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THE ROLE OF ENGINEERING IN THE NAVY

by
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In ancient times a philosopher came to a city. He was determined to save its inhabitants from sin and wickedness. Night and day he walked the streets and haunted the marketplaces. He preached against greed and envy, against falsehood and indifference. At first the people listened and smiled. Later they turned away; he no longer amused them. Finally, a child moved by compassion asked: "Why do you go on? Do you not see it is hopeless?" The man answered: "In the beginning, I thought I could change men. If I still shout, it is to prevent men from changing me."

I feel like that man as I talk to you today. I have fought for reform in the Navy for years. If I still shout, it is because I am afraid the Navy will not be able to meet the demands which will be placed upon it in the future. There are two broad reasons for this condition. First, we misread history. Second, we do not ask the root question—What is the Navy's purpose?

The Navy exists to defend our Nation—it has no other purpose. It serves as a shield in peace as well as in war; for, in final analysis, diplomacy rests upon the deployment and use of military force. We all recognize this truism. What is wrong is that the Navy misreads the lessons of its past wars. It congratulates itself upon the victories and believes that, by merely tampering with its organization, it can meet the needs of today. It does not ask the question: How well did we do compared to how well we should have done?

This question demands a fresh look at our naval past. Instead of basking in past glories, we should ask: How well were the ships designed and built; how well were they used in battle? These are matters of engineering. In discussing engineering in the Navy, I am not going to consider the present state of ordnance in the Navy. That area has been run by line officers throughout this century and its failures are well-known. I will leave that subject to another critic who has the time and experience to describe it. Nor will I address aeronautical engineering, which is a field unto itself administered within the naval aviation command.

What I will talk about today is engineering as it deals with warship design, construction, and operation. How did this type of engineering evolve? How did we get to the fix we are in now, where the Navy is dangerously weak in these technical areas? What must we do to get on the road to recovery?

Throughout naval history there have been two important groups of men: the ones who fought the ships, and the ones who designed and constructed them. The ones who issued orders in the face of the enemy were the officers of the line of battle—the line officers. Designers and constructors were considered by line officers to be inferior. Yet success on the day of battle depended upon the skill of all.

The Navy of today is far more complex than it has ever been, but the fundamental distinction still exists between the role of the line officer and that of the officer whose specialty is ship design and construction—the naval engineer. The matter is complicated because there are two types of engineers: those at sea operating the machinery and those ashore who are charged with the responsibility for design and development of new ships and their equipment.

Origins of modern engineering in the Navy go back to 1814 with the first steam-driven warship, the Demologos, designed and built by Robert Fulton. In the following decades, the Navy built few ships with steam engines. The early engines were low-powered, unreliable, inefficient, and were used chiefly as an auxiliary to sail. The Navy could easily recruit engineers from civilian life to operate these engines. Engineers were given no military duties as these were the preserve of the line officer, the aristocrat of the Navy. Therefore, from the beginning there was a gulf between the line officer and the engineer who operated the engines.

The line officer detested the greasy engineer and his smoking boilers that blackened the sails. Not until 1842 did Congress authorize an engineer corps for the Navy. The selection of the first engineer-in-chief was evidence of the low prestige of naval engineering. Gilbert L. Thompson combined the talents of law, scholarship, and diplomacy, but he knew no engineering. He could not speak for the engineers in the Navy, nor could he judge engineering problems.

Engineering, both in operating the shipboard machinery and in the design and construction of ships, became critically important with the outbreak of the Civil War. The Navy had to blockade a coastline stretching over 3,000 miles from the Potomac to the Mexican border. It had to support the Army on the rivers; it had to search out and destroy Confederate raiders. For all these purposes, the steam engine and the engineer were indispensable. On the day of battle, steam engines drove the Monitor and the Merrimack, the Kearsarge and the Alabama, as well as the gunboats which supported Grant before Fort Donelson and Vicksburg. In 1862, Congress recognized the importance of engineering by creating the Bureau of Steam Engineering.

When Lee surrendered, the United States Navy was the most effective sea power in the world. That position depended upon engineering which, in turn, was based on the skill of Benjamin F. Isherwood, first Chief of the Bureau of Steam Engineering. He designed and built engines rugged enough to

withstand the shock of combat, as well as ill-treatment by poorly-trained operating engineers. He also designed and constructed a well-armed cruiser which was faster than any abroad. In addition, American naval leadership rested upon ingenious civilian engineers and inventors such as John Ericsson, who designed and built the Monitor.

From this pinnacle of leadership the Navy fell swiftly. We had not learned the lesson of the need for good engineering and competent engineers. As a nation, we became complacent. We believed the Monitor was the embodiment of sea power, yet the turret and armored hulls had already been developed in Europe. Wrapped in the security of ignorance, we became slave to the Monitor-type. We had faith in them as major combatant ships long after other nations had recognized that they were only a brilliant improvisation to a specific problem. The main line of naval progress remained in Europe. We had misread the naval results of the Civil War.

The Navy forgot the hard-earned lessons and attempted to return to the days of sail. Aboard ship, the position of the engineer deteriorated. The chief engineer and his men were at the beck and call of the line officer. He was denied the living quarters to which he was entitled. He was forced to give way to the most junior line officer. He was not even allowed to eat in the same mess with the line officers. He found his firemen taken from his control and set to work shifting sails. One chief engineer complained

that he could not overhaul and repair the machinery because he did not have use of his men. The captain replied that he needed the engineering force for deck drills; if repairs to the engines were necessary, they could be made at night. Under these conditions the Navy had trouble recruiting and holding engineers, and ships failed to meet their commitments. The Acting Chief of the Bureau of Steam Engineering, William H. H. Smith, officially warned in 1883 that the Navy's standards had dropped below those for merchant ships. If a private shipowner operated with as few engineers, he could not insure his ship, and would be liable to criminal prosecution.

