Budget Options: Equal-Cost Alternatives but Differing Force Levels

The four program options shown in Table 4 illustrate a range of approaches to providing a fleet of modern, capable surface combatants for the Navy of the 1990s. Each of these options is calculated to require roughly $33 billion (in fiscal year 1982 dollars) in new construction funds during the period 1986-1995. This is equivalent to CBO's estimate of the cost of the program recommended by the Navy (Option II) in testimony to the Congress in February 1980. The life-cycle costs of the four options are also fairly close. 9/ Each assumes that construction of a total of 18 CG-47-class ships is approved through 1985. 10/

The options have different consequences as to the number and types of ships that would be at sea in the fleet in the year 2000. The force level and force structure resulting from each of the options are displayed in Figure 6--the dashed line

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9/ Life-cycle costs among the four options vary about ±5 percent from the average when outyear operating costs are discounted to the acquisition year. When outyear operating costs are not discounted, the life-cycle cost of Option I, with the smallest number of ships, is about 20 percent lower than that of Option IV, which has the largest number of ships. The life-cycle costs of Options II and III fall between those of Options I and IV.

10/ The options have been structured to have equal cost in order to provide a common basis for objective comparison. Another approach might have been to attempt to define equal-effectiveness options and compare their costs, but effectiveness is difficult, at best, to define and impossible (in a way that all could agree upon) for such complex issues as long-term ship procurement programs. Alternatively, the options might have been structured to meet some set of "requirements" derived from different sets of mission assumptions. This approach would be equally subjective and contentious, however, since the validity of the assumptions underlying such requirements could only be established by future events. The options are therefore structured on the best available objective measure, acquisition cost, the cost chosen being that needed to procure the most authoritative current requirement--that of the Navy's requirement estimate.

Figure 6.

Battle Group Surface Combatant Force Levels and Structures in the Year 2000: Four Equal-Cost Alternatives

