THE PHM, CONCEPTION TO REALITY, A DIFFICULT BIRTH
International Cooperation-Lessons for the Future

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INTRODUCTION

This article is a personal account of the author's involvement many years ago in conceiving, and then achieving, the Patrol Combatant Missile (Hydrofoil), the PHM. This first ship designed to meet NATO specifications, and designed to metric standards, is a credit to the U.S. Navy. There will be many who read this article, or hear an abbreviated presentation at the twenty-fifth anniversary of the IHS, who know much of what is related, and those who know a great many more details of various elements of this story. The author also shares the honor with Bill Ellsworth, and other friends and colleagues, to be a charter member of the North American Chapter of the International Hydrofoil Society (IHS). We Americans joined those in England, and elsewhere around the world who founded the IHS, and are proud to be part of it.

Over the past twenty-five years, many nationalities in the International Hydrofoil Society (IHS) have shared the excitement of world-wide hydrofoil growth, and now look to the future. Many have already read and heard from others about the hydrofoils of the world, including the PHM; and such veteran stalwarts as the United States' Ellsworth, King, Jenkins and Wilkins in their writings and speaking captured for this organization the sense of history and struggle in bringing the PHM from concept to construction, and the deployment and use of the U.S. PHM Squadron.

Today, advanced ship design advocates envision improved hydrofoils, and more of them in a variety of roles. Advanced ship design panels, such as the one led until recently by Ken Spaulding, Ship Design Panel Five (SD-5) of the Society of Naval Architects and Marine Engineers (SNAME), have been chronicling the experiences of international hydrofoil pioneers in design and manufacturing. Other institutions, like the IHS, have regularly reported on developments in the military and commercial world. As new pioneers plan for the future, nations should be buoyed by past international hydrofoil cooperation.

So it is, that as the new pioneers draw on PHM experience for future development, it is highly appropriate to salute those long devoted to other high speed, advanced design disciplines, be they ships on a bubble of air, or with a variety of underwater shapes, or hybrid designs that have evolved from the trials and tribulations of several technologies.

We pause to remember those naval and civilian advocates in each nation that were, and remain, dedicated to other advanced concept ships and weapon systems. They bring to the shipbuilding world an equally enthusiastic and creative pioneer spirit in advancing their own candidates. In the United States Navy the Surface Effect and Air-Cushion advocates competed for limited funds for research and development budgets. However, it was their shared enthusiasm for high speed on the water that helped fuel Congressional enthusiasm for the PHM in the face of fierce opposition within the Navy, the Department of Defense and several administrations.

In an early 1970's discussion of this need for mutual support, in the midst of NATO negotiations, and the rapid emergence of hydrofoils, Surface Effect Ships (SES), and Air-cushioned Vehicles (ACV's), Captain Randy King, Commanding Officer of the R&D Center at Carderock, Maryland, Captain John King and the author laid out some rules about one set of advocates supporting the others, and restraining parochialism and internecine warfare among advanced ship design communities. The very embodiment of this spirit was that shown by two Surface Effect Ship (SES) pioneers, Captain Carl Boyd and top Navy R&D civilian, Nat Kobitz, recently retired. These two gentlemen "led the charge" for SES high-speed ships; but, even while competing hard for limited funds, they also supported hydrofoil development.

Those at the R&D Center at Carderock, Maryland, deserve a special and historical place, in first nurturing the new hydrofoil technology, and then seeing it through many years of early prototypes' development and vigorous test and evaluation, that led to the future PHM. The Ellsworths, Johnstons, the Meyers, O'Neill's and Clarks, along with the Navy Ships Engineering Center's (NAVSEC's) Jeff Benson, were core in-fighters. They brought the Navy forward in hydrofoil technology along with brilliant advocates from the Naval Ship Systems Command (NAVSHIPSYSCOM) like Jim Schuler, and Captains and Project Managers, Earl Fowler, Jim Wilkins and Ed Molzan. There efforts were augmented by premier strategist, Jim Hamil, from the Office of the Chief of Operations (OPNAV), and later Naval Material Command (NAVMAT), in carrying the technical and institutional hydrofoil fight to the forefront. All worked tirelessly with officers in the Office of the Chief of Naval Operations (OPNAV) to bring the technology through its growing pains. The combined "team" spent endless hours in NATO working and project groups, Office of the Secretary of Defense Decision and Review Centers (OSD DSARC's), and Navy Office of Program Analysis (OPA), as well as nearly continuous Congressional decision-making forums, in order to create the PHM Squadron. Rear Admiral Ron Hayes, and senior civilian staffer, Bruce Ensley, were key players in gaining mutual support decisions by the Secretary of the Navy (SECNAV) and CNO, as the follow-on PHM's became a Squadron.

Navy Captain Bill Erickson is unique in hydrofoil development, participating as an engineer, an OPNAV Action Officer, and as a PHM skipper. Another naval officer, LT Chuck Rabel added enthusiastic support to Bill Ellsworth at Carderock. Great credit goes to Captain Karl Duff, who in a variety of roles for many years, contributed immeasurably to hydrofoil and PHM prominence, and has eloquently written of his adventures in the hydrofoil world.

We pay tribute also to follow-on PHM skippers and squadron Commodores, who with OPNAV warriors, and SYSCOM and Carderock engineers, kept the faith, made possible PHM operations, and suffered the "tortures-of-the-damned" in operating and maintaining a one-of-a-kind ship.