When the United States began to rebuild its Navy in the 1880's, it faced serious difficulties. The Nation had fallen behind in marine engineering, in naval architecture, and in ordnance. Because the Navy had built few ships in the previous decades, there had been no need for men skilled in naval design and construction. The United States did not have the facilities to build modern armored vessels, nor did the Navy or industry have the ability to design them. We had to import the technical knowledge, chiefly from England. In addition, the line officers had lost their professional competence because our naval ships had become obsolete. Therefore, the engineers and the line officers who were engaged in the design of new ships lacked experience.

To coordinate ship design and construction, Secretary of the Navy Benjamin F. Tracy, in 1889, set up the Board on Construction. Its membership varied, but always included the Chief of the Bureaus of Construction and Repair, Steam Engineering, Equipment, and Ordnance. The Engineer-in-Chief of the Navy headed the Bureau of Steam Engineering, while the Chief Constructor headed Construction and Repair. They were professional engineers and naval architects. Line officers usually were Chiefs of the Bureau of Equipment and the Bureau of Ordnance.

Under these conditions, mistakes were inevitable. But, by and large, the worst errors were caused by the imposition of the opinions of line officers on technical matters. The result can be seen in the Navy's first three battleships, one of which was the famous Oregon. The Bureau of Ordnance, headed by a line officer, proposed a turret and gun arrangement based on the hoped-for success of technical developments. When these did not materialize, the turrets had to be redesigned. As a result, when any of these ships swung its guns to deliver a broadside, it heeled over to such an extent that the armor belt on the side toward the enemy dipped below the waterline, and the ship had no protection.

Another example of poor design occurred during the planning of the Kentucky-class battleships, laid down in 1896. The main battery was to be two turrets with a pair of 13-inch guns, and two turrets with a pair of 8-inch guns. The Chief of the Bureau of Ordnance proposed that the

8-inch turrets be placed on top of and integral with the 13-inch turrets. The 8-inch turrets could, therefore, not rotate independently. Whatever the 13-inch guns aimed at, so did the 8-inch guns on the turret above. The Chief of the Bureau of Ordnance—a line officer—got his plan accepted over the strenuous objections of the Chief Constructor. Theodore Roosevelt, as Assistant Secretary of the Navy, was aware of the serious criticism of this design. Yet he also knew that the Chief of the Bureau of Ordnance was a line officer of great prestige among his brother officers. This episode was an instance—not uncommon in the Navy—where officers with a reputation in one field are assumed to be expert in another.

The Battle of Santiago, during the Spanish-American War, revealed that line officers did not know how to use their ships. The military situation was simple. An American squadron, consisting mainly of two armored cruisers and five battleships, had bottled up a Spanish force of four cruisers and two torpedo boats. To save coal while on blockade, captain after captain had cut down on the number of boilers in operation. In the two armored cruisers, half the engines had been uncoupled from the propeller shafts to save coal. When the Spanish came out of the Santiago Channel Sunday morning, July 3, 1898, the Navy was caught by surprise. All the Spanish ships in the battle were sunk or run aground; victory was won. Yet an analysis of the results showed little cause for complacency.

The engines of the entire fleet should have been prepared for battle, but only the Oregon had been ready. She had won her place in American history by her dash from Bremerton, around Cape Horn to Cuba, in a voyage which had been an engineering triumph. After the Oregon joined the blockade, her captain sent for his engineer, Robert W. Milligan. He urged Milligan to cut down on the number of boilers. Milligan replied that he would obey such an order—provided it was made in writing, and provided he could submit a written protest. In Milligan's words: "Damn the economy, efficiency is what we want." The captain withdrew his suggestion. Milligan used his coal carefully, but he kept fires lit under all his boilers. When the battle came, the Oregon was one of the few vessels the Spanish could not outrun.

Milligan was one of those old-fashioned engineers who was never far from his engines. He was one of that breed of men taught by experience. These engineers—and I proudly and with no false humility class myself with them—could walk through an engine room and, through the din and uproar, catch the slight sound of a component out of adjustment. They could touch a jacket of metal and feel from the vibrations whether the machinery inside was operating well. They would taste boiler water to see if it were pure, and would dip their fingers into the lubricating oil to find out if a bearing was running hot.

Milligan also gave responsibility to his young subordinates. In the Oregon, during her trip around South America and during the Battle of Santiago, Naval Cadet William D. Leahy served in the engine room. There he stood watches, was in charge of stowing coal, and clambered over boilers and furnaces to inspect and maintain them. Leahy, one of the outstanding naval leaders of World War II, could have received no better example of professional leadership.

It took time to learn the lessons of the Spanish-American War. The shooting at Santiago had been poor. Of all the shots fired, only 1. 3 percent hit the target. Fortunately, enough hits were made to set the Spanish cruisers on fire. Three years later—in 1901—the North Atlantic Squadron, consisting of three battleships, fired at a hulk 78 feet long and 30 feet high at ranges of about a mile and a half. Despite ideal weather, only one out of 185 shots hit the target. As the admiral commanding the squadron reported, it was a "percentage of only 54/100 of 1%."

There are several explanations for this bad showing, including poor training and badly designed gun mounts and sights. Perhaps the record wasn't much worse than that of other navies at this general time. But these are excuses. The proper question was then—as it is today—how well did the Navy do compared to what it should have done?

The Spanish-American War temporarily interrupted a move which would have straightened out the place of the engineer aboard ships.

George W. Melville, Chief of the Bureau of Steam Engineering, spoke for the engineers when he complained to Congress: "I have got tired of being the bastard . . . son of the Navy."