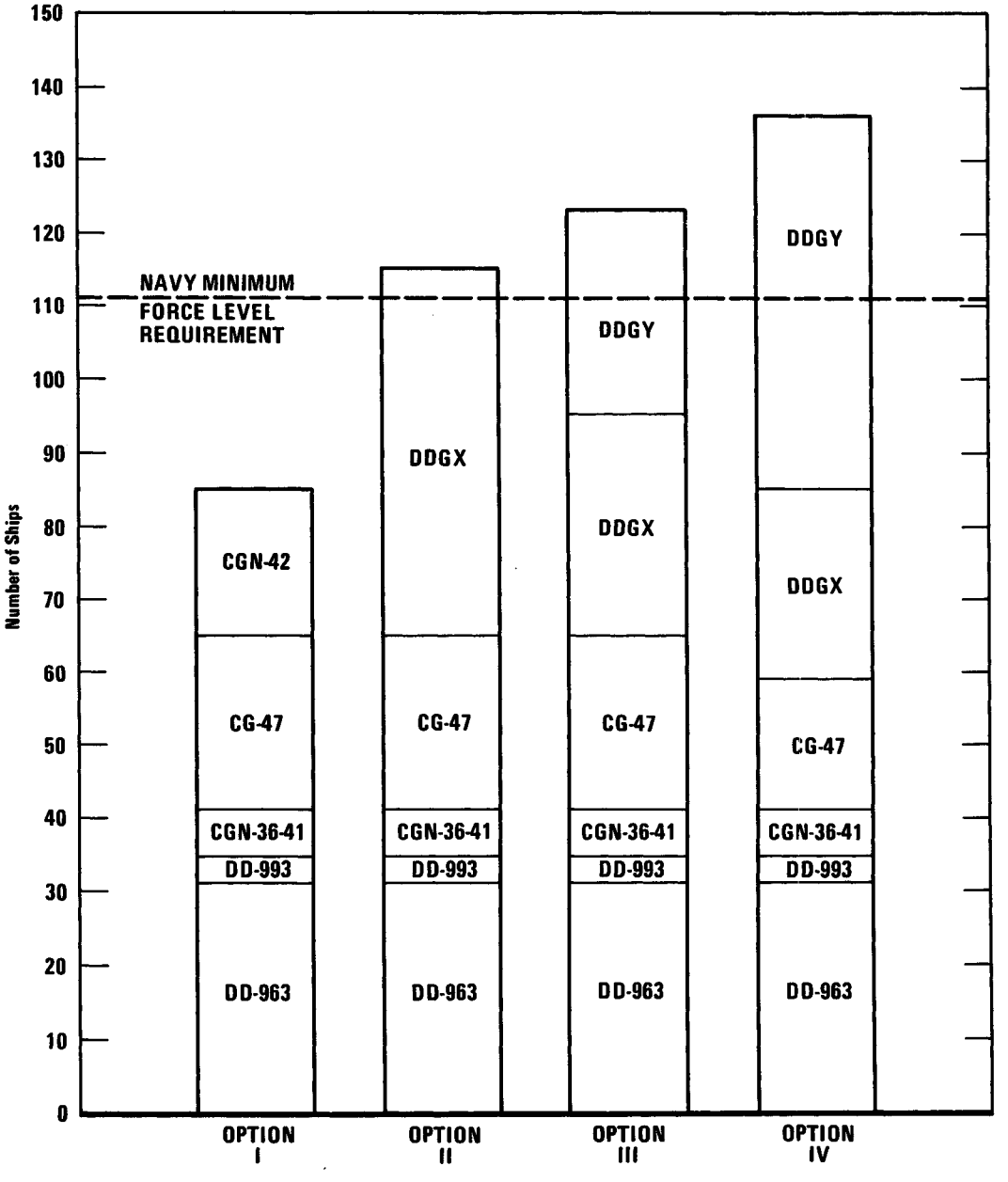

TABLE 4. ILLUSTRATIVE $33 BILLION 10-YEAR PROGRAMS FOR SURFACE COMBATANT WARSHIP CONSTRUCTION, FISCAL YEARS 1986-1995

Option	New Ships Authorized				Percent of Current Force Level at Sea in Year 2000
	Ship Type	In 1985 or Earlier	In 1986 Through 1995	Through 1995	
Option I:					
Emphasize	CGN-42	0	20	20	77
Capability	CG-47	18	6	24	
				44	
Option II:					
Emphasize Battle	CG-47	18	6	24	105
Group Operations	DDGX	1	49	50	
				74	
Option III:					
Balance Battle	CG-47	18	6	24	113
Group and Other	DDGX	1	29	30	
Mission Emphasis	DDGY	0	29	29	
				83	
Option IV:					
Emphasize Broad-	CG-47	18	0	18	124
Ocean Distributed-	DDGX	1	25	26	
Force Operations	DDGY	0	51	51	
				95	

indicating the Navy's force level requirement as stated in February 1980. Knowledgeable observers may disagree with this requirement, and even the Navy has characterized it as only a minimum acceptable level. Choosing among the options must therefore depend upon judgments about effectiveness and naval strategy. Arguments supporting each option are presented below.

Option I: Emphasize Capability

Option I is consistent with the view that warships should have the highest capabilities achievable at the time of their design and construction. The advocate of this option accepts the Navy's view that the key to victory in a future war will be

offensive strikes into enemy waters to destroy the enemy's forces and basing structure. Realizing that this strategy would almost certainly stimulate maximum resistance, he sees no alternative to building ships that can survive and be capable of winning in that situation. Although sympathetic to the need for more ships, the advocate of Option I is skeptical of claims that compromises on capability in the interest of lower cost would yield more overall fleet effectiveness. Nevertheless, he is willing to concede that the already established CG-47 program should proceed, despite its lack of nuclear power, because of its formidable combat capability and because it is necessary in order to continue ship production in the near-to-intermediate term. New programs, however, should provide ships with the best possible capabilities, including nuclear power. He therefore supports establishing a program to build nuclear cruisers having the best available weapons and sensor systems.

Option II. Emphasize Battle Group Operations

The advocate of Option II also accepts the Navy's offensive strike strategy and wants the best capabilities available for surface combatants, but he regards the "no-compromise-on-capability" approach of Option I as unrealistic and likely to result in a dangerously small Navy. He believes that it is not only possible but necessary to make judicious choices in warship design features that will produce less costly ships, but ships that are adequate to their mission and, being less costly, are more likely to be available in sufficient numbers. In making such choices, the advocate of Option II believes that the most appropriate frame of reference is a mission scenario featuring battle group operations against intensive enemy opposition in a forward area. He therefore supports the DDGX program as providing the capabilities most needed in the battle group, given the present and anticipated Navy force mix, at a cost at which sufficient ships can realistically be obtained. This option was favored by the Chief of Naval Operations in 1980 Congressional testimony.

Option III. Balance Battle Group and Other Mission Emphasis

The advocate of Option III agrees with the advocate of Option II that an uncompromising attitude on ship capabilities is unrealistic and likely to lead to a very small Navy. He believes, however, that if it is necessary to build lower-cost ships, they

should be built in a variety of types so as not to overspecialize fleet capabilities. While agreeing with the concept of offensive battle groups and supporting the DDGX as contributing to their effectiveness, he believes some resources should be put into other ship types as well. In addition to battle group operations, he perceives a variety of other tasks facing the Navy, such as extended patrol and presence operations in the Third World, where concentrated battle groups may not be the most efficient or appropriate application of naval forces. He therefore supports putting some resources into the DDGY, which, though capable of battle group operations, is oriented more toward independent and open-ocean operations than the DDGX. This, he believes, will produce a better balance of capabilities against the uncertainties of the future than buying only the DDGX.

Option IV. Emphasize Broad-Ocean Distributed-Force Operations

Like the advocates of Options II and III, the advocate of Option IV believes a judicious selection must be made in ship capabilities to obtain adequate numbers as well as adequate capabilities. He recognizes the importance of tactical air power and supports the concept of carrier battle groups. He is less convinced than advocates of the previous options, however, that a frontal assault by battle groups in enemy waters is the best strategy for a future war. He believes that, for a variety of reasons, it is more likely that a future naval war will involve worldwide operations against a much more distributed threat than the concentrated forces of the battle group scenario. Although favoring the DDGX program as necessary to support battle group operations in the 1990s, he perceives a high utility for more numerous, independently operating naval groups and therefore supports putting relatively more emphasis on the DDGY.

