military & Federal Facilities Alliance (HRMFFA)
COL Doug Isleib, USMC (ret.), Vice President, Tekla Research and former Director, Naval Aviation Community for Rotorcraft Advancement (NACRA)
CAPT Pierre Thuot, USN (ret.), WBB Consulting
Dr. Ed Barrett, The Patuxent Partnership Board of Directors
Mr. Dale Moore, Naval Air Warfare Center, Aircraft Division (NAWCAD)
Mr. Tom Evans, Assistant Director Military & Federal Affairs, Office of Military & Federal Affairs, Maryland Department of Business and Economic Development (MDBED)
Mr. Michael Palamar, The Patuxent Partnership
Mr. John Bohanan, Maryland House of Delegates, Senior Advisor to Congressman Hoyer
Mr. Kenneth "Kee" Abell, NAWCAD
Ms. Bonnie Green, Executive Director, The Patuxent Partnership
Dr. Michael Cain, Director, the Center for the Study of Democracy, St. Mary's College of Maryland
Dr. Matthew Fehrs, Assistant Professor, Political Science, St. Mary's College of Maryland
Dr. Josh Grossman, Assistant Professor, Physics, St. Mary's College of Maryland
Dr. Alan Jamieson, Assistant Professor, Computer Science, St. Mary's College of Maryland

I. Current Collaborations and Known Opportunities

1. NASA has provided valuable technology to the Navy. Superior polyimide foam developed for the space shuttle was commercialized and installed in Navy ships to lessen weight and save energy. Many NASA aviation technologies such as glass cockpits and intelligent flight control systems are used in both military and commercial aviation.

2. Research collaboration between NASA and the Navy has resulted in solving flight dynamics issues in Naval aircraft, improving flight safety, improving real time weather predictions, improving ocean measurements and creating more accurate GPS technology.

3. The Mid-Atlantic Regional Spaceport, which leverages NASA's Wallops Island launch capabilities for commercial use, is supported through the Virginia Commercial Space Flight Authority. This is an effective business model, providing for the augmentation of national resources and greater efficiency of government facilities.

4. The Navy, along with other U.S. military organizations, benefit directly from applied research taking place at NASA Langley. The US military, especially the Navy, still relies on NASA Langley for research and development needs.

5. The Navy is actively engaged in space, with a variety of needs related to space operations. NASA and NRL's Space Science Division are jointly interested in understanding, mitigating and predicting solar phenomenon that can adversely impact critical space systems and personnel. Many of the early mission collaborations were to develop rapid response or early warning systems for such solar events.

6. NASA and Navy share an interest in mapping space. It has been twenty years since we mapped the stars. The Joint Milli-Arcsecond Pathfinder Survey (JMAPS) is a space application that will develop a new star map. This updated map will serve navigation, maritime missile defense, and other defense transportation requirements.

7. NASA is undertaking a survey to examine successful programs across the spectrum and looking for common threads.

8. There are many promising opportunities between academia and government agencies, but Navy and NASA need to be more engaged with university researchers. To reduce costs, the Navy and NASA need to be more proactive with researchers at universities, rather than waiting for universities to come to them.

9. There are significant manpower issues in an environment of budget cutting, how to accomplish goals with fewer people and with a consistent focus not on who works where, but on getting the job done.

10. Successful, long term collaboration between NASA and the Navy must ultimately make economic sense. Specific areas of future cooperation include increasing the use of the current government workforce, re-establishing the "smart buyer-honest seller" relationship, partnering with universities on research, and accessing funding and findings from DARPA.

11. With NASA, DARPA functions primarily as science and technology support. There are many instances of shared science and technology with DARPA and NASA, but NASA is currently a DARPA customer. Space act agreements are not agency-wide. Geo-synchronous compared to satellites, horizontal launch, and high-altitude refueling using Global Hawk are areas of interest.

