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NAVAL POSTGRADUATE SCHOOL
Monterey, California

From Research to Reality

A Retrospective on the Development and Acquisition of Naval Capabilities During the Cold War Era

Report of a Symposium Held at the Naval Postgraduate School
12 and 13 June 2001

by

James E. Colvard
Phil E. DePoy

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NAVAL POSTGRADUATE SCHOOL
Monterey, California 93943-5000

RADM David R. Ellison, USN
Superintendent

Richard Elster
Provost

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and funded by NSWC – Carderock.

This report was prepared by:

James E. Colvard

Phil E. DePoy
Director – Institute for Defense Systems Engineering and Analysis

Released by:

David W. Netzer
Associate Provost and Dean of Research

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James E. Colvard
Phil E. DePoy

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The theme of the meeting grew out of discussions among Dr. James Colvard, Dr. Phil DePoy, and Dr. Walter LaBerge. Dr. Colvard also served as moderator during the meeting.

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INTRODUCTION

The 200-year plus history of the U.S. Navy is a proud story of battles fought and won, of outstanding leaders afloat and ashore, and of selfless service to our Nation.

Equally important, it is a story of the continuing application of new technology to the advancement of Naval capabilities. From smoothbore guns to submarine-launched ballistic missiles, from sextants to satellite navigation, from sail to steam to nuclear propulsion, the Navy's progress has been measured by the introduction of technological innovation.

Perhaps at no other period in this history has the adoption of new technology in the Navy been as pronounced and effective as during the Cold War throughout the fifty or so years following the end of World War II. This technology led, for example, to strategic submarines, submarine-launched ballistic missiles, an entire family of air-launched weapons, and, more recently, the AEGIS system. The difficulties encountered in developing these systems were formidable, and the conceptual, technological, and engineering advances necessary to bring them to fruition were remarkable, even by today's standards. Safe, reliable nuclear propulsion for submarines; long-range missiles launched into exo-atmospheric trajectories from beneath the surface of the seas; missiles fired from high-speed aircraft, with the self-contained capability to home in on other high-speed aircraft; shipboard weapon control systems simultaneously detecting, tracking, and coordinating hundreds of airborne targets. None of these would have been thought possible a generation ago. With respect to the research, development, and introduction of weapons and combat systems, this was the most productive period in Navy history.

Why was the Navy able to make such advances? What were the circumstances that led to such remarkable achievements? How were the resources of the Navy brought to bear on the operational and technical problems of the day? These questions deserve to be examined, in order that an historical picture of the Navy's experiences be captured and recorded.

One way to assess any aspect of Navy history is to seek out those were a part of that history and to solicit their views and experiences. This approach represents the basis for the present report.

BACKGROUND

The Naval Postgraduate School identified a group of individuals who, during the period of interest, had key roles in the development of technology and in its application to Naval capabilities. They were carefully selected both individually and collectively, i.e. each had had substantial duties in a particular area of expertise, and together they represented a wide range of responsibilities across both the spectrum of research, development, engineering, and system acquisition as well as within the Naval community. They are listed below, along with their major affiliations pertinent to the time period being examined. (More complete biographies for each of these individuals are shown in the Appendix.)

Dr. Alan Berman (Director, Naval Research Laboratory)
Dr. James E. Colvard (Technical Director, Naval Surface Warfare Center/Dahlgren)
Dr. Phil DePoy (President, Center for Naval Analyses)
VADM James H. Doyle Jr., USN(ret) (Deputy Chief of Naval Operations for Surface Warfare)
Mr. Ralph E. Hawes (General Manager, Pomona Division/General Dynamics)
Dr. Alexander Kossiakoff (Director, Johns Hopkins University Applied Physics Laboratory)
Dr. Walter LaBerge (Technical Director, Naval Weapons Center/China Lake)
VADM Paul F. McCarthy, USN(ret) (Director, RDT&E, Office of the CNO)
RADM Wayne E. Meyer, USN(ret) (AEGIS Program Manager)

The group encompassed the entire process from ideation and discovery through putting a combatant to sea; thus the Labs/R&D Centers, OPNAV sponsors, SYSCOM program managers, fleet operations analysis organizations, and private industry were included.

All of these individuals expressed an interest in the subject and a willingness to meet together for discussions of their respective experiences and contributions. (Dr. Kossiakoff participated in the discussions via teleconferencing.)

The object of this meeting was to record the personal views of some of the people who played key roles in the systems development and acquisition process during the time period in question. They were a collection of officers and civilians who managed the programs and directed the institutions that produced these systems. There is no record of such a group having been previously assembled for this purpose.

In advance of the meeting, which was held on 12 and 13 June 2001 at the Naval Postgraduate School, each participant was provided with some explanatory material, topics for discussion, and questions to address. Participants were asked to focus on what they did and why they did it during their years of having accountable responsibility in the R&D and acquisition process. Their views of what worked and what didn't was to be considered particularly important. Comparisons of their experiences with today's environment were to be avoided, as this should be left to future historians.

Suggested topics included:

- Resources
- Staffing
- Management structures
- Key players

Questions posed to stimulate the thinking of the participants included:

- What were the key things that allowed your organization to be successful?
- Who were the key players you dealt with; whom did you try to avoid?
- What competition did you face?
- What obstacles did you have to overcome?
- What institutions helped you the most and which hindered you the most?
- Where did you go for help?
- What irritated you the most and what elated you the most?
- Who did you consider the honest brokers in your arena?
- Were there conflicts between institutional leaders and program leaders?
- How much time did you spend seeking resources?

The meeting started with each participant individually describing his experiences in the R&D and acquisition world as he was involved in it. These individual presentations then formed the basis for a subsequent roundtable discussion among all the participants to determine whether common themes and threads could be discerned from the earlier presentations. The intent was to have a freewheeling discussion among a group of people who were key players during the Navy's most active period of combat systems acquisition in order that this experience could be captured for its historical value. The sessions were videotaped and transcribed; the transcription served as the basis for following two sections of the present report. (A complete transcription is available from the Naval Postgraduate School. Contact P. DePoy at pdepoy@nps.navy.mil, or at 831-656-5226.)

DISCUSSION

This report includes extracts from the full transcription in two major areas. These are *'keys to success'* and *'combat and weapon system examples.'* This report is not a substitute for the full transcription but is intended to serve those readers who do not have the time or need to read the entire proceedings of the symposium. In order to relay the actual thoughts of the participants, not an interpretation of their thinking, this report is comprised of grouped direct quotations appropriate to the two topics cited above. *'Keys to success'* were mentioned by every participant; the more critical points are assembled into this portion of the report, which deals with a variety of issues such as the importance of technical competence and teamwork among the institutional players.

The 'examples' section discusses large combat systems, with AEGIS being the example, and weapon systems, with SIDEWINDER as the example. While these two programs had many similarities, they also reflect a major transition that occurred during the Cold War era. SIDEWINDER was an in-house driven development of a combat subsystem. AEGIS represents a Program Manager-driven system developed by a team of in-house and industry institutions. AEGIS is a complete combat system and was the first major 'systems engineered' product of the Navy. Discussion of these examples reflects the 'keys to success' points in actual programs of the era. There was unanimity of opinion among the symposium participants that both AEGIS and SIDEWINDER were examples of very successful programs.

Keys to Success

Technical Competence. The existence of technically trained people at all levels of the officer corps, government civilians, and industry employees was considered a seminal characteristic of the success of the period. RADM Meyer, who was the first Program Manager and is known as the "founding father" of AEGIS, told of his education:

> "I don't view myself as a scientist, by any means. As a matter of fact, I like to think I'm an engineer, but that's really pushing. I've never, ever literally gone into industry and worked on a bench. Much of my education came from right here at the Postgraduate School. And it was a very fortuitous education. I would not be what I was without it and the incredible professors and officers who guided me and caused me to study, in particular, fire control."

Mr. Hawes, discussing his experience in industry:

> "During my ten years as General Manager, I never had a Program Manager who was not a technically-trained man. Why? Very simple! Technical people make better technical decisions on programs than somebody out of a financial community or somebody that came out of a marketing community or whatever else makes up a large business enterprise."

Dr. Kossiakoff contrasted the Cold War era with the present situation:

"The decline of the technical officer Navy is another great, complicated issue, particularly in the technological warfare that we find ourselves in today."