Options Versus Requirements: How Much is Enough?

The force level requirements presented to the Congress in 1980, and described in Chapter II, represent a reduction from previous estimates of surface combatant force level requirements. These new requirements, therefore, show a gravitation toward the view that individual ship capability rather than numbers of ships should govern in force planning and ship procurement decisions. Nevertheless, the Navy has frequently stated that it

has difficulty in meeting its commitments with the number of ships it has available. 11/ The tension in the Middle East has significantly increased demands upon the Navy for standing force deployments.

Option I, which places primary emphasis on ship capability, would result in a force of high-quality ships, but one numbering only 77 percent of the current force; thus, it could not simultaneously support all of the functional requirements discussed in Chapter II. Option II, which provides substantially more ships, would result in a force consistent with the requirements stated by the Navy in February 1980 and would be numerically comparable to today's force level. Options III and IV provide successively larger forces for the same investment, with Option IV resulting in a force level approximately equal to the Navy's former objective for cruisers and destroyers. Options III and IV would be more consistent with increased force level requirements brought about by contingencies such as the recent Persian Gulf and Indian Ocean developments.

As discussed in Chapter II, the Navy has stated it needs enough surface combatants to support at least six two-carrier battle groups and several surface action groups, as well as provide escorts for amphibious groups, underway replenishment groups, and convoys. Table 5 shows some implications of Options I through IV for the Navy's ability to support these requirements. The numbers in Table 5 assume that priority is given to battle group requirements. Option I would result in six well-protected battle groups, but would leave few ships for other functions. Option IV, at the other extreme, would provide enough ships to form five surface action groups after providing for battle group requirements, and would provide more ships for escort functions as well.

11/ Admiral Thomas B. Hayward, USN, Chief of Naval Operations, recently stated before the Senate Armed Services Committee that "for the first time in anyone's recollection the U.S. Navy is unable fully to meet its peace-time commitments" and would have to vacate essential areas of the world to respond to an emergency. See "U.S. Has Lost Naval Superiority Over Soviets, Leaders Tell Hill Panel," Washington Post (February 6, 1981), p. 10.

TABLE 5. MISSION SUPPORT IMPLICATIONS OF ALTERNATIVE PROGRAM OPTIONS IN THE YEAR 2000

Mission Capability	Option I	Option II	Option III	Option IV
Number of Two-Carrier Battle Groups Supported	6	6	6	6
Number of Surface Action Groups Supported	0	3	4	5
Number of Amphibious Escort Ships	9	11	13	18
Number of Underway Replenishment Escort Ships	24	32	32	32
Number of Convoy Escort Ships	66	66	68	70

LARGER NAVAL FORCE LEVELS: SOME IMPLICATIONS

The options presented above reflect the Navy's requirements and force level planning as presented to the Congress in 1980 testimony. The $33 billion assumed investment cost for each option is CBO's estimate of the 10-year investment cost of the program (Option II) recommended by the Navy in that testimony.

Recently the Reagan Administration has announced its intention to pursue a more ambitious naval program, including building and maintaining a force of 15 aircraft carriers. 12/ The program

12/ See "FY 1982 Shipbuilding and Conversion Budget Request," Statement of Vice Admiral William H. Rowden, USN, Deputy Chief of Naval Operations for Surface Warfare, before the Subcommittee on Seapower and Strategic and Critical Materials, House Committee on Armed Services (March 25, 1981; processed). See also "Interview with the Secretary of the Navy," Sea Power (March 1981), pp. 17-30.

proposed by the new Administration includes higher force level goals for other types of ships as well, including a new goal of 137 battle-group-capable surface combatants.

Of the options discussed above, only Option IV provides enough ships to support seven battle groups while meeting the Navy's other mission requirements. Programs to support seven two-carrier battle groups using the force structure approach taken by any of the other options would require an even higher level of investment--about $50 billion over the 10-year period as against the $33 billion investment level used here. At any level of investment, however, whether $33 billion, $50 billion, or some other amount, these options still illustrate two key principles: the ship capabilities needed depend upon one's view of future naval strategy, but an emphasis on high-cost ships reduces the force levels that can be achieved within a given budget.

CONCLUSION: PROVIDING SURFACE COMBATANTS FOR THE NAVY OF THE 1990s IS A PROBLEM FOR TODAY

Although the number of ships in the Navy's surface combatant force is expected to remain relatively stable through the 1980s, the force level will decline abruptly in the 1990s unless future shipbuilding programs are adequate to replace ships being retired. This situation will be especially acute for battle group surface combatants as guided missile destroyers and cruisers commissioned in the 1960s are retired upon reaching 30 years of age. These ships will, furthermore, be entering their third decade of service in the 1980s and may be of limited effectiveness if their combat systems are not upgraded.