Two solutions were possible. One was to strengthen the engineers so that their status and responsibilities were clearly defined and recognized. The second was to merge the engineers into the line. Because of the increasing complexity of ships, the Personnel Act of 1899 followed this second approach. As Assistant Secretary of the Navy, Theodore Roosevelt said: "Every officer on a modern war vessel in reality has to be an engineer whether he wants to or not." But, as Melville pointed out, the Act would only work if the line officers accepted their engineering responsibilities at sea in good faith.

Some did, others did not. In 1905, a boiler explosion aboard the gunboat Bennington, at anchor in San Diego harbor, cost 65 lives. Subsequent investigation revealed that the chief engineer was an ensign who had never stood an engine room watch before being assigned to the billet. He knew nothing of machinery, and he did not have the technical knowledge to stop the chain of events that led to the tragedy. He had never been required, nor given the opportunity, to acquire the necessary knowledge. The Bennington disaster was an extreme example of how far some line officers had yet to go to recognize the need for proficiency in engineering on board ship. The old way was simply not good enough.

In 1908, Captain Bradley A. Fiske, in testifying before the Senate Naval Affairs Committee, made a telling point, as true today as it was then: "A navy, after all, is nothing but a collection of machines, operated by men. Men are always men. They do not change very much, but machines change a great deal."

The year in which Fiske spoke was during a period of naval reform. The United States was well on its way to becoming one of the great powers. Yet most of the new naval technology was being copied from abroad. The lead in developing the Dreadnought-type of battleship had been seized by the British; the first marine turbine was of British origin. Admiral William S. Sims, the officer who is credited with teaching our Navy how to shoot, used training procedures he had copied from the British. The Navy could also rely on American industry as another source of technology. Although this was a period of rapid growth, there was a serious weakness. The status of the engineer aboard ship was by now satisfactory, but the importance of the design engineers—those who could design ships and machinery—had been forgotten.

By 1916, the Navy recognized it could no longer neglect the design engineer. That year Congress passed an act which established the engineering duty only officer—usually abbreviated as EDO. The Act reflected the controversy that had troubled the Navy for decades. The EDO's were line officers, but specialized in design engineering. Because

they could not assume military command, they were known as "restricted" line officers.

The Navy learned little from World War I. Even though the Germans had come close to victory with the submarine, we took little heed of that danger after the war. Instead, we held fleet exercises in which battleships steamed in formations and maneuvered, just as they had at the Battle of Jutland in 1916. In these exercises our submarines were used on the surface to protect the battleships. Again, as we later learned at the outset of World War II, the right questions were not being asked.

Between World Wars I and II, there was a reasonable balance between the line officers and the technical officers responsible for design and construction of ships. Few new ships were built immediately after World War I, so that line officers had a chance to learn how to use battleships, destroyers, submarines, and to experiment with aircraft carriers. The EDO's, in turn, had time to become educated in their profession. They were selected from line officers who, after six or seven years of sea duty following graduation from Annapolis, had been ordered to the Naval Postgraduate School at Annapolis for a course in naval engineering design. The latter part of this course was taken at a first-rate civilian college, such as Columbia or the University of California. After completing their two years of scholastic work, these officers returned to sea duty. Only several years later were a few of them designated EDO's. By that time they had about 15 years of commissioned service. Consequently, when the Navy

began to rebuild in the 1930's, it had a group of able line officers—among them King, Halsey, Leahy, Nimitz, and Spruance—and some able engineers and constructors—among them Bowen, van Keuren, Cochrane, Robinson, and Mills—with the technical competence to meet its needs.

The Navy was at its apogee at the end of World War II. Again we were misled by the magnitude of the victory. The United States could afford to overlook errors of leadership in the line and in engineering because we had the time and resources to outproduce the enemy. Today this is no longer true. We must be ready to defend ourselves with what we have.

Since the end of World War II, I have witnessed the deterioration of the technical competence of the Navy when compared to the job the Navy has to do. One reason is lower personnel standards. Many officers who came into the Navy during the war had reached fairly high rank. They had served their country well, but lacked the qualifications the Navy needed in its officers. The decrease in personnel standards led to a decline in standards of competence. In the non-nuclear surface ships, officers were--and are at this moment —no longer required to qualify as operating engineers.

In the period before World War II, line officers were required to complete a formal qualification in the operation of the engineering department of their ship. Since World War II, the Navy has ignored

the need for line officers to acquire operating experience in engineering. There are now no requirements for the captain of a ship to have served in the engineering department before he takes command. The result is that many captains have little knowledge, respect, or regard for their engineering plants; they do not know how to make a critical inspection of these plants, nor can they even evaluate the recommendations of their people. Is it any wonder that ships——even new ones —— are frequently found in poor material condition by outside inspectors?

The emphasis on operational engineering experience is just the opposite in nuclear ships. Since the beginning, I have required all nuclear ship captains as well as their subordinate officers to qualify as operators of the propulsion plant before being assigned to a ship. Prior to being assigned as chief engineer, executive officer or captain of a nuclear ship, the nuclear trained officer must successfully complete a comprehensive eight hour written examination and a three hour oral examination at my headquarters in Washington. I personally approve or disapprove all examination results. Before he is permitted to take this examination he must first have completed one year of academic and operational training which includes qualification as a watch officer on a fully operational, land prototype nuclear propulsion plant similar to the ones we have at sea. An engineering department officer, once he has completed his initial training, must qualify as a watch officer in a nuclear

ship and serve in the engineering department for at least one year. To be eligible for the examination, he must also be recommended by his commanding officer.