Continuity. In the discussions of the key factors for the success of development and acquisition programs, continuity of leadership and the relationships among organizations were considered to be among the most important. The AEGIS program was cited as one that benefited from relatively long tenure of key managers. Among the members of that team who were participants in this symposium:

- VADM Doyle served as the Deputy Chief of Naval Operations, Surface Warfare from 1975 until 1980, and was instrumental in obtaining funding and providing "top cover" for the AEGIS program.
- RADM Meyer was the Manager, AEGIS Weapon System, in the Naval Ordnance Systems Command from 1970 to 1972. From 1975 until 1983, he served as the founding Program Manager, AEGIS Shipbuilding.
- Dr. Kossiakoff was Technical Director of the Johns Hopkins University Applied Physics Laboratory from 1969 until 1980. APL was responsible for the integration and testing of AEGIS.
- Mr. Hawes was Vice President of the Pomona Division of General Dynamics (the builder of the Standard Missile for AEGIS) from 1973 until 1977. He served as the Vice President and General Manager of the Division from 1977 to 1988.
- Dr. Berman was the Technical Director of the Naval Research Laboratory (that developed much of the radar technology used in AEGIS) from 1967 until 1982.
- Dr. Colvard was the Technical Director of the Naval Surface Weapons Center, Dahlgren, from 1973 until 1980. NSWC was responsible for the development of the training systems and computer program certification and support for AEGIS.

VADM Doyle stated:

> "What helped me most was tenure. I was there for five years, so there was continuity. And I saw a lot of people come and go, particularly at the political level, and I outlasted a lot of people. So that was to some advantage."

Mr. Hawes commented:

> "I can't stress how important [tenure] is....If you had a four-year engineering development period, it would be nice to have your program manager there for that four years. If you had an eight-year production phase, it would be nice to have your program manager there for the eight years, but we could handle four. So that hooking of the tenure of the program manager to the phase of the program for continuity is very, very important."

Dr. Berman discussed the development of SOSUS, which also benefited from long tenure of the project manager:

> "And above all, it [the success of SOSUS] was a function of having one man, Joe Kelley, who ran the project from the time he was an O-3 until he was an O-6, roughly twenty years later. One man drove the entire project for the entire time! There was continuity!"

ORGANIZATIONAL STRUCTURE. The participants emphasized that a prime key to success was to have a simple organization with clearly understood roles and missions. Once a decision was made, it was critical to the execution process that people had the appropriate authority and were willing to use it. Mr. Hawes discussed his experience at General Dynamics with the AEGIS program:

> "During my tenure also, particularly in the early years, the agency roles, the labs, field organizations, program officers -- they had clearly-defined roles and generally lived within them. And APL had an awful lot to do with setting [those roles] in the early phases. And we didn't have, until the later years, very much conflict between what we were all about [and] what the other agencies were all about."

RADM Meyer, discussing the Navy structure during the early years of the AEGIS program:

> "...The relative straightforwardness or simplicity of the organizational structure that existed in the Navy started in Washington, D.C., and radiated downward."

VADM Doyle, discussing the structure of the Office of the CNO:

> "So again, there was the simplicity of the organization that allowed me to go directly to the CNO, not through anybody else, with a tasker to task me to do a study on what the destroyer should be."

Dr. Colvard, responding to Dr. Berman:

> "There were simpler organizations and more direct lines of communication and the speed with which decisions got made."

Dr. DePoy, discussing the early days of the POLARIS program:

> "...the difference, it seemed to me, was that OPNAV and all the [other] decision maker staffs were much smaller.....The guy who made most of the decisions on POLARIS in OPNAV was a Commander -- who later got passed over for Captain."

TEAMWORK. Given clarity of the command lines and the operational authority, developing complementary and mutually supporting relations among the organizations was the most critical challenge to Navy program leadership. Again, RADM Meyer, reacting to Dr. LaBerge's analogy of a technical leader as an orchestra leader:

> "So, now, the challenge of leadership is the very thing you just said. None of these people work for you. So you're confronted with a challenge of getting the laboratories, civilians, the production lines, the factories, study groups, everybody to play in this grand symphony in this orchestra, and playing for just for more than thirty seconds. That is a bona fide leadership challenge. So effective project management starts with that. Starts with that! The fundamentals of leadership! Certainly, you know, conductors have to master that or, in fact, they don't last very long. They can be temperamental and misbehave, but in the end if they [can't accomplish that], they're gone!"

VADM Doyle stated:

> "So we started what I think was a textbook illustration of a team effort between OPNAV and PMS-400 and the Applied Physics Laboratory and other laboratories and contractors trying to get AEGIS to sea."

Dr. Colvard commented on the change in the environment:

> "The point .... is to suggest that there was a time when the institutions tended to cooperate more with each other and not necessarily compete with each other, to steal the work and that sort of stuff. These are examples of the reality of that cooperation. It has become less possible to do that. As the competitive environment has changed, institutions are now out trying to get into each other's pockets in order to stay alive."

Dr. Kossiakoff, discussing the SMS program:

> "And we were really a team with both the contractors that were supporting the equipment and the Naval officers that ran the ships. And Eli Reich was a tough taskmaster, but he did a pretty incredible job. And, of course, Wayne [Meyer] grew up in that environment."

DISCRETIONARY FUNDS. The participants felt that one of the key factors for success was the availability of discretionary funds (6.1, 6.2, 6.2A) in the Navy and IR&D funds in industry. The availability of these funds was the key to examining future technologies in order to avoid technological surprise. Investment had to be made before the threat was fully defined or the technology was fully matured, hence could not come from program sponsors. Dr. Colvard said:

> "You've got real challenges in any process, but certainly in the R&D process. When the problems are only understandable by the person who possesses esoteric knowledge and experience, how do you generate those people? How do you stay technically capable to go out to industry and know that you're going to get what you asked for, and that what they propose is reasonable?
>
> "You can never contract out the ability to understand the military problem in the technical terms or to know who could solve it, or to recognize a correct solution when you get it. To do that, you must have technically competent people who are continuously available to you, who cannot go out of business because they're not making enough money. Whose only motivation is to tell you what they believe to be right, and they have to know a high percentage of the time what the laws of physics will permit. To generate that talent, you have to invest. Quite often the payoff isn't realized until the long-term.
>
> ".......and when you have no institutional funding, who pays for that investment? The Program Manager doesn't want to. He's got to get his product out the door, meet his schedule, meet his dollar cost.

"...so the idea of putting investment money into an institution that allows it to generate the knowledgeable people began to go away and everything is now measured down to the fraction of the penny, and overhead becomes the major driver. When we had modified Naval Industrial Funding, you had a certain amount of institutional investment. You went away from that, then you had a certain amount of independent R&D funding that the technical director had control of."

Dr. Berman:

"There was also essentially some institutional funding, the extreme case being NRL, but most of the NAVMAT labs did have what amounted to institutional funding. It was not as big as it should have been, but it did exist. With the possible exception of NRL, most of that has gone away. For instance, even at a little place like CNA, they used to have a pot of money. Now, every single individual's time has got to be assigned to a project, down to the tenth of an hour. I think it's a point of stupidity, but that's the way it is."

VADM McCarthy:

"We did have flexibility in the industry community with IR&D, which is important and which industry really needs. Hugh Montgomery was clever enough, during my tour at OP-098, to bring on the 6.3A type of structure that with a little bit of money, about ten to fifteen million dollars a year, we could select a few ideas that we could go out and experiment with. But where you are today, it's tough to do that sort of thing."

Dr. LaBerge:

"You know, another fundamental thing that has happened is that DARPA has essentially taken over the institutional funding. If you look at where the free money is, that goes on new ideas as opposed to detailed engineering of existing stuff, almost all of it is in DARPA. And so DARPA sets what the priorities are. The Navy doesn't feel that there's anything lost by going to [DARPA] and getting the money, but that doesn't mean that [DARPA] does what the Navy really wants."

PRIORITY AND SENSE OF URGENCY. Throughout the symposium, it was recognized by all the participants that the era being discussed was a time when defense programs were given a higher priority than is now the case. Hence, it was much easier to obtain the resources, both financial and human capital, than it would otherwise have been. It was also easier to accelerate the decision-making process. RADM Meyer pointed out that AEGIS had the advantage of being developed at a time when the cruise missile threat was considered to be a national priority:

"I enlisted in the Navy on the 12th day of May in 1943. Only a year and a half or so later the nation was horrified because the Germans had attacked with what was popularly referred to as a 'buzz bomb,' the V-1 rocket with a pulsejet engine in it. And subsequently with the V-2 rocket attacking all of England and London and such with the threat that Peenemunde was working on the A-4 rocket which would be used to assault New York City and other big cities in the east.

"But then in October 1945 at the Battle of Leyte Gulf was one of those defining events, which you all have alluded to earlier this morning, and that was when something occurred that the Occidental world simply couldn't deal with. And it was a divine wind, or it came to be called a Kamikaze. The Occidental just could not adjust his thinking to believe that were men who would strap themselves to a bomb and, in the name of their emperor, literally commit suicide by diving into a ship.

"And we knew not how to deal with that. We just didn't know how to deal with it, except to bring every weapon to bear that we knew. We emerged from those years finally to Okinawa in April 1945, the longest and the most decimating battle that ever occurred in Naval history. More officers, more men, more ships, more airplanes lost than ever. And it left an indelible mark on our Navy.