Since the design and procurement lead times for modern warships are very long, research and development decisions made in the next year by the Administration and by the Congress can define and constrain ship procurement options in the mid-1980s and, consequently, the ships delivered to the fleet in the 1990s. For Option II to be a real shipbuilding alternative in 1986, funding for design and combat system development for the DDGX must be provided in fiscal year 1982. Similarly, for Options III and IV to be real alternatives, research and development funding for DDGY design and combat system development must also be provided. This would probably require funding of about $100 million to $150 million per year for the DDGX and the DDGY together, depending upon the number and status of ongoing projects.

In addition, the ships currently in the fleet will require periodic upgrading to maintain their effectiveness in a rapidly changing technological environment. This will require continuing research and development funding for modernization programs, such as the CG/SM-2 Upgrade and the New Threat Upgrade programs discussed in Chapter II, as well as funds actually to carry out the upgrades when the new systems become available.

Each of the program options discussed in this report, and almost any alternative program that might be devised, must ultimately depend not only upon a continuing investment in shipbuilding but also upon continuing support of combat system research and development and the maintenance of an adequate industrial base to produce the required ships and weapons systems.

Maintaining an effective surface combatant force in the U.S. Navy to the year 2000 will require a large and sustained commitment of funds from the Congress, not only for constructing the required ships but also for developing the advanced combat systems needed to make them effective. Programs to develop surface combatants for the 1990s should begin now.

APPENDIXES

APPENDIX A. CURRENT U.S. SURFACE COMBATANTS

Among the older surface combatants that can be expected to remain in the fleet through the 1980s are a large group of frigates (62 ships) of the FF-1052 class, the FF-1040 class, and the FFG-1 class. These ships were designed primarily as ocean escort ASW ships, using echo-ranging sonar and short-range ASROC weapons. The six ships of the FFG-1 class were also fitted with the single-channel Tartar anti-air missile system, which permits them to engage only one aircraft at a time. All of these ships were delivered between the mid-1960s and mid-1970s.

The most recent frigate type is the Oliver Hazzard Perry (FFG-7) class, which is now in serial production with a total purchase of about 60 ships contemplated. Designed to have a balanced but relatively modest combat capability, the FFG-7 is intended for relatively low-threat missions. It is equipped with a two-channel AAW missile system based on the MK92 weapon control system that fires Standard-MR (SM-1) missiles. This provides an area AAW capability with modest multiple-target firepower. Performance may be degraded, however, by electronic jamming. The FFG-7 class will also be equipped with two LAMPS helicopters, the SQR-19 TACTAS towed-array sonar, and Harpoon missiles to provide long-range ASW and ASuW capability. These ships are not considered by the Navy to be battle group ships, but rather are intended for such missions as escort of amphibious groups and underway replenishment groups, and patrol and presence operations in high-tension situations around the world.

Current destroyer types include the older DDG-2 (23 ships) and DDG-37 (10 ships) classes. These guided missile destroyers form a substantial portion of the current inventory of battle group surface combatants, but, having been built in the early 1960s, they will soon have seen 20 years of service and their combat systems are now obsolescent.

A more recent destroyer type is the Spruance (DD-963). The 31-ship building program for this class is now nearly complete. At 7,800 tons displacement, the DD-963 is substantially larger than earlier destroyer types and has over twice the displacement of the 3,600-ton FFG-7-class frigates. Despite its size, cost, and general-purpose ("DD") designation, this class has

often been criticized as being deficient in overall combat capability. 1/ It was designed primarily as an ASW ship, using the SQS-53 sonar and ASROC sensor-weapon combination, and is widely acknowledged to be an excellent platform for active-sonar ASW. These ships will be backfitted with the SQR-19 towed-array sonar and the LAMPS III helicopter, which will further improve their ASW capability. As initially outfitted, however, they have only a short-range, self-defense AAW system, and their surface engagement weapons are limited to two five-inch guns. This very modest AAW and ASuW capability has been the basis of much of the criticism of these ships. The Navy plans eventually to increase the AAW and ASuW capabilities of the DD-963 class by installing a new-design AAW system and a Tomahawk missile launch capability in a mid-life upgrade around the end of the 1980s. 2/

The USS Kidd (DD-993) class (four ships) is a more capable variant of the DD-963 class that came to the U.S. Navy following the fall of the Shah in Iran. These four ships had been ordered by Iran but were cancelled in the wake of the revolution. The Congress then approved their purchase for the U.S. Navy. Essentially a DD-963 destroyer, the DD-993 also incorporates a capable area AAW system using two MK74 missile fire control systems, two MK26 missile launching systems, and the Standard-MR (SM-1) missile.

The most recent class of surface combatant to be authorized is the Ticonderoga-class (CG-47) cruiser (formerly called the DDG-47-class destroyer). The CG-47 will have the same basic hull and machinery as the DD-963. It will be equipped, however, with the AEGIS weapon system and the new SM-2 version of the Standard missile, which will provide it with a formidable AAW capability. It will also be equipped with Tomahawk cruise missiles, LAMPS III helicopters, and the basic DD-963 ASW equipment.

1/ For example, see Captain Robert H. Smith, USN, "A United States Navy for the Future," United States Naval Institute Proceedings (March 1971), pp. 18-25.

2/ See testimony of Honorable David E. Mann, Assistant Secretary of the Navy for Research, Engineering, and Systems, in Department of Defense Appropriations, Fiscal Year 1981, Hearings before the Subcommittee on Defense, Senate Committee on Appropriations, 96:2 (March and April 1980), Part 4, p. 12.