These requirements produce line officers who are familiar with the operating details of their propulsion plants and are not afraid to get their hands dirty. When reports from subordinates conflict, or where they doubt the accuracy, they know enough to look for themselves and to put the weight of their own experience behind the decision. They also know how to train their officers and men and inspect their plant. They possess that essential requisite of leadership— to educate and train. I would much rather have officers with this sort of experience than ones with postgraduate degrees in systems analysis, computer science, management or business administration—as many of the Navy's line officers have. The machinery does not respect these irrelevant capabilities.

In the rest of the Navy, engineering at sea has been relegated to a subordinate position. This is a serious mistake. Ships will not be able to fight effectively if they cannot get underway, or otherwise meet their operational requirements.

Despite the vast increase in technology, the Navy, also, has gone downhill in the areas dealing with ship design and construction. The

Bureau of Ships, which inherited these responsibilities when it was established in 1940 by the amalgamation of the Bureau of Construction and Repair and the Bureau of Engineering, failed to take steps to maintain a strong cadre of competent officer and civilian engineers who could control the increasing technical work-load and build a strong engineering organization able to meet the demands of the new technologies.

I cannot overemphasize the importance of the technological factor. For man to take full advantage of modern technology, he must raise his standards of knowledge and performance. The high temperatures, pressures, and speeds needed today require the use of metals close to their ultimate limits. Therefore, the utmost care is needed in the engineering, manufacture, installation, and operation of equipment aboard ship, and in the design and construction of the ship itself. The rising tide of technological complexity has engulfed the design engineer ashore as well as the line officer engineer at sea. In both areas, these men now face demands far beyond those which confronted their predecessors. In the face of these challenges, some of the senior EDO's have seemed to be more concerned with getting the perquisites of military command of Navy yards rather than running the technical aspects of their jobs.

To meet the demands of the technological revolution we had witnessed since World War II, the Navy had two choices. It could make the strenuous effort needed to keep abreast of technology. Or it could let technical competence fall from its grasp, placing its dependence on industry, tinkering with its organization and, through various makeshift arrangements, attempt to keep track of the technical developments upon which its future depended. The decision was to rely on reorganization and management techniques. The result was a flood of studies and an endless series of reorganizations, all of which increased emphasis on "management" and decreased the reliance on technical competence.

A chief characteristic of the reorganizations was the increasing influence of the line officer in technical matters. The line officer does have an important responsibility to think through and set the requirements for ships and weapons. But in the years since World War II, he has become deeply involved in making decisions on technical matters for which his training has not qualified him. Instead of deciding what he needs, he is now often deciding how his needs shall be met.

Up through the Civil War and beyond, there was absolute civilian control in the Navy. The Secretary of the Navy had the responsibility for promoting officers, for assigning them to commands, and for directing ship movements. Bit by bit the line officers managed to

obtain some authority in these areas. A Secretary of the Navy in the time of Theodore Roosevelt complained: "My duties consist of waiting for the Chief of the Bureau of Navigation to come in with a paper, put it down before me with his finger on a dotted line and say to me, 'Sign your name here.' It is all any Secretary of the Navy does." This powerful bureau chief was a line officer. Finally, in 1915, the line officers achieved their goal of controlling the military operation of the Navy through the establishment of the Office of the Chief of Naval Operations.

When Congress established that position, it was clearly understood that the Chief of Naval Operations—the Navy's highest ranking military officer—was subordinate to the Secretary of the Navy, and that his job was to prepare the Fleet and keep it ready for war. He could give recommendations on the shipbuilding program, but not make the decisions. He did not control the technical bureaus which were concerned with ship design and construction; the chiefs of these bureaus reported directly to the Secretary. The Navy was divided into what was called a bilinear organization. One line of authority and responsibility, that for operational matters, extended from the Secretary to the Chief of Naval Operations. The other line extended from the Secretary to the chiefs of the bureaus. Ship design and construction were handled by the Chief of the Bureau of Ships who

reported directly to the Secretary. Occasionally a Chief of Naval Operations attempted to expand his power over the bureaus. Admiral King tried to do so during World War II. President Franklin D. Roosevelt at once saw the issue. Roosevelt was no novice in naval affairs. He had been Assistant Secretary of the Navy from 1913 to 1920 — not only a long period of time, but also during the years of World War I. The President gave as his reason for opposing King that:

> 'We ought not to have all the administrative problems of personnel and material, shore establishments, production, etc., go up through the Chief of Naval Operations. When you come down to it, the real function of the Chief of Naval Operations is primarily naval operations—no human being can take on all the responsibilities of getting the Navy ready to fight. He should know all about the state of that readiness, and direct the efforts of it, . . . If they are not ready to fight, or are slow in getting ready, it is his function to raise hell about it. Details of getting ready to fight ought not to bother him."

And, mind you, this was said when the Navy had not yet reached a fraction of the technical complexity it has today.

Roosevelt clearly understood the distinction between the role of the line officer and that of the technical officer. Unfortunately, some of the policy makers who came later did not.

At the time Secretary McNamara took over the Defense Department in 1961, there was a dire need to reform the Navy's method of handling development, procurement, and maintenance of warships. The basic need

was to establish groups of technically competent people with clear authority and responsibility for executing the various Navy programs, similar to the strong technical management approach that prevailed in the nuclear propulsion program and later in the POLARIS missile program. There was also a need for strong technical groups in the shipyards and industrial contractor organizations to carry out the technical development work, under close technical direction from the Government headquarters organization. These needs were not being met.

