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MODERNIZING THE U.S. AIRCRAFT CARRIER FLEET

Accelerating CVN 21 Production Versus Mid-Life Refueling

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Summary

The U.S. Navy is currently building the last of the *Nimitz* class of aircraft carriers. The next ship to be started will belong to a new class, designated CVN 21. This new design will incorporate numerous improvements over the *Nimitz* design. Among the most important will be improved weapons handling, a propulsion plant that will generate more electricity to support functions now controlled by steam and hydraulics, an electromagnetic aircraft launch system, and a general rearrangement to improve operations. It is anticipated that the new class of ship will require fewer personnel to operate and will spend less time in shipyard maintenance, both of which will contribute to reduced operating costs.

The Navy's plan is to continue building aircraft carriers approximately once every four years. Ships of the new class will replace older ones that are retiring. *Nimitz*-class ships are scheduled to retire at approximately age 49, after two 23-year operational periods separated by a three-year midlife refueling and complex overhaul.

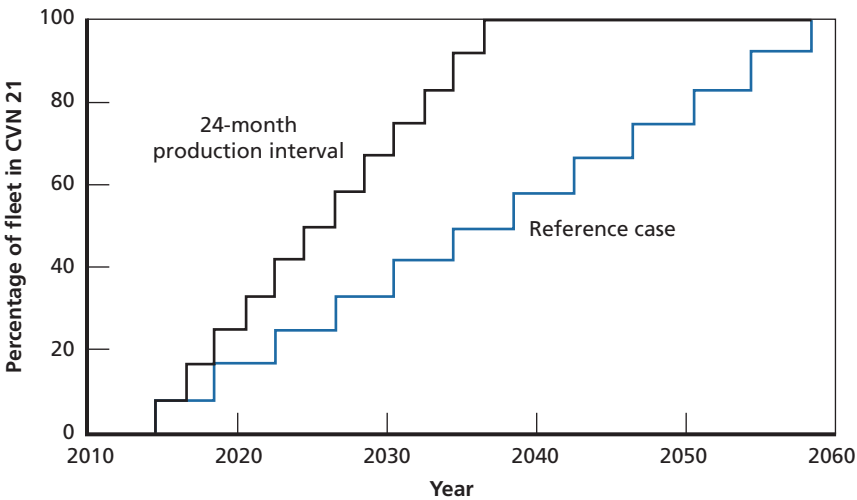
This plan will transform the carrier fleet into one composed of the higher-performance, lower-cost CVN 21 ships at a very slow rate. Even in 2035, half the fleet will be *Nimitz*-class ships.

We here propose a more rapid modernization plan: building new aircraft carriers more often and retiring about half the *Nimitz*-class ships at what would have been their midlife refueling point. We compare several variations of this approach with a reference case approximating the Navy's current plan. Criteria for comparison include rate of fleet modernization, average number of ships sustained

(total and operational), present value of acquisition and operating costs, and near- and midterm funding required. Our central finding is that the fleet can be modernized much faster, even twice as fast, for a cost premium no greater than 12 percent. That premium can be reduced through decreasing fleet size by 5 to 10 percent or possibly through aggressive cost reduction efforts. We also find that the industrial base is adequate to support the higher production rate.

The gain from a shorter interval between carrier production starts is depicted in Figure S.1, which shows the percentage of the total carrier fleet made up by the CVN 21 class as of the dates shown.[1] If the time between new carrier construction starts is halved—that is, if the production interval is dropped from the cur-

Figure S.1
A Build-New Strategy Can Modernize the Fleet Twice as Fast



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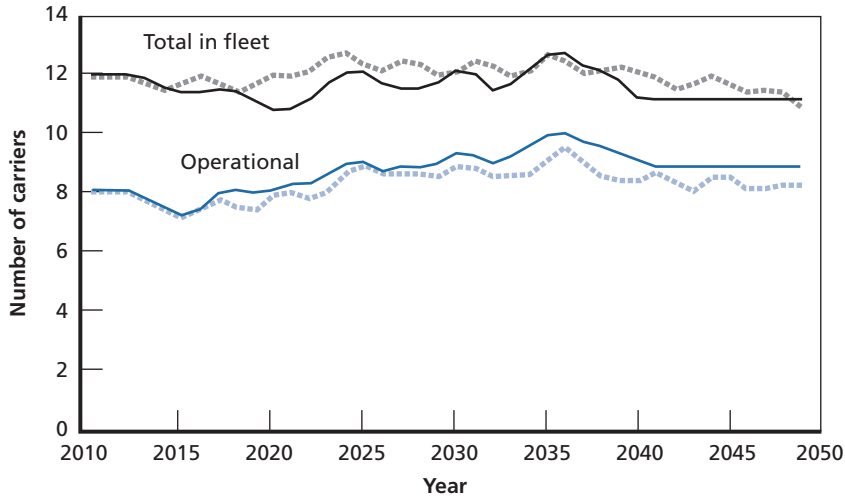
[1] Note that we show the CVN 21 percentage reaching and staying at 100 percent. However, we assume in all our analyses that CVN 21–class carriers are also retired when their initial fuel load is exhausted and that they too are replaced by carriers (presumably a follow-on class) built new.

rent notional 48 months to 24 months, the fleet is modernized twice as fast. CVN 21s will make up the fleet majority 12 years earlier, and the fleet will be transformed 22 years earlier.