The active cruiser force consists of 27 guided missile ships built over the past 20 years, nine of which are nuclear powered (CGN). In addition to their AAW missile systems, these cruisers also have large active-sonar systems and ASROC weapons for ASW. The last of the once considerable number of World War II-era big-gun cruisers have now been retired.

APPENDIX B. CURRENT ANTI-AIR WARFARE UPGRADE PROGRAMS FOR SURFACE COMBATANTS

THE CG/SM-2 UPGRADE AND NEW THREAT UPGRADE (NTU) PROGRAMS

The CG/SM-2 Upgrade program accomplishes basic modifications necessary to permit a ship to use the new SM-2 (Block I) missile and thus obtain the added AAW range and firepower made possible by the SM-2. Firepower, a very important factor in countering the growing cruise missile threat, will be essentially quadrupled by this modification.

The New Threat Upgrade program builds upon the CG/SM-2 Upgrade program by providing further radar and fire control improvements. It also gives the ship a capability to use the SM-2 (Block II) missile, a faster and still more capable version of the SM-2 AAW missile.

The CG/SM-2 Upgrade and New Threat Upgrade programs are applicable to 41 ships: all of the existing cruisers, the four ships of the DD-993 class, and the 10 ships of the DDG-37 class. (The CG/SM-2 upgrade is a prerequisite to the NTU program.) Some of these ships currently have updated Terrier (MK76) AAW systems; others have Tartar (MK74) systems. 1/ The CG/SM-2 Upgrade will cost about $8 million per ship for the Terrier ships and about $20 million per ship for the Tartar ships. The New Threat Upgrade will cost an additional $18 million per ship. Thirty-one ships are currently programmed to receive both upgrade programs. Not currently programmed for either upgrade are the 10 ships of the DDG-37 class, despite the fact that these ships are equipped with the MK10 missile launching system, which permits use of an extended-range booster on AAW missiles. These ships would therefore have an extraordinarily long-range AAW capability if they were modified to use the SM-2 missile. Although the DDG-37-class

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1/ Thirty-one ships are equipped with the Terrier (MK76) missile fire control system--all of the cruisers except the last six (CGN-36 through 41) and the DDG-37-class destroyers. Ten ships (the six latest CGNs and four DD-993s) have Tartar (MK74) missile fire control systems.

is relatively old (commissioned in 1960 to 1961), installing just the Basic CG/SM-2 Upgrade package at the modest cost of about $8 million per ship would provide the fleet with badly needed long-range AAW capability with the SM-2 missile on 10 additional ships during the period necessary to build new surface combatants.

THE DDG-2 UPGRADE

The DDG Upgrade program, applicable to all ships of the DDG-2 class, updates the present DDG-2 combat system to a digital computer-controlled basis but does not make the system compatible with the SM-2 missile. The firepower and engagement envelope of the DDG-2s will, therefore, remain governed by the capabilities of the Standard SM-1 missile. The DDG-2 Upgrade Program is relatively expensive, however, and only six of the 23 DDG-2s in the fleet are now scheduled to receive this upgrade package. The six-ship program will cost about $200 million per ship and will include combat system improvements beyond those for the AAW system alone, as well as hull and machinery overhaul items costing approximately $50 million.

APPENDIX C. SURFACE COMBATANT TRADE-OFF ISSUES

Warship design inevitably involves numerous trade-offs that affect the final size, capability, and cost of a ship. These trade-offs are generally made within the Navy, and the resulting design is proposed to DoD and then to the Congress for authorization and funding. Some of the major design trade-off issues considered by the Navy during the design process are described below.

SHOULD A SHIP BE GENERAL PURPOSE OR SPECIALIZED?

