United States Government Accountability Office

GAO

Report to the Chairman, Subcommittee on Defense, Committee on Appropriations, House of Representatives

February 2005

DEFENSE ACQUISITIONS

Improved Management Practices Could Help Minimize Cost Growth in Navy Shipbuilding Programs

G A O

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GAO-05-183

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Improved Management Practices Could Help Minimize Cost Growth in Navy Shipbuilding Programs

GAO Highlights

Highlights of GAO-05-183, a report to the Chairman, Subcommittee on Defense, Committee on Appropriations, House of Representatives

Why GAO Did This Study

The U.S. Navy invests significantly to maintain technological superiority of its warships. In 2005 alone, $7.6 billion was devoted to new ship construction in six ship classes—96 percent of which was allocated to four classes: Arleigh Burke class destroyer, Nimitz class aircraft carrier, San Antonio class amphibious transport dock ship, and the Virginia class submarine.

Cost growth in the Navy's shipbuilding programs has been a long-standing problem. Over the past few years, the Navy has used "prior year completion" funding—additional appropriations for ships already under contract—to pay for cost overruns. This report (1) estimates the current and projected cost growth on construction contracts for eight case study ships, (2) breaks down and examines the components of the cost growth, and (3) identifies any funding and management practices that contributed to cost growth.

What GAO Recommends

GAO is making recommendations aimed at improving the Navy's processes for developing cost estimates, establishing realistic contract prices and ship budgets, and providing timely and complete reporting on program costs to alert managers to potential problems.

www.gao.gov/cgi-bin/getrpt?GAO-05-183.

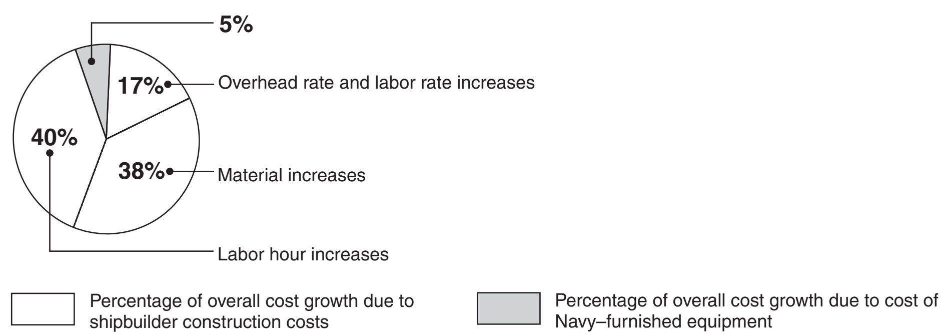
To view the full product, including the scope and methodology, click on the link above. For more information, contact Paul Francis at (202) 512-2811 or francisp@gao.gov.

What GAO Found

For the eight ships GAO assessed, the Congress has appropriated funds to cover the $2.1 billion increase in the ships' budgets. The GAO's analysis indicates that total cost growth on these ships could reach $3.1 billion or even more if shipyards do not maintain current efficiency and meet schedules. Cost growth for the CVN 77 aircraft carrier and the San Antonio lead ship (LPD 17) has been particularly pronounced.

Increases in labor hour and material costs together account for 77 percent of the cost growth on the eight ships. Shipbuilders frequently cited design modifications, the need for additional and more costly materials, and changes in employee pay and benefits as the key causes of this growth. For example, the San Antonio's lead ship's systems design continued to evolve even as construction began, which required rebuilding of completed areas to accommodate the design changes. Materials costs were often underbudgeted, as was the case with the Virginia class submarines and Nimitz class aircraft carriers. For the CVN 77 carrier, the shipbuilder is estimating a substantial increase in material costs.

Components of Cost Growth



Source: Shipbuilder and Navy (data); GAO (analysis).

Navy practices for estimating costs, contracting, and budgeting for ships have resulted in unrealistic funding of programs, increasing the likelihood of cost growth. Despite inherent uncertainties in the ship acquisition process, the Navy does not account for the probability of cost growth when estimating costs. Moreover, the Navy did not conduct an independent cost estimate for carriers or when substantial changes occurred in a ship class, which could have provided decision makers with additional knowledge about a program's potential costs. In addition, contract prices were negotiated and budgets established without sufficient design knowledge and construction knowledge. When unexpected events did occur, the incomplete and untimely reporting on program progress delayed the identification of problems and the Navy's ability to correct them.

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United States Government Accountability Office
Washington, DC 20548

February 28, 2005

The Honorable C. W. Bill Young
Chairman, Subcommittee on Defense
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

U.S. Navy warships are the most technologically advanced in the world. The United States invests significantly to maintain this advantage. In 2005 alone, the Navy devoted $7.6 billion to new ship construction in six ship classes—96 percent of which was allocated to four classes: Arleigh Burke class destroyer, Nimitz class aircraft carrier, San Antonio class amphibious transport dock ship, and the Virginia class submarine.

Cost growth in the Navy's shipbuilding programs has been a long-standing problem—one that the Congress has identified and responded to by providing both additional funding and direction to the Navy. Over the past few years, the Navy has used "prior year completion" funding—additional appropriations for ships already under contract—to pay for cost overruns. Because of the size and routine occurrence of prior year funding, we were asked to analyze cost overruns on Navy shipbuilding programs. Specifically, this report (1) estimates the current and projected cost growth on selected ship construction contracts, (2) breaks down and examines the components of the cost growth, and (3) identifies any funding and management practices that contribute to cost growth.

To address these objectives, we looked at cost growth in the four classes of ships that account for the majority of the funding for new shipbuilding and prior year bills, focusing on ships with construction contracts that were more than 30 percent complete at the time we began our review. Within each class, we selected two ships currently under contract as case studies: DDG 91 and DDG 92 in the Arleigh Burke class of destroyers, CVN 76 and CVN 77 in the Nimitz class of aircraft carriers, LPD 17 and LPD 18 in the San Antonio class of transports, and SSN 774 and SSN 775 in the Virginia class of submarines. To estimate the total projected cost growth on construction contracts, we used contractor performance reports, projecting high and low estimates for the costs to complete the ships in the four classes we reviewed. We looked at cost growth by comparing the initial budget request to the Congress and the updated budget included in the 2005 President's budget and by comparing the initial contract award to the latest estimate at completion. The latest estimate at completion includes changes to the original baseline or scope of work. For all ships currently under construction, we also estimated total cost growth since contract award, using contractor performance reports to project high and low estimates for the costs to complete construction of these ships. To break down and examine the components of cost growth on the eight case study ships, we analyzed the Navy's cost estimates, its budget requests to the Congress, contractor performance reports, and other cost data for each of the eight case study ships. To assess funding and management practices, we spoke with the shipbuilders, Navy and Defense Contract Audit Agency officials, and reviewed supporting documentation. Our work was conducted between July 2003 and December 2004 in accordance with generally accepted government auditing standards. Our analyses and forecasts were based on data available to us in July 2004. To the extent significant changes occurred, we incorporated information from the fiscal year 2006 President's budget. For a complete description of our scope and methodology, see appendix I. Details on the eight case study ships are discussed in appendixes II to V.

Results in Brief

The Navy's shipbuilding programs continue to experience significant cost growth. For the eight case study ships alone, the Congress has appropriated funds to cover a $2.1 billion increase in the ships' budgets. Cost growth was pronounced for the CVN 77 carrier and for the lead ships in the two new classes we looked at—the Virginia class and especially the San Antonio class. We estimated cost growth could exceed $3 billion, and these estimates are likely understated because they assume that the shipyards will maintain their current efficiencies and meet scheduled milestones. Thus, additional appropriations, in excess of $1 billion, will be needed to cover the additional cost growth.

Increases in labor hour and material costs account for 78 percent of the cost growth on the eight ships we reviewed, while overhead and labor rate increases account for 17 percent. Navy-furnished equipment—including radars and weapon systems—represent just 5 percent of the cost growth. Shipbuilders cited a number of direct causes for the labor hour, material, and overhead cost growth in the eight ships. The most common causes were related to design modifications, the need for additional and more costly materials, and changes in employee pay and benefits. For example, the lack of design maturity when introducing new technologies led to rework, increasing growth in labor hours for most of the ships. The design of ship systems for LPD 17 continued to evolve even as construction proceeded. As a result, workers were required to rebuild completed areas of the ship to accommodate design changes. Growth in materials costs was due, in part, to the Navy's and shipbuilders' underbudgeting of these costs. For example, the materials' budget for the first four Virginia class submarines was $132 million less than quotes received from vendors and subcontractors at contract award. Price increases also contributed to the growth in materials costs.

Navy practices for estimating costs, contracting, and budgeting for ships have resulted in unrealistic funding of programs, increasing the likelihood of cost growth. Despite inherent uncertainties in the ship acquisition process, the Navy does not measure or provide for the probability of cost growth when estimating costs. Moreover, the Navy did not conduct independent cost estimates for carriers, which could have provided decision makers with additional knowledge about a program's potential costs. In addition, contract prices were negotiated and budgets established without making full use of design knowledge and construction experience. Finally, when unexpected events occurred, the incomplete and untimely reporting on program progress delayed the identification of problems and the Navy's ability to correct them.

We are making seven recommendations aimed at improving the Navy's processes for developing cost estimates, establishing realistic contract prices and ship budgets, and providing timely and complete reporting on program costs to alert managers to potential problems. In its comments on a draft of this report, DOD concurred with two of our recommendations and partially concurred with five. We believe the Navy needs to take concrete action to establish realistic estimates, prices, and budgets and to improve the quality of cost reporting.

Background

The U.S. Navy currently operates 288 surface ships and submarines. Four ship classes, with 23 ships under construction or recently completed, make up 96 percent of the Navy's fiscal year 2005 budget for new construction shipbuilding. (See table 1.)

Table 1: Overview of Navy Shipbuilding Programs Represented in GAO's Case Studies

Ship class	Mission	Percent of Navy's fiscal year 2005 new construction and prior year shipbuilding budget[a]	Ships under construction or recently completed	GAO's case study ships[b]
Arleigh Burke destroyer	Destroyers provide offensive and defensive capabilities; can operate independently or as part of strike groups	46%	13	• DDG 91 (follow-on ship) • DDG 92 (follow-on ship)
Nimitz aircraft carrier	Nuclear-powered aircraft carriers form building block of Navy's forward-deployed peacetime presence, crisis response, and warfighting forces	N/A[c]	2	• CVN 76 (follow-on ship) • CVN 77 (follow-on ship)
San Antonio amphibious transport dock ship	These amphibious ships provide a sea-based platform for transporting, embarking, and landing Marines and their equipment and supplies during an assault	14%	5	• LPD 17 (lead ship) • LPD 18 (follow-on ship)
Virginia class submarine	This new class of nuclear submarines is designed to combat enemy submarines and surface ships; fire cruise missiles at land targets; and provide improved surveillance and special operations support	36%	4	• SSN 774 (lead ship) • SSN 775 (lead ship)

Sources: Navy (data); GAO (presentation).

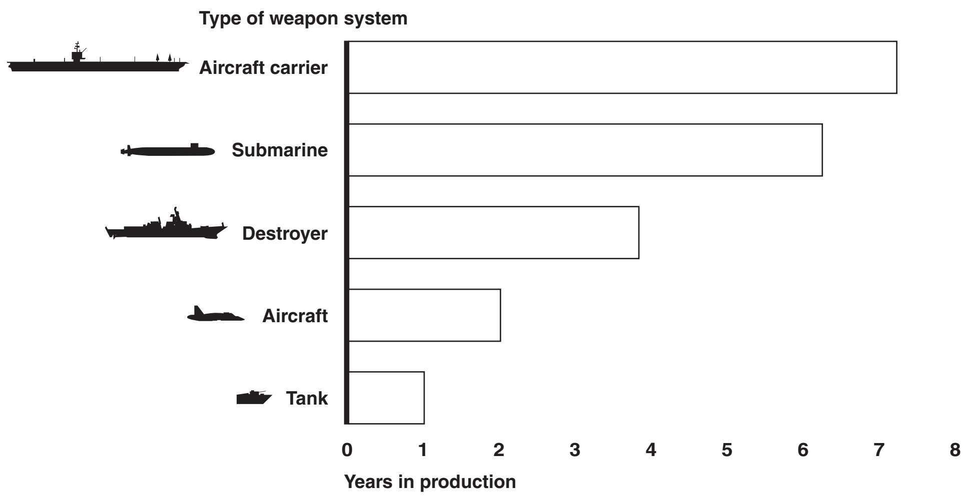
[a]Including completion of ships authorized in prior years

[b]A lead ship is the first to be built in a class or the first to be built after a major redesign of a class of ships. If two different shipbuilders are constructing ships that fall within the same class, their first ships are also referred to as lead ships. Follow-on ships are those built after the lead ship.

[c]Not applicable. CVN 76 and CVN 77 were funded in earlier fiscal years and are not included in these percentages.

Navy ships are complex defense systems, using advanced designs with state-of-the-art weapons, communications, and navigation technologies. Ships require many years to plan, budget, design, and build. Like other weapon acquisition programs, ship acquisitions begin with developing a system design. For ships, system design is followed by a detail design phase where specific construction plans are developed. Ship construction follows and typically takes 4 to 7 years. Construction time for other defense systems is much shorter—a fighter aircraft takes about 2 years from start of production to roll out from the factory floor; a tank takes about a year. (See fig. 1.)

Figure 1: Typical Production Times for Various Weapon Systems



Source: Navy (data); GAO (presentation).

Note: A varying number of years of preliminary planning and early design work precede the start of production.

The long construction times increase the uncertainty that ship cost estimates—and budgets—must provide for. Moreover, the total cost for a ship must be budgeted for in its first year of construction. Provisions are made in the event cost growth occurs during construction. The Navy's budgeting for cost growth has changed over the past 2 decades. During the early 1970s and through most of the 1980s, the Navy used program cost reserves built into ship construction budgets and the Ship Cost Adjustment process to manage cost growth. During the 1980s, the Navy procured an average of 17 ships each year. In fiscal year 1988, the Navy removed program cost reserves from ship construction budgets and began exclusively using the Ship Cost Adjustment process, shifting funding between shipbuilding construction programs underrunning cost to programs that were overrunning costs. Following the end of the Cold War, the Navy decreased the procurement rate of ships to about 6 per year. Beginning in fiscal year 1999, cost increases could no longer be covered using the Ship Cost Adjustment process because no shipbuilding program was under cost. In 2001, the process was eliminated, which required the Navy to fund cost growth through the current mechanism of prior year completion bills.

Components of Shipbuilding Costs

The cost of building a ship can be broken down into four main components: labor, material, and overhead associated with the shipbuilders' contract for the basic ship, and Navy-furnished equipment—that is, items purchased by the Navy and provided to the contractor for installation on the ship. (See table 2.) The shipbuilding contract also includes profit (referred to as fee).[1]

Table 2: Shipbuilding Budget Cost Categories

Construction			
Labor	**Materials**[a]	**Overhead**[a]	**Navy-furnished equipment**
Labor hours for production, engineering and other direct support Costs based on labor hours and the labor rate (the hourly wage paid to workers)	• Metals (steel, copper, titanium) • Tools • Miscellaneous parts (pipe, cables) • Subcontracts	• Medical insurance • Pensions • Holiday pay • Facilities maintenance and utilities • Taxes	• Items purchased by the Navy and provided to the shipbuilder for installation on the ship; items include ship weapon systems, propulsion equipment, and electronics

Sources: Shipbuilder and Department of Defense (data); GAO (analysis).

[a]List is not exhaustive.

Types of Shipbuilding Contracts

Two broad categories of contracts are used to procure ships: fixed-price and cost-reimbursement. Fixed price contracts provide for a firm price or an adjustable price with a ceiling price, a target price, or both. If the ceiling is reached the shipbuilder is generally responsible for all additional costs. Cost reimbursement contracts provide for payment of allowable incurred costs, to the extent prescribed in the contract. If the ship cannot be completed within agreed upon cost limits, the government is responsible for the additional costs to complete.[2]

[1] The contract also includes funds for the cost of money.

[2] See Federal Acquisition Regulation Part 16.

The level of knowledge, or certainty, in the cost estimates for a ship is key to determining which type of contract to use. Contracts for the first ship of a new class are often negotiated as cost-reimbursable contracts because these ships tend to involve a high-level of uncertainty and, thus, high cost risks. Cost reimbursement contracts were used to procure the San Antonio and Virginia class ships we reviewed. More mature shipbuilding programs, where there is greater certainty about costs, are typically fixed-price contracts with an incentive fee (profit). Fixed-price contracts were used to procure the Arleigh Burke and Nimitz class ships we reviewed. Both cost-reimbursable and fixed-price incentive fee contracts can include a target cost, a target profit, and a formula that allows the profit to be adjusted by comparing the actual cost to the target cost. Construction contracts for ships generally include provisions for controlling cost growth with incentive fees, whereby the Navy and the shipbuilder split any savings when the contract cost is less than its anticipated target. Conversely, when costs exceed the target, the excess is shared between the Navy and the shipbuilder.

New Ships Continue to Cost More Than Budgeted

Ship cost growth continues to pose additional funding demands on the budget. Budgets for the eight case study ships alone have required increases of $2.1 billion, and Congress has appropriated funds to cover these increases. However, the total projected cost growth on contracts for the eight ships is likely to be higher. Consequently, the Navy will need in excess of $1 billion in additional appropriations to cover the total projected cost growth. Cost growth was more pronounced for the lead ships in the two new classes we looked at—the Virginia class and especially the San Antonio class—than the more mature Arleigh Burke and Nimitz classes. (Our forecasts for cost growth on all ships that are more than 30 percent complete are shown in appendix VI.)

The fiscal year 2005 budget for the eight case study ships was about $20.6 billion—representing cost growth of $2.1 billion above the initial budget request of $18.5 billion for these ships. (See table 3.) Ship construction costs comprise the majority of this increase.