There is another group of officers and enlisted men who deserve to share our anniversary of hydrofoil enthusiasts. Frequently maligned, and usually forgotten for praise, are U.S. Navy, Fleet maintenance staffs. They deserve hydrofoilers' profound gratitude, because they planned and executed the day-to-day PHM logistic support so vital to this new, and unique fleet addition. They had a tough job, because they primarily served conventional ship masters. They tried very hard to support the new weapons system in a drug interdiction role that is to this day not recognized as a military mission by Defense officials, including the Navy. Boeing's logistic support is patently worthy of mention; and is prominent in post-operations' reports such as RIMPAC 78, and drug interdiction mission reports by the PHM's. Boeing, and Tony Maier, who was first with Boeing, and then on his own in Florida, were always there, able to solve some really tough problems. Shipboard enlisted crewmen, rose to every occasion superbly.

INTERNATIONAL HYDROFOIL DEVELOPMENT

In reviewing PHM history, we rightfully pay homage to the earliest U.S., Canadian, Swiss and Italian efforts to first invent, and then enhance surface-piercing and fully-submerged foil craft. We salute the pioneering efforts of NATO countries, notably Canada and Italy, who built and sailed early operational hydrofoils. It is with great respect that we remember the critical advocacy efforts in NATO of the British, Germans, Dutch, French, Norwegians and Danes, who joined Italian advocates in the Mediterranean, as they pressed for speed on the turbulent North Atlantic and Baltic high seas for small ships they knew and historically operated so superbly.

We should never forget that basic hydrofoil technology existed elsewhere during the NATO hydrofoil development period, and most certainly does today, in Asia, notably in Japan, Hong Kong, and China. It has taken the innovative thinking, the commercial impetus, and the technical successes and failures of worldwide hydrofoil advocates to bring this species into being. Most maritime nations, including Russia, and continue to contribute to the knowledge needed to combine hydrofoil technology with other new ship design concepts.

Israel and arab countries such as Saudi Arabia are part of recent hydrofoil and Air Cushion Vehicle (ACV) history too. Let members from all nations pause on the twenty-fifth, IHS birthday to remember an important lesson: *Human ingenuity and curiosity abound everywhere. Creative ideas are not limited to one place, one people, by a nation's power and wealth, or a single common interest.* Still, while many nations are part of hydrofoil history in one way or another, it is in NATO, led by the United States, that the PHM design was born; and this personal story honors the author's own compatriots and those of our allies.

THE RIPLEY INVOLVEMENT WITH THE PHM

The author's association with the PHM, a concept then not yet envisioned in any detail, or yet named for its weapons and role, came from a new assignment in 1970, the third time around in the Pentagon since 1960. This assignment to the Ship's Characteristics Board in the Surface Warfare Division of the Office of the Chief of Naval Operations, followed two ship commands in Vietnam, with familiarity on those wartime tours with both "brown water" and "blue water" navies as that war first started in earnest, stalled and changed to winning Vietnamese "hearts and minds" through in-country operations in Vietnam.

This author may have been assigned to that Shipbuilding Board because in the course of three amphibious commands since 1957, his ships suffered about every conceivable operational casualty that could require investigation and repair. Command at sea led to close contact with the Engineering Duty Officers (EDO's) and civilian scientists and managers of the Navy and their shipbuilding cohorts in industry. It was experience, good and bad, in how to keep ships afloat that put the author in the Pentagon. As an amphibious "desk officer", one first assignment in (OPNAV) was to serve in 1970 as an intermediary to three admirals, two of which became CNO's over the years, as they began to lay ground-work for a modest, long-range program to develop small, high-speed ships and craft, since the U.S. Navy limited inventory was largely handed over to the South Vietnamese, scrapped, or sold to third countries. Understanding and appreciation of the role played by Swift Boats and other Fast Patrol Boats (FPB's) in Vietnam later led to most needed high-level Navy support, sometimes when least expected.

Recall, if you will, that the U.S. Navy faced in 1970 vast shipbuilding expense to renew the fleet, while decommissioning nearly a thousand WW II ships, as the Vietnam War was "winding-down". The resultant program of modernization, and increased Navy inventory of new and more capable fighting ships, became known as the "high-low" mix. This was a combination of conventional and/or readily re-producible ships on the one hand, and on the other, those ships that required full concept development that contained the most sophisticated hull design and expensive weaponry possible for the "New Navy". It was the "low" end of the cost and risk spectrum that the hydrofoils represented, at a relatively well proved state of development when this strategy began.

Part of the job of the Characteristics Board in the office of the Deputy Chief of Naval Operations for Surface Warfare (OP 03) was that of translating the "soft-money" of Research and Development (R&D) to the Ship Building and Conversion (SCN), "hard" money of ship improvement and new construction for both high and low mix ships. A small cadre of officers, representing varied ship types, became named the Ship Acquisition and Improvement Division to reflect these dual roles. Our leader, VADM Jerry King, was elevated to the Surface Warfare head (OP-03), and our new leader became RADM, later VADM, Frank Price, with a special designator, Director of the Ships' Acquisition and Improvement Division (OP 97, then OP 097). OPNAV advanced ship desk officers worked for Admiral Price, his brilliant Deputy, RADM George Halvorson, and at one time directly for Admiral King, and his Deputy, RADM Jim Morrison. All these flag officers were hard working, hands-on leaders that had great experience in operations and technical programs. All were enthusiasts for the "new Navy", and converts to the Zumwalt way of getting difficult things done differently.