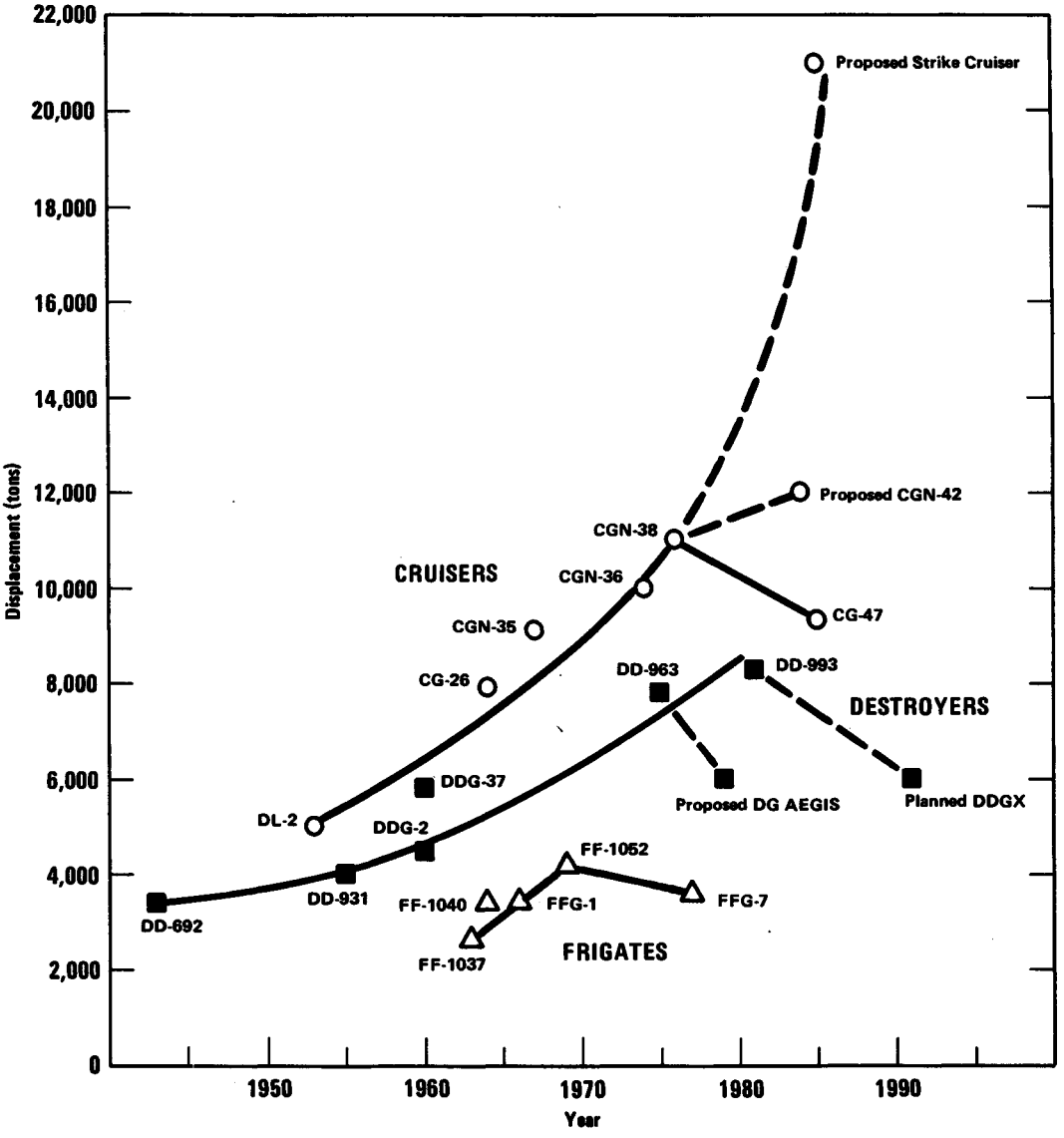
It is probably fair to say that most naval officers would prefer a general-purpose ship that will perform well against any kind of opposition, whether from aircraft, surface ships, or submarines. A prime example of such a ship is the CG-47. The high cost of these ships, however, often forces compromises in the interest of affordability. These can take the form of specialization--that is, emphasizing one kind of capability over another--as was done in the DD-963 and FF-1052 classes, in which ASW capability was stressed. Alternatively, a ship can be designed to have a more balanced capability but at a lower performance level, as was the case with the FFG-7 class. Decisions in this regard turn on the missions of a ship and how best to optimize overall fleet capability.

HOW LARGE SHOULD A SHIP BE?

While the size of a ship is determined by many factors in the design process, it is generally true that more capability requires a larger ship. The growth trend of U.S. surface combatants since World War II is shown in Figure C-1. An increase in displacement over time is quite clear, although there is some evidence of a falling off in the growth trend with respect to the most recent ships. Costs, as measured in constant dollars, have shown a parallel growth over time. Since large ships offer unquestionable advantages in endurance, sea-keeping ability, survivability, and growth potential, and since the cost of

Figure C-1.

Growth Trends for U.S. Surface Combatants



SOURCE: U.S. Navy

an extra pound of ship is relatively low 1/ in comparison with the cost of an extra pound of payload, many believe that large ships are a good investment. Others, however, contend that a ship should be only as large as is necessary to carry its design payload and to obtain its required performance. Since one does not attack the enemy with growth potential, they argue, burdening a ship with unnecessary size is inefficient.

WHAT CAPABILITY TRADE-OFFS SHOULD BE MADE?

Capability improvements almost always involve additional costs. These costs are manifested not only in the acquisition cost of a ship's weapons and equipment but also in their effect on the size of the ship required to carry them. For example, high-capability AAW may have a large impact on cost but only a modest effect on ship size, whereas a large active sonar like the SQS-53 has a substantial impact on both cost and size. Features such as additional endurance and survivability normally affect a ship's size much more than its cost.

AAW Trade-Offs

While the Navy's new AEGIS air defense system would seem to be an obvious choice for AAW in a new surface combatant, the system has several disadvantages. Foremost among these is its cost. Another disadvantage is that the current version of AEGIS, which has been in development for more than 10 years, now lags behind the latest technological advances. During the long AEGIS gestation period, technology has improved to the point that it is now possible to build a lighter, cheaper system that would provide better performance. 2/

1/ A breakdown of the acquisition cost of a typical modern surface combatant shows that the ship platform accounts for about 43 percent of the ship's cost and 91 percent of its weight. The combat system, on the other hand, accounting for only 9 percent of the ship's weight, represents about 57 percent of its cost.