Table 3: Growth in Program Budgets for Case Study Ships

Dollars in millions

Case study ship	Initial and fiscal year 2005 President's budget: Initial[a]	FY2005[b]	Difference in budgets: Total difference	Difference due to Navy-furnished equipment	Difference due to construction costs[c]
DDG 91	$917	$997	**$80**	$43	$37
DDG 92	925	979	**55**	(7)[d]	62
CVN 76	4,476	4,600	**124**	(128)[e]	252
CVN 77	4,975	5,024	**49**	100	(51)[f]
LPD 17	954	1,758	**804**	21	784
LPD 18	762	1,011	**249**	3	246
SSN 774	3,260	3,682	**422**	95	327
SSN 775	2,192	2,504	**312**	18	294
Total	**18,461**	**20,556**	**2,095**	**145**	**1,951**

Sources: Navy (data); GAO (presentation).

[a]Estimated cost from the President's budget submission for year of ship authorization.

[b]Includes all prior year requests through fiscal year 2005.

[c]Part of increased cost is due to changes in the scope of the contract.

[d]Negative reflects savings resulting from the use of a more economical warfare system than was initially budgeted on the DDG 92.

[e]Negative reflects savings garnered from Navy-furnished reactor plant equipment.

[f]Negative reflects shifting of funds from the construction contract to Navy-furnished equipment.

We were not able to determine how much of this increase was due to changes in the scope of the contract and how much of the growth funded increases in the costs of completing the initial contract scope. Amounts identified by shipbuilders and Navy program offices differed substantially. However, the initial program budgets included funding to support changes in the scope of the construction contract. These funds amounted to a small share of the initial program budget: 3 percent for DDGs 91 and 92; 5 percent for CVN 76 and CVN 77; 7 percent for LPD 17 and 4 percent for LPD 18; and 3 and 4 percent for SSNs 774 and 775, respectively.

While the Congress has appropriated funds to cover a $2.1 billion increase in the ships' costs, more funds will likely be needed to cover additional cost growth likely for these eight ships. At the time we completed our analysis in 2004, we calculated a range of the potential growth for the eight case study ships and found that the total projected cost growth would likely exceed $2.8 billion and could reach $3.1 billion. (See table 4.)

Table 4: GAO's Forecasts of Additional Cost Growth for Construction

Dollars in millions

Forecasts based on data available July 2004

Case study ship	Percent of ship construction completed	Amount already requested to cover contractor's increased cost	GAO's forecast of additional cost growth	GAO's forecast of total cost growth[a]
DDG 91	Delivered	$37		**$37-37**
DDG 92	Delivered	62		**62-62**
CVN 76	Delivered	252		**252-252**
CVN 77	45	(51)[b]	$485-637	**434-586**[c]
LPD 17	93	784	112-197	**896-981**
LPD 18	69	246	102-136	**348-382**
SSN 774	Delivered	327		**327-327**[d]
SSN 775	88	294	103-219	**397-513**
Total growth		**1,951**	**802-1,189**	**$2,753-3,140**

Sources: Shipbuilder and Navy (data); GAO (analysis).

[a]Forecast reflects expected price to the Navy.

[b]Negative reflects shifting of funds from the construction contract to Navy-furnished equipment.

[c]The 2006 budget submission indicates $908 million additional cost growth on CVN 77 above the fiscal year 2005 budget.

[d]The Navy has requested an additional funding to cover completion of SSN 774.

These cost growth estimates have already proven to be too conservative. In its fiscal year 2006 budget submission, the Navy recognizes an additional cost growth of $223 million for SSN 775 and $908 million for CVN 77 above its fiscal year 2005 request. In addition, our estimates assumed that the shipyards will maintain their current efficiency through the end of their contracts and meet scheduled milestones. Any slips in efficiency and schedules would likely result in added costs. For example, the delivery date for SSN 775 is expected to slip by as many as 9 months, which, according to the fiscal year 2006 President's budget has increased the final cost of the ship even more. According to program officials, the delivery date for the LPD 17 has been changed from December 2004 to May 2005, and the delivery date for the CVN 77 is expected to slip into 2009.

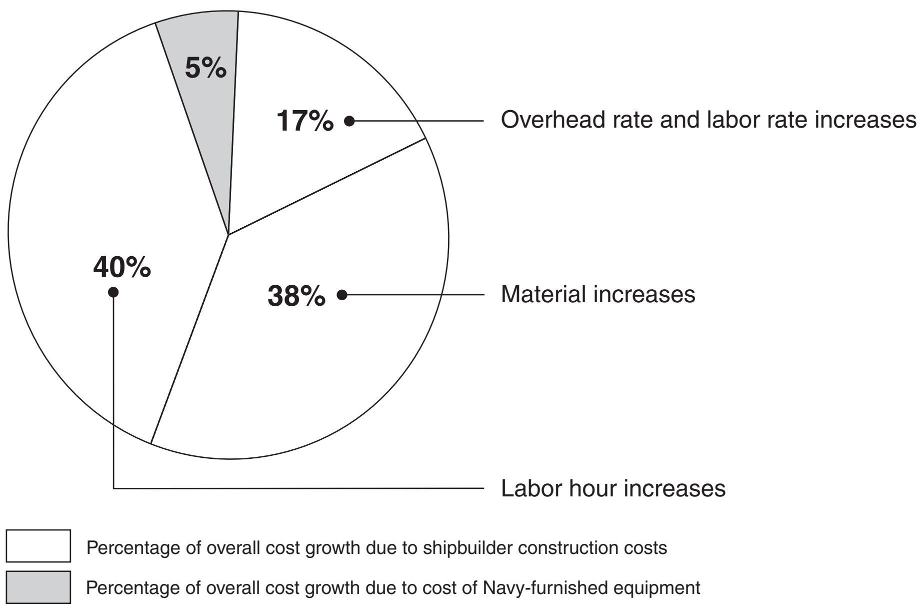
Cost growth on new ships has a number of implications. Most tangible, perhaps, is the significant portion of the ship construction budget that must be devoted to overruns on ships already under construction. From fiscal years 2001 to 2005, 5 to 14 percent of the Navy's ship construction budget, which totaled about $52 billion over the 5-year period, went to pay for cost growth for ships funded in prior years. This reduces the buying power of the budget for current construction and can slow the pace of modernization. The Navy is in the early stages of buying a number of advanced ships, including the Virginia class submarine, DD(X) destroyer, CVN 21 aircraft carrier, and Littoral Combat Ship. The Navy's ability to buy these ships as scheduled will depend on its ability to control cost growth.

Labor and Materials Drive Increases in Construction Costs

Increases in labor hour and material costs account for 78 percent of the cost growth on shipbuilding construction contracts, while overhead and labor rate increases account for 17 percent. Navy-furnished equipment[3]—including radars and weapon systems—represents just 5 percent of the cost growth. (See fig. 2.) Shipbuilders cited a number of direct causes for the labor hour, material, and overhead cost growth in the eight case study ships. The most common causes were related to design modifications, the need for additional and more costly materials, and changes in employee pay and benefits.

[3] These costs are items provided by the Navy to the contractor for installation on the ship. The Navy pays for this equipment—not the shipbuilder.

Figure 2: Components of Cost Growth



Source: Shipbuilder and Navy (data); GAO (analysis).

Note: Total growth in construction costs is $3.2 billion, based on shipbuilders' estimate at completion.

Design Changes and Lack of Skilled Labor Contributed to Labor Hour Cost Growth

Labor hour increases for the eight case study ships ranged from 33 percent to 105 percent—for a total of 34 million extra labor hours. For example, the shipbuilders for LPD 17 and CVN 76 each needed 8 million additional labor hours to construct the ships

Cost growth due to increased labor hours totaled more than $1.3 billion. (See table 5.) While the total dollars were the greatest for LPD 17 ($284 million), the labor cost as a percent of total cost growth was the greatest for DDG 91 (105 percent).

Table 5: Growth in Labor Hour Costs

Dollars in millions

Analysis based on data available July 2004

Case study ship	Shipbuilder reported labor cost growth	Overhead and labor rate costs on increased labor hours	Total cost due to increased labor hours	Labor hour cost as a percent of total contract growth
DDG 91	$23	$24	**$47**	**105%**
DDG 92	43	42	**85**	**66**
CVN 76[a]	78	144	**222**	**35**
CVN 77[a]	75	107	**182**	**42**
LPD 17[b]	182	102	**284**	**33**
LPD 18	117	67	**184**	**48**
SSN 774	149	10	**159**	**55**
SSN 775	218	(38)	**180**	**42**
Total	**$885**	**$458**	**$1,342**	

Sources: Shipbuilder (data); GAO (analysis).

Note: We compared initial target cost to the current estimate at completion to determine total contract cost growth. Cost growth may be due to Navy changes in contract scope, shipbuilder performance, or unanticipated events. Our analysis captures all costs associated with labor hour growth—including overhead and labor rates. Methodology is discussed in appendix 1.

[a]Contractor performance reports included $63 million in overhead costs for CVN 76 and $40 million for CVN 77 that have been disallowed (not charged to the government).

[b]LPD 17 relied heavily on subcontracts with partners (Bath Iron Works and Raytheon) to design the ship. Since these costs are captured as material, we did not include them in our analysis of labor cost increases.

The lack of design and technology maturity led to rework, increasing the number of labor hours for most of the case study ships. For example, the design of LPD 17 continued to evolve even as construction proceeded. When construction began on DDG 91 and DDG 92—the first ships to incorporate the remote mine hunting system—the technology was still being developed. As a result, workers were required to rebuild completed areas of the ship to accommodate design changes. Most of the shipbuilders cited a lack of skilled workers as a driver behind labor hour cost growth. According to the shipbuilders we interviewed, many of the tasks needed to build ships are complex and require experienced journeymen to efficiently carry them out. Yet, the majority of the shipbuilders noted that the shipyards have lost a significant portion of their highly skilled and experienced workers. Delays in delivery of materials also resulted in increased labor hours. Table 6 shows the reasons for labor hour increases for each case study ship.

Table 6: Reasons Given by Shipbuilders for Labor Hours Cost Growth

Case study ship	Reasons for increase
DDG 91	• Inexperienced laborers • Design upgrades that result in rework
DDG 92	• Introduction of a new construction facility, setting workers back on the learning curve • Design upgrades that result in rework and workarounds • Strike increased number of hours needed to construct ship
CVN 76	• Less-skilled workers due to demands for labor on other programs at shipyard • Extensive use of overtime • Design changes resulting in rework
CVN 77	• Late material delivery results in delays and workarounds • Design changes resulting in rework
LPD 17	• Inexperienced subcontracted labor • Design difficulties led to doing work out of sequence and rework • Schedule delays • Bused workers to meet labor shortages
LPD 18	• Increases in LPD 17 translated into more hours for LPD 18
SSN 774	• Late material delivery • First in class design issues
SSN 775	• Quality problems and design changes • Inclusion of non-recurring labor hours

Sources: Shipbuilder (data); GAO (analysis).

Underbudgeting and Price Increases Contributed to Materials Cost Growth

For several of the case study ships, the costs of materials increased dramatically above what the shipbuilder had initially planned. (See table 7.) Materials cost was the most significant component of cost growth for three ships: LPD 17, SSN 775, and CVN 76. However, for LPD 17, which experienced over 100-percent growth in material costs, 70 percent of the material cost increases were actually costs for subcontracts to support design of the lead ship.

Table 7: Growth in Material Costs

Dollars in millions

Analysis based on data available July 2004

Case study ship	Total dollars due to increased material costs	Percent increase	Material cost as a percent of total contract growth
DDG 91	**($22)**	(13%)	(49%)
DDG 92	**30**	20	23
CVN 76	**294**	43	46
CVN 77	**134**	13	31
LPD 17	**400**	103	47
LPD 18	**93**	39	24
SSN 774	**141**	43	49
SSN 775	**209**	56	49
Total	**$1,280**	**38%**	

Sources: Shipbuilder (data); GAO (analysis).

Note: We compared initial target cost to the current estimate at completion to determine total contract cost growth. Cost growth may be due to Navy changes in contract scope, shipbuilder performance, or unanticipated events.

Growth in materials costs was due, in part, to the Navy and shipbuilders' underbudgeting for these costs. For example, the materials budget for the first four Virginia-class submarines was $132 million less than quotes received from vendors and subcontractors. The shipbuilder agreed to take on the challenge of achieving lower costs in exchange for providing in the contract that the shipbuilder would be reimbursed for cost growth in high value, specialized materials. In addition, the materials budget for CVN 76 and CVN 77 was based on an incomplete list of materials needed to construct the ship, leading to especially sharp increases in estimated materials costs. In this case, the Defense Contract Audit Agency criticized the shipbuilder's estimating system, particularly the system for material and subcontract costs, and stated that the resulting estimates "do not provide an acceptable basis for negotiation of a fair and reasonable price." Underbudgeting of materials has contributed to cost growth recognized in the fiscal year 2006 budget.

Price increases also contributed to the growth in materials costs. For example, the price of array equipment on the Virginia class submarines rose by $33 million above the original price estimate. In addition to inflation, a limited supplier base for highly specialized and unique materials made ship materials susceptible to price increases.[4] According to the shipbuilders, the low rate of ship production has affected the stability of the supplier base—some businesses have closed or merged, leading to reduced competition for the services they once produced and that may be a cause of higher prices. In some cases, the Navy lost its position as a preferred customer and the shipbuilder had to wait longer to receive materials. With a declining number of suppliers, more ship materials contracts have gone to single and sole source vendors. Over 75 percent of the materials for the Virginia class submarines—which were reduced in number from 14 to 9 ships over a 10-year period—is produced by single source vendors.

Spending on subcontracts and leased labor also increased material costs on some case study ships.[5] On LPD 17, for example, subcontracts to support lead ship design accounted for 70 percent of the increase in material costs. Table 8 highlights the various reasons cited for increased materials costs on case study ships.

[4] Cost estimates are based, in part, on the number of units produced and learning curves—the more units produced, the less expensive each unit is expected to be. Thus, if contractors and subcontractors are assured a high, consistent level of business, they are able to produce the ship and ship parts at a lower cost. Conversely, if purchases are erratic or dip to historically low levels, the ship and ship parts will be more expensive to produce, although the exact amount is uncertain.

[5] Subcontracted labor is labor performed to a fixed price contract. Leased labor is the employment of outside workers under the direct supervision of the shipyard management and foreman systems.

Table 8: Reasons Given by Shipbuilders for Material Cost Growth

Case study ship	Reasons for growth
DDG 91	• Consolidation with Northrop Grumman allowed for quantity material buy savings
DDG 92	• Rework requiring additional tools, utilities, and shop stock • Information technology costs shifted from overhead to materials
CVN 76	• Increases in costs for specialized materials • Underbudgeted material costs • Accounting changes • Additional subcontracting
CVN 77	• Increases in costs for specialized materials • Underbudgeted material costs
LPD 17	• Subcontractor engineering design efforts • Design tool development, originally assumed to be funded by the state resulted in additional costs to Northrop Grumman.
LPD 18	• Increases in LPD 17 translated into more costs for LPD 18
SSN 774	• Lack of suppliers for highly unique materials • Immature design on material components
SSN 775	• Lack of suppliers for highly unique materials • Nonrecurring costs for computer integration

Sources: Shipbuilder (data); GAO (analysis).

Program Overhead and Labor Rates Account for Remaining Ship Construction Cost Increases

Program overhead costs, which include increases in labor rates, represented approximately 17 percent of the total cost growth for the eight case study ships. (See table 9.) While increases in overhead dollars totaled more than $1 billion, almost half of the increase was related to growth in labor hours. (See table 9.)

Table 9: Growth in Overhead Costs and Labor Rates

Dollars in millions

Analysis based on data available July 2004

Case study ship	Shipbuilder reported overhead growth	Increase in overhead related to growth in labor hours	Increase in overhead related to overhead and labor rates	Overhead cost as a percent of total contract growth
DDG 91	$43	$24	$20	**44%**
DDG 92	56	42	14	**11**
CVN 76[a]	263	144	119	**19**
CVN 77[a]	219	107	113	**26**
LPD 17	277	102	175	**20**
LPD 18	177	67	110	**28**
SSN 774	0	10	(10)	**(3)**
SSN 775	0	(38)	38	**9**
Total	**$1,035**	**$457**	**$579**	

Sources: Shipbuilder (data); GAO (analysis).

Note: We compared initial target cost to the current estimate at completion to determine total contract cost growth. Cost growth may be due to Navy changes in contract scope, shipbuilder performance, or unanticipated events. Our analysis captures only costs associated with overhead and labor rate changes. Increases in overhead related to growth in labor hours are captured in the analysis of labor hour increases.

[a]Contractor performance reports included $63 million in overhead costs for CVN 76 and $40 million for CVN 77 that have been disallowed (not charged to the government).

Increases in program overhead were largely due to decreased workload at the shipyards. Six of the eight case study ships experienced increased overhead because there were fewer programs to absorb shipyard operation costs. Increases in benefit costs, such as pensions and medical care costs, and labor rate increases—the result of negotiations with labor unions and inflation—also drove up program overhead costs. Table 10 highlights the various reasons cited for increased overhead costs on case study ships.

Table 10: Reasons Given by Shipbuilders for Overhead and Labor Rate Cost Growth

Case study ship	Reasons for growth
DDG 91	• Pension plans affected by financial market changes • Increase in medical benefit costs • Union negotiations increase labor rates • Loss of workload
DDG 92	• Medical care cost increases due to inflation and loss of favorable medical care contract • Loss of workload
CVN 76	• Changes in accounting of overhead • Union negotiations following strike increase labor rates
CVN 77	• Changes in accounting of overhead • Union negotiations following strike increase labor rates • Medical care cost increases • Capital investments • Pension plans affected by financial market changes • Workload changes
LPD 17	• Pension plans affected by financial market changes • Loss of anticipated workload • An over 2-year delay in lead ship delivery and change in the procurement schedule
LPD 18	• Pension plans affected by financial market changes • Loss of anticipated workload • An over 2-year delay in lead ship delivery and change in the procurement schedule
SSN 774	• Changes in pension, health care, and workman's compensation • Overhead rates decreased due to increased workload
SSN 775	• Loss of expected business and training new workers • Additional costs to restart submarine production capability at the shipyard

Sources: Shipbuilder (data); GAO (analysis).