"Well, what happened in the case of these weapons, these three, the two I mentioned in Germany and the Kamikaze? We somehow could understand the German ones because there was no man strapped to it. But we couldn't grasp what was happening in the Pacific. I get very upset when I find people rewriting history, particularly concerning the use of the atomic bomb. I think that President Truman made an extraordinary decision of the need to do so. So what really happened is, the war ended. We never overcame them. The war ended. That's how we solved that problem.

"So when I look at my life as it flowed from being commissioned in the reserve Navy, transferring to the regular Navy and sailing around the world in sundry ships in those years, part of the occupation forces, part of several wars which had occurred throughout that era, my whole life has really, really been driven. Not by my choice, particularly, but it's almost as though God had a destiny for me, when I thought about it in later years, by the cruise missile or the Kamikaze. So you can define almost everything that I have integrated up or led or done as being driven by that compulsion, which all of you here at this table had a role in, in one dimension or another, some in much longer periods than others. That's what drove my life.

"And I listen to this extraordinary recitation by Jim Doyle, a short summation, one of which I've never heard him say it as well before. There was that really short era, half a decade or so, that did change the world. And it did change the Navy. And it changed it irreversibly, and each of you has alluded to it when your turn came."

Mr. Hawes, the Vice President and General Manager of the plant that produced the Standard Missile for the AEGIS system, commented from his viewpoint:

"My first point is the challenge of missilery. I came onboard [the Pomona Division of the General Dynamics Corporation] in 1956, which was about four years after it was born. I think 1952 was kind of the birth year. And I stayed until about three years before the death of the organization. So I wasn't quite at the birth, but also wasn't quite at the death. I look at it that I was really at the golden years of that particular division.

“So missilery was something new. It attracted the youngest and brightest and most eager of the engineers that were really still coming out of the era of the GI Bill and World War II. It attracted large numbers of very bright people, most of whom, by the way, had a service background, or many of them did.

“They had an experience base that many of the young engineers coming out of the academic community do not have today. And that created a very different environment with the young engineers who were going into an organization like the Pomona Division.

“My second point is there was a national priority on defense systems. What we were doing was important, nationally. It wasn't so much about business or money, because a lot of us down in the organization knew that we were doing something of national importance. Of course, a lot of that was driven by the fact that we had a more coherent threat at that time called the Russian Bear.”

EXAMPLES

WEAPON SYSTEM: SIDEWINDER. From 1951 to 1957, Walt LaBerge served as Project Manager for the SIDEWINDER program at China Lake. His description of the early days of the program follows:

“Looking back with fifty years of perspective, the early days at NOTS were really very creative. Usually that's the result of good senior management. At China Lake, it was almost all Dr. Bill McLean's doing. However, Bill McLean, who was TD [Technical Director] while I was there, was there only because of those who preceded him and promoted him.

“When NOTS first opened, Dr. Charles Lauritsen had brought with him the professional ethics, work standards, and the freedom for creativity that was imbued in him at Cal Tech. For my money, without Bill McLean and Lauritsen's Cal Tech standards, the place wouldn't have been nearly as good as it was. And for many years after Lauritsen went back to Cal Tech, Charlie was asked to stay involved with the station's progress as a member of the station's Advisory Board.

“For me, that was the first over-riding lesson I took from my SIDEWINDER experience; namely, organizations rapidly take on the character of their bosses, and if you want an organization to be honest, energetic, and creative, you must get an honest, energetic, and creative person to run it. A second important lesson I took was that quality oversight through Boards almost always is a great asset.

“To properly understand SIDEWINDER, you need to remember that in those times missilery was very new and there was no book on which to base one's designs. Creativity was essential, but had to be a special kind of creativity. It was a creativity where a new state-of-the-art had to be built upon bits and pieces of the world as it then existed. Old though it may be, SIDEWINDER may also be a harbinger of the future.

"That was the kind of thing the Navy needed and China Lake was good at in those olden days. Curiously, though, it is also the situation today. Today, new technology abounds everywhere and the trick is how to blend and meld old and new and to get to the marketplace quickly with something that outperforms your opponent's products. SIDEWINDER did that for the Navy. SIDEWINDER was just an idea in 1950, was operational by the mid-fifties, and is still in the fleet today.

"To give you some appreciation for the solid engineering creativity of those days I'd like to explain what SIDEWINDER really was. The fundamental design problem of SIDEWINDER was to build a simple but accurate transonic and supersonic missile out of the only seven available vacuum tube types that could meet the acceleration and vibration environments of air-to-air missile flight. Those existing tubes had all come out of the artillery influence fuses developed during WWII. As well, the early China Lake crew also had a bunch of rocket parts and warheads in the various lockers around the station left over from unguided rocket developments at the end of WWII.

"The China Lake design question was: 'How, from the technology then available, could a reliable and affordable guided missile system be designed that could really help Navy pilots flying jet fighter aircraft in combat for the first time?' Those pilots engaged in combat in Korea had found that jet-against-jet combat was substantially different from all previous air-to-air combat. Pilots found that their early jet engines used gas so fast that they no longer close on their jet fighter opponents to machine gun range without running out of gas.

"It turned out that there were three necessary ingredients that made SIDEWINDER successful in this new era of guided missile technology. They were; firstly, the Navy had a clear problem that urgently needed a solution. Secondly, that China Lake had an unusually creative leader who knew both the mission environment and the technology available. And thirdly, because the Navy gave China Lake enough time to work out and test SIDEWINDER's components before they scheduled it into production.

"The latter ingredient, allowing the necessary time to do and test the SIDEWINDER components, was a bit of an accident. Then, the Navy in Washington felt that it already had an air-to-air missile and didn't see why it needed another. However, Washington didn't mind its lab at China Lake doing R&D and testing on advanced missile components. Of course, the only way to demonstrate these components was to put them all together and hit targets, which NOTS did. That really is how the Navy got a missile it originally didn't want but eventually made more of than the sum of all it ever officially wanted.

"BuAir had started the SPARROW missile several years earlier. It used radar guidance and had to put up with guidance errors caused by unpredictable scintillation in signal direction during missile flight. As a result it had a big warhead to cover anticipated miss distances and therefore was quite heavy. This restricted the number of missiles small fighters could carry.

"The question that Bill chose for his China Lake design team was: 'How can we at NOTS provide a much lighter missile to small fighters like F9F's and F86's that can be carried in numbers so as to sustain combat support to the bombers they were escorting?'

"The common theme through the many SIDEWINDER examples that follow is that when the state-of-the-art in any technology doesn't let you do what you need to do, don't struggle with an unsolvable problem but, rather, find a way to design around the problem. Find some easier, simpler, and therefore more reliable way to do what you want.

"The SIDEWINDER airframe was picked in the following way. McLean challenged us by saying: 'We don't know much yet in this country about transonic and supersonic aerodynamics and anyway BuAir won't give us time in a wind tunnel, so our airframe had better be pretty simple.' Essentially, we started off knowing that we were going to have to build a miniature supersonic airframe that had to be more-or-less independent of aerodynamics, simple, and straightforward. Aerodynamics had not been the pacing item of our missile. In the beginning we even had square wings in front and back. This demand for this lack of aerodynamic subtlety drove our Chief Aerodynamicist, Lee Jagiello, wild -- saying that he was embarrassed among his peers at his society meetings. This was the next life-time principle that I learned from SIDEWINDER; to the greatest possible degree keep things simple and don't invent things you don't have to.

"At McLean's insistence, we went to a canard airframe, a virtual feathered arrow with lots of stability in the back and small canard wings up in the front for maneuvering. In that kind of an airframe, shifts in Center of Pressure and Center of Gravity due to changing speeds, attitude, and burnout don't make much difference. Unfortunately however, when one buys into a canard airframe, one buys into a known big problem. Namely, when you wiggle the front wings, the resulting downwash runs over the back wings and makes the airframe try to roll. This means that when you command, 'go here,' you actually end up going some other direction. How that downwash problem was fixed demonstrated great ingenuity.

"McLean posed this known problem to his staff one day and solicited all their opinions on the best way to fix it, no matter their position on the local organization chart. The winning idea in came in fact from one of his lathe operators.

"That idea, then (and still) unique in the missile world, was cultural simplicity itself. That idea was to let the airstream do all the work and to do it without requiring any measurements or computations. It was simply to put control tabs at the rear outside corners of each of the missile's four rear wings. Inside each control tab was inserted a flat wheel, pivoted in the middle of the tab and spun by the airstream around it.

"This wheel became a gyroscope and when spun up, any tendency of the wing to roll precessed the tab gyro in the direction to force the tab to move into the airstream in the direction needed to stop the roll. That early 1950's design concept can still be seen at the turn of the 21st century on every operational SIDEWINDER in the world.