The Navy, obviously, had not done a good job, so when Secretary McNamara took office, the Navy was, quite properly, investigated and much was found in need of improvement. Unfortunately, the changes he made were in the wrong direction. He took the advice of analysts and management experts rather than seeking the advice of people with technical expertise. He changed the administration of the Navy's technical work to coincide with the Air Force organizational method; he established the Naval Material Command—a Command to be responsible for the design, development, and procurement of all naval equipment and the supporting shore establishment—to be similar to the Air Force Material Command. He did not recognize that procurement of warships is a far different matter than procurement of aircraft. He appointed a line officer as the Chief of Naval Material. He eliminated

the technical bureaus and assigned their functions to new "Systems Commands" under the Chief of Naval Material. Most of the technical people in the Bureau of Ships—other than in my nuclear propulsion organization—were removed to a new Naval Ship Engineering Center located in an outlying area, which was established as a field activity of the Naval Ship Systems Command. They are now merely consultants and are no longer responsible for what happens.

This reorganization, which created a new bureaucracy—now grown to about 800 people—the Office of the Chief of Naval Material—added another huge layer of management between the technical people who have to deal with the engineering details if they are to get the job done, and the people in charge whose approval must be obtained to proceed. They are empowered to ask any and all questions and to stop the work from proceeding. Their endorsement must be obtained prior to forwarding a recommendation to higher authority in the chain of command. But there is no one that I can find in the Naval Material Command who has the authority to approve proceeding with programs.

Subsequently, the organization was again changed to have the Chief of Naval Material report to the Chief of Naval Operations rather than directly to the Secretary of the Navy, thus ending the bilinear organization of the Navy.

That change, which President Roosevelt had prevented in 1942, was supposed to keep the Chief of Naval Operations in the responsible chain of command. However, the net effect on the technical people was to add still another layer of management through which to fight proposals before they could get approval. To understand the overwhelming and detrimental effect of these changes, it must be realized that every officer and civilian in the Offices of the Chief of Naval Material and the Chief of Naval Operations regards himself as senior to the Commanders of the technical Systems Commands, and feels free to introduce his thoughts, questions, and desires into any technical matter coming through his office. These people involve themselves in every aspect of ship design, construction, and procurement, including the construction of shore facilities and settlement of contract claims.

Recently, serious consideration was even given to placing a line officer in charge of the Systems Command which is responsible for the design and construction of all warships. If that move had been carried out, it would have been the first time in a century that the Navy did not have a chief engineer—and this at a time when the engineering complexity of the Navy has passed all bounds. It would have marked the final take-over by the line officers of every aspect of naval technical work. At the last moment, that proposal was fortunately abandoned.

The staff of the Chief of Naval Operations (CNO) has grown in recent years, until it now includes 65 admirals. This is about twice as many as were assigned to Fleet Admiral King's staff at the height of World War II. In addition, the CNO staff has more than 300 captains in comparison to only 187 billets for captains to command all ships and squadrons at sea. There are also over 320 commanders on the CNO staff, as well as many senior civilians and lower-ranking officers. These staff officers get involved in technical matters for which they have no qualifications. Recently, I attended a CNO meeting at which the only subject discussed was technical ship characteristics. In addition to the large number of line admirals present, there was also a Marine general—although the meeting had nothing to do with the Marine Corps. He volunteered no comments; how could he?

The purpose of the Navy has become lost in its organizational complexity. New layers of administrators and managers, civilian and naval, are interposed between the high echelons of the Navy and the people who are doing the actual work—the hewers of wood and drawers of water. The Navy no longer has adequate in-house technical capability. There was far greater technical competence in the Bureau of Ships in 1939 for the job it had to do to prepare for World War II than there exists now to meet the needs of today.

The growing dependence upon management systems has been another characteristic which has evolved in the years since World War II.

Secretary McNamara, instead of requiring the Navy to build up its in-house technical capability, decreed that it should depend on industry. The Navy could "manage" the projects which it assigned to industry. His successors have followed the same path. I have learned from many years of bitter experience that we cannot depend on industry to develop, maintain, and have available a technical organization capable of handling the design of complex ships and their equipment without the Navy, itself, having a strong technical organization to oversee the work in detail.

Management systems are as endemic to the Government as the black plague was in Medieval Europe. Brochure after brochure crosses my desk offering seminars and courses in management. Usually these are aimed at Government officials. Details vary, but the substance is the same. For a substantial fee, paid by the Government, and for a few days spent in pleasant surroundings, those attending the seminars will be taught management. Usually the agenda contains numbers: seven trends of management, five differences between a leader and a manager, four functions of a leader, five ideas for improving human relations, and three basic situations. There are gimmicks. I have a pocket-sized plastic card, complete with different colored eggs and long-sweeping arrows and fine print. Problems go one way, decisions another, and plans in yet a third direction. Presumably a person, faced with a decision, has only to pull out this card and follow the arrows. That is if he has the time and the patience, and can comprehend it. I can't.

A management system is broad and sweeping in its generalities. But technical problems are a matter of detail. The devil is in the details. Management systems cannot help when the difficulties are technical. A badly designed machine on which the safety of the ship and its crew may depend, is impervious to the blandishments of a management system. But a badly designed machine will yield to an exhaustive analysis by a technically trained man.

What if Columbus had applied modern management systems to his proposed voyage? He would have attended management seminars. He would have studied tables with brightly colored squares and broad arrows to show which way plans, decisions, and problems were to go. He would not have bothered with details such as navigation and seamanship. These were technical matters. He would simply have "managed" the voyage. He would have used a colored-plastic decision-making card. Further, his analyst—I mean systems analyst—would have presented him with several volumes proving that the venture was not cost-effective. America would never have been discovered. We would all be Indians.