II. Joint Problem Solving and Technological Innovations

Collaboration between NASA and the Navy include solving flight dynamics issues in Naval aircraft, joint problem-solving, technological development and sharing personnel. Although some partnerships between these organizations resulted in specific and measurable technological innovations, other collaborative efforts provided critical research infrastructure to make technological improvements faster and less costly.

The most visible examples of successful joint collaboration between NASA and the Navy involve improvements in Naval aircraft. These include the F-18 Hornet, the F-14 Tomcat and the P-3 Orion. Each aircraft went through extensive wind tunnel testing to produce improved flight designs including improved fly by wire technology.

An illustration of the value of collaboration between NASA and the Navy can be seen by reviewing the flight dynamics problems encountered in the F/A-18E/F during the 1990s. NASA worked with the Navy and McDonnell Douglas (now Boeing) to test the aerodynamics and flight dynamics of the F/A-18E/F design using a wide range of wind-tunnel techniques (including statics, free flight, free spin, rotary balance) and piloted simulations. NASA-Navy collaboration investigated the causes of the abrupt wing stall on the F/A-18E/F. These investigations identified the source of the problem and devised a cost effective solution. The partnership on high-performance fighters not only helped build technical capacity in the Navy, it also allowed NASA to maintain its leadership position in applied aeronautics research.

NASA's multidisciplinary expertise has also aided problem-solving and development across a variety of system platforms and technologies. Another joint NASA-Navy collaboration involved investigating transport aircraft designs to predict flight dynamics in the sub-sonic flight regime. Knowledge gained during NASA's Aviation Safety Program has also been applied to the Navy's P-8 program.

Besides problem solving and increased engineering capacity, NASA has provided valuable technology to the Navy. For example, NASA technologies that are part of today's military include glass cockpits, intelligent flight control systems, digital fly by wire, composite structures and vertical, short takeoff and landing vehicles (VSTOL). NASA technologies are also incorporated into the Navy's fleet. Superior polyimide foam developed for the space shuttle was commercialized and installed in Navy ships with weight savings of as much as 100 tons per ship as well as other beneficial properties. Collaboration between NASA and the Navy resulted in improvements in real time weather predictions, improved ocean measurements and more accurate GPS technology.

There is also a human dimension to the relationship, as more than fifty U.S. Naval Academy graduates have gone on to become NASA astronauts. NASA is able to access top notch naval aviators to conduct missions and flight research.

III. Space Research and Space Operations

Collaboration between NASA and the Navy is not restricted to aviation or applied military technologies. Two vivid examples of cooperation between NASA and the Navy are the NASA Langley Research Center and NRL. These facilities focus on space operations and space research. The Navy is actively engaged is space, with a variety of needs related to space operations. The Navy currently spends about 20 billion dollars on space related operations and space assets.

NASA Langley Research Center has been engaged in civil work and aeronautical research for almost 100 years, the last 50 years as a NASA facility. As a small and highly productive lab, NASA Langley solves advanced problems of civilian and military aeronautics through applied basic research. Many experts believe that the Navy, along with other U.S. military organizations, benefit directly from applied research taking place at Langley. Over the years, NASA Langley has responded to numerous urgent calls to solve tough performance problems. In this sense, the military, especially the Navy, still relies on NASA Langley for critical types of research and development needs.

NRL has a long history of collaboration with NASA in space research and technology development. In fact, NASA's Goddard Space Flight Center (GSFC) was formed from NRL personnel in 1958. NRL's Naval Center for Space Technology has developed and launched 100 space missions and therefore has extensive launch experience related to space operations. NRL continues to look for cost reductions through improved system integration and component benchmarking. The NRL currently operates 28 satellites in space.

Small successful projects help change a larger bureaucratic culture. For example NASA Marshall partnered with the Navy on a small satellite that was delivered in less than 18 months. Working in a shorter timeframe forces one to accept a greater risk. This strategy allows for lower costs.

There are significant space-related research goals shared by each organization. NASA and NRL's Space Science Division are jointly interested in understanding, mitigating and predicting solar phenomenon that can adversely impact critical space systems and personnel. Many of the early mission collaborations were to develop rapid response or early warning systems for such solar events. NRL also frequently supports NASA with its world-class space environmental test facilities.