After a brief hiatus in 1974-76, where the author went to Greece to undergo their revolution and U.S. Navy home-porting expulsion, as the Navy Chief of the Joint Military Aid Group to Greece (JUSMAGG), he returned to become Deputy for RADM Bill Read, who had relieved VADM Price as the Director of the Ship's Acquisition and Improvement Division, now (OP-37). VADM Price became OP 03, and was soon relieved by VADM Jim Doyle. This was the era dedicated to the time-consuming fight for full PHM Squadron construction and hydrofoil survival.

At the beginning of the PHM journey, it was a long-time shipmate and friend, John King, who brought the author into the hydrofoil world, along with another Surface Warfare Requirements Division leader for clandestine warfare (now called Special Operations), Captain Larry Kelly.

There is a prized picture of the conceptual PHM, given to the author by Captain John King on the wall as this article is written, with a hand-written endorsement on it --"To Bob Ripley, one of three who had the dream!". The other two believers in that dream instilled enthusiasm for the PHM that has never faded. Thus it was that Admiral Zumwalt, now Chief of Naval Operations (CNO), had an embattled team of contentious warriors, King, Kelly and Ripley, that are still around to tell the story of the birth of the PHM. John the heart of it all, Larry who knew what it took to get a mission for a NATO high speed ship, and how to use hydrofoils, and this author-Captain that joined them.

NATO 1970-1974

In considering the early '70's as the NATO European period, as a "cowboy from Montana", the author prefers to refer to the PHM perambulations in the United States, as, "meanwhile, back at the ranch." This is because the NATO impetus for its first shipbuilding experiment had a virtual life of its own, while interested government "ranches" reacted in different ways to this new concept in warfare, developed on the NATO "range."

There are many players remembered with affection that for nearly four years were deeply involved in hydrofoil development. Many of these NATO delegates are known to you, some are not; but PHM could not have been designed had they not bombarded their respective governments with their ideas and enthusiasms for hydrofoils, first in exploratory, then in a dedicated hydrofoil project working groups. During this period, U.S. Navy delegates had the close personal attention of ADM Zumwalt, and instant decision-making communication through Admirals King and Price. This direct access and immediate decision-making response were key factors in moving the PHM design program along successfully in NATO. Equally effective in providing strong and responsive, technical decision-making support were two Commanders of the NAVSHIPSYSCOM, RADM's Sonenshein and Gooding.

Working in several NATO working groups, which became more sharply focused on the PHM final design agreements between Italy, Germany and the United States as time went on, each country's delegation struggled to get started. Italian VADM Cioppa, our NATO senior, proved invaluable in planning the strategy, and setting the scene within NATO. At the start, each delegation had to convince the NATO high command and mother governments that high speed ships were needed; and it was then necessary to prove that the hydrofoil was the best Fast Patrol Boat (FPB) candidate, and the only one that fully met NATO requirements.

To accomplish this task, the U.S. Delegation worked with the staff of the Commander in Chief of NATO Southern Forces (CINCSOUTH) in Naples in 1969 to develop a mission statement for that area requiring very high speed small craft. This concept of attacks by many small boats against larger ships had its Mediterranean origins in very early Italian history, and was first called the "sea-dust principle", as hundreds of small boats grappled with "biremes and triremes", and won! The basic military requirement, which was predicated on countering the Soviet OSA KOMAR class ship, was firmly established, and soon extended to the Baltic areas, and thus to NATO everywhere. Careful negotiations, and strong support from the other hydrofoil delegates from Canada, U.K. France, and especially the Netherlands, along with Italy, Germany, Denmark and Norway convinced their NATO governments that high speed craft needed joint development.

The mutually-agreed, NATO speed and sea state requirements were set sufficiently high that conventional hull ships fell short on meeting operational requirements for speed over thirty-five knots. The requirement all spelled out fast patrol boats (FPB's) with excellent sea-keeping characteristics in small size, which are prized characteristics of hydrofoils. Thus it was that the stage was set for a new, high-speed hydrofoil ship of advanced design to meet NATO specifications. The requirement for the hydrofoil was soon validated, and approved, by higher NATO command. The individual governments (back at their respective "ranches") approved the requirement developed by the International Exploratory Group. The next task was to develop NATO design specifications in the newly formed, PHM Project Group.

Once the need for speed on the water was identified, and the hydrofoil became a NATO requirement, part of that generated solution called for proof that there were military or commercial hydrofoil prototypes available in the world that could be turned into small warships. The U.S. Navy arranged during this critical decision period to have the Boeing prototype hydrofoil, TUCUMCARI, brought to Europe with a converted "mothership," (LST WOOD COUNTY) to support its operations and ship visits. TUCUMCARI, and its subsequent captain, LT ED Bond, did much for the hydrofoil program. Ed continues to view us hydrofoilers with affection as a high official in Boeing.

In the course of NATO negotiations, a memorable "sail-off" demonstration took place off southern England with TUCUMCARI, conventional patrol craft and air-cushioned British vehicles, in which the "Tuke" performed admirably under its Captain, Lt. Dick Stedd. Other visits were made at various times to NATO countries. One visit to Italy included an Italian Navy in a fleet exercise, where there was an opportunity to observe the sea-keeping of the hydrofoil in sufficiently high seas to support our assertions about usefulness. The Chief of Naval Material, Admiral Ike Kidd, accompanied by Captain Jack Lowentrout, John's, Larry's and the author's immediate boss at the time, observed these particular trials.