"The rest of the SIDEWINDER design issues had similarly creative solutions. Among those questions was: How in the world do you take an airframe that continuously wiggles back and forth and unscramble where it is going from where it is instantly pointing? And after that you do that, how do you make it go where you want it to go when it almost never is going where it's pointed, and do all that with the leftover vacuum tubes of WW!!?

"After some collective head scratching, McLean opted for an optical telescope gyro stabilized in space to free the gyro from motions of missile that carried it. The result was a spinning Cassagrain telescope gyro firmly attached to a large magnet. Both were to be spun about their center of mass and connected to a central ball bearing supported by the missile body. The spin, as well as precession of the free gyro, was provided by coils in the missile's outer body. In this way, we eliminated lots of feedback computations otherwise needed. Again, it was McLean's insistence on doing complicated things the easiest way possible.

"As far as making SIDEWINDER go where you want, his design also was an original one. The problem in missile servos has always been that the servo has to be connected to the missile body. Therefore, usually you have to know at all times where the body is pointed in order to know how far to stick out the control wings. This forces one not only to move the control surfaces about responding to what the target is doing, but also to make necessary compensation for the missile's angle of attack with the airstream as it pulled 'g's . Keeping track of a lot of variables at one time normally is a complicated process.

"So McLean decided to skip all that and to produce torque directly, saying: 'Let's design our servo to command torque directly on the control surfaces instead of wing position as airplanes do. If we can do that, it will make SIDEWINDER independent of how its unsophisticated airframe wiggles about.' And so that's how we designed the servo that's still around today, fifty years later.

"The moral of all these examples as I see it is this: the China Lake Lab, in those days, was set so as to encourage creativity, simplicity, and responsiveness to Navy operational needs. It was allowed to define and be responsible for developing for BuAir its air-launched weapon designs. It did so in a truly spectacular way because this China Lake environment encouraged very good people to come, to stay, to become a part of the Navy family, and to feel productive. And that system worked. More SIDEWINDER's (about 250,000) have been purchased and flown by more countries and more combat kills recorded than by any other air-to-air missile.

"This China Lake environment of the 'old days' produced not only SIDEWINDER, but has also given the Navy a large number of other air-launched weapons came from this creative environment, to name but a few; SHRIKE, HARM, and WALLEYE. And then things changed, and things don't work that way anymore.

"DOD became convinced that industry could do better than its labs and set up a system where the Navy and the other Services became managers of the doers who were to be all in industry. Sometimes it worked out well, as did AEGIS. But for the most part I don't believe it has served the Navy well. And I suspect that things are getting worse than better. Over the years I have seen hands-on leadership becoming management from afar. That in turn has led to a plethora of management 'busy-work' that is almost always diverting from the solution of crucial program issues. Managers now have to pay more attention to binding contractual requirements, monthly reports, PERT charts, budget forecasts, OT&E reports and Milestone deadlines and the like than the pressing technical issues of their programs.

"There seems no longer time nor any patience for creativity of the kind demonstrated in the development of SIDEWINDER. Such creativity as does exist finds its way more frequently into Power Point charts than into mission-oriented hardware.

"As a result I believe that the DOD and the Navy now do everything the hard way and for that most often get very complicated, over-designed, very costly weapons that take forever to get to the fleet. From my perspective, the 'good old days' actually were as good as remembered."

COMBAT SYSTEM: AEGIS. VADM Doyle, the Deputy Chief of Naval Operations for Surface Warfare, discussed the early stages of the AEGIS program:

"Well, getting back to priorities, it seems to me in looking over the various priorities and trying to keep everything in balance, that it was very important to get the AEGIS system to sea as soon as possible. So that became my number one priority. So we started what I think was a textbook illustration of a team effort between OpNav and PMS-400 and the Applied Physics Laboratory and other laboratories and contractors trying to get AEGIS to sea.

"Of course, we had several aborted attempts. And Admiral Meyer, I'm sure, will give us more detail. But there was the LONG BEACH possibility. There was a possibility, which the CNO had recommended, that we build eight CGN strike cruisers and sixteen DDG-47s. And we had a problem with Title 8 and Admiral Rickover insisting that all ships be nuclear powered. I think it was 1977, there were no warships in the budget because of a failure to come to agreement between the House and the Senate on that. Finally, we got that turned around and got agreement that the TICONDEROGA, the CG-47, would be authorized and appropriated.

".....You know, we talk about transformation these days. And the real transformation in acquisition took place under Admiral Meyer's dynamic leadership. I mean, this was a transformation in organization, acquisition, fleet introduction, shore-based training and infrastructure, land-based prototype, engineering support, manning and billet structure, and new concepts of ship integration and system engineering. You know, as he puts it, there was an evolution of some 20 years of build a little, test a little.

"And so that was really a transformation that just revolutionized the way we introduced surface ships. Rather than just having the situation where the hull, mechanical, and electrical people were the designers who would design the ship, and the shipbuilder would build the ship, and all of a sudden one day at the pier, here comes the delivery of the combat systems to be put aboard, and you hoped to hell it would work. And so that transformation was done.

"Now, this didn't come about easily. A lot of blood and sweat went with it. I remember particularly there was a year there -- there may have been more – but for about a year the there was a DDG-47 manager, PMS-389, and there was an AEGIS PMS-403, and nothing was happening. So Admiral Meyer and I both approached the Chief of Naval Material.

"Here's a good point: that we had a Chief of Naval Material that we could go to. And he authorized a study, or directed a study, to be made by a flag officer. Ed Ott, I believe, did that study and reported back that, 'Hey, you've got to combine. You've got to create PMS-400. We've got to get on with it. You've got to integrate the combat systems and the ship.'

"It was obvious that we needed to keep the AEGIS line going, not only the TICONDEROGA class, but also we needed a new destroyer. So again, there was the simplicity of the organization that allowed me to go directly to the CNO, not through anybody else, with a tasker to task me to do a study on what the destroyer should be. The words in the tasker were 'Battle Group capable.' That was the criterion: Battle Group capable.

"So we formed the study. Admiral Meyer supplied Admiral Roane, I believe, at that time. And my people and a number of lab people were involved, and they went off to White Oak for a year and did the study and came back. And they compared all the various systems in AAW particularly against what we had and said, 'Well, it's got to have AEGIS aboard; AEGIS based on AEGIS technology.'

"We also made a pitch in the study, in the analysis, to use TOMAHAWK. Actually, we played TOMAHAWK in the analysis, and, interestingly, we used it in the initial phases of some scenario. I have forgotten what it was, Vladivostok or wherever, but we programmed the TOMAHAWK in the study against the air defense sites. And we proved, on paper, that if you did that, the follow-on aircraft strikes would suffer less attrition.

"Of course, when we got that resolved we got all sorts of skeptics. PA&E didn't believe that at all. And so forth and so on. In any event, we reported out the study to the CNO. And I was told, initially, that, 'We're not going to build AEGIS. We're never going to build AEGIS. We're not going to build an AEGIS destroyer. They're too expensive. They're too vulnerable,' et cetera, et cetera. 'Over my dead body will we build it.' Well, fortunately, nobody had to die, and in the ensuing fray we persevered and our successors persevered. And now how many AEGIS ships are in commission?"

RADM Meyer:

"There are fifty-eight now in commission; twenty-seven cruisers and thirty-one destroyers. And about ten years' worth of ships are on the building ways right now."

RADM Meyer discussed some of the details of the program:

"..... fast-forward to the first AEGIS, which had some 22 cabinets in a signal processor. And had moving target indication, MTI, as a requirement in it. And there was continuing argument, fussing, fighting, almost on a national basis on how many coefficients of the equation could you get into that design.

"And, of course, RCA, one of the greatest outfits ever raised, even exceeding Sperry, perhaps, in its grand design, was on a schedule and being measured. The Applied Physics Laboratory kept fussing around, interfering. Other laboratories were fussing round, interfering, saying, 'Well, that ain't the right design. That ain't the right design. Let's do this. Let's do this.'

"I said, enough of this. We're going to freeze MTI as the RCA design is, knowing that it is not adequate. And we're going to return MTI to the laboratory and send it back to APL and set up a joint structure and everything to, in fact, go do the necessary research and the necessary experimentation to overcome the flaws that existed in the MTI.

"I recall we sent NORTON SOUND on a long cruise up into the Bay of Alaska; its sole assignment was to gather data. And she gathered some six million data points on the MTI design, and proofed it. And ultimately it entered into the production AEGIS system.

"Well, the single processor went from room-sized down to twenty-two cabinets and then to eleven, when it came out of NORTON SOUND, then in the engineering development model up at CSEDS to eight cabinets. Then the next maturity was four cabinets. I believe today it's two cabinets. Of course, these two cabinets today, no one would dare try to carry them because they ain't carriable. They're really packed to a fare-thee-well. But it taught how important, not only tenure, but evolution is. Alan [Berman] mentioned earlier, that occasionally something momentous disrupts evolution and how important that is.