Besides testing and joint knowledge, NASA and Navy share an interest in mapping space. It has been 20 years since we mapped the stars. JMAPS is a space application that will develop a new star map. This updated map will serve navigation, maritime missile defense, and other defense transportation requirements. Areas of emphasis include critical communications, meteorological astronomical data, naval and maritime navigation systems, and missile defense technology. The challenge for the Navy is how to develop critical space capability for less money in a much shorter timeframe.

The Navy, the Department of Defense and NASA depend heavily on space assets for mission success and to defend against threats to existing space assets. Freedom to operate in space is critical for the United States. The Navy needs to identify and prioritize space capability and position the Navy's space cadre to capitalize on material solutions, to leverage and use existing international assets in space, and to plan for future space systems. This includes engaging with other space agencies whenever possible, including joint space agency personnel. Recognizing the limited dollars available, key Navy science, technology, research and development must be funded and NASA assets must continue to be leveraged to assist with cost reductions.

IV. Sharing Facilities, Expertise and Research

The core of collaboration between NASA and the Navy is sharing facilities and expertise to multiply the assets and capabilities of each organization. NASA has provided technical expertise on a number of critical issues for the Navy, as well as sharing assets such as the Wallops Flight Facility. The Navy also regularly shares with NASA technical capacity and expertise developed in ONR. Each side takes the lead in different critical research areas to leverage in-house capabilities that can be used by each organization. This collaboration has resulted in the value-added use of resources for the government and taxpayers.

NASA

One of NASA's greatest strengths is bringing top engineers and experts together to solve problems related to a particular challenge or question. The NASA Engineering and Safety Center recruits experts to focus on problems and provide recommendations very quickly. For example, the Columbia accident was a wake-up call to the NASA organization to get out of their comfort zone. The NASA Engineering and Navy Safety Center collaborated after the Columbia accident, to get the right people together to study the accident, provide recommendations and make organizational and engineering changes. The credibility of safety and reliability increased dramatically after this incident, resulting in quality engineering and stabilization of the program.

In addition to its excellent in-house technical expertise, NASA also owns a number of world-class test facilities. Specifically, NASA's Wallops Flight Facility provides research on carrier flight systems and space technology, as well as earth science technology. It is the home of the Surface Combat Systems Center, providing engineering combat systems development, warfare experiments and Ship Self Defense (SSD). All of the tenant organizations are engaged in building future technologies in a joint facilities environment.

The Wallops Flight Facility is also deeply engaged in the development of unpiloted systems. UAS will be increasingly important to all areas of the military in the 21st century. NASA researchers at Wallops are also looking at the conversion cycle of Navy propulsion systems for space platforms. The Mid-Atlantic Regional Spaceport, which leverages the Wallops Island launch capabilities for commercial use, is supported through the Virginia Commercial Space Flight Authority. This is an effective business model, providing for the augmentation of national resources and greater efficiency of government facilities. Maryland also advocates on behalf of this operation.

US Navy

Programs within ONR focus on continued research and development in areas of critical importance to the Navy and Marine Corps. They also offer significant value to NASA. ONR is able to leverage resources from academia, industry, DoD and other US government agencies to solve critical technological challenges. This office acts as a steward of critical applied knowledge outside of the commercial marketplace.

The National Naval Responsibility (NNR) program established in 1998 provides research, recruitment and education in order to maintain an adequate base of talent and sustain critical infrastructure for research and experimentation. NNRs exist to highlight areas where the Navy and Marine Corps depend on robust, long-term research that may not be driven otherwise by commercial demand. ONR designates certain critical science and technologies areas as part of the NNR. One such area is Sea-based Aviation (SBA). The Naval Air Warfare and Weapons Department (http://www.onr.navy.mil/en/Science-Technology/Departments/Code-35.aspx) in ONR was directed to lead the SBA NNR program.

