Changes in Naval Aviation: Guest Editor's Introduction

Thomas R. Foard

Emerging technologies are profoundly affecting system development in military aviation. For example, the Global Positioning System has advanced navigation with relative ease and reasonable cost and provided a means to address evolving mission and weapon deployment challenges. Thrust vectoring for manned aircraft has alleviated the need for drag-producing control elements, thereby creating new approaches to basic control fundamentals. This change is as significant as when hinged aileron control replaced wing-tip warping. Ironically, new aircraft skin material technology may make control surface warping attractive again. These technological advancements, however, are only part of a rapidly changing environment.

The threat world has changed, and our approach as a world power to protect our interests and those of our allies has changed commensurately. The Honorable Paul G. Kaminski, Under Secretary of Defense (Acquisition and Technology), noted recently that because of its chaotic nature, the post–Cold War era has not even developed its own name.* This situation has made it difficult to define specific threats in a way that, in the past, defined directions for improvements in combat aviation systems.

The contemporary requirement to prevent the loss of aircraft and the taking of prisoners of war is steering the course of mission planning. In addition, aircraft must be designed to accommodate both male and female aviators in combat. Thus, aviation system development has become a multidimensional process, not driven by technological progress alone.

In the first article in this issue of the *Digest*, Rear Admiral Craig Steidle emphasizes that affordability is an independent variable in the procurement process of military jointness. The jointness starts at a combined operational level, as discussed by Vice Admiral William Owens (now retired) in a previous *Digest* article.[1] The "system-of-systems" concept discussed by Owens combines the strengths of the services into a united force. This joint force context has found its way into the procurement process, where overlapping requirements of the services can be met using economies of scale. Rear Admiral Steidle's challenge in the Joint Strike Fighter (JSF) program is to balance stealth, speed, short-takeoff, and vertical-landing characteristics to meet the many mission requirements of the U.S. Air Force, Navy, and Marine Corps, as well as the United Kingdom Royal Navy. Commonality

* Address to the Precision Strike Technology Symposium, The Johns Hopkins University Applied Physics Laboratory, Laurel, MD (10 Oct 1996).

across such a joint set of requirements is indeed a challenge that requires a new way of thinking in planning new systems.

The complexity of aviation is compounded by the extensive breadth of platform types that exist. One taxonomy is to sort as heavier-than-air or lighter-than-air aircraft. For heavier-than-air aircraft, fixed- and rotary-wing versions exist, whereas for lighter-than-air aircraft, there are tethered balloons and airships. Currently, tethered lighter-than-air platforms carrying sophisticated radars are of interest for extending the detection range of surface-based missile systems, as well as for providing guidance for ground-based interceptors.

Manned vs. unmanned air platform is another taxonomic distinction in developing requirements. Stealth technology adds yet another element in the design of aircraft and missiles; the development of the "blue whale" prototype is a very interesting page in aviation history, which led to the creation of the F-117 and the B-2. Further naval aviation distinctions derive from whether aviation platforms are operated from aircraft carriers, amphibious ships, or smaller combatant ships, or are limited to land-based operations. Sensors are selected for performance while operating over land and sea, as well as undersea, and weapons with increasingly precise guidance are strongly steering overall aircraft systems design.

All of the foregoing considerations make the acquisition of a major military aircraft a substantial challenge. This task is addressed in the article by James White. The concept of a "competency aligned organization" brings together a system of a "team of teams" that spans the development of a new aircraft from specification through its life cycle. Although the team concept is nothing new to aviation, the new lexicon and the use of customer and supplier members on the teams satisfy procurement reform requirements of the Department of Defense. The historical background presented previously and the new role playing by team members afford an appreciation for how the organization, procurement process, systems engineering, and foreign military sales interact with new technology decision drivers facing the management team.

A familiar role for APL in serving a program sponsor is to provide unbiased technical assessments. This is the subject of an article by Halpin et al. describing F/A-18 E/F Program Independent Analysis. The F/A-18 E/F *Super Hornet* is the successor to the currently produced C/D models of carrier-based fighter and attack units; the new models will extend the range and other performance characteristics of the aircraft. The development models of the E/F have been delivered to the Navy for extensive testing and evaluation consisting of demonstrations and analysis to optimize subsequent mainline production models. APL, as a member of the Program Independent Analysis Team, has participated in a risk analysis addressing 13 distinct test and evaluation categories covering approximately 2000 planned test flights. Selection of one of two versions of the radar warning receiver was complicated by the requirement that units be bought over the procurement cycles of the C/D and E/F models of the F/A-18.

Statistical models and judgment-based weighting factors were used in the assessment of risk. Attention was given to materials issues involving composites and windscreen coatings. Engine compressor blade fouling and vertical tail assembly aerodynamic characteristics in high angle-of-attack situations were addressed. The Global Positioning System integration with several of the aircraft weapon systems brought to bear APL's expertise in navigation. The breadth of technologies covered highlighted the complexity of the developmental needs of this kind of acquisition program.

The foregoing activity leads naturally to the article by Casasnovas and White, which addresses reliability of aircraft plastic encapsulated microcircuits needed to support a large number of aircraft over the long-term life cycle envisioned. Testing to determine delamination and attendant moisture and corrosion is described in a way that illustrates how experience deriving from high-reliability parts utilization for spacecraft finds its way into aircraft parts consideration.