2/ Development of such a system, commonly called the AN/SPY-1B radar, has been proposed, and studies funded by the Navy have identified specific reductions in cost and weight and specific performance improvements that can be made.

Actual development of such a system, however, would require additional time and development funds. If a new AAW system were to be developed, it could either be a reengineered version of the current system or a completely new system using updated AEGIS technology. While a reengineered version may save development time and money, a completely new system could have different operating parameters, most notably transmitter frequency, which would greatly complicate the job of jamming a future battle group containing both AEGIS and a new system. For this and other reasons, the Navy is giving serious consideration to a new phased-array radar for the DDG X that would be similar to the AN/SPY-1 AEGIS radar but would operate with different electromagnetic characteristics than those of AEGIS. It can be expected that these characteristics will be chosen to permit the new system to be smaller and lighter in weight than the current AEGIS.

The cost and weight of an AAW system can be further reduced by using a single-face, mechanically rotated radar antenna for three-dimensional air search in lieu of a large four-faced phased-array radar, and by placing the new-technology emphasis on the fire control radar, as discussed in Chapter III. Such a system would use a new-technology agile-beam fire control radar and the interrupted continuous-wave illumination technique discussed in Chapter III to achieve substantial firepower improvements, and would have the advantage of being more readily backfitted into existing ships than could the large phased-array radar system discussed above. 3/ There is, however, no essential incompatibility between "front-end" improvements, such as a large phased-array radar, and "back-end" improvements to missile fire control systems. Both provide needed improvements, and the best capability would be obtained by using both together.

ASW Trade-Offs

In ASW, a ship can emphasize long-range detection and attack with towed-array sonar and LAMPS, or it can emphasize active search and attack with hull-mounted sonar and weapons. Or,

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3/ A currently operating prototype for this kind of system is FLEXAR (Flexible Adaptive Radar), a system being tested under the Navy's Prototyping Program, which incorporates the technology required for the agile-beam illuminator discussed in Chapter III.

as in the case of the DD-963 and the CG-47, a ship can be equipped to do both. Emphasis on active search means installation of the SQS-53 sonar, which has a large impact on ship size and cost. Emphasis on towed-array passive search, on the other hand, requires a LAMPS installation, which also affects ship size, cost, and arrangement. 4/ The choice of emphasis on active or passive search depends upon one's assessment of ASW trends and upon the mission of the ship. A ship intended for inner-screen operations in a battle group would emphasize active search, whereas a ship intended for a broader range of missions might emphasize passive search capability and long-range prosecution with LAMPS.

ASuW Trade-Offs

As discussed in Chapter II, a long-range antisurface warfare capability requires not only long-range antiship missiles but also some means of detecting and targeting enemy forces at over-the-horizon ranges. This can be accomplished with external resources such as land-based or carrier-based aircraft, but the best independent capability is obtained with internal resources such as LAMPS helicopters. The cruise missiles can be put aboard with relatively little ship impact, but LAMPS affects both ship size and arrangement.

There is also the question of whether to put guns on a ship and, if the guns are mounted, whether they are primarily for anti-air or for antisurface/shore-bombardment purposes. Small-caliber, rapid-fire guns such as the 76mm MK75 gun on

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4/ Fitting the ship with the large SQS-53 sonar rather than the smaller SQS-56 would add about 500 tons and $57 million (fiscal year 1982 dollars) to the size and cost of a typical destroyer. Adding the SQR-19 (TACTAS) towed-array sonar would add about 90 tons to the ship's size and about $15 million (fiscal year 1982 dollars) to its cost. Provision of LAMPS helicopter facilities requires a ship size increase of about 375 tons (for hangar, haul-down and handling equipment, electronics, personnel, and aircraft fuel) and results in a cost increase of about $16 million (fiscal year 1982 dollars) over that required for a destroyer without helicopter facilities.

the FFG-7 are best for anti-air or antiship missile defense; larger guns are usually better for antisurface and shore bombardment. 5/

5/ The Naval Sea Systems Command has recently developed a design for a lightweight large-caliber gun that would be especially attractive for the latter functions. This proposed 155mm (6.1-inch) gun would be lighter in weight and have greater range and lethality than the Navy's current five-inch 54-caliber Gun Mount MK45, and would be compatible with the large family of 155mm ammunition available in the existing inventories of the U.S. Army and NATO.

APPENDIX D. DERIVATION OF DDGY DISPLACEMENT AND COST ESTIMATES

This appendix describes how displacement and cost estimates for the DDGY were derived using both the DDGX and the FFG-7 as a baseline.

Incorporating additional combat system or ship performance features into a warship usually increases both the size and the cost of the ship. This is a result not only of the cost and weight of the system components themselves but also of the additional support requirements (electrical power, cooling, additional personnel, etc.) they impose. Similarly, if combat system or ship performance features are deleted from a given baseline, the size and system support requirements of the resulting ship will be reduced and its cost should decrease as well. Using estimates of the total effect on displacement and cost of various features for a typical destroyer, one can derive rough estimates of the ship's size and cost. Such estimates, though useful as a first approximation, are not substitutes for the kind of detailed engineering study upon which firm budget estimates should be based.