IV. Sharing Facilities, Expertise and Research

Sea-based aviation addresses a broad scope of Naval responsibility by assessing technical disciplines, technical challenges, and research topics associated with a wide range of Naval aircraft types. The taxonomy contains elements common to all aircraft types and programs, including Air Force, Army and commercial aircraft. Many of these elements represent common challenges broadly addressed by DOD and NASA. SBA requires a distinctive knowledge and technology infrastructure to enhance Naval Aviation's role and effectiveness in power projection. Establishing sea-based aviation as an NNR will help ensure ONR continues to focus on basic and applied research to meet future aviation needs of the Navy and Marine Corps.

VI. Education and Workforce Development

Central to the success of future collaboration is training a workforce able to meet new technical and scientific challenges. The United States needs additional scientists and engineers to accomplish this work, so the development of Science, Technology, Engineering and Math (STEM) programs is critical to develop the workforce to meet these challenges. STEM is also vital to develop workforce that will design and implement next generation technologies, critical to our national defense. Both NASA and the Navy have strong commitments to STEM, and to student opportunities at high school and university levels.

Universities have a significant role in developing this workforce. For example, the University of Maryland is engaged in aviation, space programs and research across the spectrum, including substantial involvement with ONR. Currently, there are 3200 undergraduates in the Clark School of Engineering at the University of Maryland. That number needs to grow significantly in the near term. How do we inspire the next generation of scientists and engineers? Ideas to build human capital, i.e. nextgen scientists and engineers, and to link research work to intellectual property will play key roles in the near future.

The science and engineering workforce continues to be supported by strategic partnerships between educational institutions and government agencies. The University of Maryland and its partner institutions, Georgia Tech and Penn State, work with NASA, the Navy, the Army, and the Air Force, as well as the tenant commands, Naval Air Systems Command (NAVAIR) and NAWCAD, at Naval Air Station Patuxent River. Some twenty-two universities and corporations are likewise engaged in these endeavors. Optimization is the enemy; we "overmodel," leading to unconstrained requirements, and there are no margins. We optimize ourselves into oblivion because we can't model everything.

The University of Maryland's work with NASA includes propulsion, structural development, and systems modeling. Rotorcraft and helicopter development will be advanced through these partnerships, especially through the Rotorcraft Center for Excellence at the University of Maryland. There are many potential research requirements to be addressed jointly by academia and government agencies. Navy and NASA need to go to universities, and increase the level of engagement with research. To reduce costs, the Navy and NASA need to be more knowledgeable of existing and developing research at universities and engage more fully university researchers, rather than wait for universities and labs to come to them.

Again, STEM education is critical to building long term capacity in our workforce. In the case of Southern Maryland, the question is how to keep STEM college graduates local. The development of the Southern Maryland Higher Education Council in partnership with the University of Maryland College Park, the College of Southern Maryland, St. Mary's College of Maryland, The Patuxent Partnership, and county governments in Southern Maryland (St. Mary's, Charles, and Calvert Counties) must be proactive in improving science and technology. Applied problems from NASA and the Navy should be used to engage and challenge STEM students.

VI. Organzing and Funding Future Collaboration and Innovation

Successful, long-term collaboration between NASA and the Navy must make economic sense. Specific areas of future cooperation include increasing the use of the current government workforce, re-establishing the "smart buyer-honest seller" relationship, partnering with universities on research, and accessing funding and findings from DARPA.

There has been a fundamental shift in the way that the aeronautics community values NASA and the Navy. In an environment of continued budget cuts, new work must be brought in-house to lower costs. The value of the government workforce - scientists, engineers, researchers, etc. - needs to be recognized and the use of their capabilities maximized. Programs and projects should move forward with the government as lead system integrator. There should be a greater, not lesser, reliance on our government workforce.