"....I want to say something about the Advanced Surface Missile System. It's one of the obstacles in the way. Recall for a minute the momentous events of 1967. The Egyptian sinking of the Israeli destroyer was one of those momentous events. And in December of 1969 under the aegis, so to speak, of DCP-16, it was described as the Advanced Surface Missile System, twenty pages long. And it is, by the way, the governing document today, thirty years later, still the governing document AEGIS design.

"But at the last minute it was determined that the ASMS missile was too expensive. One of the difficulties was McNamara's geniuses and the newly created heroes which continue to be sustained, called 'systems analysis' had determined that the Navy had no need for a surface-to-air missile more than fifty miles in range. That was the most the Navy needed.

"So the missile was determined to be too expensive. And two weeks before Christmas it was determined to strike the missile out of the development. Captain Lou J. Stecker happened to be the aide to John Foster when they were sitting late at night arguing on this. And Lou Stecker picked up his pencil and wrote a phrase in there, which said: 'The missile shall be Standard Missile with midcourse guidance.' Just a phrase! That is what was written in. Closed the deal! Christmas week the contract was let to RCA Corporation. Not one nickel was laid out for the missile. There was no program any place for the missile, and no one had the foggiest idea what 'standard missile with midcourse guidance' meant.

"But it was one of those little teensy things that changed the whole course of history. And the irony of this thing was that the contract was awarded to RCA because the Navy felt so strongly about trying to get a fixed-array radar, and viewed RCA as the strongest. And they were teamed with Raytheon and, therefore, it was overwhelming. Bendix was on that team. And with the missile being struck, Bendix disappeared. General Dynamics/Pomona, was on the losing team. And there was sadness all during Christmas in Pomona because the mighty Casey had struck out. And yet look how it was reborn, totally reborn, in another whole manner.

"That one little phrase and one leader! I learned a couple things through those years that I believe have enduring significance. One is, you have to work with what you've got, until, as you said, some momentous thing occurs. You've got to work with what you've got, not with what you want to wish would be. My personal view is that this is a fundamental flaw right now in the DD-21 effort. You have to work with what you've got.

"Number two, tactical dimensions are significant and important. And all of you at this table in your lifetime have been through crises that occurred with tactical dimensions, particularly in air-to-air weapons. And recall the infamous Liz Begg's investigation where she was sent to look into the panoply of weapons we had of various dimensions and how to fit them in our airplanes. So what drove AEGIS to where it is, is Standard Missile's thirteen-and-a-half inches. And if you couldn't get it in that thirteen-and-a-half inches, you weren't going to get it. So necessity drove the engineering. It's what kept the PHOENIX missile out and later in life the PATRIOT missile, because their dimensions didn't meet the tactical structures, logistically, that we had to work in. And I think that that is an important lesson.

"I mentioned tenure and work with what you got. Rickover taught me, really, a couple of significant things in my life. One is very well known, and that is: the devil is in the details. That was one of his favorite expressions, meaning that engineering is detail, detail, detail, detail, detail, not generalities.

"But he had another one that you don't very often see. He said, 'You must make all decisions as though you're going to live forever.' That is to say, you have to be prepared to live with the decision, meaning you can't make expedient decisions no matter what the cost. You must try to make the right one. Well, it doesn't follow that you do, but the matter of the code, to me, seems very significant in trying to deal in large programs.

"I want to make up another story in 'The Naked City.' It had to do with a point that Jim Doyle made. When we started out in this design, there were no screens at all in the design. Even though there were specialized consoles, Bill Goodwin and I drove them out of the system, to get to the Navy standards, UYA-4, which sailors all knew how to use already, which was very significant in my mind. And since it was, in essence, a destroyer design, it had no flagship requirements.

"Well, of course that evolved in a few months: we need a unit commander's requirements, so we need a screen. And by the way, we want independent facilities for the unit commander. So we want him in a room that's totally isolated from the CIC so he does not contaminate the system. You can understand that. Build a glass. He can look through the glass, and he could act as unit commander. Well, of course, that didn't last very long.

"I want to talk about tenure and the significance of interchange because Admiral Doyle wasn't the first OP-03 that I dealt with by any means, as you full well appreciate. I had some really free spirits there; for example, Frank Price, Roho Adamson, just to name a couple.

"Jim Doyle again, one of those momentous things, or defining moments as ComThirdFleet, laid down in TACNOTES the warfare-commander concept, which has prevailed to this day until the reformers are starting to disassemble it, and that formed the basis for CIC design. And then we had to do something about flag design. And so he wanted screens. Well, here was a risk situation because there, in fact, were no projectors available that could provide those screens with high reliability.

"And that's when we embarked on the liquid-crystal projector with a scientist out at Hughes-Fullerton. And it turned out to be a high risk, and in some respects even today is a little iffy sometimes in its operation. But that liquid crystal is what pioneered these screens into our ships, even though there are any number of people on the benches who would say: 'That's not modern.' 'You're not keeping up.' 'We've got all this touchscreen stuff coming along.' But none of it met the rigor needed in shipboard application in reliability and maintenance and so forth. I thought that was a very significant, important thing that occurred. So where four screens finally emerged, and these, in fact, became significant flagships within our Navy, because of the four large-screen displays.

"In this program, there was an obstacle that hardly anyone thinks of anymore, and it was Vietnam. In the anti-Vietnam attitude, which emerged in our nation, RCA virtually tried to deny that AEGIS existed. In fact, the RCA Corporation printed two annual reports in a row that failed to mention AEGIS in any way, shape or form. And what finally blew my head off was when Bill Goodwin, my friend, associate, and also the AEGIS manager, had to make a periodic report to 30 Rockefeller Center one day. And he got over there and they told him, 'Look. One Elvis Presley record brings more income to this company than you're bringing. And that's where you stand.' And I've never forgotten that little incident, that there at 30 Rock we were in the category of an Elvis Presley record.

"Well, it kept getting a little worse. So one day Jim [Doyle] said, 'We got to do something about this.' So we got on our body armor and got together our slides. And he and I took off and assaulted 30 Rockefeller Center, the CEO of the corporation. And we came out of there unscathed, but we also came out with a whole different attitude and a reversal of the behavior of corporate for the AEGIS program.

"Just two officers going and talking about the seriousness and the necessity of it for the country. And that CEO, he didn't like it, but he bit the bullet. And even though he was anti-Vietnam and even though we didn't equate to an Elvis Presley record, we turned it around. I don't think either one of us could have done it alone. And I don't think we could have done it without significant dedication and passion with which we attacked it.

SYNOPSIS OF PRINCIPAL OBSERVATIONS

The foregoing report presents excerpts from the individual presentations. The following is a review of the significant points from the presentations and discussions about which there seemed to be general agreement. Support for each point was not unanimous among the group, and attribution is not assigned to issues presented.

- Continuity was a major point in all the discussions. This included continuity of leadership, funding, and focus on the problem being solved or the capability being developed.

- Technical competence, appropriate to the requirements of the role, was viewed as critical at all levels. This was true for Naval officers, the civil service and University labs, as well as industry.

- The existence of discretionary funds, in the form of IR&D or B&P in both industry and the government was viewed as critical to the advancement of new technology during the Cold War era.

- Clarity of role among private and public sector institutions and between the policy and execution components of institutions enhanced trust and facilitated strong positive interrelationships.

- Program managers who were successful had rather similar characteristics. They were extremely focused, they knew the technical details of their program, and were, in effect, their own chief engineers. They developed loyal dedicated contractors, they did not tolerate fools gladly, they remained in the same assignment for many years, they maintained a stable funding flow, and they were persuasive in their presentations.

- There probably never were any "good old days," and no matter what we think, the current acquisitions system is very unlikely to revert to the way we did business thirty or forty years ago.

- In all successful programs and institutions there was an emphasis on results rather than cost, mutual trust and respect, and a sense of urgency backed up by the courage of convictions.

- The existence of a defined potential enemy created a rather stable funding environment, which reduced the amount of infighting and institutional competition. It may have also contributed to the perceived higher tolerance for failure of that time.

- There was strong uniformed leadership, with rank aligned with responsibility, for those officers who dealt with the OSD and Congress. This was important in the provision of "high cover" for major programs.

- The approach to building AEGIS cruisers and destroyers effected an historical transformation in organization, fleet introduction, shore-based training and infrastructure, land-based prototypes, engineering, manning and billet structure, and new concepts of ship integration and systems engineering. This was due to the tenacity and tenure of both the Deputy Chief of Naval Operations for Surface Warfare and the AEGIS Program Manager.

- The in-house laboratories played an important role as honest brokers and keepers of the technical safety net. Industry worked well with most of the laboratories, but was at times uncomfortable with others. Industry was frustrated by the perceived lack of ability to hold an in-house laboratory accountable.