A personal sidelight occurred as the time to commit to a common PHM design program approached. Jeff Benson, then a feisty LCDR, and the author, made a ten day trip to five NATO capitols to argue the need for hydrofoil support versus conventional small craft. Our cohorts in the NATO working group had laid the groundwork for a warm welcome, and identified the degree of support we could expect in NATO. Benson's ability to translate the technical jargon to understandable language for laymen later served him well as he followed Jim Schuler, and brought to fleet prominence the air-cushioned landing craft, the LCAC's we have today.

After long, and often frustrating negotiations, hard commitment came finally from Germany and Italy for the Design Phase of the PHM Project. Detailed planning followed, orchestrated by the U.S. side, led by John King, who became the International Chairman of the NATO PHM Working Group, whose U.S. Delegation Representative was the author of this article. Even before negotiations with our NATO partners came to fruition, the U.S. Navy, led by Admiral Zumwalt, had already started an information and advocacy campaign in the Navy Secretariat and the Office of the Secretary of Defense (OS). Players were varied, ranging from R&D approval "chain" desk officers, to Secretary and Under-Secretary level in both OSD and the Navy. This Secretarial, rather than the Joint Chiefs of Staff (JCS) "route" on many Research and Development (R&D) initiatives was important in the total shipbuilding era.

There were greater possibilities for shipbuilding programs in this course of action than those that might result in simply splitting the defense funding "pie" among all Services four ways in the JCS arena. Everyone is aware of the tremendous amount of money over many years that was necessary to build the "new Navy". Advanced design ships increased the Navy's R&D budget by a needed percentage, and advanced the state of the art at the same time. It will be greatly interesting to hear Admiral Zumwalt recall his own thoughts during the PHM program; but, suffice to say, that hydrofoilers could not have had a better advocate.

Both hull and integrated weapons system design were an integral part of PHM planning, once the idea of a fast patrol hydrofoil was accepted. The Project Group had to consider weapons systems to meet new problems that were generated by the hydrofoil's size and high-speed design implications, and find ways to adapt and procure them. In this endeavor, Admiral Price, who was the Program Coordinator for the development of the Patrol Frigate, and anxious to promote "downstream" sales in other countries, took the lead in finding NATO weaponry that could be adapted to both ship types. Thus it was that the Italian OTO MELARA 76MM fully automatic gun, and the Dutch, SIGNALL MARK 94 fire control system, adapted for PHM and Frigate use by the Republic of Germany, and later by the U.S. Navy, and now called the U.S. MARK 96, became part of the PHM weapons system.

After much debate about these installed weapons, and the introduction of the missile weaponry in the form of the newly developed U.S. "HARPOON" (thus the designation Patrol Combatant Missile (Hydrofoil) [PHM]) as the candidate chosen over those of several other countries, a common, integrated ship weapon system was approved for detailed PHM design that met the needs of the U.S. Navy Patrol Frigate Program, and at the same time advanced the PHM Program. Weapons testing and demonstration on small high speed ships is an interesting part of PHM history, and deserves separate treatment at another time.

In designing to NATO specifications, the PHM Project Group had to consider international balance of payments, individual country weapons and propulsion contributions and trade-offs, which in both hull and weapons systems would have to be designed in metric dimensions. This very important "first" required a major decision, and concession, by the U.S. Navy technical community, and was made by VADM Bob Gooding. Of course, mutual design, stressing commonality, involved many different government and industrial players in each committed nation; and it is a credit to the three design-stage participants, and their respective CNO's, that agreement could be reached.

The author had the great fortune on the Ripley-Benson trip to Italy to gain three OTO MELARA guns for our eventual testing, modification and PHM installation from the Italian CNO, and full credit is due to the Italian PHM Project Group members, and Admiral Cioppa, for setting the stage for the offer. Back at the U.S. "ranch" we had to convince the Department of Defense (OASD-ISA) to support the trade-offs necessary to procure the Italian weapon system.

The internal PHM Project Group design considerations, and decisions that needed resolution, first in NATO and then in respective national chains of command, soon began to boil and bubble "back at the U.S. ranch". News of intense debates related to both requirements and technical commonality choices reached our Administration and Congress, as well as the government hierarchies of Germany and Italy.

No time was wasted by NATO "in-fighters" to decide what it would take to convince respective governments that we should and could build a PHM. That fighting ship could not merely be a research "toy", but had to be a viable fighting ship that could compete fully with other war ships in NATO threat scenarios, or national threats outside of NATO. A key requirement was that such a PHM had to be easy to construct by member nations. *These considerations drove the "commonality" argument so that more than one nation could convince its government to participate in both design and construction.* The Group settled on a basic hydrofoil concept, the Boeing-built "TUCUMCARI" in a close competition with the Grumman "FLAGSTAFF." This was a critical technical decision, as the NATO mixed group of technically and mission-oriented members, spelled out the compelling need for speed; reviewed prototype candidates available; and made the design decisions necessary to reach final 95 % commonality. This was a formidable task, considering national military-industrial complexes' "not-invented here" tendencies and parochial weapon system and propulsion equipment choices. Jim Wilkins, the PHM Project Manager, and Karl Duff, then his Deputy, were key figures in these choices. They, and the U.S. Navy civilian hydrofoil "gurus", Ellsworth and Schuler, and LCDR Benson, were the heart and soul of diplomacy in the war of "technical smarts".

In this intense period of trade-off decisions, You would be pleased to know that the author participated in design of various coffee pots, but in this single, and most traditional, area failed to achieve full commonality. If memory serves, we selected some 17 different wire sizes, all needing conversion to metric descriptions, and different electric power requirements for European and U.S. versions of the PHM.