Table D-1 derives displacement and cost estimates for the DDGY using the DDGX as a baseline. The DDGX incorporates the latest design practices of the Navy, but, since it is still in the early design stages, its ultimate size and cost are as yet uncertain. It is prudent, therefore, also to derive DDGY displacement and cost estimates using as a baseline a ship that has actually been built and delivered. This is done in Table D-2, which uses the FFG-7 as the baseline.

This analysis yields a DDGY displacement of about 4,900 tons and a follow-on ship cost of $337 million to $428 million per unit. CBO's cost estimate for the DDGY of about $375 million is taken from the middle of this range; the ship's displacement has been rounded upward to 5,000 tons.

TABLE D-1. DERIVATION OF DDGY DISPLACEMENT AND COST USING DDG X AS BASELINE

Feature	Differences DDGY	vs.	DDG X	Displacement Effect (Tons)	Cost Effect (Millions of 1982 dollars)
AAW System	New Agile-Beam System		AEGIS-like system	-100	-60.0
ASW System	SQS-56 (Hull)		SQS-53 (Hull)	-500	-57.0
	SQR-19 (Towed)		None	+90	+15.3
LAMPS	Complete Facilities for Two LAMPS III Helicopters		Electronics and Emergency Pad Only	+375	+16.4
Growth Margins	Austere		Liberal	-550	-27.3
Noise Signature	Standard		Quiet	-350	-18.6
Range	10 percent lower		--	-130	-0.7
Gun	New 155mm		None	+36	+10.0
	500 rounds ammunition		--	+29	--
Total Difference				-1,100	-$121.9

Resulting Displacement and Cost Estimate

Displacement (Tons)	
DDG X	6,000
Difference	-1,100
DDGY Displacement	4,900
Cost (Millions of 1982 Dollars)	
DDG X	550
Difference	-122
DDGY Cost	428

TABLE D-2. DERIVATION OF DDGY DISPLACEMENT AND COST USING FFG-7 AS BASELINE

Feature	Differences DDGY	vs. FFG-7	Displacement Effect (Tons)	Cost Effect (Millions of 1982 dollars)
AAW System	New Agile Beam System	MK92/STIR	+75	+10.0
	SPS-48E	No 3-D Radar	+75	+10.0
Missile Launcher	90-cell VLS	MK13 Launcher	+350	+16.0
Speed	30 knots	28 knots	+400	+6.6
Gun	155mm	76mm	+20	+5.0
Range	10 percent higher	--	+130	+0.7
Overpressure	7 psi	3 psi	+100	+3.3
Fragment Protection	Level I	Inherent	+160	+5.5
Total Difference			+1,310	+57.1

Resulting Displacement and Cost Estimate

Displacement (Tons)	
FFG-7	3,600
Difference	+1,310
DDGY Displacement	4,910
Cost (Millions of 1982 Dollars)	
FFG-7	280
Difference	+57
DDGY Cost	337

GLOSSARY

AAW: Anti-air warfare.

AEGIS: New anti-air warfare system developed by the Navy.

ASROC: Antisubmarine rocket.

ASuW: Antisurface warfare.

ASW: Antisubmarine warfare.

CG: Guided missile cruiser designation.

CGN: Nuclear-powered guided missile cruiser designation.

CIWS: Close-In Weapon System; also known as "Phalanx".

DD: Destroyer designation.

DDG: Guided missile destroyer designation.

DE: Destroyer escort designation.

DL: Destroyer leader designation.

ECM: Electronic countermeasures.

ECCM: Electronic counter-countermeasures.

FF: Frigate designation.

FFG: Guided missile frigate designation.

FLEXAR: Flexible adaptive radar.

HARPOON: Intermediate-range antiship cruise missile.

ICW: Interrupted continuous-wave illumination.

IOC: Initial operational capability.

GLOSSARY (continued)

LAMPS: Light airborne multipurpose system; specially outfitted helicopters deployed on surface combatants.

MFAR: Multi-function array radar.

MK32 Tubes: Torpedo tubes for launching antisubmarine torpedoes.

MK99 Fire Control System: Missile fire control system used with the AEGIS anti-air warfare system.

OTH: Over-the-horizon.

PCW: Pulsed continuous-wave illumination.

SAG: Surface action group.

SM-1: Basic version of the Navy's Standard anti-air missile.

SM-2: Advanced version of the Navy's Standard anti-air missile.

SPY-1: Phased-array air search radar used in the AEGIS anti-air warfare system.

SQR-19: Designation for a tactical towed-array sonar system deployed on surface combatants.

SQS-53: Large, hull-mounted active sonar.

SQS-56: Small, hull-mounted active sonar.

TACTAS: Tactical towed-array sonar.

TASM: Tactical antiship missile.

TER: Terminal engagement radar.

TERCOM: Terrain comparison guidance.

TLAM: Tactical land attack missile.

TOMAHAWK: Long-range cruise missile used against ships (TASM) and land targets (TLAM).

TWS: Track while scan.

VLS: Vertical launching system.

V/STOL: Vertical/short takeoff and landing aircraft.