NASA has research capacity, innovators, and skills that the Navy and Marine Corps need. These resources should be used, not purchased externally, when they are available in NASA. Benchmarking and expert surveys are therefore critical to assess current NASA capacities. As a way to preserve expertise within the space operations community, personnel should be shared between the Navy and NASA. NASA has experienced flight test engineers and pilots, interested in RDT&E, not necessarily as pilots, but in the lab. As NASA moves beyond the shuttle program, the Navy, and NAVAIR in particular, can benefit from existing NASA resources.

Taking this approach may help move towards thinking about aircraft more from the perspective of the crew. This contrasts with a manufacturers' approach, which tends to emphasize complexity. Government to government collaboration, while difficult at first, is critical to mission success. Fewer dollars make innovative ideas more difficult to get across and collaboration more valuable than ever. Moreover, when outside work is required, both organizations can work together to negotiate "firm" specifications with contractors to minimize waste of time and money.

With so many exquisite systems in use by NASA and the Navy, the pressure to make them succeed no matter what is great, and valuable resources and money are sometimes lost. The small pieces may be more valuable than the large exquisite system.

To foster continued collaborations, mutual needs must be clearly recognized. There must be ongoing, increased dialogue between both sides. Specifically, the opportunity to reestablish the smart buyer (Navy) and honest broker (NASA) relationship exists and should be reinstituted. Through expanded research and increased levels of communication across the organizations, there are numerous opportunities to share knowledge, be more efficient and increase mission and project success.

New areas for strategic alignment must be identified, particularly for research. Although the Navy's space budget is about 20 billion dollars, less than 5% is directed to science and technology research. However, by improving administrative efficiency, more R&D dollars will be available. Third-party funds should be sought for seed-funding of new research programs in areas such as unmanned systems, robotics, rotorcraft prototypes and systems modeling of engineering processes.

VII. New Collaborative Models with DARPA

DARPA is unique in the world of DoD research and development because "failure is a given." There is no other way to reach advanced, technological success. At DARPA, the Director has complete discretion over agency funds. It is an agency of technology enablers that works with technology that has already been started, develops it further, and then tries to look for a buyer or "home" for it. DARPA does not have consumer-direct deliverables and many of the programs do not really have customers. DARPA usually works outside the users' paradigm, so the users come back to DARPA to discuss the work and recognize the value.

DARPA does not face the same financial limitations that challenge the military services and NASA. DARPA money can be focused on a few specific projects as opposed to spreading limited resources over many projects. DARPA prefers to hire industry to do work and to focus on hardware systems rather than processes.

For DARPA, the Navy is a consumer and represents a conglomeration of requirements, operators, science, and technology. Navy brings money to projects, but not necessarily a significant percentage. There is shared work in labs and through subject matter experts, yet DARPA is careful about firewalls. The customer side of the Navy needs to talk to the warfighters to find the right operators and relevant science and technology workforce to drive requirements. There are numerous Navy memorandums of agreement in place with DARPA.

With NASA, DARPA functions primarily as science and technology support. There are many instances of shared science and technology with DARPA and NASA, but NASA is currently not a DARPA customer. Space-act agreements are not agency wide. Geo-synchronous versus satellites, horizontal launch, and high-altitude refueling, using Global Hawk, are areas of interest.

The community at large is hardwired to a "programs" way of thinking and there is a focus on specific technical accomplishments. However, the emphasis at DARPA is on leadership vision in the science and technology field, where everything is a learning opportunity and everything reduces uncertainty. The emphasis is on agility: the greater the agility, the more easily plans can be changed. Warfighter capability and agility are critical.

Still, many promising opportunities exist. The development of unmanned systems brings renewed emphasis on working together for the greater good of both organizations. Current and future opportunities to collaborate are extensive and include: power lift configurations, NAWCAD work, missile testing, decision-making technology for unmanned aircraft, advancing sensing and surveillance, solar probe plus, solar orbiter, electrodynamics propulsion, robotic servicing of space assets,
and training and skill development for the global technology community. Working with the Federal Aviation Administration (FAA) is another factor to consider, from software and restricted military airspace to opening commercial airspace for unmanned aerial systems.