It is hard to describe how pervasive management systems are; how they have dulled the sharp edge of purpose and competence. Nor are line officers the only ones to depend on the teachings of modern management. A recent Chief of the Bureau of Ships told his engineers that their key role was management in a technological revolution. He did not deny the need

Management is taught at Annapolis. I am aware of the serious harm that has been done to these young men. My people and I interview midshipmen before they enter the nuclear program. We do this because it takes time, effort, and expense to train an officer to operate nuclear ships. We cannot afford to penalize men who are working hard to learn atomic power plant technology by wasting our resources on individuals who have been taught the easy social science courses, or who cannot or will not make demands upon themselves. We must also select men who will seek facts and face them. Officers in nuclear ships cannot rely on theory alone. One midshipman, who had taken management courses, told me that he was able to learn my job in six months; he could run General Electric in a year.

It was not his fault. It was no crime for him to make this answer. He had been taught by his supposedly responsible and knowledgeable professors that his job was to "manage." It will take some of these men years to unlearn the Annapolis social science propaganda, and some never will. What is tragic is that often these young men have good potential as naval officers. They report to the Academy expecting to be taught the elements of the naval profession and have no reason to expect otherwise. Instead, they learn that a naval officer shouldn't bother with technical details. All he needs to know are broad concepts on how to manage.

Someone else will do the work. There will always be available to him a sufficient number of cheerful, willing, competent, hard-working "serfs" to do the technical work, as well as the money to do the job. He will be the leader, the aristocrat.

The service academies once gave professional education in engineering. Early graduates of West Point did much to develop our waterways and our railroads. In fact, for many years West Point was the only school that taught civil engineering. After some uncertain beginnings, Annapolis, too, gave good engineering and professional courses. The curricula of the academies was based on the assumption that the military service was a profession, but since the end of World War II, Annapolis, at least, has changed. It has added more and more social science courses, so that it now produces men more fitted for civilian life—if even for that—than for a career in the Navy. Even rewards for scholastic ability do not lead midshipmen further toward their careers. I recently learned of a midshipman who will spend his senior year studying "The Effects of Low Frequency Electromagnetic Fields on the Circadian Biorhythms of Common Mice." We are raising a generation of naval officers who are ill-equipped to carry out their jobs in peace or war. Again, it is a question of purpose. What is Annapolis for? Does a naval officer need to know the rhythms of mice?

Nor are engineering and science adequately stressed as undergraduate requirements for many other young officers entering the Navy today. The Naval Reserve Officers Training Corps (NROTC) which annually supplies more new officers for the Navy than the Naval Academy, is a case in point. Over the years officers commissioned through this program have been allowed to pursue practically any undergraduate major they desire. The Navy therefore finds itself subsidzing prospective anthropologists, foresters, sociologists, or perhaps even landscape architects—skills not needed by the Navy. To pay for this training is a waste of Navy funds.

Young officers today must be able to understand the technical details of their equipment and they cannot do this without learning the fundamentals of engineering and science. I have been recommending for years that, as a minimum, all NROTC students be required to take mathematics through integral calculus and at least one year of college physics. Despite these efforts, I have only been partially successful in convincing those responsible that this should be done.

There are also signs that the Naval War College has lost its sense of purpose. That college was founded in 1884 to give a few naval officers a chance to think about strategy. But today strategy is one among other themes. For example, in the Naval War College Review of January, 1972, the lead article was entitled "A Revolution in Organization Concepts."

A single sentence sums up the author's philosophy. "A person's ability to manage his own affairs or those of any public or private organization or institution depends less on the methods, techniques, and tools he employs than on his understanding of, and attitudes toward, the world that contains him and the groups of which he is a part." Put another way, he is saying that an attitude is more important than knowing the details of a job. The article's author has taught in several colleges here and abroad, and at one point was a professor of city planning and a co-author of a book on management. But would you go to a doctor who believes his "world outlook" is more important than his medical knowledge?

Contrast this philosophy with that of another article in the same issue of the Review. It describes how Admiral Joseph Mason Reeves, who was Commander of the United States Fleet in 1934, gathered officers of all ranks for a lecture at the War College. He told them: "In everything we do, we must ask ourselves: does this directly advance preparation for war? . . . . If war comes, this Fleet must fight 'as is.' You must fight at sea and not on paper." These two examples from the Review go to the heart of the matter—one is professional advice from an experienced naval officer; the other is not.

The Navy is raising a generation of officers who believe that technical training is not essential and that they can rely on management techniques to

make decisions. Further, they want subordinates with whom they can be comfortable rather than those who are qualified. On the other hand, the Russians do not put management experts into highly technical positions. A recent Soviet listing suggests that the head of the Russian space program is a design engineer who has been associated with Soviet rocket development since World War II.

The dependence on management systems has been an important factor in the loss of technical competence in ship design and construction. For example, over the years, with monotonous regularity, representatives from large and well-known companies propose to undertake—at Government expense—studies of small, high-speed ships propelled by small, cheap, light-weight nuclear power plants. These proposals appear very attractive to officer managers who do not understand the technical flaws and are dazzled by the promises of miraculous achievements by representatives of industry with high sounding management titles who are seeking large Government contracts.

My people and I find that the technical bases for these proposals are unsound. When we object to these schemes on scientific and engineering grounds, we are told that we are unimaginative and stubbornly conservative, that we could make these systems work if we really tried and wanted to do so. Such an argument reduces all engineering to the simple matter of personal will.

Senior line officers have lived most of their lives in an operating environment where they issue orders to which they obtain immediate execution by their subordinates. When they assume command of a technical organization, they become frustrated when the response to their directives is inadequate or delayed.

I well remember when, many years ago, a senior line admiral issued a directive which said "There will be no more rust." They do not understand that technical directives are not self-executory, because they involve far more than compliance with the type of order required to change ship course or speed. Such a directive may require a large amount of engineering work and take much time and the work of many engineers; it may not even be possible of achievement. Nor do they understand that a complex engineering directive requires more than a management decision; it requires also a strong technical organization to carry it out.