The spirited competition between Program Managers Gene Myers of Boeing, and those of their Italian subsidiary, ALINAVI, and Bob Johnston of Grumman, was highly professional, and for the author, eye-opening and inspirational. Such was their expertise and so effective their candid testimony about design features and prototype operational performance of both hydrofoils, that all NATO delegates were convinced that the fledgling U.S. hydrofoil industry was fully committed without reservations to produce the PHM to NATO specifications.

It was obvious to the three nations committed to design of the PHM that we had to insert this new element in naval warfare, the high-speed, missile-firing small ship, into the very much more complicated international naval warfare scene, even while deciding the PHM mission and design.

In short, we had to foresee what world and area roles countries that possessed a nominal PHM might play; and how to retain the NATO control over design and construction necessary to prevent misuse of the PHM design between warring factions outside of NATO, who were affiliated with member NATO nations. Israel and the arab states come to mind. When this subject came up, some of the most delicate negotiations of all took place, including with U.S. State-Defense working groups faced with the realities of the Middle East conflict. Middle East considerations were immediately added to those concerned with the Soviet bloc that we normally considered in NATO.

The Soviets were equally interested in hydrofoils, and remained so. They vigorously began to build the latest technically advanced hydrofoils in significant numbers that they needed for their rivers, coastlines and inland seas. The Asian theater nations were beginning to show interest in our progress; and, even at an early date, information was requested by other governments outside of NATO, including Japan. It became evident also that the PHM, with possible "down-stream" sales to other countries throughout the world, would be suitable in both major oceans by our Navy, and those of our allies. Thus, our NATO PHM begin to burst the confines of NATO, even before PHM cooperative design commenced in earnest.

It seems highly ironic to the author that this unique PHM evinced such great interest as a newly emerging weapon system, and appeared to pose such a threat to stability in the region, when at the same time we faced, and to a degree, still face, a variety of national critics that denigrate PHM importance and capability.

It was always fundamental, and a paramount concern, that the U.S. government (Navy) stand solidly behind the PHM, and that it must be clear that the U.S. intended to build them. Thanks to Admiral Zumwalt this happened, despite bitter opposition in and out of the Navy. Stories of generating essential and critical support have been told by others who were, like the author, privy to incessant in-fighting by anti-hydrofoil, then anti-PHM, never-ending critics.

It is more than fair to say that our PHM USN team had its arguments at every level; and when finally we agreed on anything technical or mission-oriented in NATO, we didn't have to go far in Washington to find opposition. Special tribute is due the work of the US-NATO international development team, whose OPNAV Research and Development Officers of (OP 98-098), RADM Tag Livingston, Bill Montgomery, and John King in succession as NATO Exploratory and PHM Project Group leaders, worked closely with (OP 03) officers during PHM development. The OPNAV team's work, coupled with the budgetary and mission work provided by the Material Command, and the analytic help provided by the System Analysis Division (OP 96), and the Navy Comptroller chain of command, ensured that critical opposition was defeated, and PEGASUS, the PHM lead ship PEGASUS (PHM-1) was approved. Italy and the FRG then agreed that the first PHM would be a U.S. version.

THE PHM SQUADRON

We determined at one critical part of negotiations within NATO that the United States would build as many as thirty six ships (six squadrons), which were later drastically reduced throughout several years of U.S. decision making, largely dictated by cost, to one squadron of eight ships, which cost considerations again reduced to six, with two lead prototypes, of which PEGASUS would be the first PHM built. We announced this to the NATO PHM Working Group. It was about this time, the author left OPNAV for Greece, but was kept current by RADM Bill Read and Captain John King.

In the fall of 1976, the arguments so well described by George Jenkins were going on "full throttle". These decisions about the future of the PHM, U.S. Version, and the plans by the Italians and Germans to move into the construction phase were being formulated. In discussion were lead ship numbers (two versus one), PHM-2 construction and weapons systems, support ship versus aircraft van maintenance, and fleet assignment of Pegasus and the rest of the follow-on ships. Homeporting, deployment plans and manning and organizational considerations, were an on-going part of the often contentious dialogue.

During this period, RADM Bill Read was a pillar of strength, having been long convinced that this ship squadron must be part of the Navy inventory of fighting ships, and that the hydrofoil had uses not yet envisioned that we would discover once the PHM Squadron was built, properly maintained and deployed. He was often alone in his enthusiasm within the Pentagon, although VADM Doyle and Admiral Zumwalt gave him every chance to carry the battle up the chain-of-command to the President. He also was warmly supported in the Ship System Command by RADM Bob Walters. Several other key players in the Office of Program Appraisal (OPA), OP 96, Systems Analysis, and in OSD, the Office of International Security Affairs (ISA), played vital roles in withstanding a massive budgetary and technical attack by almost everyone else in Washington that played a role in Navy shipbuilding programs. Admiral Kidd, Chief of Navy Material (CHNAVMAT), supported the PHM program that Admiral Zumwalt proposed during several key decisions to proceed, and COMNAVSHIPSYSCOM provided strong and convincing technical argument. We later had strong post-construction support within the Navy and in Congress by a famed-WW II PT boat hero, RADM John D.Buckley, who was then President of the Board of Inspection and Survey.