Navy-Furnished Equipment

Navy-furnished equipment covers the costs for the technologies and equipment items—such as ship weapon systems and electronics—purchased by the Navy and provided to the contractor for installation on the ship. While Navy-furnished equipment accounts for 29 percent of the budget for the eight case study ships, such equipment accounted for only 6 percent of the total cost growth. According to Navy officials, much of the Navy-furnished equipment is common among many programs and, therefore, benefits from economies of scale. However, the integration and installation of these systems—especially the warfare systems—contributes to cost growth and is captured in the shipbuilders' costs rather than Navy-furnished equipment.

There was considerable variance from program to program. In addition, in some cases, decreases and increases in Navy-furnished equipment were the result of funds being reallocated. For example, the Integrated Warfare System on CVN 77 was originally funded through the shipbuilder construction contract, but was later deleted from the contract in favor of an existing system furnished by the Navy.

Navy Funding and Management Practices Result in Insufficient Provision for Risk

Navy practices for estimating costs and for contracting and budgeting for ships have resulted in unrealistic funding of programs and when unexpected events occur, tracking mechanisms are slow to pick them up. Tools exist to manage the challenges inherent in shipbuilding, including measuring the probability of cost growth when estimating costs, making full use of design and construction knowledge to negotiate realistic target prices, and tracking and providing timely reporting on program costs to alert managers to potential problems. For the eight case study ships, however, the Navy did not effectively employ them to mitigate risk.

Navy Estimates Do Not Capture Uncertainty and Are Often Not Independently Evaluated

In developing cost estimates for the eight case study ships, Navy cost analysts did not conduct uncertainty analyses[6] to measure the probability of cost growth, nor were independent estimates conducted for some ships—even in cases where major design changes had occurred. Uncertainty analyses and independent estimates are particularly important given the inherent uncertainties in the ship acquisition process, such as the introduction of new technologies and volatile overhead rates over time, creating a significant challenge for cost analysts to develop credible initial cost estimates. The Navy must develop cost estimates as much as 10 years before ship construction begins—before many program details are known. As a result, cost analysts have to make a number of assumptions about certain ship parameters, such as weight, performance,

[6] According to Navy cost analysts, while they did not conduct uncertainty analyses, they did perform sensitivity analyses in which they examined the effects of different variables, including changes in procurement quantities and labor rates.

or software, and about market conditions, such as inflation rates, workforce attrition, and supplier base.

In the eight case study ships we examined, cost analysts relied on the actual cost of previously constructed ships without adequately accounting for changes in the industrial base, ship design, or construction methods. Cost data available to Navy cost analysts were based on higher ship construction rates from the 1980s. As a result, these data were based on lower costs due to economies of scale—which were not reflective of the lower procurement rates after 1989. In addition, in developing cost estimates for DDG 91, DDG 92, LPD 17, and SSN 774, cost analysts relied on actual cost data from previous ships in the same class or a similar class but that were less technologically advanced. By using data from less complex ships, Navy cost analysts tended to underestimate the costs needed to construct the ships.

For CVN 76, cost analysts used proposed costs from CVN 74 with adjustments made for design changes and economic factors. However, CVN 74 and CVN 75 were more economical ships because both were procured in a single year—which resulted in savings from economies of scale. While cost analysts adjusted their estimates to account for the single-ship buy, costs increased far beyond the adjustment. Even in more mature programs—like the Arleigh Burke destroyers and the Nimitz aircraft carriers—improved capabilities and modifications made the costs of previous ships in the class essentially less analogous.

Other unknowns also led to uncertain estimates in the case study ships. Labor hour and material costs were based not only on data from previous ships but also on unproven efficiencies in ship construction. We found analysts often factored in savings based on expected efficiencies that never materialized. For example, cost analysts anticipated savings through the implementation of computer-assisted design/computer-assisted manufacturing for LPD 17, but the contractor had not made the requisite research investments to achieve the proposed savings. Similar unproven or unsupported efficiencies were estimated for DDG 92 and CVN 76. Changes in the shipbuilders' supplier base also created uncertainties in the shipbuilders' overhead costs.

Despite these uncertainties, the Navy did not test the validity of the assumptions made by the cost analysts in estimating the construction costs for the eight case study ships nor did the Navy identify a confidence level for estimates.[7] Specifically, it did not conduct uncertainty analyses, which generate values for parameters that are less than precisely known around a specific set of ranges. For example, if the number of hours to integrate a component onto a ship is not precisely known, analysts may put in a low and high value. The estimate will generate costs for these variables along with other variables such as—weight, experience, and degree of rework. The result is a range of estimates that enables cost analysts to make better decisions on likely costs. Instead, the Navy presented its cost estimates as unqualified point estimates, suggesting an element of precision that cannot exist early on and obscures the investment risk remaining for the programs. While imprecision decreases during the program's life cycle as more information becomes known about the program, experts emphasize that to be useful, each cost estimate should include an indication of its degree of uncertainty, possibly as an estimated range or qualified by some factor of confidence. Other services qualify their cost estimates by determining a confidence level of 50 percent.

The Navy also did not conduct independent cost estimates for some ships, which is required at certain major acquisition milestones.[8] Independent cost estimates can provide decision makers with additional insight into a program's potential costs—in part because these estimates frequently use different methodologies and may be less burdened with organizational bias. Independent cost analysts also tend to incorporate cost for risk as they develop their estimates, which the Navy cost analysts did not do. As a result, these independent estimates tend to be more conservative—forecasting higher costs than those forecast by the program office. Department of Defense officials considered the CVN 68 and DDG 51 programs mature programs and, therefore, did not require independent estimates. Yet, an independent cost estimate has never been conducted on a CVN 68 class carrier because the program for this class of ships began prior to the establishment of an independent cost-estimating group in DOD. However, Navy officials noted that every carrier is a new program,

[7] A level of confidence depicts how much confidence the estimators have, stated as a percentage, in a budget or schedule estimate. The higher the confidence level, the lower the risk.

[8] 10 U.S.C. §2434. These milestones include Milestone B, which marks the beginning of the system development and demonstration phase. Milestone C marks the beginning of the production and deployment phase.

different from previous carriers. Although an independent cost estimate was conducted for the DDG 51 program, it was conducted in 1993, and since that time, the DDG ships have undergone four major upgrades.

The Navy has begun taking some actions to improve its cost estimating capabilities. For example, future programs will be funded at the DOD independent estimators' level, which should provide a more conservative estimate and include risk analysis. In addition, Navy officials told us that they are in the process of revising cost estimating guidance to include requirements for risk and uncertainty analysis. The degree to which this guidance will enable the Navy to provide more realistic cost estimates for its shipbuilding programs will depend on how it will be implemented on individual programs.

Contract Prices Negotiated and Budgets Set Without Making Full Use of Design Knowledge and Construction Experience

Uncertainty about costs is especially high for new classes of ships, since new classes incorporate new designs and new technologies. Yet, the Navy's approach to negotiating contract target prices for construction of the lead ship and early follow-on ships does not manage this uncertainty sufficiently—evidenced by substantial increases in the prices of the first several ships. Target prices for detail design and construction of the lead and early follow-on ships are typically negotiated at one time.[9] In these cases the Navy does not make use of knowledge gained during detailed design or during construction of the lead ship to establish more realistic prices. When this approach to negotiating prices was used, it also affected the information that was available to the Congress at the time it funded construction of lead and follow-on ships.

Target prices for all of the case study ships increased, but, as shown in table 11, the increase was greater for the two San Antonio class ships and the two Virginia class ships—both new classes of ships. Increases in the target prices of the LPD 17 and LPD 18 were particularly pronounced, reaching 139 and 95 percent, respectively.

[9] The Virginia class was an exception to this practice. For this program, the Navy separated the funding of detail design from construction.

Table 11: Target Prices for Case Study Ships

Dollars in millions

Analysis based on data available July 2004

Case study ship	Initial target price	Shipbuilders' estimated price	Cost growth	Percent change
DDG 91	$355	$390	$35	10%
DDG 92	351	422	71	20
CVN 76	2,967	3,391	424	14
CVN 77	3,446	3,879	434	13
LPD 17	644	1,539	896	139
LPD 18	391	764	373	95
SSN 774	1,028	1,301	273	27
SSN 775	1,084	1,488	404	37
Total	**$10,266**	**$13,174**	**$2,910**	**28%**

Sources: Shipbuilder and Navy (data); GAO (analysis).

The realism of target prices reflects the Navy's approach to negotiating contract prices—the Navy negotiates target prices for the first several ships at a stage of the program when uncertainty is high and knowledge limited. For example, for the San Antonio class ships, the Navy negotiated prices for the detail design and construction of the lead ship (LPD 17) and the first two follow-on ships (LPD 18 and LPD 19) at the same time.[10] By negotiating target prices for these ships before detail design even began, target prices for these three ships did not benefit from information gained during detail design about the materials and equipment or specific processes that will be used to construct the ship. Target prices for the follow-on ships, LPD 18 and LPD 19, did not benefit from knowledge gained in initial construction of LPD 17. In contrast, for the Virginia class ships, the Navy negotiated detail design separately from construction,[11] benefiting from the knowledge gained from detail design in negotiating prices for construction. However, 2 years after negotiating the detail design contract, the Navy negotiated target prices for the SSN 774 and

[10] LPD 18 and LPD 19 were included in the contract as options to buy.

[11] The practice followed with the San Antonio class ships of negotiating detail design and lead ship construction together is a common Navy practice. For example, over the next 3 years, the Navy's acquisition plans call for awarding contracts covering both detail design and lead ship construction for three new ship classes: DD(X) surface combatant, CVN 21 aircraft carrier, and the Littoral Combat Ship.

SSN 775, both considered lead ships for the two shipyards involved in constructing submarines. Target prices for the first two follow-on ships, SSN 776 and SSN 777 were agreed on at this time as well. As a result, target prices for these follow-on ships did not benefit from the knowledge gained from constructing the lead ships.

The practice of setting target prices early on affects not only the realism of the contract target prices, but also the realism of the budgets approved by the Congress to fund these contracts. In order to fund a contract covering both detail design and lead ship construction, authorization and funding for detail design and lead ship construction is approved by the Congress in one budget year, before detail design begins. For example, the Congress funded detail design and construction of LPD 17 in the fiscal year 1996 budget. While the follow-on ships, LPDs 19 and 20, were funded in later years, budgets were still unrealistic because the target prices were used as a basis for the budget request.

The size of the budget and the contract conditions can also affect the realism of target prices. In negotiating the contract for the first four Virginia class ships, program officials stated that the target price they could negotiate was limited to the amount included in approved or planned budgets. The shipbuilders said that they accepted a challenge to design and construct these ships for $748 million less than their estimated costs because the contract protected their financial risk. The contract included a large minimum fee (profit), in addition to the incentive fee that would be reduced in the event of cost growth. Moreover, the contract was structured so that the Navy would pay the full cost of increases for specialized, highly engineered components rather than share the cost increases with the shipbuilder. The Navy also was responsible for the full amount of growth in certain labor costs.

Recently, the Navy has supported the preparation of more realistic budget requests. Program managers are encouraged to budget to their own estimate of expected costs rather than at target prices that are not considered realistic. For example, for the LPD 17, an acquisition decision memorandum stated that the program will be budgeted to the Cost Analysis Improvement Group estimate.[12] Also, in negotiating recent

[12] The Cost Analysis Improvement Group provides independent cost and risk assessments and analyses of Major Defense Acquisition Programs for the Office of the Secretary of Defense.

contracts for additional Virginia class and San Antonio class ships, the Navy structured the contracts to encourage more realistic target prices.

Other Factors Affect Budget Realism

Beyond target prices, shifting priorities, and inflation accounting can have a significant impact on the realism of ship budgets. Specifically, budget requests are susceptible to across-the-board reductions to account for other priorities, such as national security and changes in program assumptions. Competing priorities create additional management challenges for programs that receive a reduced budget without an accompanying reduction in scope. For example, during the budget review cycles of 1996 through 2003, the initial cost estimate for DDGs 89-92 was decreased by $119 million—or 55 percent of the total cost growth for the four DDGs. Had the initial estimate not been reduced, the cost growth would have only amounted to $96 million.

Inflation rates can also have a significant impact on ship budgets. Until recently, Navy programs used Office of the Secretary of Defense and Office of Management and Budget inflation rates.[13] Inflation rates experienced by the shipbuilding industry have historically been higher. As a result, contracts were signed and executed using industry specific inflation rates while budgets were based on the lower inflation rates, creating a risk of cost growth from the outset. For the case study ships, the difference in inflation rates, while holding all other factors constant, explains 30 percent of the $2.1 billion in cost growth for these ships.

In February 2004, the Navy changed its inflation policy directing program offices to budget with what the Navy believes are more realistic inflation indices. The Navy anticipates this policy change should help curtail future requests for prior year completion funds.

[13] The Office of the Secretary of Defense and Office of Management and Budget inflation indices are based on a forecast of the implicit price deflator for the Gross Domestic Product prepared by the Office of Management and Budget and the White House Council of Economic Advisors. The Gross Domestic Product includes all U.S. goods and services and is a general economic indicator overarching many different commodities.

Cost Reporting Weaknesses Delayed Efforts to Mitigate Cost Risks

While DOD guidance allows some flexibility in program oversight, we found that reporting on contractor performance was inadequate to alert the Navy to potential cost growth for the eight case study ships. With the significant risk of cost growth in shipbuilding programs, it is important that program managers receive timely and complete cost performance reports from the contractors. However, earned value management—a tool that provides both program managers and the contractor insight into technical, cost, and schedule progress on their contracts—was not used effectively.[14] Cost variance analysis sections of the reports were not useful in some cases because they only described problems at a high level and did not address root causes or what the contractor plans were to mitigate them.

Earned value management provides an objective means to measure program schedule and costs incurred. Among other requirements, DOD guidance on earned value management requires that "at least on a monthly basis" schedule and cost variances be generated at levels necessary for management control. Naval Air Systems Command, which is considered a center of excellence for earned value management, recommends that cost performance reports be submitted at a minimum on a monthly basis, in part to help the program manager mitigate risk. Officials from the command stressed that because earned value management acts as an early warning system, the longer the time lapse in receiving the cost performance report, the less valuable the data become.

However, shipbuilders for the Nimitz and Virginia class ships we reviewed submitted their official earned value management cost performance reports to the Navy on a quarterly basis instead of monthly,[15] delaying the reports—and corrective action—by 3 to 4 months. Had the reporting been monthly, negative trends in labor and materials on the Virginia class submarine would have been revealed sooner and enabled corrective action to occur quickly in areas of work that were not getting completed as planned. Earlier reporting would have also alerted managers of cost performance problems on the CVN 76 carrier. Because data on actual cost expenditures for CVN 76 were provided incrementally and late, the program manager did not identify a funding shortage until it was too late

[14] For more information on the importance of Earned Value Management see Appendix IV of our report GAO-03-600 entitled "Missile Defense: Additional Knowledge Needed in Developing System for Intercepting Long-Range Missiles."

[15] Beginning in March 2006 the Navy will require monthly cost reporting for CVN 77.

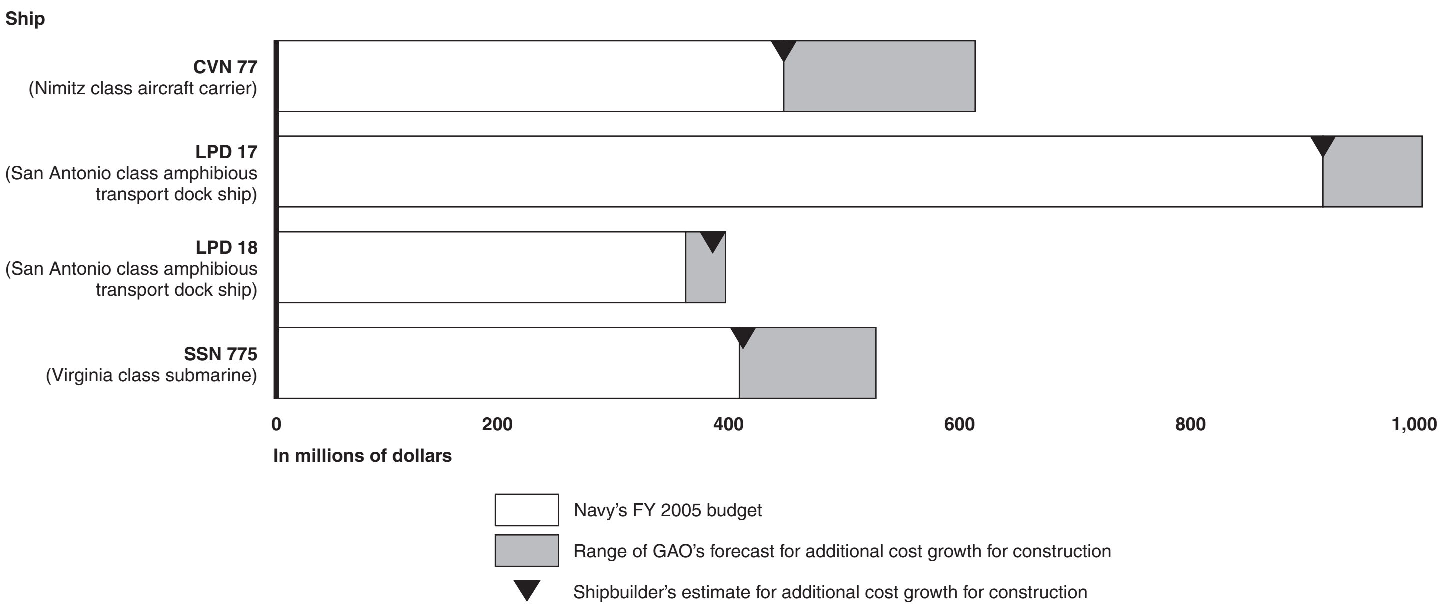
to remedy the problem. As a result, a contractwide stop-work order was given. LPD 17 also experienced cost and schedule problems. To allow for better tracking of schedule and costs and more timely response to problems, the program manager changed the cost performance reporting requirement from quarterly to monthly.