The most important job of the man in charge of a technical organization is to select and train the technical people working for him—not to issue orders and directives. But to do so he, himself, must be technically competent. No one, no matter how high his position, can accomplish a technical aim by simply ordering it. Nature knows no rank.

The loss of professionalism among the engineers, and the interference of line officers in technical matters, has resulted in naval ships of questionable design. I do not include our nuclear ships in this category, but only because of my ability to insist upon the contrary.

If the acceptance of these schemes illustrates the technical poverty of those officers and civilians in the Navy who are managing technical projects, the 1, 200 pound boiler is an example of incompetence on board ship. The Navy has had difficulty with these boilers, which deliver steam at a pressure of 1, 200 pounds per square inch. They have been hard to operate, and men have lost their lives in accidents with them. These boilers are important because well over one hundred of our escort ships and seven of our thirteen aircraft carriers are fitted with these boilers. Consequently, when the Navy had trouble with them, a significant number of important ships were involved.

My organization discovered that at the basic school ashore, the sailors were being trained to stand watches on, and record the water level of, a boiler that had no water in it. This is the equivalent of teaching your sons and daughters to drive by letting them sit in the garage behind the wheel, but never turning on the engine or putting the car in motion. And then sending them out on the highways to earn their living as truckdrivers. On board escort ships, we found commanding officers who had never given the boilers priority. I talked to admirals who were responsible for the care of these ships, yet had never seen the boilers which were giving them so much trouble—and a number of these ships could not operate.

What is the condition of the ships in our Fleet? In my opinion, there has been no period in the past 50 years where the Fleet has been in as poor condition as it is today. This is often excused because of the Vietnam War

and the inadequate appropriations for shipbuilding and ship repair. It appears to me that the prime reason for the inability of the officers of the Fleet to supervise their equipment is their lack of training. The poor condition of the Fleet is well-documented in official reports of the Board of Inspection and Survey of the last few years.

I have gone into the historical background to show that the problems the Navy is facing today are not new. More often than not, the line officers and the engineers, aboard ship or ashore, have been in conflict. Nothing I have said is intended to give the impression that engineers do not make mistakes. But engineers are less likely to make mistakes in engineering than line officers who make engineering decisions. The pendulum has swung too far in the direction of the line officer. I would be just as disturbed if the balance favored the engineer. The issue is not whether one group is exalted over the other; the issue is the very purpose of the Navy. On October 15, 1912, President Taft said: "A navy is for fighting, and if its management is not efficiently directed to that end the people of the country have a right to complain."

What Taft said in 1912 applies today. So does Roosevelt's statement made fifteen years earlier: *"Every officer on a modern war vessel . . . has* to be an engineer . . . ." Defining purposes is deceptively easy. Setting standards is not hard. What is difficult is to keep them firm—to prevent them from being eroded by people more interested in their careers and their status than in the organization. This is a hard lesson to learn.

Those who ask again-and again the simple question: "Does this make sense?" are accused of disloyalty. We should not be loyal to the idea of loyalty. We should be loyal to the purpose of the organization.

What should be done? Here I can only draw upon my own experience. When I came to Washington at the beginning of World War II, my job was to run the electrical section of the Bureau of Ships. Our object was to develop and supply electrical equipment for the fleet. I found that one man was in charge of design, another took care of production, a third handled maintenance, while a fourth dealt with fiscal matters. This was the way the entire Bureau operated. But it didn't make sense to me. Design problems showed up in production, production errors showed up in maintenance, and financial matters reached into all areas. I changed the system. I made one man responsible for his piece of equipment—for design, production, maintenance, and contracts. If anything went wrong, I knew exactly where to look. I run my organization today upon the same principle. Our nuclear ships have to work. We have developed the technical knowledge to see that they do. We know that our responsibility extends for the life of the ship—from womb to tomb.

Reform of an institution rarely comes from within. Inertia and resistance are too strong from those who shelter behind the ramparts of custom or find comfort from the soothing narcotic of ritual. Occasionally the defense against new ideas takes strange forms. In 1897, Theodore Roosevelt was chairman of a board set up to reduce the number of senior

line officers—a problem that is with us today, too. Promotion had been so slow that the upper ranks were filled with men who arrived too late in their life to learn how to exercise responsibility. A few officers on the board seriously proposed that the reduction be made by a system of chance—a sort of lottery—so that the choice of officers to be retired would be made "without the intervention of human intelligence." Roosevelt tossed the suggestion aside, for he and others saw that in this method the good officer was as liable to retirement as the poor one. He observed that intelligent men can make mistakes, but surely intelligence is better than blind chance.

Nearly all decisions in the Navy today deal with engineering problems. Technology will not stand still. The penalty for technological surprise can be enormous, even fatal. To avoid getting caught, we must know where the responsibility lies for the quality of our ships and the readiness of our Navy for war. We should return to the bilinear system, in which the technical bureaus reported directly to the Secretary of the Navy. They should no longer report through the Chief of Naval Material to the Chief of Naval Operations. The entire office of the Chief of Naval Material with its huge staff should be recognized as the huge burden it is, and disbanded. Not only would this step relieve those engaged in technical work from unnecessary meetings and paperwork, it would allow the Chief of Naval Operations to cut back on the size of his office. He could then face his primary job: seeing to it that the Navy is ready for war.