RADM Monroe, who became the Commander of The Navy's Operational Test and Evaluation Force (OPTEVFOR), the Navy arm of the OSD Assistant Secretary for Development, Research Test and Evaluation (ASD-DRT&E), after previously serving as the head of Navy System Analysis (OP-96), performed the key technical and operational evaluation of PEGASUS (PHM 1) that sustained PHM advocates' arguments with the Secretary of Defense and the Congress at one key juncture.

ADM Monroe's first preliminary draft report on Operational Evaluation (OPEVAL) of the PHM lead ship could have, but did not, scuttle the PHM program with the Secretary of the Navy and Congress, because it was prematurely far more negative than it should have been, as was later proved as the testing progressed and the final, completely supportive formal report was submitted. A rumor by the "grapevine" to GAO about this unfortunate OPTEVFOR preliminary draft test report, that Bill Read refused to believe, eventually was dragged forward, and was of some embarrassment to SECNAV, a year or so later. Bill Read was criticized for not submitting the first raw data, when, in his Deputy's view, he should have been congratulated for moral courage in resisting the trumpeting of that erroneous preliminary data.

This incident, and other problems with senior Defense, Congressional Committee and administration officials can be attributed in large measure to the general negative attitude of some staff in both the offices of the Assistant Secretary of the Navy for Research and Development (ASN R&D) and in OSD, namely in (ASD-RDT&E). As most Pentagon experts know, key players for their own reasons, some not related at all to this program, but who advocated other programs competing for the limited funds available, were consistently opposed to the PHM, and it took the Assistant Secretary for International Security Affairs (ISA) to break the construction logjam.

To illustrate the depth of Administration skepticism, President Carter rescinded the PHM squadron construction program; and it took the resolute support of the PHM by Senate and House Armed Services and Appropriations Committees to keep the program going. Even then, the in-fighting delays during the mid-1970's caused fiscal year budget snafu's and delays that resulted in under-funding of the PHM's and deferral of funding for Squadron PHM combat systems. In retrospect, this author considers the budget arguments over several years that resulted in the loss of the very important PHM support ship in the Navy shipbuilding budget, also to be short-sighted.

PHM OPERATIONAL HISTORY AND RETIREMENT

The remainder of PHM history (1978-1992) is capsuled because the author was not an on-scene player, although in civilian consultant work in 1988, there was occasion to study the high-tech inventories of the world, particularly the Soviet Union. The U.S. PHM was placed against the world competitor hydrofoils and was of the highest capability. The author has carefully studied general operational PHM history, gained in part because the author belatedly came to Washington to join a great many others more prominent senior officers and civilians, including the Chairman of the Senate Armed Services Committee, as they tried to save the PHM Squadron from early retirement. Further information has kindly been provided in editing this article by John King and George Jenkins. From this background, the author's conclusion is that the eventual retirement decision was a premature one; and in the Navy's rush for PHM retirement, the ships' final disposition was clumsily handled, including the planning for research and development, and in dealing with foreign military sales opportunities.

Because of sea-going experience and PHM involvement, this author has found time over the years to draw some strong conclusions. First among them is that hydrofoil advocates have been far more objective, and fair-minded than have hydrofoil adversaries, and in their desire for fairness they appear overly self-critical. It must be remembered, that in creating the PHM Squadron, the program benefitted from those with no particular "axe to grind", and primarily because they understood the value of the PHM, the value of hydrofoil sea-keeping in small size, and economic benefits of small PHM crews which could make equal contributions with ships that were large and personnel-intensive.

It seems obvious that the hydrofoil "product", when properly understood by laymen and technically informed people alike, "sold", and continues to "sell", itself. One ride above the waves at high speed, as the PHM banked and turned like an aircraft, with the passenger in relative comfort, hull-borne in heavy weather, served to turn many of the most skeptical critics into "believers". The future of hybrid high-speed ships should be as bright, and the hydrofoil contribution to that hybrid concept, is a major one.

SUMMARY AND LESSONS-LEARNED

Now to thoughts of how we could have done better in all phases of PHM development, and the lessons-learned from failure, as well as success. Let's review the PHM story together for these pearls of hind-sight wisdom!

The first question is that of operational research prototype vehicles versus operational ships. If someone could have told us at the beginning of NATO negotiations that the problems of designing, constructing, then redesigning, maintaining and repairing a sea-going operational PHM for the first time would be as intensely frustrating and costly as was the case throughout PHM history, the NATO Exploratory Group probably would have been forced to abandon the project. There are those today that believe that the timing of the shift from R&D to Shipbuilding and Conversion (SCN) budgetary funding was a mistake.

This "doomed" the fiscal support for follow-on progression to larger hydrofoils and hybrids, and led to premature decommissioning of the PHM Squadron. There is credence to these arguments because of the many problems of transition to PHM warships from research platforms. It was the competition within the Navy for hard-to-come-by shipbuilding funding that generated such intense opposition when these ships became part of the Navy's active inventory.

Obviously, during inflationary and "down-sizing" periods the PHM's remained a contentious issue. The reader may not consider a PHM a "one-on-one" trade-off with a destroyer, but when non-sympathetic "bean counters" wanted to "dump" the program, they found ways to use the few operational PHM's in such comparisons with other ships of the line in order to justify putting them out of commission.

The R&D community is acutely aware that high visibility problems, and competition for limited funds, are often the downfall of solid research projects that need more time and money for successful development. The PHM had highly over-stated and over-publicized problems in the Navy and at Boeing that plagued construction, along with repair and routine maintenance problems that contributed to premature end of the PHM Squadron's operational life. Notwithstanding, as one who helped make those decisions of transition from "research craft" to operational weapon system, the author is thoroughly convinced that a much stronger case can be made that the total PHM experience added far more to advancing the state of the art than it detracted from it.