The quality of the cost performance reports, whether submitted monthly or quarterly, was inadequate in some cases—especially with regard to the variance analysis section, which describes any cost and schedule variances and the reasons for these variances and serves as an official, written record of the problems and actions taken by the shipbuilder to address them. Both the Virginia class submarine and the Nimitz class aircraft carrier programs' variance analysis reports discussed the root causes for any cost growth and schedule slippage and described how these variances were affecting the shipbuilders' projected final costs. However, the remaining case study ship programs generally tended to report only high-level reasons for cost and schedule variances with little to no detail regarding root cause analysis or mitigation efforts[16]—making it difficult for managers to identify risk and take corrective action.

Finally, the periodic reassessment of the remaining funding requirements on a program and a good faith estimate at completion—another part of earned value management—were inadequate to forecast the amount of anticipated cost growth. Managers are required to evaluate the estimate at completion and report it in the cost performance report, updating when required. The Defense Contract Audit Agency recently observed the importance of the shipbuilders' developing credible estimates at completion and ensuring all estimates at completion revisions are justified and made in a timely manner. However, the shipbuilders' estimates for the study ships tended to be optimistic—that is, they fell at the low end of our estimated cost growth range. Specifically, shipbuilder estimates for four ships that are still under construction were near our low estimate, (See fig. 3), leading management to believe that the ships will cost less than what is likely to be the case.

[16] A recent Defense Contract Audit Agency audit found that while one shipbuilder identified material cost and schedule variances in its variance analysis report, it did not provide written documentation related to the reasons for the variance or provide explanation for the variances in the cost performance report.

Figure 3: GAO and Shipbuilder Construction Cost Growth Forecasts for Case Study Ships



Source: Shipbuilder (data); GAO (analysis).

See appendix VI for more details on the cost growth forecasts for ships currently under construction.

Conclusions

The challenge in accurately estimating and adequately funding the construction of Navy ships is framed by the long construction time cost estimates must account for and the fact that ships must be fully funded in the first year of their construction. Thus, an underestimation of costs, a budget reduction, or an increase in cost, creates a need for additional money that must be requested and appropriated. The fact that requests have been sizable and have occurred routinely over the years suggests that the Navy can do better in getting a match between the estimated costs of new ship construction and the money it budgets to pay for them. The goal is not necessarily to eliminate all requests for additional funds, for that could lead to overbudgeting or deferring necessary design changes. Rather, the goal is to get a better match between budgeted funds and costs in order that the true impact of investment decisions is known.

Our work shows that currently, the Navy's cost estimating, budgeting, and contracting practices do not do a good enough job of providing for the likely costs of building ships. This is particularly true for first of class ships, for which uncertainty is highest. Moreover, when actual costs begin to go astray of budgeted funds, management tools intended to flag variances and enable managers to act early are not always effectively employed. If these practices are to lead to more realistic results—and reduced overruns—they will have to produce and take advantage of higher levels of knowledge. In some cases, improved techniques, such as performing uncertainty analyses on cost estimates, can raise the level of knowledge. In other cases, such as contracting for detail design and construction on first-of-class ships, contracting in smaller steps can allow necessary knowledge to build before major commitments are made.

The Navy has recognized the need to get a better match between funding and cost and is providing guidance to achieve this match. The success of this guidance will depend on how well it is implemented on individual programs. There are additional steps the Navy can take, which are detailed in our recommendations. Taking these steps now is especially important for the Navy as it embarks on a number of new, sophisticated shipbuilding programs. If a better match between funding and cost is not made, additional funds needed for cost growth will continue to compete for the funds needed for new investments in ships or other capabilities. Difficult budget choices are ahead making it essential that priorities are set with a clear understanding of the financial implications of different spending and investment alternatives. To the extent unplanned demands on the budget can be reduced, better informed decisions can be made.

Recommendations

We are recommending that the Secretary of Defense take the following seven actions.

To improve the quality of cost estimates for shipbuilding programs and reduce the magnitude of unbudgeted cost growth, we recommend the Secretary of Defense

- conduct independent cost reviews for all follow-on ships when significant changes occur in a program and establish criteria as to what constitutes significant changes to a shipbuilding program,
- conduct independent reviews of every acquisition of an aircraft carrier, and
- direct the Secretary of the Navy to develop a confidence level for all ship cost estimates, based on risk and uncertainty analyses.

To assure that realistic prices for ship construction contracts are achieved, we recommend that the Secretary of Defense direct the Secretary of the Navy to

- negotiate prices for construction of the lead ship separately from the pricing of detail design and
- separate pricing of follow-on ships from pricing of lead ships, negotiating prices for early ships in the budget year in which the ship is authorized and funded.

To improve management of shipbuilding programs and promote early recognition of cost issues, we recommend that the Secretary of Defense direct the Secretary of the Navy to

- require shipbuilders to submit monthly cost performance reports and
- require shipbuilders to prepare variance analysis reports that identify root causes of reported variances, associated mitigation efforts, and future cost impacts.

Agency Comments and Our Evaluation

DOD agreed with our recommendations to conduct independent reviews of every aircraft carrier and to develop a confidence level for all ship cost estimates, based on risk and uncertainty analysis. DOD partially agreed with our recommendations about contract pricing and cost performance reporting—areas the Navy noted it has taken some measures to improve. While the Navy has taken steps in the right direction, we believe more must be done to reduce ship cost overruns, consistent with our recommendations.

We made a recommendation in our draft report that independent reviews be conducted for all follow-on ships when significant changes to the program occur. DOD responded that it will request additional assessments, if needed after Milestone B. It is important that criteria be established for determining when additional assessments are needed. Programs may undergo several changes after the required estimate, such as the Arleigh Burke destroyer, which underwent four major upgrades since its only independent estimate in 1993. We believe DOD needs to establish criteria concerning what significant changes to a program trigger an independent cost estimate and have modified our recommendations accordingly. DOD could clarify whether these changes include baseline, profile, or major systems upgrades, for instance.

DOD stated that it will consider, on a case-by-case basis, negotiating detail design separately from the lead ship and negotiating early follow-on ships separately from the lead ship. We believe that this approach should be the normal policy, if overruns are to be reduced. Ships represent a substantial investment--more than $1 billion for each destroyer and amphibious transport, about $2.5 billion for the lead ship in the next class of destroyers, $2.5 billion for submarines, and several billion for carriers. Ships costing substantially less—for example, $220 million for each Littoral Combat Ship—are the exception rather than the norm. A realistic target price is important for structuring contract incentives and providing informed budgets to the Congress. Deciding prices for the lead ship and follow-on ships together before detail design has even begun on the lead ship is unlikely to yield realistic prices. Insight gained into material costs and labor effort even in the first year of detail design will make realistic pricing of the lead ship more feasible. Similarly, experience gained in the first years of construction can benefit the realism of prices for follow-on ships.

DOD noted that the Navy is already requiring shipbuilders to submit cost performance reports monthly with one exception. With the Nimitz class program beginning monthly reporting in March 2006, the Virginia class will be the only program to submit quarterly instead of monthly cost performance reports. DOD states that the Navy has access to labor hour data in the interim. While informal access to timely data is preferable to delayed access, without written, formal cost reporting there is less visibility or accountability from the last formal report to the next cost performance report 3 months later. The Virginia class program has experienced significant cost increases and experienced one of the largest prior year funding requests of programs we reviewed. LPD 17 and carrier program officials recognized that more frequent formal reporting and review of cost performance helped them to better manage cost growth and changed their program reporting requirements from quarterly to monthly. Although variance analysis reporting is required as part of cost performance reporting and is being conducted by the shipbuilders, we observed that there is wide variation in the quality of these reports. DOD rightly observes that these reports are one of many tools used by the shipbuilders and DOD to track performance. To be a useful tool, however, we believe it is important that shipbuilders provide the government with detailed analyses of the root causes and impacts of cost and schedule variances. Cost performance reports that consistently provide thorough analysis of the causes of variances, their associated cost impacts, and mitigation efforts will allow the Navy to more effectively manage, and ultimately reduce, cost growth.

DOD's detailed comments are provided in appendix VII.

As agreed with your office, unless you announce its contents, we will not distribute this report further until 30 days from its date. At that time, we will send copies to the Secretary of Defense, the Secretary of the Navy and interested congressional committees. We will also make copies available to others upon request. In addition, the report will be available at no charge on the GAO Web site at http://www.gao.gov.

If you or your staff have any questions concerning this report, please contact me at (202) 512-4841 or Karen Zuckerstein, Assistant Director, at (202) 512-6785. Key contributors to the report are identified in appendix VIII.

Sincerely yours,

Paul L. Francis
Director
Acquisition and Sourcing Management

Appendix I: Scope and Methodology

Our methodology for all three objectives included a case study analysis of eight ships. These ships were in four ship classes: Virginia class submarines, LPD 17 amphibious assault ships, Arleigh Burke destroyers, and Nimitz class carriers. We selected these ship classes and these ships based on data contained in the "Naval Sea Systems Command Quarterly Progress Report for Shipbuilding and Conversion Status of Shipbuilding Programs," dated July 1, 2003. This report identifies all ships under construction and the progress in terms of "percent complete" for each ship. We looked only at new construction and excluded ship conversions. This report identified eight ship classes with ships under construction. In addition to the four ship classes that we studied, the report identified ships in the Seawolf attack submarine, LHD amphibious assault ship, T-AKE cargo ship, and T-AKR vehicle cargo ship classes. We did not review the Seawolf and T-AKR ship classes because construction of these classes was at an end and were unlikely to affect future budgets. We did not include ships from the remaining two classes because we limited the ship selection to those ships that were more that 30 percent complete and none of the ships in those two classes met those criteria.

We selected two ships per class for the four classes we reviewed. Where possible, we chose a lead and follow-on ship. We also looked at which shipyards were building these ships in order to get coverage of the major shipyards. We limited the selection to ships more than 30 percent complete so we had sufficient information on program performance. Three Virginia-class submarines, three amphibious assault ships, two carriers, and 12 destroyers met this criterion. For the Virginia class program, we initially chose SSN 774 and SSN 776; both built and integrated at the Electric Boat, Connecticut shipyard.[1] As we gained knowledge of the program and Newport News' role in constructing and launching half of the submarines in this class, we substituted the SSN 775 for the SSN 776.

Characteristics of the ships we selected are summarized in table 12.

[1] Under a teaming arrangement, two-thirds of the SSN 774 and 776 is constructed at Electric Boat with the remaining third built at Newport News and shipped to Electric Boat for final assembly. For the SSN 775, the inverse is true.

Table 12: Characteristics of Case Study Ships

	Amphibious assault ships		Virginia class submarines		Nimitz class carriers		Arleigh Burke destroyers	
	LPD 17	LPD 18	SSN 774	SSN 775	CVN 76	CVN 77	DDG 91	DDG 92
Shipyard	Avondale Operations	Avondale Operations	Electric Boat	Newport News Shipbuilding	Newport News Shipbuilding	Newport News Shipbuilding	Ingalls Operations	Bath Iron Works
Percent complete as of July 2003	86	43	87	79	99	35	96	89
Lead/follow	Lead	Follow	Lead	Lead[a]	Follow	Follow	Follow	Follow

Source: Navy (data), GAO (presentation)

[a]SSN 775 is considered the lead ship for Newport News.

Because a large percentage of the ship construction budget is allocated to fund the shipbuilding contracts, we assessed the shipbuilders' cost performance for the four classes of ships in our study. To make these assessments, we applied earned value analysis techniques to data captured in shipbuilder cost performance reports. We also developed a forecast of future cost growth. For ships currently under construction (and more than 30 percent complete), we compared the initial target costs with the likely costs at the completion of the contracts using established earned value formulas. We based the lower end of our cost forecast range on the costs spent to date added to the forecast cost of work remaining. The remaining work was forecast using the cumulative cost performance index efficiency factor. Studies have shown that using this method is a reasonable estimate of the lower bound of the final cost. For the upper end of our cost range, we relied on either the actual costs spent to date added to the forecast of remaining work with an average monthly cost and schedule performance index or a cost/percent complete trend analysis, whichever was higher.

In order to understand the components of cost growth, we used cost data provided by the shipbuilders for each of the case study ships. In most cases we compared the initial target cost to the current target cost. As a result some of the increases in target cost could have resulted from additional contract modifications initiated by the Navy, cost overruns due to the shipbuilder, or unanticipated events. Most shipbuilders allocate contract costs into three categories: material costs, labor costs, and overhead costs. We, however, used these data to allocate costs into the following categories: labor hours, material costs, and labor and overhead rates. Since labor costs and overhead costs can change due to labor hours, and labor and overhead rates, we separated the program overhead cost associated with an increase in labor and overhead rates from the program overhead cost associated with an increase in labor hours. This was accomplished by holding each component constant to isolate the impact. After we isolated the program overhead cost associated only with additional labor hours, we added this to the shipbuilders' reported labor cost growth and subtracted this from the shipbuilders' reported overhead cost growth. Our analysis captures all costs associated only with overhead and labor rate changes. Increases in overhead related to growth in labor hours are captured only in our analysis of labor hour increases.

We used the latest cost performance data available to us in July 2004. The latest available cost performance reports for the case study ships were as follows

- DDG 91 June 2004,
- DDG 92 May 2004,
- CVN 76 July 2003,
- CVN 77 March 2004,
- LPD 17 and LPD 18 May 2004, and
- SSN 774 and SSN 775 July 2004.

In order to understand the funding and management practices that contribute to cost growth, we reviewed Navy acquisition guidance and reviewed best practices literature for weapons systems construction. To better understand the budgeting of ships and the acquisition process we met with officials at the Navy and Office of Secretary of Defense Comptroller. Based on indicators from our case study analysis that cost estimating practices may contribute to cost growth, we met with cost estimators, including those from Naval Sea Systems Command, Cost Analysis Improvement Group, and the Navy Cost Analysis Division. We reviewed DOD and Navy cost estimating policies, procedures, and guidance. Additionally, we met with cost estimators from the Naval Air Systems Command, the Air Force, and the Army to compare how Naval Sea Systems Command estimating practices vary from other military cost estimating practices. We interviewed program officials, contracting officers, and shipbuilders and reviewed shipbuilder reports, which included explanations for cost growth. We met with officials at Supervisor of Ships and the Defense Contract Audit Agency both at the shipyards and at headquarters to review their oversight policies, procedures, and practices. We met with Navy Audit Service officials to gain information on earned value management reviews at shipyards. We also reviewed contract documentation and audit reports.

Our analysis relied on shipbuilders' earned value data. To establish the reliability of the data, we examined the integrated baseline reviews that are conducted at the beginning of a contract. We also confirmed that the shipbuilders had validated earned value systems.

We performed our review from July 2003 to December 2004 in accordance with generally accepted government auditing standards.

Appendix II: Arleigh Burke Class Destroyer

Program Description

The USS Arleigh Burke class destroyer (DDG 51) provides multimission offensive and defensive capabilities, and can operate independently or as part of carrier strike groups, surface action groups, and expeditionary strike groups. The DDG 51 class, which is intended to replace earlier surface combatant classes, was the first U.S. Navy ship designed to reduce radar cross-section and its detectability and likelihood of being targeted by enemy sensors and weapons. Originally designed to defend against Soviet aircraft, cruise missiles, and nuclear attack submarines, the ship is to be used in high-threat areas to conduct antiair, antisubmarine, antisurface, and strike operations.

As of May 2004, 43 Arleigh Burke destroyers have been delivered to the Navy, with a total of 62 to be delivered at the end of the production. Funding for the lead ship (DDG 51) was provided in fiscal year 1985. The lead ship construction contract was awarded to Bath Iron Works in April 1985. With the award of the follow-on ship—DDG 52—to Ingalls Shipbuilding Incorporated—a second shipbuilder was established. The DDG 91 and DDG 92, which are covered in this report, include a number of upgrades, such as the most current Aegis weapons system; installation of a remote mine-hunting system capability and the introduction of commercially built switchboards.

Figure 4: Arleigh Burke Class Destroyer

Source: Navy.

Table 13: Major Events in the Acquisition of DDG 91 and DDG 92

May 1996	• Initial estimate for three ships developed using actual costs from DDG 70—the last ship of the prior configuration in preparation for the 1998 President's budget.
September 1996	• Congress authorizes procurement of 4 DDGs—DDGs 89-92.
August 1997	• Competition to determine contract awards. Navy uses "Profit Related to Offers" strategy, where the lower offeror receives a larger proportion of the contract's target profits, while the higher offeror receives a smaller proportion. Both shipbuilders stated that they proposed aggressively low costs in an effort to win the higher profit margin on the contract that included DDG 91 and DDG 92.
January 1998	• Fiscal Year 1999 Presidential Budget submission is $119 million less than the initial budget estimate due to across the board DOD and Office of Management and Budget reductions.
March 1998	• Bath Iron Works receives a contract for the DDG 92 with an initial target price of $351 million. Ingalls Shipbuilding receives a contract for the DDG 91 with an initial target price of $355 million.
September 2000	• DDG 91 construction begins.
December 2000	• DDG 92 construction begins.
April 2001	• Northrop Grumman Ship Systems acquired Ingalls Shipbuilding.
June 2002	• Northrop Grumman Ship Systems and Bath Iron Works agree to a swap in which LPDs (including LPD 19) will be built by Northrop Grumman and future DDG ships will be built at Bath Iron Works.
October 2003	• DDG 91 delivered.
May 2004	• DDG 92 delivered.