APL has long been involved in the operational capability assessment and test and evaluation of guided missile systems. The understanding of antiair warfare obtained from the earliest efforts on Terrier, Tartar, and Talos missile systems led naturally to a role for APL in developing techniques for defeating enemy antiaircraft missile systems. This work led to long-standing programs for the EA-6B *Prowler* and EF-111 *Raven* and ultimately to self-protection countermeasures. The article by Kennedy, Patterson, and Munshower describing the cost and operational effectiveness analysis (COEA) of several alternative airborne countermeasure systems highlights the need for an operational understanding of the F/A-18 aircraft attacking a set of ground targets while being subjected to specified levels of surface-to-air missiles and radar-directed antiaircraft artillery. This mission-driven analysis was done for a complex matrix of configurations, threats, and scenarios, illustrating the breadth of scope necessary to address such a warfighting assessment. Cost considerations appear again, underscoring the importance of system affordability in contemporary analysis.

The missions used in the countermeasures COEA work have a complementary component described in the article by Maurer, Chamlou, and Genovese. This article concerns the internal signal processing function used to help guide an antiradiation missile intended to physically destroy radar detection and guidance systems. The application of digital receiver and acousto-optic designs, in conjunction with algorithms that assist in on-the-fly target parameter and classification estimates, is described. The future of this research is encouraging.

The articles described thus far have related to manned aircraft and, in particular, strike warfare. An important element of strike warfare, first employed during the Persian Gulf War and later in Bosnia, is the Tomahawk missile system. This ship- and submarine-launched cruise missile may be the basis for the term "precision weapons," which is now widely used. The article by Pollack, Ferguson, and Chrysostomou describes a collision avoidance system for air vehicles derived from the accurate navigation capability of the Tomahawk and the desire to use a low-cruise altitude for defensive system avoidance. This Tomahawk system addresses airspace usage, given that no manned aircraft will interfere; coordination with manned aircraft missions remains a technical challenge.

William Menner, in his article on tactical aircraft strike planning, blends intelligence resources with complex resource planning to develop a process for using different aircraft in a variety of mission capabilities. The ultimate integration with Tomahawk strike planning is a natural evolution, so that an optimum time and space mix of manned and unmanned air vehicles will be woven into a best-case scenario for using advancements in aircraft and precision weapons with ground combat support scenarios.

The Navy and Marine Corps have new dimensions to deal with in littoral areas. The ability to conduct antisubmarine warfare is essential to any strike or amphibious operation. Historically, detection and destruction of submarines have been achieved by conducting air antisubmarine warfare operations using carrier, surface combatant, and land-based aircraft, together with the other Fleet elements. Understanding and using sound propagation in the submarine's underwater operating environment have long been useful for detection. For years, listening for the submarine's rich set of sound signatures was a way to carry out long-range detection and to reliably discriminate the submarine from similar sound sources generated by surface ships. Advances in submarine quieting dramatically changed the level to which this passive listening approach could be employed. Active sources produced by ship sonar and air-dropped sonobuoy systems have been augmented by high-powered, impulsive sources tailored to produce sound at the low frequencies that propagate for long distances in the ocean. APL has developed training systems for fleet operators based on its technical experience and emerging computer technologies. The two articles discussing active acoustics by Andrew Coon and Coon et al. address the technical work in signal processing that led to the development of tactical training systems.

Air antisubmarine warfare has, for many years, also employed nonacoustic detection systems to deny submarines unrestricted use of the ocean surface for conducting snorkel and periscope operations. Air independent propulsion has lessened the need of submarines for snorkel operations, but periscope and communications antennae are still important tools for optical and electronic links to nonsubmarine platforms. Periscopes scar the complex surface of the ocean in an almost insignificant way when the sea state is rough. When searching with radar systems, periscope reflections are largely indistinguishable from sea clutter. Furthermore, operations in littoral areas involve small boats, debris, and other small objects that produce false targets. High-scan-rate radars with retrospective scan information processing techniques are applied to process and filter this information; Ousborne, Griffith, and Yuan describe advancements in this area and the related APL participation.

Taken as a set, the articles in this issue cover much of the breadth of air systems used in military operations. Both strike and sea control elements have been addressed, but some dimensions exceed the scope of what has been described. The challenge is to develop a capability that will derive from the integrated and efficient use of space-based assets, manned and unmanned aircraft, and intelligence gathering sensor systems, all used to bring hostilities to a rapid close through overwhelming force and information superiority. Military aviation platforms, with their wide range of capabilities, contribute greatly to the efforts of our nation and our allies to maintain order in a world whose complexity increases every day.

REFERENCE

[1] Owens, W. A., "Joint Littoral Warfare: Our Future," *Johns Hopkins APL Tech. Dig.* **14**(2), 90–93 (1993).

ACKNOWLEDGMENT: Ken Plesser of the Power Projection Systems Department assisted measurably in the structure and critique of this article. His help was greatly appreciated.

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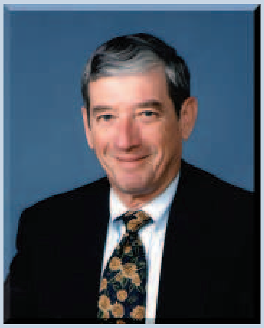

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