The lessons learned in designing and building this part-ship, part-aircraft, enhanced understanding of high-speed ships much more quickly than would otherwise be the case. Said another way, by virtue of the PHM competing as a fighting ship on the high seas, hydrofoils' utility for the future has been demonstrated; and those improvements and increases in size and capability that make them more valuable were clearly identified and readily translatable to the commercial use of this high-speed platform as well. There is nothing like "kicking the tires" of an operational ship or weapons system to advance progress. It remains for new advocates to make those advances, and no apologies are in order to "arm-chair quarterbacks" for decisions along the way to build and use the PHM's, and put them "on-the-line" for all to see.

A NEW IDEA IN A BUSY WORLD

Organizational and government institutional problems are part of the lessons-learned department where PHM's are concerned. Again, let us review the background considerations during the last quarter century of hydrofoil development. As we know, a major world power, such as the United States, has different considerations than a lesser power. Decisions made from that perspective dominate the form and substance of military inventory. During development of the PHM, two major world powers existed; and the political and economic stakes were high for both of them. Military inventory included nuclear weapons and launching systems, substantial conventional forces, and intensive and extensive research and development of weapons and counter-weapons. "Star Wars" expense comes to mind.

Furthermore, what represents a major system to a minor power, is a minor-system to a major one. Thus, the PHM, a major system to some of our allies, was still too expensive for them, no matter how much they wanted the inherent capability that PHM's provided.

Conversely, PHM looked too insignificant to the U.S. "blue-water" Navy, relative to the cost to fully utilize the PHM in single-mission scenarios. In our three-branch Navy, every single weapons system clamors for each dollar, particularly in highly inflationary times.

Budget estimates were very poor, and over-runs were commonplace in the ship-building world in the late 1970's and early 1980's, and continued to be difficult in subsequent periods of Soviet Union decline and collapse, and U.S. forces' subsequent down-sizing. All these factors played a part in PHM's turbulent history.

After sharing design costs, three NATO partners considered respective construction plans after PEGASUS was launched. A case can be made that the Germans probably would have built some form of the PHM design, as the Italians later did (in smaller size), had it not been for two factors. The FRG government was kept informed in detail on every PHM test and evaluation, and early operational, PEGASUS casualty report, no matter how minor. At this same time, the U.S. Navy PHM advocates were fighting to have the remaining five ships of the PHM Squadron constructed. As the U.S. wavered on acceptance of the PHM Squadron progress, this indecisive attitude contributed negatively; and when our hesitancy was combined with this steady "water drip" of maintenance complaints, the two situations may have influenced the FRG decision not to build at that critical time. On the positive side, the Italian Government went ahead with smaller versions of the PHM, and their commercial hydrofoils added much to technical knowledge needed to build better hydrofoils and hybrids.

THE FRUSTRATION OF OPERATIONS, REPAIRS AND MAINTENANCE

Let us review the problems of repair and maintenance of the PHM's from early construction through Key West operations. Clearly, despite highly placed claims to the contrary, the PHM's performed very reliably in spite of operational casualties, with repair and maintenance usually complicated by being one-of-a-kind in the fleet. It is a fact that for several years the PHM logistic support program was nominated for top Defense Department logistic support awards.

The author will always believe that if there had been a greater will to do so by senior Navy officers, we would have used these ships in more than the drug interdiction role, a role in which they really did extremely well, by the way. Despite some unfortunate and highly-publicized operational casualties throughout PHM Squadron history, and the natural loss of confidence by the non-initiated that accidents and casualties engender, particularly in new weapons systems, there appears little doubt that PHM's would have proved useful in the Persian Gulf during several crises in both the Carter and Reagan administrations.

During the Bush administration, they could have played a part in the Gulf War. They might have been of use in Panama, and, finally, done much more in Grenada, where they were used, but not to any extent, due to late arrival.

The reasons given that PHM's were never considered an operational "plus" during this period, was because, since their commissioning, at crises times, the entire squadron was not ready for deployment; or, if deployed, they would have required unusual efforts for transport to the Mid-East theater, and to maintain them while there; and lastly, and perhaps more importantly, that they were single mission ships without any anti-submarine warfare (ASW), and no effective anti-air warfare (AAW) capability against missile attack.

From a hydrofoil advocate perspective, these are the arguments of those who never wanted to use PHM's, or to risk their popular appeal to the detriment of other U.S. Navy fleet assets. While not wanting to second-guess too much from a safe perch in Montana, it is obvious to this author, that in NATO PHM scenarios that were used during PHM development, there were several that would have applied to Mideast operations. Such scenarios utilized the unique qualities of hydrofoil attack craft, including foil-borne imperviousness to mines and submarine torpedoes, and maneuvering agility to avoid aircraft attack.

It is significant that unique PHM qualities were demonstrated by prototype research and development prototypes, as well as during the extensive hydrofoil evaluation and post-construction testing of PHM-1, PEGASUS. One clear-cut attribute of the PHM, due to its inherent high speed and agility, is hit-and-run capability intended to keep the enemy off-balance against enemy capital ships, and emplaced weapons systems. The PHM has superior ability to keep slower small craft at bay. In a key scenario during PHM development, often called the "dark and stormy night" scenario, postulated in narrow seas or straits, the small crew and relative cost of PHM loss in an exchange with enemy capital ships, weighed heavily in favor of the PHM in mission-effectiveness analyses.