Sources: Navy and shipbuilders (data).

Cost Experience on DDG 91 and DDG 92

DDG 91 and DDG 92 cost $135 million more than budgeted. (See table 14.) The Congress has appropriated almost $100 million to cover these increases.

Table 14: Growth in Program Budgets for Case Study Ships

Dollars in millions

	Initial and FY 2005 President's budget		Difference in budgets		
Case study ship	**Initial**	**FY2005**	**Total difference**	**Difference due to Navy-furnished equipment**	**Difference due to construction costs[a]**
DDG 91	$917	$997	**$80**	$43	$37
DDG 92	925	979	**55**	(7)[b]	62
Total	**$1,842**	**$1,976**	**$135**	**$36**	**$99**

Sources: Navy (data); GAO (presentation).

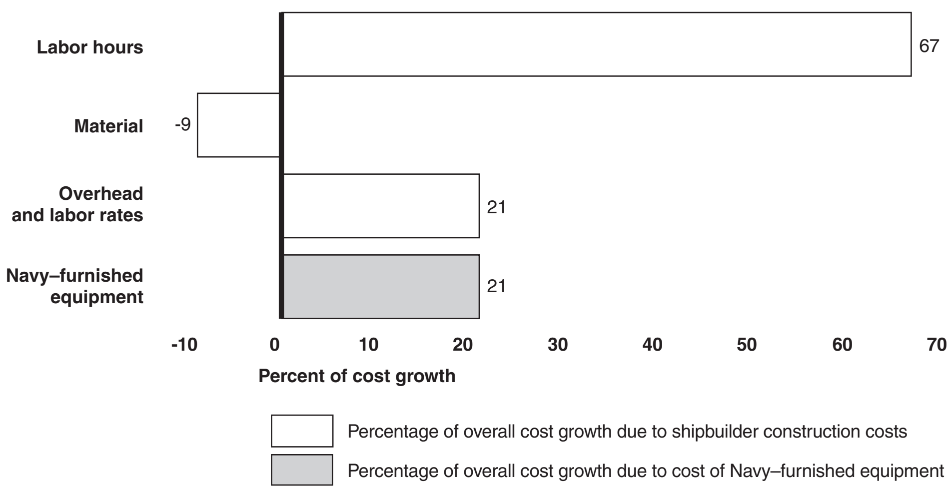
[a]Part of the increased cost is due to changes in the scope of the contract.

[b]Negative reflects savings resulting from the use of a more economical warfare system than was initially budgeted on the DDG 92.

Main Drivers of Cost Growth for DDG 91 DDG 92

Construction costs—especially the costs associated with the number of labor hours needed to build the ships—were the major source of cost growth. Navy-furnished equipment, including the Aegis weapon system, was also a significant source of cost growth for the two DDGs, representing 21 percent of the cost growth. Increases in the number of labor hours account for 67 percent of the cost growth on shipbuilding construction contracts. We found that ship overhead—such as employee benefits and shipyard support costs—and labor rate increases accounted for 21 percent of cost growth. The two DDGs actually underran material costs, due to DDG 91 material cost savings.

Figure 5: Average Sources of Cost Growth on DDG 91 and DDG 92



Source: Navy (data); GAO (presentation).

Labor Hours

Labor hour increases account for the majority of the cost growth on DDG 91 and DDG 92. (See fig. 5.) DDG 91 required almost 1 million hours of additional labor hours and DDG 92 required an additional 2 million hours above the original contract proposal. DDG 91 and DDG 92 incorporated a number of new technologies in their design, including the remote mine-hunting system, which consists of a remote operated vehicle and a launch and recovery system stored within the ship. To accommodate this system, designers had to make significant structural changes to 26 of the ship's 90 design zones. When construction began on DDG 91 and DDG 92, the remote mine-hunting system's design was not mature. As a result, significant details of the design could not be captured in the shipbuilders' planned contract costs. Moreover, the shipbuilders anticipated that the system's design would be completed in July 1999—several months before the start of ship fabrication in November 1999. However, it was not completed until November 2001, with additional revisions to the design occurring through March 2003. Because the design was changing as installation of the system began, laborers re-installed parts of the system, increasing the engineering and production hours.

As the number of hours to construct the ship increased, total labor costs grew, with the shipbuilder paying for additional employee wages and overhead costs. As table 15 shows, we separated the overhead and labor rates associated with the additional hours and added this to the shipbuilders reported labor cost growth. Our analysis thus captures all costs associated with labor hour growth—including overhead and labor rates. The methodology we used to separate the overhead costs associated with rate increases and labor hour increases is discussed in appendix 1.

Table 15: Growth in Labor Hour Costs

Dollars in millions

Analysis based on June 2004 (DDG 91) and May 2004 (DDG 92) data

Case study ship	Shipbuilder reported labor dollar growth	Overhead and labor rate dollars on increased labor hours	Total dollars due to increased labor hours	Labor hour cost as a percent of total contract growth
DDG 91	$23	$24	**$47**	**105%**
DDG 92	43	42	**85**	**66**
Total	**$66**	**$66**	**$132**	

Sources: Shipbuilder (data); GAO (analysis).

Note: We compared initial target cost to the current estimate at completion to determine total contract cost growth. Cost growth may be due to Navy changes in contract scope, shipbuilder performance, or unanticipated events.

According to the shipbuilder, additional labor hours were also needed to complete DDG 91 because many experienced workers had left the trade in favor of higher paying jobs in the area and, as a result, less experienced workers took longer to finish tasks and made mistakes that required rework. For DDG 92, workers encountered challenges in building the ship due to a new transfer facility that enabled the shipyard to construct a greater proportion of the ship on land. The ship was constructed using larger subsections or units. While the shipbuilder expects that the facility will improve efficiency, on DDG 92, workers had to learn new processes and had difficulties aligning larger units of the ship to one another. Labor hours increased as workers spent additional time realigning and combining the units to make larger sections of the ship.

Navy-Furnished Equipment

About $38 million of Navy-furnished equipment cost growth is associated with the Aegis weapon system, specifically the purchase of an additional SPY-D radar used in system testing.[1] The Navy originally planned to move the developmental radar from the engineering and development site to the final testing and certification center. However, increased complexity

[1] These costs are non-recurring, affecting only DDG 91 costs.

involved with the introduction of a new radar and new computing plant required more development time than was originally planned. In order to ensure timely delivery of DDG 91, the Navy procured a second radar for the testing facility, allowing the Navy to simultaneously finish final development of the radar, while at the same time beginning testing and certification of the Aegis weapon system computer program.

Overhead Rate Increases

Our analysis shows that program overhead costs and increases in labor rates accounted for approximately 21 percent of the cost growth on the DDG 91 and 92 contracts. Table 15 includes overhead increases that were a consequence of labor hour increases. Table 16 isolates the remaining portion of overhead increases due to increases in rates.

Table 16: Growth in Overhead Costs and Labor Rates

Dollars in millions

Analysis based on June 2004 (DDG 91) and May 2004 (DDG 92) data

Case study ship	Shipbuilder reported overhead growth	Portion related to growth in labor hours	Portion related to overhead and labor rates	Overhead cost from rate increases as a percent of total contract growth
DDG 91	$43	$24	$20	**44%**
DDG 92	56	42	14	**11**
Total	**$99**	**$66**	**$34**	

Sources: Shipbuilder (data); GAO (analysis).

Note: We compared initial target cost to the current estimate at completion to determine total contract cost growth. Cost growth may be due to Navy changes in contract scope, shipbuilder performance, or unanticipated events.

Despite savings incurred through the consolidation of Ingalls Shipyard into Northrop Grumman,[2] overhead rates were about 13 percent higher than anticipated in 2001. According to shipbuilders, increases in overhead rates can be attributed largely to changes in the shipyard's workload and employee benefit costs. After the cancellation of the construction contract for a commercial cruise ship due to the company's bankruptcy and the delay in signing the contract for the next generation destroyer, overhead costs had to be absorbed by the remaining contracts at the yard, including the DDG 91. Similarly, on DDG 92, the shipbuilder based its overhead rates on anticipated work from the construction of the next generation

[2] According to the shipbuilder, consolidation of Ingalls shipbuilding and Avondale shipyards into Northrop Grumman reduced overhead costs by approximately 3 percent.

destroyer and the San Antonio class ships. When these programs did not materialize as expected, the other programs at the yard assumed overhead costs. At both shipyards health and dental care costs increased. For example, at one shipyard, the shipbuilder negotiated a favorable medical insurance contract but the insurance company went bankrupt, forcing the shipbuilder to become self-insured—at a higher cost.

Both shipbuilders were also affected by labor rate increases. Following a strike at Bath Iron Works, the union negotiated a $1.12 increase in labor rates or a $6 million increase above the costs projected in the contract. For Northrop Grumman, between the initial proposal and the latest estimate, the labor rate increased by $1.50 per hour for a total impact on the DDG 91 of $7 million.

Material Costs

As shown in table 17, material cost increases did not represent a major source of cost increases for DDG 91 and DDG 92—largely because the materials were purchased for four ships at one time.

Table 17: Growth in Material Costs

Dollars in millions

Analysis based on June 2004 (DDG 91) and May 2004 (DDG 92) data

Case study ship	Increased material costs	Percent increase	Material cost as a percent of total contract growth
DDG 91	($22)	(13%)	**(49%)**
DDG 92	30	20	**23**
Total	**$8**		

Sources: Navy (data); GAO (analysis).

However, DDG 92 overran its material budget by $30 million—73 percent of which was due to information technology, small tooling, and other material costs. Although these costs comprise only 17 percent of the material cost budget, their costs are driven by labor hour usage—as additional labor hours were needed to construct DDG 92, additional tools were needed, raising material costs. Material costs also increased because the shipbuilder began allocating information technology costs to materials—not overhead, as it had initially done. DDG 91 experienced a $22 million underrun of material costs. According to the shipbuilder, the underrun was due to efficiencies gained through the consolidation of Ingalls Shipyard with nearby Avondale Shipyard—also owned by Northrop Grumman Ship Systems. With the consolidation, Northrop Grumman stated it could purchase materials for both shipyards—creating cost savings that were not anticipated in DDG 91's original material cost budget.

Appendix III: Nimitz Class Aircraft Carrier

Program Description

The mission of the Nimitz class nuclear powered aircraft carriers—which are intended to replace the Navy's conventionally powered carriers—is to provide a sustained presence and conventional deterrence in peacetime; act as the cornerstone of joint allied maritime expeditionary forces in crises; and support aircraft attacks on enemies, protect friendly forces, and engage in sustained independent operations in war. Nine Nimitz class nuclear carriers—CVN 68 through CVN 76—have been delivered since acquisition of the first ship in October 1967. CVN 77, the tenth and final ship of the class, is a modified version of CVN 76 and will serve as a transition ship to the next generation of aircraft carriers. Both CVN 76 and CVN 77 included several significant design changes, including a bulbous bow; larger air-conditioning plants; a redesigned island; weapons elevator modifications; and an integrated communications network.

Figure 6: Nimitz Class Aircraft Carrier

Source: Navy.

Table 18: Major Events in the Acquisition of CVN 76 and CVN 77

August 1993	• Initial estimate for CVN 76 developed based on CVN 74/75 proposal data with adjustments made for design and economic factors.
September 1994	• Congress appropriates funding for the construction of CVN 76.
December 1994	• Navy awards a fixed-price incentive fee contract for detailed design and construction of CVN 76 to Newport News Shipbuilding for a target price of $2.5 billion.
May 1995	• Construction of CVN 76 begins.
April 1999	• 4-month strike at Newport News causes work stoppage on construction of CVN 76.
July 2000	• Congress appropriates funding for the construction of CVN 77.
January 2001	• Navy awards a fixed-price incentive fee contract for detailed design and construction of CVN 77 to Newport News Shipbuilding for a target price of $3.4 billion.
February 2001	• Navy requests $86 million for CVN 76 and $20 million for CVN 77 in prior year funding to cover cost growth.
June 2001	• Construction begins on CVN 77. Advanced construction began in 1998 to provide sustaining work for the shipyard.
February 2002	• Prior year request of $94 million for CVN 76 and $75.4 million for CVN 77.
September 2002	• Development delays prompt Navy to revert to a legacy warfare system on CVN 77. Costs for warfare system are transferred from the shipbuilder to the Navy.
December 2002	• Original contract delivery date for CVN 76.
June 2003	• CVN 76 delivered to the Navy—6 months later than the original delivery date.
August 2003	• Navy initiates a contract wide stop work order on CVN 76 to prevent depletion of program funding. Stop work order is rescinded 3 months later.
February 2005	• Navy requests $870 million in prior year funding over fiscal years 2006 to 2008 for CVN 77. This includes an increase in $908 million in construction costs and a $38 million decrease in Navy-furnished equipment.
March 2008	• Initial expected delivery date for CVN 77.
January 2009	• Current expected delivery date for CVN 77.

Sources: Shipbuilder and Navy (data), GAO (presentation).

Cost Experience on CVN 76 and CVN 77

The Fiscal Year 2005 President's Budget showed that budgets for the CVN case study ships had increased by $173 million, and the Congress has appropriated funds to cover these increases. However, based on March 2004 data, we projected additional cost growth on contracts for the carriers is likely to reach $485 million and could be higher. Therefore, the Navy will need additional appropriations to cover this cost growth.

The fiscal year 2005 budget for the carriers is about $9.6 billion—$173 million more than the initial budget request for these ships. (See table 19.) As a result, the Navy has requested $275.4 million through both the prior year completion bill and other financial transfers to fund cost increases on the CVN program.[1] Ship construction costs comprise the majority of this increase.

On CVN 76, ship construction costs grew by $252 million above the initial budget. As a result of cost growth, CVN 76 was in danger of running out of funding. The program office issued over 75 stop work orders—including one contract wide stop work order to temporarily save funding. Lower priority work was cancelled or halted to avoid further cost growth. While stop work orders saved money in the short term, they resulted in significant costs later. On CVN 76 some work had to be completed in a post-delivery contract—at a higher cost.

Table 19: Growth in Program Budgets for Case Study Ships

Dollars in millions

	Initial and FY 2005 President's budget		Difference in budgets		
Case study ship	**Initial**	**FY 2005**	**Total difference**	**Difference due to Navy-furnished equipment**	**Difference due to construction costs[a]**
CVN 76	$4,476	$4,600	**$124**	($128)	$252
CVN 77	4,975	5,024	**49**	100	(51)
Total	**$9,451**	**$9,624**	**$173**	**$28**	**$201**

Sources: Navy (data); GAO (presentation).

[a] Part of the increased cost is due to changes in the scope of the contract.

We calculated a range of the potential growth for CVN 77 and found that the total projected cost growth is likely to exceed $485 million and could reach $637 million.[2] (See table 20.)

[1] $180 million was for CVN 76 and $95.4 million for CVN 77.

[2] We did not project cost growth for CVN 76 because the ship has been delivered to the Navy.

Table 20: GAO's Forecasts of Additional Cost Growth for Construction

Dollars in millions

Analysis based on July 2003 (CVN 76) and March 2004 (CVN 77) data

Case study ship	Percent of ship construction completed	Amount already requested to cover contractor's increased cost	GAO's forecast for additional cost growth for construction	GAO's forecast of total cost growth
CVN 76	Delivered	$252	$0-0	**$252-252**
CVN 77	45%	(51)[a]	485-637	**434-586**
Total growth		**$201**	**$485-637**	**$686-838**

Sources: Navy (data); GAO (analysis).

Note: Cost growth is from original contract target price, not from the current contract target price. Forecast reflects expected price to the Navy.

[a]Negative reflects shifting of funds from the construction contract to Navy-furnished equipment.

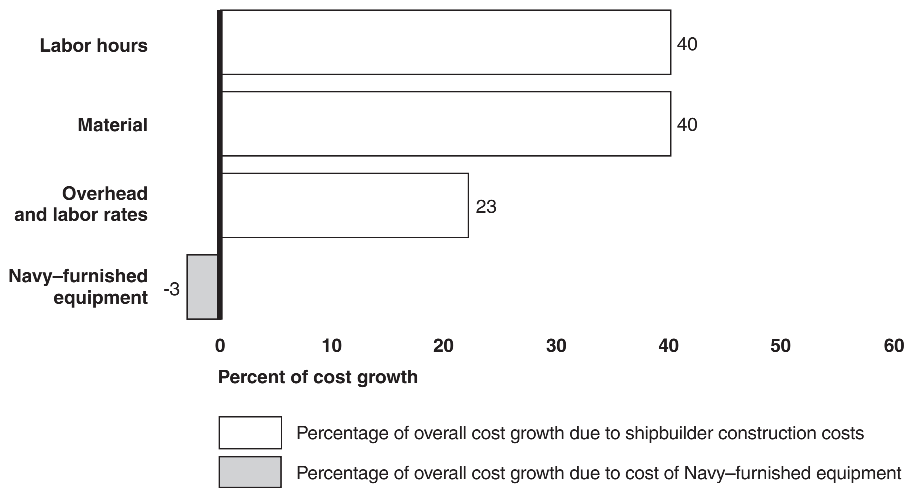
Our cost growth estimates have proven to be understated. The Fiscal Year 2006 President's Budget recognizes cost growth of $908 million for ship construction above the prior year's budget request. In addition, we assumed that the shipbuilder will maintain its current efficiency through the end of the contracts and meet scheduled milestones. For example, Navy officials told us that delivery of CVN 77 is likely to slip to January 2009, further increasing the final cost of the ship.

Main Drivers of Cost Growth for CVN 76 and CVN 77

Based on 2004 data, increases in labor hour and material costs account for 80 percent of the cost growth on CVN 76 and CVN 77, while the costs for Navy-furnished equipment—including propulsion and weapon systems—declined.[3] (See fig. 7.) The remaining 23 percent of cost growth resulted from increases in overhead costs. The shipbuilder cited a number of direct causes for the labor hour, material, and overhead cost growth in the case study ships. The most common causes were related to demands for labor on other programs at the shipyard, the need for additional and more costly materials, and changes in employee pay and benefits.