The principle behind these actions is that line officers must be taken out of technical positions they are not qualified to hold. The line officer has become an aristocrat. If an aristocracy fills a need in society, it has a valid place. But if it arrogates to itself privileges without responsibilities; if it assumes responsibilities without the necessary qualifications; then an aristocracy is dangerous, not just to itself, but to the society of which it is a part. The aimless way in which the line officers have taken over engineering in the Navy in the last ten years has just about destroyed the engineering capacity of the Navy.

Members of the inner circle of the naval aristocracy have often been rewarded by receiving choice assignments no matter what their experience, or lack of it. The situation is similar to placing favorites and members of the nobility in command of armies, or to Pope Alexander VI making his son Caesar Borgia a Cardinal at seventeen.

Today, many of our naval leaders are actually "cheerleaders," making heroic attempts to keep the Navy together with endless exhortations and lectures on the value of leadership. Yet they themselves are not knowledgeable enough to instruct or to see that the work has been done properly. What we must recognize is that the purpose of the Navy is to defend the country, not to provide a place for comfortable careers. After Pearl Harbor, President Roosevelt sent for Admiral King. Supposedly

King remarked: "When they get into a war, they send for the sons of bitches." Whether King used these exact words or not, it is their spirit—the determination to cut through difficulties to get the job done—that is important.

The line officer has a professional responsibility to learn how to operate his ship and his fleet. From his experience he should be able to say what kind of ships the Navy needs to meet its obligations.

Translating those requirements into operational hardware is the job of the engineering officers and the civilian engineers. These men must be forced to learn their job and assume responsibility for their work. To do this requires long term assignments. We can no longer permit officers to hold their position for a short time before moving on to their next job. The headquarters organization responsible for the design and construction of ships should be reestablished as a technical organization with its engineers returned to positions requiring them to be responsible for the technical state of affairs instead of being field consultants. As the Navy gains technical competence, it can build up its in-house technical capability, and demand high quality work at reasonable cost from the industrial contractors.

I do not underestimate the difficulties. It demands a clear recognition of purpose. It demands a leadership that knows that its main job is to train and educate officers and men to meet the highest standards at sea and ashore.

To a large extent, the Navy reflects the Department of Defense. Here, too, we are overwhelmed with a suffocating organization. In 1969, the Secretary of Defense asked a leading executive from private industry to serve as chairman of a committee to investigate the Department. Based on the work of his committee, the chairman wrote: "The Defense Department is the single most wasteful, incompetent, overstaffed department in the Government. It consists largely of paper-shufflers and memo-writers." He was right. As to be expected, the recommendations of this board—like its innumerable predecessors—were not taken seriously. Boards and commissions are useless because they can only suggest. Frequently they are set up just to quiet criticism by showing that "action" is being taken. The government is littered with reports of boards and committees which have never been acted on.

Changes can only be made by those who are responsible and act responsibly. To cut through the thick underbrush of the paper jungle, the Department in the 1960's tried system analysis, program management, and cost effectiveness. McNamera and his "whiz kids," with their cost analyses and computer methods, "managed" us into the situation where we lost the lead we had in nuclear submarines. Had not Congress intervened at the last moment, we would have stopped

nuclear submarine construction almost entirely. Even worse, these system analysts recommended that we sink ten of our Polaris submarines as a cost saving measure.

If at times the Navy Department has difficulty in fending off such proposals, one reason is that the Secretary of the Navy does not hold the position of esteem and importance he once possessed. No longer a member of the President's cabinet, he is merely one of three service secretaries who report to the Secretary of Defense.

Today we have new leadership in the Navy and the Department of Defense. I hope these men will give serious thought to reestablishing engineering competence in the Navy. I spoke earlier that we had misread our naval past. I study naval history from the perspective of an officer who is interested in the development of his profession. To me, most of these histories are seriously flawed. With a few notable exceptions, they are written by the victors to hail their own achievements. It is true in any walk of life that past success can engender a dangerous confidence and complacency that can lead to future defeat. In the glow of victory, all error is forgotten.

Recognizing the uncertainty of tomorrow is an important attribute of leadership. But a leader is acting in his highest capacity when he recognizes that his primary function is to train and educate. Naval officers cannot exercise true leadership if they lack the sense of purpose that comes from competence. No classroom courses and no books on leadership can take its place. There is no broad and easy highway to leadership, but only the

long road of experience gained through hard and unremitting work at one's career.

When I am told that I should not attack any of the policies of the Navy Department, it is the same as saying that a son should not warn his mother of a cliff until she has fallen over it. Perhaps, in the end, the facts of life, like a sheepdog with an awkward flock, will finally nudge the Navy toward common sense. But I doubt it. Had I refrained from attacking the policies of the Navy Department over the past 25 years by going to Congress and the Atomic Energy Commission, we probably would not now have our nuclear Navy which is a prime factor in keeping war from this country.

Like the philosopher who came to the ancient city, I know that reform means progress, and progress means strife. Where there is no friction, there is no motion. It has always been this way. We must ever seek the purpose of our lives. We must not give in to despair over the state of our technological competence as it is today. The danger lies in the future; it can be averted if we will but act.

It is not the duty of the critic to become responsible for correcting the deficiency he has found. This argument is frequently used to prevent the critic from pointing out what is wrong. When Eurystheus discovered that the Augean stables were dirty, was he then responsible for cleaning them?

Unpleasant facts are unwelcome and no one builds statues to critics. But today we are not quite as impatient of a critic as the ancient Locrians. These people gave freedom of speech to all citizens. At public meetings anyone could stand up and argue for changes in law or custom, on one condition. A rope was placed around his neck before he began to speak and, if what he said did not meet with public approval, he was forthwith hanged. That, no doubt, prevented disturbing the even tenor of familiar customs and ways of life. I am sure there are some in government today who look back with nostalgia on this ancient custom.

But we must face the stark fact that an uncriticized society cannot long endure.