- The best leaders, in both industry and government, were those who were rotated through both experiential and educational assignments such that they developed an understanding of the Navy and industry from a corporate sense.

- There was an emphasis on objective rather than process.

APPENDIX

BIOGRAPHIES OF SYMPOSIUM PARTICIPANTS

ALAN BERMAN

Education: A.B. Columbia University 1947
Ph.D. Columbia University 1952

Professional Experience:

1995 - present Applied Research Laboratory, Pennsylvania State University (part-time). Provide management support and program appraisal as directed.

1987-1995 Fellow, Center for Naval Analyses. Responsible for analyses of Navy R&D investment programs, space operation capabilities, information operations, C4ISR programs.

1982-1987 Dean, Rosenstiel School Marine and Atmospheric Sciences, University of Miami. Responsible for graduate programs in physical oceanography, marine biology, geology and geophysics, applied ocean science, underwater acoustics.

1967- 1982 Director of Research, NRL. Directed broad programs in basic and applied research; including EW, radar, communications, space systems, space sciences, material sciences, plasma physics, ASW underwater acoustics, oceanography, space-based time standards for GPS, etc.

1963-1967 Director Hudson Labs, Columbia University. Directed program in ASW, underwater acoustics, and applied oceanography.

1957-1963 Associate Director Hudson Labs. Columbia University.

1952- 1957 Research Scientist, Hudson Labs. Columbia University.

Memberships:

Member Naval Research Advisory Committee 1986- 1992
Member National Academy of Science Naval Studies Board 1995-2001
Member numerous panels and committees of Defense Science Board and President's Science Advisory Committee
Oversight panel of DOE National Laboratory

James E. Colvard

Education: BA Physics Berea College, KY 1958
MAPA University of Oklahoma, 1973
DPA University of Southern California, 1982

Professional Experience:

Currently: Visiting Professor, Virginia Polytechnic Institute and State University.
Consultant to the U.S. Navy on Ballistic Missile Defense.

1991-99 Senior Fellow, Office of the President, Center for Naval Analyses
1988-91 Associate Director, Applied Physics Laboratory, Johns Hopkins University
1986-88 Deputy Director, U.S. Office of Personnel Management
1985-86 Director of Personnel Policy and EEO, U.S. Navy
1980-85 Deputy Chief, Naval Material Command
1973-80 Technical Director, Naval Surface Weapons Center, Dahlgren, VA

Publications:

Over twenty articles on technical management and personnel policy in referenced journals from 1980-2001.

Honors and Professional Affiliations:

1956 Sigma Pi Sigma, President of Berea College chapter
1957 Phi Kappa Phi
1968 Michelson Laboratory Award in Management
1977 Navy Distinguished Civilian Service Award
1980 Distinguished Alumni Award, Berea College
1980 Presidential Rank of Distinguished Executive
1983 Department of Defense Distinguished Civilian Service Award
1985 Presidential Rank of Distinguished Executive
1985 Elected a Fellow in the National Academy of Public Administration
1986 Navy Distinguished Civilian Service Award
1988 Office of Personnel Management Distinguished Federal Service Award
1990 Appointed as Chairman of the Navy's Research Advisory Committee
1991 Federal Executive Institute's Director's Award
1991 Elected Trustee of the National Academy of Public Administration
1996 Navy Distinguished Public Service Award
2000 Naval Surface Warfare Center establishes Dr. James E. Colvard Award for Leadership

Other Professional Activities:

Life member, Navy League
Life member, American Defense Preparedness Association

Phil E. DePoy

Education: Program for Senior Executives, Massachusetts Institute of Technology, 1978
Ph.D. Chemical Engineering, Stanford University, 1974
M.S. Nuclear Engineering, Massachusetts Institute of Technology, 1958
B.S. Chemical Engineering, Purdue University, 1957

Professional Experience:

2000 - present Visiting Professor of Warfare Studies; Chair of Expeditionary Warfare; Director, Institute for Systems Engineering and Analysis, Naval Postgraduate School

1992-2000 President and CEO, National Opinion Research Center, University of Chicago

1959-1992 Center for Naval Analyses

1990-1992	Distinguished Senior Fellow
1985-1990	President and CEO
1984-1985	Executive Vice President and Director of Research (Acting President)
1974-1984	Vice President, CNA and Director, Operations Evaluation Group)
1969-1974	Director, Systems Evaluation Group
1967-1968	Field representative to Commander Sixth Fleet
1965-1967	Director, S.E. Asia Combat Analysis Division
1964-1965	Field representative to Commander Seventh Fleet
1963-1964	Field representative to Commander Task Force 77
1961-1963	Analyst, Naval Warfare Analysis Group
1960-1961	Field representative to Air Development Squadron 5

Other Professional Affiliations:

Member, U.S. Air Force Scientific Advisory Board, 1983-1987
Vice Chairman, U.S. Army Science Board, 1978-1981
Chairman, U.S. Army Summer Study on Statistical Techniques in Testing, 1980
U.S. Representative to NATO Systems Science Panel, 1976-1979
Chairman, NATO Systems Science Panel, 1978
Chairman, Board of Investigation on Safety of Production at Radford Ammunition Depot, 1978
Member, OT&E Subpanel of the Blue Ribbon Defense Panel, 1969

Honors and Memberships:

Defense Distinguished Public Service Award (1990)
Navy Distinguished Public Service Award (1989)
Air Force Meritorious Civilian Service Award (1987)
Army Outstanding Civilian Service Medal (1981)
Member, CNA Board of Trustees (1990-present)
Member, NORC Board of Trustees (1999-present)
Member, Applied Physics Laboratory, U. of Washington, Advisory Board (1991-present)
Trustee and Member, N. American Wildlife Park Foundation Board of Advisors (1991-present)
Member, Nichols Research Corporation Board of Directors (1994-1999)
Member, Kapos Associates, Inc. Board of Directors (1994-1999)
Member, Visiting Committee, Graduate School of Public Policy, U. of Chicago (1996-present)
Member, Council on Foreign Relations (1999-present)

Vice Admiral James Henry Doyle, Jr., U. S. Navy (Retired)

James Henry Doyle, Jr. was born March 27, 1925 in Medford, Massachusetts to Lieutenant junior grade (later Vice Admiral) and Mrs. James H. Doyle (both deceased). He attended grammar and high school in San Diego, the Philippines, Norfolk, Honolulu, and Berkeley, California. He graduated from the Naval Academy in 1946 (Class of 1947) and from George Washington University Law School in 1953 with the degree of Juris Doctor with distinction under the Navy postgraduate program.

As a junior officer, he served in USS CHICAGO (CA-136) and USS JOHN W. THOMASON (DD-760). He was Executive Officer of USS BULWARK (MSO-425), USS JOHN S. McCAIN (DL-3), and USS NEWPORT NEWS (CA-148). He commanded USS RUFF (AMS-54), USS REDSTART (MSF-378), and USS JOHN R. CRAIG (DD-885). Following instruction in nuclear propulsion in 1965, he took command of the nuclear powered, guided missile cruiser USS BAINBRIDGE (CGN-25), a four year tour including three deployments to the Seventh Fleet during the Vietnam War, and the ship's first refueling.

Ashore, he served in the International Law Division of the Judge Advocate General, as Aide and Flag Lieutenant to Commander-in-Chief, U. S. Pacific Fleet, and in the Programming and Planning Division of the Office of the Chief of Naval Operations.

As a flag officer, Admiral Doyle was Chief, International Negotiations Division, Joint Chiefs of Staff, involved in SALT 1 and Incidents at Sea negotiations with the Soviet Union, and represented the Joint Chiefs of Staff on the U. S. Delegation to the Law of the Sea Conference. He commanded Cruiser-Destroyer Group TWELVE and deployed to the Sixth Fleet as Commander Attack Carrier Striking Group TWO embarked in USS FORRESTAL (CV-59). His last sea assignment was Commander Third Fleet from 1974 to 1975.

From 1975 to 1980, he was the Deputy Chief of Naval Operations, Surface Warfare, with responsibility for the Navy's shipbuilding and surface ship programs, including surface warfare education and training. Specifically, he sponsored the development, construction, and introduction of the AEGIS fleet of cruisers and destroyers and their associated combat systems. His responsibility also included a number of ongoing surface warfare programs: TOMAHAWK, Vertical Launch System, HARPOON, LAMPS, SQR-19 Towed Array, SQS-23 Sonar, MK-46 Torpedo, AEGIS Weapon System, New Threat Upgrade, Standard Missile, CIWS, RAM, NATO SEASPARROW, SLQ-32, Battle Group AAW, and Gas Turbine propulsion.

Admiral Doyle was twice awarded the Distinguished Service Medal for exemplary service, first in international negotiations and then in surface warfare. He also holds two Legions of Merit and the Bronze Star.