[3] Analysis is based on data available through March 2004.

Figure 7: Average Sources of Cost Growth on CVN 76 and CVN 77



Source: Navy (data); GAO (presentation).

Materials

Material costs increased on CVN 76 by $294 million and on CVN 77 by $134 million since the contracts were first awarded.

Table 21: Growth in Material Costs

Dollars in millions

Analysis based on July 2003 (CVN 76) and March 2004 (CVN 77) data

Case study ship	Total dollars due to increased material costs	Percent increase	Material cost as a percent of total contract growth
CVN 76	**$294**	43%	**46%**
CVN 77	**134**	13	**31**
Total	**$428**		

Sources: Navy (data); GAO (analysis).

Note: We compared initial target cost to the current estimate at completion to determine total contract cost growth. Cost growth may be due to Navy changes in contract scope, shipbuilder performance, or unanticipated events.

On both CVN 76 and CVN 77, material costs grew, in part, because the shipbuilder underestimated the original budget for materials. In April 2002—7 years after construction began on CVN 76—about $32 million in errors in material purchase estimates were revealed. CVN 77 has also experienced a significant increase in material costs due to under budgeting. According to the shipbuilder, a compressed construction schedule on CVN 77 resulted in the budget for materials being established prior to the completion of the carrier's design and even the completion of design work on certain systems on CVN 76. As a result, the true magnitude of the carrier's material costs was not known at the time of the contract negotiation. Early in CVN 77 construction, however, the shipbuilder reassessed the materials needed for construction in order to have a more realistic estimate of final material costs. The Navy and the Defense Contract Audit Agency recognized the absence of needed information on materials during its review of the shipbuilder's proposal and expressed concerns about the adequacy of the cost estimating system. According to Newport News officials, the shipyard and Defense Contract Audit Agency are working to resolve their concerns. The shipbuilder is estimating $200 million in material cost increases and additional funds are being requested to cover this increase.

According to the shipbuilder, material cost increases on both CVN 76 and CVN 77 can be attributed to increases resulting from a declining supplier base and commodity price increases. Both carriers' material costs have been affected by an over 15 percent increase in metals costs, which, in turn, increases costs for associated components used in ship construction. Moreover, many of the materials used in the construction of aircraft carriers are highly specialized and unique—often produced by only one manufacturer. With fewer manufacturers competing in the market, the materials are highly susceptible to cost increases.

Other reasons for material cost increases include the following:

CVN 76

- Expenses of about $20 million in non-nuclear engineering effort that were subcontracted for in late 1997 and of about $50 million for information services were transferred from overhead to material in the middle of the project.

CVN 77

- The expansion of commercial-off-the-shelf equipment in CVN 77 resulted in additional costs to test the materials to make sure military specifications were met.

Labor Hours

Costs on both carriers grew because of additional labor hours required to construct the ships. At delivery, CVN 76 required 8 million hours of additional labor hours to construct, while CVN 77 has required 4 million hours. As the number of hours to construct the ship increased, total labor costs grew, with the shipbuilder paying for additional employee wages and overhead costs.

Table 22: Growth in Labor Hour Costs

Dollars in millions

Analysis based on July 2003 (CVN 76) and March 2004 (CVN 77) data

Case study ship	Shipbuilder reported labor dollar growth	Overhead and labor rate dollars on increased labor hours[a]	Total dollars due to increased labor hours	Labor hour cost as a percent of total contract growth
CVN 76	$78	$144	**$222**	**35%**
CVN 77	75	107	**182**	**42**
Total	**$153**	**$251**	**$404**	

Sources: Shipbuilder (data); GAO (analysis).

Note: We compared initial target cost to the current estimate at completion to determine total contract cost growth. Cost growth may be due to Navy changes in contract scope, shipbuilder performance, or unanticipated events. We separated the overhead and labor rates associated only with the additional hours and added this to the shipbuilders' reported labor cost growth. Our analysis captures all costs associated with labor hour growth—including overhead and labor rates.

[a]Contractor performance reports included $63 million in overhead costs for CVN 76 and $40 million for CVN 77 that have been disallowed (not charged to the government).

Increases in labor hours were due in part to an underestimation of the labor hours necessary to construct the carriers. The shipbuilder negotiated CVN 76 for approximately 39 million labor hours—only 2.7 million more labor hours than the previous ship—CVN 75. However, CVN 75 was constructed more efficiently because it was the fourth ship of two concurrent ship procurements. (See table 23.) CVN 76 and CVN 77, in contrast, were procured as single ships. As table 23 shows, single ship procurement is historically less efficient than two ship procurements, requiring more labor hours.

Table 23: Historical Man-hours Used to Produce Prior Ships Compared to CVN 76 Negotiated Man-hours

Man-hours in millions

Hull	Total man-hours	Labor-hour change	Type of ship buy	Contract award date
CVN 70	**36.4**	0	Single	April 1974
CVN 71	**44.3**	7.9	Single	September 1980
CVN 72	**42.7**	(1.6)	Two	December 1982
CVN 73	**38.2**	(4.5)	Two	December 1982
CVN 74	**36.9**	(1.3)	Two	July 1988
CVN 75	**36.3**	(0.6)	Two	July 1988
CVN 76	**39.0**	2.7	Single	December 1994

Sources: Navy, Shipbuilder (data); GAO (analysis).

The shipbuilder and Navy budgeted the same number of hours to construct CVN 77 as to construct CVN 76, despite forecasts showing that at 55 percent complete CVN 76 would need almost 2 million more hours above the negotiated hours to complete the ship. To date, CVN 77 is expected to incur over 4 million man-hours more than negotiated.

Some of the labor hour increase on CVN 76 occurred as a result of demands for labor on other programs at the shipyard. During construction of CVN 76, 1 million hours of labor were shifted from the construction of the carrier to work on the refueling and overhaul of CVN 68. The Navy deemed the carrier overhaul and refueling effort as a higher priority than new ship construction because carriers were needed back in the fleet to meet warfighting requirements. Many of the most skilled laborers were moved to the refueling effort, leaving fewer workers to construct CVN 76. Without many of the necessary laborers to construct the ship, the CVN 76 construction schedule was delayed. In order to meet construction schedule deadlines employees were tasked to work significant overtime hours. Studies have shown, however, that workers perform less efficiently under sustained high overtime.

Problems with late material delivery also led to labor hour increases on both CVN 76 and CVN 77. When material did not arrive on time, the shipbuilder tried to work around the missing item in order to remain on schedule—which is less efficient than had the material been available when planned. On CVN 77, for example, parts for a critical piping system were delivered over a year late, necessitating work-arounds and resequencing of work, driving labor costs up.

Other reasons for labor hour increases on CVN 76 and CVN 77:

CVN 76

- A 4-month strike in 1999 led to employee shortages in key trades, contributing to a loss of learning with many employees not returning to the shipyard. According to Navy officials, the shipbuilder was given $51 million to offset the strike's impact.

CVN 77

- Program schedule required concurrent design, planning, material procurement, and production activities. Additional labor hours were spent responding to design changes, which ultimately affected CVN 77 cost and schedule.
- Due to unavailability of large-sized steel plates the shipbuilder had to re-plan the ship's structure so it could be constructed with smaller-sized plates. This required not only extensive redesign, but resulted in additional production hours because laborers needed additional time to fit and weld the smaller plates together.

Overhead and Labor Rates

While the total overhead and labor rate costs on both the CVN 76 and CVN 77 grew by $232 million over the life of the contract, labor hour increases accounted for over half of that amount (See table 6.) According to Navy officials, some of the overhead cost growth on CVN 76 can be attributed to three major accounting changes since the contract was awarded in late 1994. While these accounting changes increased overhead costs, they resulted in a reduction of material costs. According to the shipbuilder, overhead cost increases on CVN 77 can be attributed to increases in pension and healthcare costs. Changes in the shipyard's workload and employee benefit costs also led to overhead cost increases on CVN 77. After delays in signing contracts for a carrier overhaul and the next generation aircraft carrier, overhead costs had to be absorbed by the CVN 77 program.

Table 24: Growth in Overhead Costs and Labor Rates

Dollars in millions

Analysis based on July 2003 (CVN 76) and March 2004 (CVN 77) data

Case study ship	Shipbuilder reported overhead growth[a]	Increase in overhead related to growth in labor hours	Increase in overhead related to overhead and labor rates	Overhead cost as a percent of total contract growth
CVN 76	$263	144	$119	**19**
CVN 77	219	107	113	**26**
Total	**$482**	**251**	**$232**	

Sources: Shipbuilder (data); GAO (analysis).

Note: We compared initial target cost to the current estimate at completion to determine total contract cost growth. Cost growth may be due to Navy changes in contract scope, shipbuilder performance, or unanticipated events. Our analysis captures only costs associated with overhead and labor rate changes. Increases in overhead related to growth in labor hours are captured in the analysis of labor hour increases.

[a]Contractor performance reports included $63 million in overhead costs for CVN 76 and $40 million for CVN 77 that have been disallowed (not charged to the government).

According to the shipbuilder, labor rate increases on CVN 76 resulted from union negotiations following a strike at the shipyard, as well as significant use of overtime labor, which is more expensive than normal hourly wages. According to Navy officials, between 30 and 40 percent of the work on CVN 76 was done on overtime in 2003.

Navy-Furnished Equipment

Navy-furnished equipment did not represent an area of cost growth on CVN 76 and CVN 77. On CVN 76, the costs for propulsion equipment decreased by close to $145 million—driving down the overall cost of Navy-furnished equipment. Since 2001, costs for Navy-furnished equipment on CVN 77, however, have grown by $100 million. This growth on CVN 77 can be attributed to increases in the cost associated with the Integrated Warfare System—the carrier's combat system. The Integrated Warfare System included new phased array radar that was being developed by the next generation destroyer program. However, when the radar technology did not become available as planned, the Navy decided to install a legacy system on the ship. Because the shipbuilder was suppose to buy and install the Integrated Warfare System as part of the original contract scope, the costs for the Integrated Warfare System were removed from the contract and used by the Navy to procure a legacy system as Navy-furnished equipment.

Appendix IV: San Antonio Class Amphibious Transport Dock Ship

Program Description

The San Antonio class amphibious transport dock ship is designed to transport Marines and their equipment and allow them to land using helicopters, landing craft, and amphibious vehicles. The class is expected to increase operational flexibility and survivability over each ship's 40-year lifespan and to operate at lower cost than previous amphibious transport ship classes. The new class is also designed to reduce crew size and provide significant improvements in command, control, communications, computer, intelligence, and quality of life.

In acquiring LPD 17, the lead ship in the class, a three-dimensional computer-aided design tool and a shared data tracking system has been used. The shared data tracking system was intended to provide significant savings within the San Antonio class program through the reuse of critical data in future design, construction, and operational activities. We focused our review on the LPD 17 and 18.

Figure 8: San Antonio Class Amphibious Transport Dock Ship

Source: Navy.

Table 25: Major Events in the Acquisition of LPD 17 and LPD 18

February 1996	• Citing industrial base concerns and LPD 17's improved survivability features, Congress authorized the LPD 17, accelerating the Navy's schedule by 2 years.
March 1996	• Initial estimate developed for the class in support of a milestone review. In developing the estimate, cost analysts used data from the LHD and LSD amphibious ships, which were constructed in the 1980s. The LHD is larger than the LPD, and the LSD is less technologically complex. Cost analysts assumed that technologies would mature on schedule and that acquisition reforms would produce savings.
December 1996	• LPD 17 cost-plus award fee contract awarded after a competitive selection of the Avondale Alliance for detail design and construction of LPD 17. The contract included options for construction of LPD 18 and 19. Target costs were set for LPD 17 and LPD 18 at $644 million and $391 million, respectively.
December 1998	• Contract modified to exercise option for construction of LPD 18.
August 1999	• Litton Shipbuilding purchased LPD 17's prime contractor, Avondale Industries.
December 1999	• Design schedule delays cause a 10-month slip in anticipated delivery of LPD 17.
August 2000	• LPD 17 construction begins.
February 2001	• The Navy and Litton Alliance reassess the lead ship construction schedule and delay LPD 17 delivery another 14 months to November 2004.
April 2001	• Northrop Grumman Ship Systems assumed responsibility as primary contractor for the LPD 17 program through an acquisition that included Avondale.
September 2001	• Cost growth led to renegotiation of the contract.
September 2001	• The contract was converted to cost-plus incentive fee contract. For LPD 17, the original award fee was based on the total cost of the ship over its operational lifetime. The incentive fee contract tied the fee to controlling construction costs. This shifted the focus of the program from lowering future maintenance costs to delivering the ship.
November 2001	• Cost growth by more than 43 percent triggered a Nunn-McCurdy unit cost breach, causing a new baseline to be established in June 2002 and requiring $1.4 billion in additional funding.
February 2002	• LPD 18 construction begins.
June 2002	• With the Navy's approval, Northrop Grumman Ship Systems and Bath Iron Works agreed to a swap that shifts all LPD construction, including LPD 19, to Northrop Grumman and all future DDG 51 ships to Bath Iron Works.
February 2005	• Navy requests $25 million in additional prior year completion funding for LPD 18.
May 2005	• LPD 17 expected delivery date.
September 2005	• LPD 18 expected delivery.

Sources: Navy, shipbuilder (data); GAO (presentation).

Cost Experience on LPD 17 and LPD 18

Budgets for the two LPD case study ships have grown by $1 billion, and funds have been appropriated to cover these increases. However, the Navy could need additional appropriations of $200 million to $300 million to fund projected cost growth.

For detail design and construction of LPD 17, the Congress initially appropriated $953.7 million to fund the construction contract (the basic contract plus a budget for future changes) and acquisition of Navy-furnished equipment. The Congress later appropriated $762 million to fund LPD 18 construction. (See table 26.)

Table 26: Growth in Program Budgets for Case Study Ships

Dollars in millions

	Initial and FY2005 President's budget		Difference in budgets		
Case study ship	**Initial**	**FY2005**	**Total difference**	**Difference due to Navy-furnished equipment**	**Difference due to construction costs[a]**
LPD 17	$954	$1,758	**$804**	$21	$784
LPD 18	762	1,011	**249**	3	246
Total	**$1,716**	**$2,769**	**$1,053**	**$24**	**$1,030**

Sources: Navy (data); GAO (presentation).

[a]Part of the increased cost is due to changes in the scope of the contract.

Since that time, the Congress has appropriated $1 billion to cover the increases in the ships' costs. However, more funds will likely be needed to cover additional cost growth for these two ships. We project that, if the current schedule is maintained, total cost growth for the LPD 17 and LPD 18 will exceed $1.2 billion and possibly reach $1.4 billion. (See table 27.)

Table 27: GAO's Forecasts of Additional Cost Growth for Construction

Dollars in millions

Analysis based on data through May 2004

Case study ship	**Percent of ship construction completed**	**Amount already requested to cover increased cost**	**GAO's forecast for additional cost growth**	**GAO's forecast of total cost growth**
LPD 17	95%	$784	$112-$197	**$896-$981**
LPD 18	67	246	102-136	**348-382**
Total growth		**$1,030**	**$214-333**	**$1,244-1363**

Sources: Navy, Shipbuilder (data); GAO (analysis).

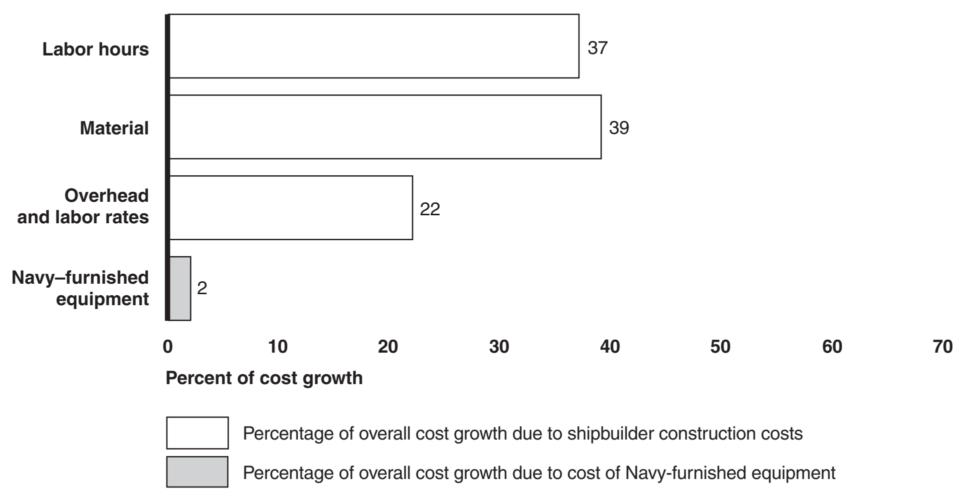
Note: Cost growth is measured from original contract price, not from the current contract target price. Forecast reflects expected price to the Navy.

Our cost growth estimates—both low and high—are likely understated because we assumed that the shipyards will maintain their current efficiency through the end of their contracts and meet scheduled milestones. LPD 17 did not meet the planned December 2004 delivery date. Delivery is now scheduled for May 2005, increasing the final cost of the ship.

Main Drivers of Cost Growth for LPD 17 and LPD 18

Increases in labor hour and material costs account for 76 percent of the cost growth on LPD 17 and LPD 18 construction contracts. Navy-furnished equipment—including radars, propulsion equipment, and weapon systems—represents just 2 percent of the cost growth. The remaining 22 percent was due to increases in overhead and labor rates. (See fig. 9.)

Figure 9: Average Sources of Cost Growth on LPD 17 and LPD 18



Source: Navy (data); GAO (presentation).

The shipbuilder cited a number of direct causes for the labor hour, material, and overhead cost growth in the two case study ships. The most common causes were related to the concurrent development of a new and unproven design tool and design of the lead ship, initial focus on controlling total lifetime costs, and changes in employee pay and benefits.