It is not hard to visualize, that a PHM, high-speed, on-foil, run at an oil rig in the Gulf would have "terrorized the natives", and could have been attacked with smaller risk than possible with any other surface ships in theater. Some experts tartly observe that finding old mines by large ships hitting them is a poor substitute for potential mine area search by small hydrofoils, whose imperviousness to mine fields was demonstrated by TUCUMCARI in Denmark mine-field operations even before PHM's were built. Parenthetically, Air Cushion Vehicles are even more impervious to mines.

Of interest in regarding the tactical maneuvering possible for a PHM, the agility of those PHM's was proved during the Operational evaluation of PEGASUS, when her agility was such that the PEGASUS could maintain a probe light, which was mounted in the barrel of the 76MM cannon, constantly in the cockpit of the "attacking" fighter plane as it maneuvered to attack, and the PHM could very often turn successfully inside the airplane's attack parameters. Given that the range of AAW capability of the PHM is extremely limited in a highly sophisticated setting of multiple missile air attacks, there still was mission-effective utility for PHM's during the times at the places in question.

As for readiness for Gulf or other European and Mid-East theater operations, most insiders know of the "one-hoss-shay" variety of engineering problems that hit the PHM Squadron at just the wrong time; the reluctance to go far from overly-elaborate van maintenance support by some PHM commanders, whose caution was natural considering OPNAV and operational seniors' own inherent fears, which in hind-sight appear largely unsubstantiated. While some do not agree with this thesis, this author believes there was a critical short-fall in failure to have a mobile, forward-based in-theater, PHM support ship (that was lost in budgetary cuts that, even if made, need not have been charged against this program), a concept that had been proved in TUCUMCARI deployment years before. Having operated for long periods at sea with limited support in Vietnam, as well as in-country, and aware of the ingenuity of our Navy when they need to employ it; it is hard for an amphibious naval officer, or a destroyerman, to believe that all obstacles could not have been overcome, with results justifying that effort, had PHM's been allowed to prove themselves overseas as fighting ships.

Critics of the author's thesis should refer to several fleet operational reports of exercises with early hydrofoil prototypes, and PHM's, that show that this high-speed attack ship can more than justify its cost; and that such attacks can completely disorient a conventional task force defenses, particularly at night; and post-exercise conclusions dramatically demonstrate that the PHM would be a valuable fleet asset today.

WHAT IT WILL TAKE TO GO FROM HERE

What should be emphasized in this personal PHM experience is the thrill and challenge of the up-hill struggle to produce the PHM's, and the pride in hydrofoil performance. It is easy to translate the past excitement to the struggles ahead to produce new and better hydrofoils; or other advanced design ships that also go extremely fast on the water, or show superior sea-keeping qualities in various sizes. The author knows from keeping reasonably current on world developments, and from the work of the SD-5 Design panel, of which he is a member, that pioneers are already hard at work on plans for future development that are very promising, particularly in the world of commerce on the high seas. For military applications, threat analyses support new technology, as do cost considerations in this post-Soviet, politically turbulent era. New hydrofoil improvements of evolutionary nature have already been identified. They include: longer sea legs, perhaps up to 2,000 miles; huskier and higher hull-borne diesel power, at least to 15 knots; increased redundancy in foil-borne mode of operation; replacement of faulty power units with more reliable ship service generators; and increased multi-capable weapon systems, and addition of more versatile systems. The U.S. must fight many distractions as we strive to stay abreast of the technologies available, and continue to advocate the need for speed and stability in high seas in our small craft and large ships.

Many PHM program participants believe the United States Navy itself would not initiate another hydrofoil program; and that it would take the Congress, or outside warfare analyses "think tanks" that include hydrofoil proponents, to force the Navy in this direction. Having played fair with what is recognized as a lack of enthusiasm by our Navy, this author suggests that you summarize in your own mind what qualities in men of all nations it will take to bring into being truly new and controversial design ideas and translate them to greater capabilities for sea commerce.

Looking though the PHM experience, perhaps they can be summarized in a "Pact for the Future". In writing this article, there appeared to be a convenient way to remember the qualities required, described by using the acronym P.A.C.T. in the following way:

"P" stands for prescience, patience, and perseverance. Those traits will give you a vision of the future, the ability to press on, or retreat, at the proper moment, and the courage to move forward despite man-made obstacles to achieving your vision.

"A" stands for accuracy, adaptability and accountability. Whether it be in matters of technology or program progress, you will need to be accurate about what you say; be able to adapt to new solutions for problems and situations, usually unforseen; and accountable in all you say, so that people, including adversaries, believe you. A program "oversold" is a program eventually lost.

"C" stands for creativity, competence and character. These traits will bring you new ideas and strategies, if they are based upon your technical and tactical competence, and the inherent character to be true to yourself, and to unselfishly, without personal aggrandizement, pursue your vision.

"T" stands for talent, trust and temperament. You will succeed in reaching a bright and productive future only if you have the ability to invent, invest and convince, and the belief in your fellow advocates and strugglers against the tide of indifference and ignorant opposition. If you then possess the level temperament to forgive your enemies, forget past mistakes or slights, and look always forward, you will succeed!

This "Pact for the Future" is held in large measure by past hydrofoilers, and by its successors in all countries; and that young and ambitious thinkers and innovators in our shipbuilding and aerospace industries will bring us into the twenty-first century with far more than "old-timer-hydrofoilers" were given.