On September 1, 1980, he retired after 34 years of commissioned service. Since then he has been advising the Johns Hopkins University Applied Physics Laboratory on various aspects of Anti-air Warfare and Fleet Air Defense. He is also associated with the National Defense Industrial Association as Vice Chairman of the Strike, Land Attack and Air Defense Committee. He serves on an Advisory Board at the U. S. Naval War College and is on the Board of Directors of the Center for Oceans Law and Policy, University of Virginia. From 1982 to 1989, he taught International Law of the Sea at the National Law Center, George Washington University. He also participated in revising the laws of naval warfare sponsored by the San Remo Institute of Humanitarian Law.

Admiral Doyle is married to the former Jeannette Eleanor Blair of Berkeley, California. The Doyle's have three children, Kathleen (Mrs. C. Michael Watson), James H. III, and Anne (Mrs. I. Bruce Cauthen), and five granddaughters, Alice and Laura Watson, Katherine and Alison Doyle, and Eleanor Cauthen.

Ralph E. Hawes, Jr.

Ralph E. Hawes, Jr. is the Managing Principal of Hawes & Associates, a management consulting business, serving as a consultant and advisor to government agencies and aerospace/defense companies on technical, systems, and business related matters.

Prior to this, he served as Executive Vice President - Missiles and Electronics of the General Dynamics Corporation until he retired on March 1, 1991. He was appointed to this position in January 1988, after serving since June 1985 as Vice President and General Manager of the company's Valley Systems Division as its chartering General Manager.

Mr. Hawes joined the company's Pomona Division in California as an electronics engineer in 1956. He served in numerous technical and management positions related to advance system design, missile guidance system design, program development, and production for tactical missile and electronic systems. In these capacities he gained national recognition as a pioneer in the design, development, and production of tactical missiles using homing guidance techniques for their effectiveness. He holds technical patents on several systems.

Mr. Hawes served as the Pomona Division Vice President, Research & Engineering from 1973-1977. In 1977, he was appointed Vice President & General Manager at the Pomona Division. He was elected a Vice President of the Corporation in 1978. He served in the positions until being appointed chartering General Manager of the Valley Systems Division that he formed from the Pomona Division as a result of high internal growth of that division.

On being appointed Executive Vice President - Missiles and Electronics, Mr. Hawes assumed senior management responsibility for four General Dynamics divisions with a combined revenue of nearly $2.5 billion, employing over 20,000 employees.

Prior to joining General Dynamics in 1956, Mr. Hawes was an electronics engineer with the Clarke H. Joy Company located in Bay Village, Ohio.

Mr. Hawes' honors include receiving the Clarkson Golden Knight Award for professional accomplishment, the National Management Association (NMA) Silver King of Management Award in 1982, the NMA Golden Knight of Management Award in 1988, and the Boy Scouts of America "Good Scout" Award in 1982.

He has served as a member of the Board of the American Defense Preparedness Association, a Director of the Atlantic Council (Business Advisory Board), member of the Navy League, member of the Association of the United States Army, and a member of the Corporation of the Charles Stark Draper Laboratories.

Mr. Hawes is a Trustee of Clarkson University, having served as Chairman, and served on the Board of Advisors of the Southern California School of Engineering; served on the Executive Board of the St. Louis Area Council, the Old Baldy Council, and the Occoneechee Council, Boy Scouts of America; served on the Arts and Education Council of Greater St. Louis; and was a member of the Galileo Society of Harvey Mudd College, the Los Angeles Fair Association, and the President's Council of the California State Polytechnic University at Pomona.

Mr. Hawes was born December 27, 1930 in Covington, Louisiana. He received a BSEE from Clarkson University, Potsdam, New York in 1955 and his ME through the Engineering Executive Program from the University of California at Los Angeles in 1969.

Mr. Hawes is married to Solita Anna Staack. They have three children and three grandchildren. Ralph and Solita Hawes currently reside in Pinehurst, North Carolina.

Alexander Kossiakoff

Dr. Kossiakoff is Chief Scientist of the Johns Hopkins Applied Physics Laboratory and member of the Laboratory's Science and Technology Council. He is also Program Chair of the Master of Science in Systems Engineering and Master of Science in Technical Management programs for the Johns Hopkins University, G.W.C. Whiting School of Engineering.

Dr. Kossiakoff is a graduate of the California Institute of Technology and received his PhD at Johns Hopkins. He served with the wartime Office of Scientific Research and Development in the development of solid rocket technology and was Deputy Director of Research at the Allegheny Ballistics Laboratory, Cumberland, Maryland from 1944 to 1946. In recognition of his work on national defense during WWII and at APL, Dr. Kossiakoff was awarded the Presidential Certificate of Merit, the Navy's Distinguished Public Service Award and the Department of Defense Medal for Distinguished Public Service.

Dr. Kossiakoff jointed the Applied Physics Laboratory in 1946. He was appointed Assistant Director in 1948, and served as Director from 1969 to 1980. His technical contributions at APL have been principally in the systems engineering of guided missiles, automation of radar surveillance systems, and software engineering technology. He is co-author of the textbook on systems engineering used in the core courses of the JHU MS in Systems Engineering program.

Walter B. LaBerge

Education: BA Naval Science, University of Notre Dame 1944
BS Physics, University of Notre Dame 1947
Ph.D. Physics, University of Notre Dame 1951

Professional Experience:

Current	Visiting Professor, US Naval Postgraduate School Visiting Professor, Institute for Advanced Technology, U. of Texas
1993-1999	Senior Research Scientist, Institute for Advanced Technology
1981-1989	Corporate VP, Lockheed Corp., Dir. LMSC Research Labs.
1981	Acting UnderSec R&D, Dept. of Defense
1979-1980	Principal Dep. UnderSec R&D, Dept. of Defense
1977-1979	Under Secretary of Army, US Army
1976-1977	Assistant Secretary General, NATO
1973-1976	Assistant Secretary, R&D, US Air Force
1971-1973	Technical Director, ASTD, NOTS China Lake, CA
1957-1971	VP, Div. GM and engineer, Philco-Ford Corp.
1951-1957	Program Manager (SIDEWINDER), NOTS, China Lake, CA

Awards:

Member, National Academy of Engineering
Distinguished Civilian Service Medals from USN, USA, USAF, and DOD

Significant Accomplishments:

PM NOTS	Introduction of SIDEWINDER into Navy, USAF
PM Philco	Design and implementation USAF Ground Satellite net
PM Philco-Ford	Design and improvement, NASA Mission Control Center, Houston
NATO	Introduction of AWACS into NATO
Army Science Board	Chairman, 1989 seminal ASB Army Technology Review

Vice Admiral Paul Fenton McCarthy, US Navy (Retired)

Paul McCarthy, current incumbent of the Admiral Peter C. Conrad Chair of Financial Management, Naval Postgraduate School, is a former Navy flag officer with significant leadership and management experience in both the military and industry. His disciplines include strategic planning, program management, engineering and financial management.

Professional Experience:

1997 to 2000: After the merger with the Boeing Company, Mr. McCarthy became the Director of Naval Systems Integration. This venture introduced Boeing to the naval weapons systems integration arena. In rapid succession, his office won three contracts: DD-21, the U. S. Navy's next generation surface combatant; Integrated Deep Water Systems, the restructuring of the U.S. Coast Guard force structure; and CVN-77/CVNX, the U.S. Navy's next generation carrier. Mr. McCarthy developed the strategy, teaming arrangement, and directed the proposal and contract efforts for these programs. He also was involved with BAe in the Royal Navy's CVF program, the United Kingdom's next generation carrier. The ultimate value of all these efforts is well over $70 billion.

1992-1996: Joining the McDonnell Douglas Company in January 1992 as Director, Engineering, he was sequentially promoted to Division Director, then Vice President Engineering, and, Vice President Systems Integration. Through out that time, he was responsible for instituting a number of streamlining and affordability measures involving processes, tools, training and the implementation of Integrated Product/Process Development. With the integration of these measures, savings of over 14% were achieved in the design, manufacturing and assembly of a number of programs highlighted by the F/A18E/F.

1990-1992: Prior to joining McDonnell Douglas, Mr. McCarthy was President of McCarthy and McCarthy, a consulting firm involving strategic planning, management, programmatics and technical areas. Clients included McDonnell Douglas, Boeing, Lockheed, Westinghouse, Texas Instruments, Alenia, and a number of other major corporations.

1954-1990: A career naval officer for over 35 years, Mr. McCarthy rose to the rank of Vice Admiral. His seven sea commands included squadron, air wing, carrier, task force and finally command of the U.S. SEVENTH Fleet. His experience encompasses over 250 combat missions, 850 carrier landings, as well as qualifications in Surface Warfare and Naval Aviation.