Materials

Engineering costs (classified as material costs) associated with use of a three-dimensional product model to design LPD 17 were a key contributor to material cost growth. The design tool was not fully developed and subsequent problems affected all aspects of the design. Subcontracts for engineering design doubled, accounting for $215 million in cost growth on LPD 17. Development of an integrated production data environment, originally assumed to be funded by the state, has instead been shifted to the contract, representing an additional $35 million in cost spread across LPD. (See table 28.)

Table 28: Growth in Material Costs

Dollars in millions

Analysis based on data through May 2004

Case study ship	Increased material costs	Percent increase	Material cost as a percent of total contract growth
LPD 17	$400	103%	47%
LPD 18	93	39	24
Total	**$493**		

Sources: Shipbuilder (data); GAO (analysis).

Note: We compared initial target cost to the current estimate at completion to determine total contract cost growth. Cost growth may be due to Navy changes in contract scope, shipbuilder performance, or unanticipated events.

Labor Hours

Labor hours, the second largest component of cost growth, increased significantly for the LPD 17 and LPD 18. For example, engineering labor hours for the LPD 17 increased by over 100 percent from the original proposal.

As the number of hours to construct the ship increased, total labor costs grew, with the shipbuilder paying for additional overhead costs and employee wages. We separated the overhead and labor rates associated only with the additional hours and added this to the shipbuilder's reported labor cost growth. (See table 29.) Our analysis captures all cost growth associated with labor—including labor hours, overhead, and labor rates.

Table 29: Growth in Labor Hour Costs

Dollars in millions

Analysis based on data through May 2004

Case study ship	Shipbuilder reported labor cost growth	Overhead and labor rate costs for increased labor hours	Total cost due to increased labor hours	Labor hour cost as a percent of total contract growth
LPD 17 [a]	$182	$102	**$284**	33%
LPD 18	117	67	**184**	48
Total	**$299**	**$169**	**$468**	

Sources: Shipbuilder (data); GAO (analysis).

Note: We compared initial target cost to the current estimate at completion to determine total contract cost growth. Cost growth may be due to Navy changes in contract scope, shipbuilder performance, or unanticipated events. Our analysis captures all costs associated with labor hour growth, including overhead and labor rates.

[a]LPD 17 relied heavily on subcontracted labor to design the ship. Since these costs are captured as material, we did not include them in our analysis of labor cost increases.

Factory inefficiencies and loss of skilled laborers, including significant employee attrition (35 percent annually) contributed significantly to labor hour increases. Difficulties with the design tool and turnover in engineering staff led to increases in engineering labor hours and delayed achieving a stable design. Without a stable design, work was often delayed from early in the building cycle to later, during integration of the hull. Shipbuilders stated that doing the work at this stage could cost up to five times the original cost. On LPD 17, 1.3 million labor hours were moved from the build phase to the integration phase. Consequently, LPD 17 took much longer to construct than originally estimated. Moreover, a diminished workforce at Avondale required the busing of shipyard workers from Ingalls Shipyard in Pascagoula, Mississippi to Avondale in New Orleans, Louisiana and the subcontracting of skilled labor.

Program Overhead and Labor Rates

While the total overhead costs on both the LPD 17 and 18 grew by $0.5 billion over the life of the contract, labor hour increases contributed to about half of that amount. (See table 30.)

Table 30: Growth in Overhead Costs and Labor Rates

Dollars in millions

Analysis based on data through May 2004

Case study ship	Shipbuilder reported overhead growth	Portion related to growth in labor hours	Portion related to overhead and labor rates	Overhead cost rate increases as a percent of total contract growth
LPD 17	$277	$102	$175	**20%**
LPD 18	177	67	110	**28**
Total	**$454**	**$169**	**$285**	

Sources: Shipbuilder (data); GAO (analysis).

Note: We compared initial target cost to the current estimate at completion to determine total contract cost growth. Cost growth may be due to Navy changes in contract scope, shipbuilder performance, or unanticipated events. Our analysis captures only costs associated with overhead and labor rate changes. Increases in overhead related to growth in labor hours are captured in the analysis of labor hour increases.

According to Northrop Grumman, increases in overhead costs not related to labor hour growth can be attributed largely to changes in the shipyard's workload and employee benefit costs. Beginning in 2001, the shipyard experienced a rise in overhead rates. For example, the overhead rates in the 2004 latest estimate by Northrop Grumman are 39 percent higher than what was originally proposed on the LPD 17 in 1996. Several factors helped to increase overhead. For example; due to the loss of the bulk military cargo T-AKE ship, the cancellation of the construction of a commercial ship (American Classics Voyage), and the delay in signing the contract for the next generation destroyer, overhead costs had to be absorbed by the remaining contracts at the yard, including LPD. This led to 36 percent of the increase in overhead rates—24 percent for the T-AKE and cruise ship and 12 percent for DD(X).

According to the shipyard, changes in the financial market affected the pension fund and the rise in medical care costs were responsible for 16 percent of the increase in the shipyards overhead rates.

Labor rates rose due to inflation impacts of an over 2-year delay in lead ship delivery and subsequent changes in the procurement schedule and wage rates negotiated with labor unions.

Navy-Furnished Equipment

According to program officials, cost growth for Navy-furnished equipment on the LPD 17 was due to increased costs for a shock wave test that was not anticipated in the original cost estimate. This cost was a one-time increase, affecting only LPD 17 costs.

Appendix V: Virginia Class Submarine

Program Description

The Virginia-class attack submarine, the newest class of nuclear submarines, is designed to combat enemy submarine and surface ships, fire cruise missiles at land targets, and provide improved surveillance and special operations support to enhance littoral warfare. Because the Virginia class is designed to be smaller than the Seawolf and slightly larger than the Los Angeles class submarines—ships the new class will eventually replace—the Virginia class is better suited for conducting shallow-water operations. Major features of this new class of submarine include new acoustic, visual, and electronic systems for enhanced stealth. An objective of Virginia class is to reduce the life-cycle cost through better design and engineering resulting in one third fewer man-hours than were needed to construct Seawolf (SSN 21), the lead ship in the previous class of attack submarines. The first ship, the SSN 774, was delivered in October 2004. Our review focused on the SSN 774 and 775.

Figure 10: Virginia Class Submarine

Source: Navy.

Table 31: Major Events in the Acquisition of SSN 774 and SSN 775

October 1991	• Program initiated with focus on building more versatile and less costly submarines.
July 1994	• Initial estimate developed for Virginia class based on historical data from Seawolf (SSN 21) and Los Angeles (SSN 688) classes. A sole source contract with Electric Boat was planned. Major challenges involved estimating new technologies still under development and estimating the cost impact of a 6-year gap in submarine production.
January 1996	• Contract for $1.4 billion awarded to Electric Boat for detail design of Virginia class. Approximately 3.4 million man-hours for one-time production start up activities were included.
February 1997	• Cost analysts updated estimates to reflect proposed shipbuilder teaming agreement between Electric Boat and Newport News Shipbuilding assuming teaming would be less expensive than dual sources due to shipbuilder collaboration. Costs were increased to reflect additional non-recurring effort for Newport News to reconstitute submarine production.
February 1998	• Based on congressional direction that teaming agreement would be the most efficient way to produce submarines in a low rate production environment, the Navy authorized a teaming agreement between Electric Boat and Newport News Shipbuilding. Deliveries of the ships would alternate between shipyards with Electric Boat delivering the first ship. According to the Navy, this change increased the estimated cost of developing and building 30 submarines when compared to building them in a single yard.
September 1998	• Contract is modified by $1.028 billion to fund construction of Electric Boat's SSN 774 lead ship. Options for construction of SSN 775 – 777 were included.
October 1998	• Construction of SSN 774 begins.
December 1998	• Contract is modified by $1.084 billion to initiate construction of Newport News Shipbuilding's SSN 775 lead ship.
September 1999	• Construction of SSN 775 begins.
February 2001	• Navy requests $119 million for Virginia class in prior year funding to cover cost growth.
December 2001	• Northrop Grumman Corporation acquires Newport News Shipbuilding creating Northrop Grumman Newport News.
February 2002	• Prior year completion request of $227 million for Virginia class.
April 2003	• Prior year completion request of $327 million for Virginia class triggers a Nunn-McCurdy unit cost breach.
June 2004	• Planned delivery date for SSN 774.
October 2004	• SSN 774 delivered 4 months late, an improvement over the Seawolf and Los Angeles lead ships which were delivered 25 and 26 months late, respectively.
February 2005	• Fiscal Year 2006 President's Budget recognizes an increase in the budget of $82 million for SSN 774 and $223 million for SSN 775. These increases are funded through transfer of funds and prior year funding of $28 million for SSN 774 and $97 million for SSN 775.
June 2005	• Initial planned delivery date for SSN 775.
March 2006	• Current planned delivery date for SSN 775.

Sources: Navy, shipbuilder (data); GAO (presentation).

Cost Experience on SSN 774 and SSN 775

The Fiscal Year 2005 President's Budget showed that budgets for the two Virginia class case study ships have increased by $734 million. However, based on data of July 2004, we projected additional cost growth on contracts for the two ships is likely to reach $840 million and could be higher. In fiscal year 2006 budget, the Navy has requested funds to cover cost increases that are now expected to reach approximately $1 billion.

The fiscal year 2005 budget for the SSN 774 and SSN 775 is about $6.2 billion, compared with the initial fiscal year 1998 budget request of $5.5 billion. (See table 32.) Ship construction costs comprise the majority of this increase.

Table 32: Growth in Program Budgets for Case Study Ships

Dollars in millions

	Initial and FY2005 President's budget		Difference in budgets		
Case study ship	**Initial**	**FY2005**	**Total difference**	**Difference due to Navy-furnished equipment**	**Difference due to construction costs[a]**
SSN 774	$3,260	$3,682	**$422**	$95	$327
SSN 775	2,192	2,504	**312**	18	294
Total	**$5,452**	**$6,186**	**$734**	**$113**	**$621**

Sources: Navy (data); GAO (presentation).

[a]Part of the increased cost is due to changes in the scope of the contract.

While the Congress has appropriated funds to cover the increases in the ships' costs, more funds will be needed to cover additional cost growth for these two ships. In its fiscal year 2006 budget submission the Navy is requesting an additional $125 million in prior year completion funding between fiscal years 2006 to 2007 for the case study ships. We calculated a range of the potential growth for the two case study ships and found that the total projected cost growth is likely to exceed $724 million and could reach $840 million or higher. (See table 33.)

Table 33: GAO's Forecasts of Additional Cost Growth for Construction

Dollars in millions

Analysis based on July 2004 data

Case study ship	Percent of ship construction completed	Amount already requested to cover contractor's increased cost	GAO's forecast for additional cost growth	GAO's forecast of total cost growth
SSN 774	Delivered	$327[a]	$0-0	**$327-327**
SSN 775	88%	294	103-219	**397-513**
Total growth		**$621**	**$103-219**	**$724-840**

Sources: Navy (data); GAO (analysis).

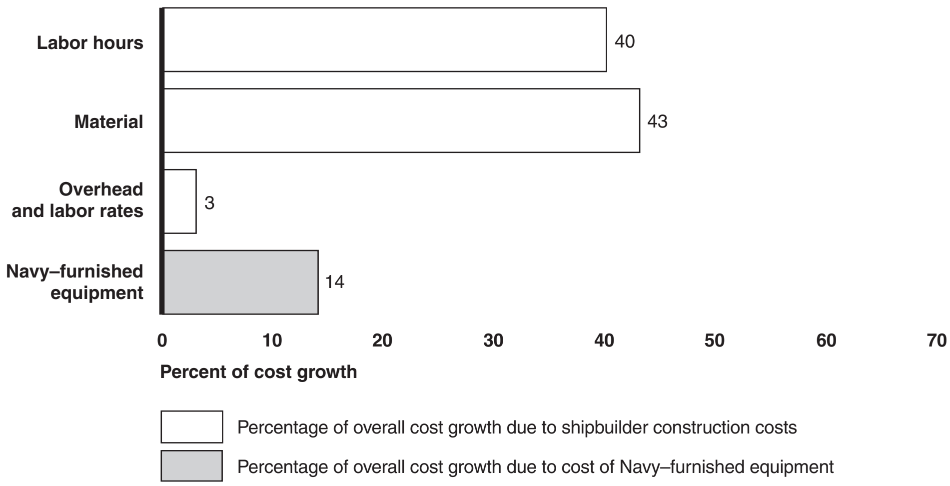
[a]Program officials indicated that $70 million in additional funding has been requested for SSN 774 completion.

Our cost growth estimates—both low and high—may be understated because we assumed that the shipbuilders will maintain their current efficiency through the end of their contracts and meet scheduled milestones. Any slips in efficiency and schedules would likely result in added costs. For example, the delivery date for SSN 775 is expected to slip by as many as 8.5 months, which could increase the final cost of the ship.

Main Drivers of Cost Growth for SSN 774 and SSN 775

Our analysis shows that the submarine contract costs have grown because initial construction costs were underestimated—especially the costs associated with the cost of material and number of labor hours needed to build the ships. For the two case study ships we examined, we found that increases in the number of labor hours and material costs to build the submarines accounted for 83 percent of the cost growth on shipbuilding construction contracts. Navy-furnished equipment, including radars, propulsion equipment, and weapon systems, caused 14 percent of the cost growth. We found that ship overhead—such as employee benefits and shipyard support costs—and labor rate increases accounted for 3 percent of cost growth.

Figure 11: Average Sources of Cost Growth on SSN 774 and SSN 775



Source: Navy (data); GAO (presentation).

In negotiating the contract for the first four Virginia class ships, program officials stated they were constrained in negotiating the target price to the amount funded for the program, thereby risking cost growth at the outset. The shipbuilders said that they accepted a challenge to design and construct these ships for $748 million less than their estimated costs because the contract protected their financial risk. Despite the fact that there was significant risk of cost growth, the Navy, based on guidance at the time, did not identify any funding for probable cost growth.

We analyzed shipbuilder contract costs to identify the sources of cost growth. Using shipbuilder cost data, we allocated the sources of shipbuilder cost growth on the contract into three categories—labor hours; material costs; and labor and overhead rates. Since labor costs and overhead costs can change due to labor hours, labor rates, and rates associated with individual elements of overhead—or a combination of these—we examined each in isolation by separating the program overhead cost associated with an increase in labor hours from costs that resulted from an increase in overhead rates, such as an increase in health care costs.

Materials

Due to high risk that specialized material could not be procured for the amount budgeted, the Navy agreed to purchase this material as a cost plus fixed fee item. This agreement protected the shipbuilder from having to fund any resulting cost increases for highly specialized material. Indeed, cost growth for material increased by $350 million for the two Virginia class submarines we examined.

Table 34: Growth in Material Costs

Dollars in millions

Analysis based on July 2004 data

Case study ship	Total dollars due to increased material costs	Percent increase	Material cost as a percent of total contract growth
SSN 774	**$141**	43	**49**
SSN 775	**209**	56	**49**
Total	**$350**	**99**	

Sources: Shipbuilder (data); GAO (analysis).

Note: We compared initial target cost to the current estimate at completion to determine total contract cost growth. Cost growth may be due to Navy changes in contract scope, shipbuilder performance, or unanticipated events.

The Navy and shipbuilders attribute material cost growth to several factors including

- unrealistic budgets not supported by current vendor costs,
- diminished supplier base for highly specialized materials,
- nonrecurring costs for Computer Data Integration between shipbuilder teams,
- lack of design maturity for certain electronic components, and
- full funding of ships in the year of authorization.

Shipbuilders stated they based more than 70 percent of their estimate for major material costs on updated vendor quotes while the Navy relied on historical costs that were not analogous to the low number of submarines being planned for construction. While the Navy knew there would be a price penalty for a 6-year gap in submarine production, there were no studies or actual data to support what the overall effect would be. Thus, Navy cost estimators assumed that costs for major material items would increase by 20 percent. When the Navy negotiated the costs for Virginia-class high value, specialized material, the shipbuilder agreed to take on the challenge of achieving lower costs in exchange for funding these materials on a cost-plus-fixed-fee basis.[1] By the time the lead ship was delivered

[1] Under this arrangement, the Navy is responsible for any cost growth.

8 years later, the true cost increase for highly specialized material was closer to 60 percent more than historical costs.

Following the cancellation of the prior submarine program—Seawolf—and a decrease in submarine production of three to four submarines per year to one over a period of 6 years, many vendors left the nuclear submarine business and focused instead on more lucrative commercial product development. As a result, prices for highly specialized material increased due to less competition and a lack of business. For example, many vendors were reluctant to support the Virginia class submarine contract because costs associated with producing small quantities of highly specialized materials were not considered worth the investment—especially for equipment with no other military or commercial applications.

Material costs also increased due to nonrecurring costs for integrating computer data so that the shipbuilders could work from a common design. In addition, costs to develop high-risk systems like the array and exterior communication system were underestimated. Recognizing the significant cost risk involved, the Navy procured these systems under a separate contract line item that guaranteed the shipbuilders a fixed fee and made the Navy responsible for funding all cost growth.

Finally, the Navy believes that the block-buy contract has contributed to increased material costs. Under a block-buy contract, subcontracts for submarine materials are for single ships spread over several years. According to the Navy, this type of acquisition approach does not take advantage of bulk-buy savings and incurs the risk that funding will not be available in time to order the material when needed. In addition, since ships are funded individually, the Navy believes suppliers are unwilling to risk investing in technology improvements due to the uncertainty that future ships will not be purchased. To stabilize the vendor base, the Navy awarded a multiyear contract that commits the Navy to purchasing additional submarines. While a multiyear contract can provide such savings, a program must meet criteria to demonstrate a sufficient level of stability for such a contract. In June 2003, we noted several aspects of the Virginia class program that indicated instability.[2] Another factor to be considered in using multiyear contracts is the budget flexibility the

[2] GAO-03-895R, *Multiyear Procurement Authority for the Virginia Class Submarine Program*, (Washington, D.C.: June 23, 2003).

government gives up in exchange for the commitment of funds for the future years of the contract.