IX. Conclusion

All government organizations face obstacles that impede collaboration between agencies. There are differences in organizational structures, differences in jargon and acronyms and differences in organizational incentives for collaboration. Despite a long history of collaboration, cooperation between NASA and the Navy has waned in recent years. Recent challenges have included total system performance acquisitions, limited program sponsored research, manpower shortfalls in science and technology, and lack of funds. From NASA's perspective, the availability and scheduling of facilities, reductions in aeronautics funding relative to the overall budget, and the requirement for full cost recovery when working with external organizations all present challenges.

While challenges to the partnership between the Navy and NASA remain, there are also significant opportunities for future work. Collaboration is difficult but absolutely critical for advancing mutual research goals of each organization. Although it may not be popular because it takes up organizational time and additional money, NASA and the Navy should again move into the lead system integration business.

Large accidents can be very costly because there is a tendency to spend a great deal of money trying to identify and fix problems and then set up an improved infrastructure. But as funding for basic research decreases, NASA and the Navy need to establish a better joint safety apparatus. This collaboration can be utilized immediately, along with training and education to unite talent and resources from a variety of scientific fields. Human factors and testing are of critical interest to NASA and the Navy. There must be a shift in the way incidents and failure are assessed and dealt with.

Another important opportunity for collaboration in research is to continue interagency job sharing. Having people spend time in other organizations reminds researchers that there are other people doing similar research work. With collaboration, it becomes possible to discuss what worked, what did not, and why. This can assist and encourage future cooperation.

NASA and the Navy need to collaborate on the way planes are flown, especially in terms of the human factors, which NASA can understand very well. For the next generation of flight dominance airframes, they have to think "revolutionarily," start with functionality rather than simply adding layers of complex capability to older platforms. We are not going back to the moon or on to Mars until this problem is fixed. This reduces training time on new platforms and improves the time from development to projection into the field.

How is mission focus maintained with everyone distracted by declining budgets and potential program impact? The mindset in the Pentagon could be considered as a distraction, with a focus on the overall impact to DoD of budget deficits and reductions. What does this mean for the Navy? Are we engaged and doing our best to influence Navy program budgets for long-term defense and research? How are the books kept—are we looking at the Navy or at the OSD level? Is OSD looking at the services' budgets? How do we stay focused in an increasingly unstable fiscal environment?

Notes

CENTER FOR THE STUDY OF DEMOCRACY

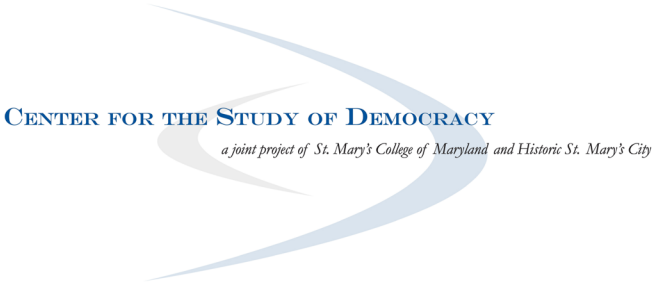
a joint project of St. Mary's College of Maryland and Historic St. Mary's City

The Center for the Study of Democracy

The Center for the Study of Democracy was founded as a joint initiative of St. Mary's College of Maryland and its partner institution, Historic St. Mary's City, the site of Maryland's first capital. The purpose of the Center is to explore contemporary and historical issues associated with democracy and liberty in national and international contexts. The Center provides a forum for presentations by government officials, journalists, and scholars; publishes scholarly writings on subjects of civil governance; encourages and supports public participation in political processes; and engages undergraduate students in study and research on related subjects.

The Patuxent Partnership

The Patuxent Partnership works with government, industry and academia on initiatives in science and technology, hosts programs of interest to Naval Air Systems Command (NAVAIR) and the broader DoD community, supports workforce development including education initiatives and professional development. Visit www.paxpartnership.org.



THE PUBLIC HONORS COLLEGE

St. Mary's College of Maryland
at Historic St. Mary's City