During his time in Washington, Admiral McCarthy had three acquisition tours in the Pentagon on the staff of the Chief of Naval Operations. His first tour as a Commander, was in OP-96, analyzing a wide variety of programs for cost, schedule and technical risks.

Mr. McCarthy's second tour as a newly frocked Rear Admiral was OP-50 (N-880) with the budget responsibility for Naval Aviation of over $23 billion. This responsibility included shepherding programs through the Pentagon's Program, Planning and Budgeting Cycle, working with the Systems Commands, Navy Laboratories, and Test Centers. Daily interfaces included the staff of the Secretary of Defense, as well as Congressional members and staff. Strategic planning and budgeting were major focal areas. In his final acquisition tour, Vice Admiral McCarthy was the Director, Research, Development and Acquisition, OP-98, reporting to both the Chief of Naval Operations and the Secretary of the Navy. This assignment included oversight of a $10 billion account of over 600 programs which ultimately leveraged over $200 billion in production funds. This tour again involved interfaces with all the other services, military and commercial laboratories, as well as other government agencies and a broad spectrum of industry.

Education:

A native of Boston, Massachusetts, Mr. McCarthy holds a Bachelor's degree in Marine and Electrical Engineering from the Massachusetts Maritime Academy and a Master of Science degree in Management from the U.S. Naval Post Graduate School. He participated in post graduate studies in Engineering at the U.S. Navy Nuclear Power Facility, Idaho Falls, Idaho.

Honors:

Doctorate of Public Administration, Massachusetts Maritime Academy
Order of the Rising Sun, Japan
National Service Medal, Korea
Cross of Gallantry, South Vietnam
Distinguished Service Medal, U.S. Navy
Who's Who in America, 1982
Who's Who in Aviation, 1983

Memberships:

Society of Experimental Test Pilots
Trustee, Naval Institute Foundation
Board of Visitors, Massachusetts Maritime Academy

Rear Admiral Wayne E. Meyer, US Navy (Retired)

Rear Admiral Wayne E. Meyer, a native of Brunswick, Missouri, retired in 1985 as the Deputy Commander for Weapons and Combat systems, Naval Sea Systems, Naval Sea Systems Command and Ordnance Officer of the Navy. His career began in 1943 as an apprentice seaman. He was commissioned Ensign, U.S. Naval Reserve, in 1946 and was transferred to Regular Navy in 1948.

Rear Admiral Meyer graduated from the University of Kansas in 1946 as a B.S. in Electrical Engineering. He is also a B.S. in Electrical Engineering and a M.S. in Astronautics and Aeronautics from the MIT, and a B.S. in Electrical Engineering from the Naval Postgraduate School.

His first sea duty in GOODRICH (DDR-831) was followed by sea tours in SPRINGFIELD (CL-66) and SIERRA (AD-18). From 1951 through 1955, he attended the Joint Guided Missile School, Fort Bliss, Texas, the Naval Line School, Monterey, California, and served as instructor at the Special (atomic) Weapons School, Norfolk, Virginia. He returned to sea as Executive Officer in STRICKLAND (DER-333) followed by service on the Staff, Commander, Destroyer Force, Atlantic.

After Graduate School, Monterey, and MIT, he was ordered to the TALOS cruiser GALVESTON (CLG-3) as conversion Fire Control and subsequently Gunnery Officer. He then reported to Secretary of the Navy's Special Task Force for Surface Missile Systems (later Surface Missile Systems Project, Naval Material Command) in Washington, D.C. He transferred to the Naval Ordnance Engineering Corps in 1966.

In 1967, he reported as Director of Engineering at the Naval Ship Missile Systems Engineering Station, Port Hueneme, California. In 1970, he reported to the Naval Ordnance Systems Command, as Manager, AEGIS Weapons System. He was named Project Manager (the final one) for Surface Missile Systems in 1972 and in July 1974, he was named the first Director of Surface Warfare, Naval Sea Systems Command.

He was selected for Admiral in January 1975. In July 1975, he assumed duties as the founding Project Manager, AEGIS Shipbuilding. In September 1983, he was reassigned as Deputy Commander, Weapons and Combat Systems, Naval Sea Systems Command.

Rear Admiral Meyer's personal decorations and service medals include: Distinguished Service Medal, Legion of Merit, Meritorious Service Medal, Navy Meritorious Unit Commendation Ribbon with Bronze Star, China Service Medal, American Campaign Medal, World War II Victory Medal, Navy Occupation

Service Medal, National Defense Medal with Bronze Star, Armed Forces Expeditionary Medal, Vietnam Service Medal, and the Republic of Vietnam Gallantry Cross with Palm Unit Citation and Republic of Vietnam Civil Actions Unit Citation. He holds the American Society of Naval Engineers Gold Medal (1976), Silver Medal from the Old Crow Electronics Countermeasure Association and was recognized in 1981 by the University of Kansas with its Distinguished Engineer Alumni Award. He holds Naval Ordnance Engineer Certificate #99. He is a Fellow in the American Institute of Aeronautics and Astronautics and 1983 recipient of that Institute's Missile Systems Award for distinguished service. He was recipient of the Navy League's RADM William Parsons Award in 1985 for scientific and technical progress in construction of the nation's AEGIS fleet. In 1985, the American Society of Naval Engineers again recognized him with its Harold E. Sanders Award for a lifetime of contributions to Naval Engineering. In 1988, the National Security Industrial Association recognized him with its Admiral J. H. Sides Award for major contributions to Anti-Air Warfare. Again, in 1997 he was designated a Pioneer in the U.S. Navy's newly-created Acquisition Hall of Fame in the Pentagon.

He is the son of Mr. and Mrs. Eugene Meyer (deceased) of Brunswick, Missouri. He is widower to the former Margaret Garvey of Dorchester, Massachusetts. He lives in Falls Church, Virginia and has three grown children and four grandchildren.

Rear Admiral Meyer presently operates a consultancy with rooms in Crystal City, Virginia. His consultancy embraces both private and government clients in the fields of project management, system engineering and strategic planning. He chairs and serves on numerous Panels and Committees chartered by various DOD civil and military officials. He has served on the National Ballistic Missile Defense Advisory Committee for the past seven years, serving as its Chairman for the past three years. He also gives numerous speeches besides reviewing and editing articles, essays and books.

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Assistant Deputy Commander for Surface Ship Technology, SEA 53, NAVSEASYSCOM/Commander, Naval Surface Warfare Center
1333 Isaac Hull Ave., SE
Stop 5011
Washington Navy Yard
Washington, D.C. 20376-7001

9. RADM Lewis W. Crenshaw Jr. 1
Director, Assessment Division, N81, OPNAV
2000 Navy Pentagon
Room 5D644
Washington, D.C. 20350-2000

10. RADM Charles H. Johnston Jr. 1
Vice Commander
Naval Air Systems Command
47123 Buse Rd., Unit #IPT
Patuxent River, MD 20670-1547

11. VADM William H. Rowden, USN (Ret) 1
55 Pinewood Court
Lancaster, VA 22503

12. RADM George H. Meinig, USN (Ret) 1
120 Lamb Tavern Lane
Glenmoore, PA 19343

13. VADM J.T. Parker, USN (Ret) 1
3061 Mimon Road
Annapolis, MD 21403

14. VADM James H. Doyle, USN (Ret) 1
5121 Baltan Road
Bethesda, MD 20816

15. RADM Wayne E. Meyer, USN (Ret) 1
President
The W.E. Meyer Corporation
2231 Crystal Drive, Suite 1005
Arlington, VA 22202

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32.	Mr. Troy Kimmel Anteon, Inc. 2231 Crystal Drive, Suite 1000 Arlington, VA 22202-3742	1
33.	Dr. James Colvard 16411 Ridge Road King George, VA 22485	1

33. Dr. James Colvard — 1
16411 Ridge Road
King George, VA 22485

34. Mr. Robert Murray — 1
President
Center for Naval Analyses
4825 Mark Center Drive
Alexandria, VA 22311-1850

35. Ms. Christine Fox — 1
Center for Naval Analyses
4825 Mark Center Drive
Alexandria, VA 22311-1850

36. Dr. Ralph Passarelli — 1
Center for Naval Analyses
4825 Mark Center Drive
Alexandria, VA 22311-1850

37. Dr. Fred Bomse — 1
Center for Naval Analyses
4825 Mark Center Drive
Alexandria, VA 22311-1850

38. Mr. Charles Giacchi — 1
Executive Director
4363 Missile Way
Point Hueneme Division
Naval Sea Systems Command
Port Hueneme, CA 93043-4307

39. Mr. Kenneth Boyd — 1
P.O. Box 177
LaPlata, MD 20646

40. Research Office, Code 09 — 1
Naval Postgraduate School
Monterey, CA 93943-5138

41. Institute for Defense Systems Engineering and Analysis — 108
Naval Postgraduate School
777 Dyer Rd.
Mail Code 97
Monterey, CA 93943-5100