Labor Hours

Labor cost increases have led to $339 million in cost growth for the SSN 774 and SSN 775 combined. Problems with mastering state-of-the art design tools, first in class technical and teaming issues, and material availability all contributed to the labor cost growth.

Table 35: Growth in Labor Hour Costs

Dollars in millions

Analysis based on July 2004 data

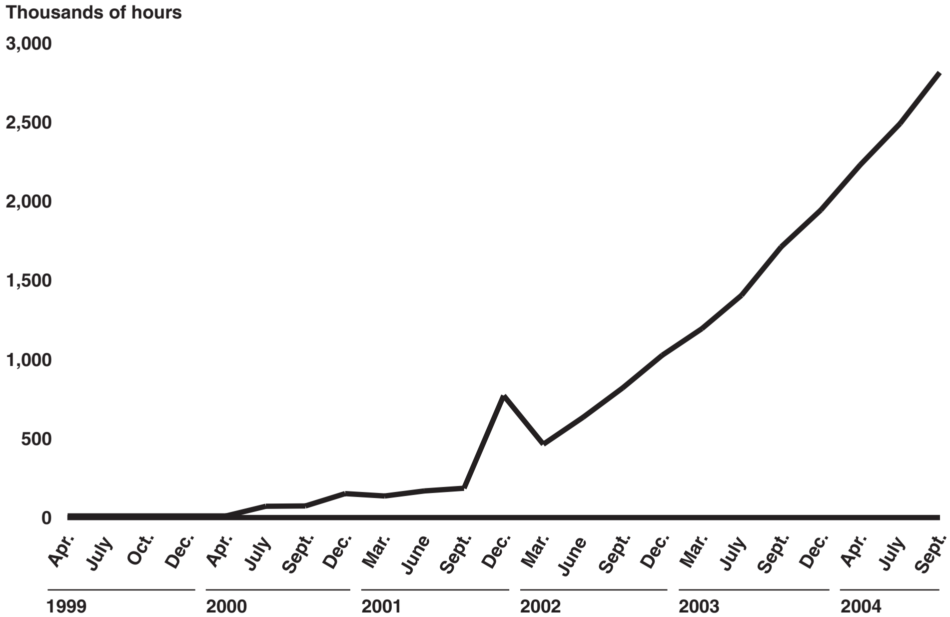
Case study ship	Shipbuilder reported labor cost growth	Overhead and labor rate costs for increased labor hours	Total cost due to increased labor hours	Labor hour cost as a percent of total contract growth
SSN 774	$149	$10	**$159**	**55%**
SSN 775	218	(38)	**180**	**42**
Total	**$367**	**$(28)**	**$339**	

Sources: Shipbuilder (data); GAO (analysis).

Note: We compared initial target cost to the current estimate at completion to determine total contract cost growth. Cost growth may be due to Navy changes in contract scope, shipbuilder performance, or unanticipated events. Our analysis captures all costs associated with labor hour growth, including overhead and labor rates.

We found that SSN 774 required almost 3 million additional labor hours than planned, reflecting a growth of 25 percent. (See fig. 12.) In addition, we found that SSN 775 required almost 4 million more labor hours than planned. Approximately 3.4 million nonrecurring labor hours for SSN 774 were procured on a separate contract line item and therefore not included in our analysis while some SSN 775 nonrecurring labor hours are embedded in the labor hours for that ship.

Figure 12: SSN 774 Lead Ship Labor Hour Growth



Source: Shipbuilder (data), GAO (presentation).

Technical issues commonly associated with first-in-class ships also contributed to the overall labor cost growth. For example, shipbuilders experienced problems with crossed hydraulic lines on the lead ship. In addition, problems with the torpedo tube and weapons handling design issues also contributed to labor hour growth in both ships. Labor hours also increased as quality problems discovered for a component made by one shipyard were reworked by the shipyard integrating the components. Because the shipyard doing the integration was not as familiar with the effort, the work was not completed as efficiently.

Late material deliveries also disrupted the work-flow sequence. Because many vendors either went out of business or focused on developing new commercial products in response to low demand, the Navy was no longer considered a preferred customer. In cases where there was no ready supplier, the shipbuilder had to request old subcontractors to supply the highly specialized material. This caused delays in material deliveries as well as quality problems arising from strict inspection processes that subcontractors were no longer familiar with. Although the shipbuilders tried to work around late material deliveries when they could, this caused workers to perform less efficiently than had the material been available when scheduled. Moreover, when the material did arrive, the shipbuilders had to work overtime to make up the schedule causing additional growth in labor costs.

Navy-Furnished Equipment

According to Navy program officials, radar costs increased due to more design effort needed to fix problems associated with the Seawolf program. Other costs increases were driven by changes in how certain items were purchased. For example, the advanced display system was recently established as a line item in the budget when in the past it was paid for as part of the shipbuilder's construction contract. Moreover, the Navy initially planned to use research and development funds to cover costs for the propulsor but switched to ship construction funds instead, leading to an increase in the program's budget for Navy-furnished equipment.

Ship Overhead and Labor Rates

Our analysis shows that program overhead costs and increases in labor rates were not significant sources of cost growth—causing approximately 3 percent of the cost growth. To isolate true increases in overhead rates from increases that were a consequence of labor hour increases, we separate the two in table 36.

Table 36: Growth in Overhead Costs and Labor Rates

Dollars in millions

Analysis based on July 2004 data

Case study ship	Shipbuilder reported overhead growth	Increase in overhead related to growth in labor hours	Increase in overhead related to overhead and labor rates	Overhead cost as a percent of total contract growth
SSN 774	$0	$10	($10)	**(3%)**
SSN 775	0	(38)	38	**9**
Total	**$0**	**$(28)**	**$28**	

Sources: Shipbuilder (data); GAO (analysis).

Note: We compared initial target cost to the current estimate at completion to determine total contract cost growth. Cost growth may be due to Navy changes in contract scope, shipbuilder performance, or unanticipated events. Our analysis captures only costs associated with overhead and labor rate changes. Increases in overhead related to growth in labor hours are captured in the analysis of labor hour increases.

Costs associated with growth in labor hours are shown in table 35 calculations.

According to the shipbuilder, overhead and labor rate increases were related to pension, workers compensation, and health care costs rising beyond what was expected. Furthermore, when other ship acquisitions did not materialize, shipyard overhead costs were spread over a fewer number of contracts causing an increase in the Virginia class overhead costs. Similarly, the loss of business caused the shipbuilders to lay off skilled workers. According to the shipbuilders, many of the experienced workers did not return to the shipyard. Hiring and training new workers increased costs.

We found that one shipbuilder was affected by labor rate increases. Following a strike at the shipyard, union negotiations resulted in four pay increases totaling an average of $3.10 per hour.

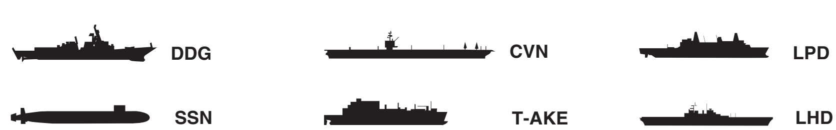
Appendix VI: GAO's Forecast of Additional Costs to Complete Construction Contracts

This appendix discusses GAO's forecast of future cost growth for all ships in construction that are more than 30 percent complete. The forecast is also compared with the shipbuilders' forecasts of estimated costs at completion.

Figure 13: Comparison of Shipbuilders' and GAO's Forecasts of Additional Construction Costs for Six Classes of Ships Actively under Construction

Based on data available to GAO through July 2004

Ships under construction	Percent of ship constuction completed	Shipbuilder's estimate of costs to complete ship	Low end of GAO's forecast of costs to complete[a]	High end of GAO's forecast of costs to complete[b]
DDG 91	100	$65	$65	$65
DDG 92	100	71	71	71
DDG 93/95	88	75	75	103
DDG 94	93	76	76	83
DDG 96	81	44	37	44
DDG 97/98	76	35	35	46
DDG 99	67	34	27	34
DDG 100	54	18	16	18
DDG 101	52	28	28	43
CVN 76	100	424	424	424
CVN 77	45	434	434	586
LPD 17	93	896	896	981
LPD 18	69	373	348	382
LPD 19	60	311	311	413
LPD 20	44	243	243	249
SSN 774	100	274	274	274
SSN 775	88	399	397	513
SSN 776	63	145	160	217
SSN 777	48	148	146	231
T-AKE 1	45	60.7	60.7	70.6
LHD 8	39	108.6	108.6	177.2



Sources: Navy, Shipbuilder (data); GAO (analysis).

Notes: Active construction in this table means ships are at least 30 percent complete. Cost growth figures are in millions of dollars. Ships' names that are bolded are case study ships.

[a]We based the lower end of our cost forecast range on the costs spent to date added to the forecast cost of work remaining. The remaining work was forecasted using the cumulative cost performance index efficiency factor. Studies have shown that using this method is a reasonable estimate of the lower bound of the final cost.

[b]For the upper end of our cost range, we relied on either the actual costs spent to date added to the forecast of remaining work with an average monthly cost and schedule performance index or a cost/percent complete trend analysis, whichever was higher.

- **CVN 76 and CVN 77:** CVN 76 was delivered to the Navy in 2003. While we forecasted an overrun of up to $586 million over the initial target price for CVN 77, the fiscal year 2006 budget request indicates a need of $870 million in prior year funding.
- **SSN 774-SSN 777:** SSN 774 was delivered to the Navy in October 2004. We found that the contractors' forecasts are unlikely to be achieved based on continuing cost growth on the remaining 3 ships. In addition, the SSN 776 and SSN 777 are the follow-on ships to a new class and still may experience production problems that could lead to future cost growth.
- **DDG 91-DDG 101:** The DDGs have experienced cost growth at both shipyards. All the DDGs under construction at Bath Iron Works and more than 30% complete have experienced cost growth. Similarly, cost growth is also expected on the DDGs built by Northrop Grumman.
- **LPD 17-LPD 20:** LPDs currently under construction are likely to experience significant cost overruns. On all of the LPDs, with the exception of LPD 18, the shipbuilder is estimating overall cost growth to be at the lower end of our predicted range. Hence we believe, the shipbuilder's forecast of cost growth is optimistic.
- **T-AKE:** Major cost growth is being predicted for T-AKE 1. We estimate that costs could grow more than $70 million beyond the initial contract price. The shipbuilder believes that escalating material costs resulting from rising commodity prices and unfinalized vendor subcontracts are driving contract cost growth.
- **LHD 8:** It also has the potential for significant cost growth—as much as $177 million more than what was anticipated. Cost growth thus far is attributed to increases in overhead and general and administrative costs.

Appendix VII: Comments from the Department of Defense

OFFICE OF THE UNDER SECRETARY OF DEFENSE
3000 DEFENSE PENTAGON
WASHINGTON, DC 20301-3000

ACQUISITION, TECHNOLOGY AND LOGISTICS

FEB 0 [illegible]

Mr. Paul L. Francis
Director, Acquisition and Sourcing Management
U.S. Government Accountability Office
441 G Street, NW
Washington, DC 20548

Dear Mr. Francis:

This is the Department of Defense (DoD) response to the Government Accountability Office (GAO) draft report, "DEFENSE ACQUISITIONS: Improved Management Practices Could Help Minimize Cost Growth in Navy Shipbuilding Programs," dated December 23, 2004 (GAO Code 120237/GAO-05-183).

The Department has reviewed the draft report and concurs with two of the recommendations and partially concurs with the remainder. I am enclosing specific DoD comments that address each of the seven recommendations. We have previously provided technical comments directly to the GAO staff for consideration.

We appreciate the opportunity to comment on the draft report.

Sincerely,

Glenn F. Lamartin
Director
Defense Systems

Enclosure:
As stated

GAO DRAFT REPORT - DATED DECEMBER 23, 2004
GAO CODE 120237/GAO-05-183

"DEFENSE ACQUISITIONS: IMPROVED MANAGEMENT PRACTICES COULD HELP MINIMIZE COST GROWTH IN NAVY SHIPBUILDING PROGRAMS"

DEPARTMENT OF DEFENSE COMMENTS TO THE RECOMMENDATIONS

RECOMMENDATION 1: The GAO recommended that the Secretary of Defense conduct independent reviews for all follow-on ships when significant changes occur to the program. (p. 28/GAO Draft Report)

DOD RESPONSE: Partially concur.
In accordance with Title 10, USC Sec. 2434, an independent cost estimate (ICE) is required for all major defense acquisition programs (MDAPs). The current Department of Defense practice is to have the ICE prepared by the Office of the Secretary of Defense (OSD) Cost Analysis Improvement Group (CAIG) in support of Milestone B decisions on Navy MDAPs, including ship programs, that are designated ACAT 1D. The USD(AT&L) will request the CAIG conduct additional independent cost estimates or assessments, if needed, to support follow-on ship decisions after Milestone B. For Navy MDAPs designated as ACAT 1C, whereby the Navy Service Acquisition Executive is the Milestone Decision Authority, the Naval Cost Analysis Division performs the independent cost estimate.

RECOMMENDATION 2: The GAO recommended that the Secretary of Defense conduct independent reviews of every acquisition of an aircraft carrier. (p. 28/GAO Draft Report)

DOD RESPONSE: Concur.
This recommendation is consistent with the Department's current approach for the CVN 21 aircraft carrier program.

RECOMMENDATION 3: The GAO recommended that the Secretary of Defense direct the Secretary of the Navy develop a confidence level for all ship cost estimates, based on risk and uncertainty analysis. (p. 28/GAO Draft Report)

DOD RESPONSE: Concur.
The Navy is already pursuing this action and therefore the Secretary of Defense does not need to provide further direction to implement the recommendation. The Naval Sea Systems Command conducted training of 60 staff members in quantitative risk analysis in October 2004 to support introduction of these techniques in shipbuilding platform cost estimating.

RECOMMENDATION 4: The GAO recommended that the Secretary of Defense direct the Secretary of the Navy to negotiate prices for construction of the lead ship separately from the pricing of detail design. (p. 29/GAO Draft Report)

DOD RESPONSE: Partially concur.
The Department will consider this on a case-by-case basis as the Department develops the acquisition strategy for each individual program. The Navy currently negotiates the lead ship construction and the detail design prices as separate distinct contract line items based on the best information available, within the negotiation process. Negotiation of ship contracts is an involved and time-consuming process that can extend several months. Separating pricing of the lead ship until detail design is complete could result in loss of significant leverage in the contract negotiations and might not be a cost effective strategy for smaller shipbuilding programs with shorter construction periods.

RECOMMENDATION 5: The GAO recommended that the Secretary of Defense direct the Secretary of the Navy to separate pricing of follow-on ships from pricing of lead ships, negotiating prices for early ships in the budget year in which the ship is authorized and funded. (p. 29/GAO Draft Report)

DOD RESPONSE: Partially concur.
The Department will consider this on a case-by-case basis as the Department develops the acquisition strategy for each individual program. Negotiation of ship contracts is an involved and time-consuming process that can extend several months. In programs with a lengthy period of time between ship procurements (i.e., aircraft carriers), this is the Department's current practice. However, this concept proves difficult to implement in programs with annual procurements (i.e., submarines). In the early stages of an annual procurement program, there is little cost data from the previous (or lead) ship that the Navy can use as a baseline. Until actual cost data is available, the Navy uses the cost estimate based on the best data available at the time. Additionally, because of the rigorous negotiations that are common to shipbuilding, in an annual procurement cycle, negotiations for the next ship would have to begin within three months of the award for the previous ship contract.

RECOMMENDATION 6: The GAO recommended that the Secretary of Defense direct the Secretary of the Navy to require that shipbuilders submit monthly cost performance reports. (p. 29/GAO Draft Report)

DOD RESPONSE: Partially concur.
The Navy is currently undertaking this initiative with every program and therefore the Secretary of Defense does not need to provide further direction to implement the recommendation. All of the programs examined by the GAO, with the exception of the CVN 77 and SSN 774 programs, receive reports on a monthly basis. The CVN 77 program will begin receiving monthly cost performance reports in March 2006. The SSN 774 Virginia class program receives bi-weekly labor hour performance data, typically within ten days of the close of the accounting period through the Integrated Management and Control System. General Dynamics, Electric Boat provides the SSN 774 data for both of the construction shipyards.

RECOMMENDATION 7: The GAO recommended that the Secretary of Defense direct the Secretary of the Navy to require shipbuilders to prepare variance analysis reports that identify root causes of reported variances, associated mitigation efforts, and future cost impacts. (p. 29/GAO Draft Report)

DOD RESPONSE: Partially concur.
The Navy already requires shipbuilders to do this because they have invoked the DoD and industry guidance that requires variance reporting and analysis as part of earned value management. Therefore the Secretary of Defense does not need to provide further direction to implement the recommendation. Variance analysis is only one of many tools available to the Program Manager. The Program Office must also maintain oversight and monitor performance at the shipyard and major Government Furnished Equipment (GFE) vendors. The Supervisor of Shipbuilding monitors shipyard performance and the Defense Contract Management Agency provides contract oversight for major Navy furnished equipment procurement. Both organizations provide on-site representation and maintain daily communication with the Program Office. Furthermore, the Navy holds quarterly production reviews with the shipbuilders to resolve cost and schedule issues. These reviews occur throughout the entire construction/production process to identify root causes for many issues, including reported variances.

Appendix VIII: GAO Contacts and Staff Acknowledgments

GAO Contacts

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Acknowledgments

In addition to the contacts named above, Margaret B. McDavid, Christina Connelly, Diana Dinkelacker, Christopher R. Durbin, Jennifer Echard, R. Gaines Hensley, Ricardo Marquez, Christopher R. Miller, Madhav Panwar, Karen Richey, Karen Sloan, Lily Chin, and Marie Ahearn made key contributions to this report.

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