As shown in Figure S.2, a 24-month interval sustains a fleet that is about half a ship short of the reference fleet in size. However, the number of operational ships (those not in the shipyard) is at least as great as in the reference case. This bonus emanates from the lower maintenance requirements designed into the CVN 21. More CVN 21s in the fleet mean more ships available for deployment or training.

These benefits come at a cost. Although the larger number of CVN 21s in the fleet translates into lower personnel and maintenance costs, the fleetwide savings are not large, particularly for personnel, for two reasons. First, it still takes a number of years for the fleet to evolve from a *Nimitz*-class fleet to a CVN 21 fleet; second, the greater savings many years in the future are worth much less than

Figure S.2
A Build-New Plan Sustains at Least as Many Operational Ships and Almost as Many Total as the Navy's Current Plan (Reference Case)



NOTE: Reference case data displayed as dotted lines.

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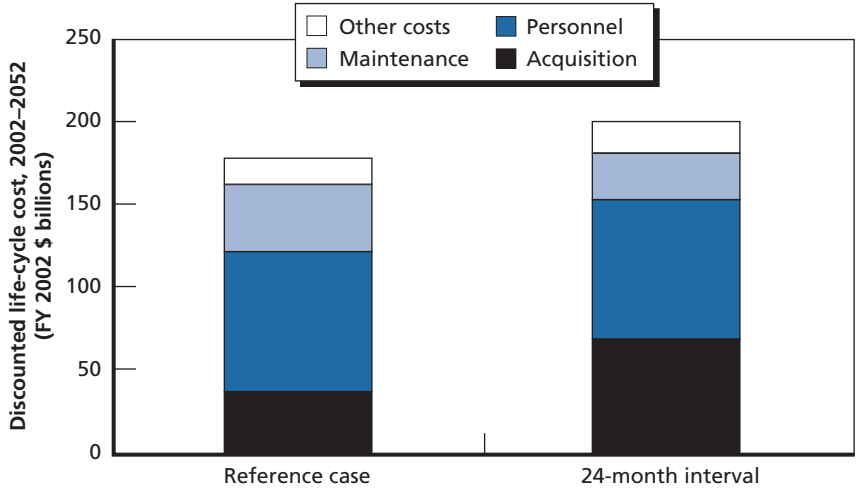
their nominal value today—that is, they must be discounted. Furthermore, a multibillion-dollar charge is incurred when an extra carrier is built every fourth year. Less than half those charges are offset by avoiding refueling a *Nimitz*-class ship. If the various costs and savings offsets in the construction, personnel, and operations and maintenance budgets are calculated for the 50-year period beginning in 2002, the net result is a cost premium for the build-new plan. That premium amounts to 12 percent, or $22 billion in present discounted value (see Figure S.3).[2] The extra costs would manifest themselves as an added $700 million annual budgetary requirement from 2005 to 2015 alone.

We examined two approaches to reducing that cost premium. First, we varied the specifics of the build-new strategy. Instead of 24 months, we tried a 30-month interval, which would modernize the

Figure S.3
Increasing the Production Interval to 24 Months Costs an Extra 12 Percent



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[2] For lack of data, our estimates do not include the cost of defueling and demilitarizing retired carriers, activities that will occur earlier and more frequently under the build-new plan than in the reference case. Our cost premium estimate may thus be somewhat conservative.

fleet almost as fast as the 24-month option. We tried retaining the 24-month interval but running one fewer *Nimitz* refueling (stopping with CVN 71 instead of CVN 72). Finally, we analyzed an option combining these two variants.

The results are shown in Table S.1. The first row under "After CVN 72" represents the nominal build-new plan and the other three cells (where each cell comprises *w*/*x y*% (*z*%)) represent the three alternatives just specified (further explanation follows).

The 30-month variants solve the cost problem. The cost premiums relative to the reference plan are near zero or even negative (see the numbers outside parentheses on the right side of each cell in Table S.1). However, the variants have the effect of taking one or more ships out of the fleet (see the numbers at the left under both the "After CVN 72" column and the "After CVN 71" column; the total reference fleet averages 12.1 ships). The penalty in operational ships ranges from almost nothing for the 24-month plan with one less refueling and complex overhaul (RCOH) to half a ship or more for the 30-month plans (see the numbers on the left side of each cell, to the right of the slash; the reference fleet averages 8.4 operational ships).

Our second approach to reducing the cost premium was to examine several cost reduction measures:

- Multiship buys: The faster build schedule might promote two-ship contract packages that could lower costs for engineering and for materials and equipment.

Table S.1
Build-New Options with Best Cost Implications Have Worst Fleet Size Implications

How Long to Allow Between CVN 21 Starts	When to Stop Performing RCOHs			
	After CVN 72		After CVN 71	
24 months	11.7/8.7[a]	+12% (+6%)[b]	10.9/8.2[a]	+8% (+1%)[b]
30 months	10.6/7.9[a]	+1% (–4%)[b]	9.8/7.3[a]	–3% (–8%)[b]

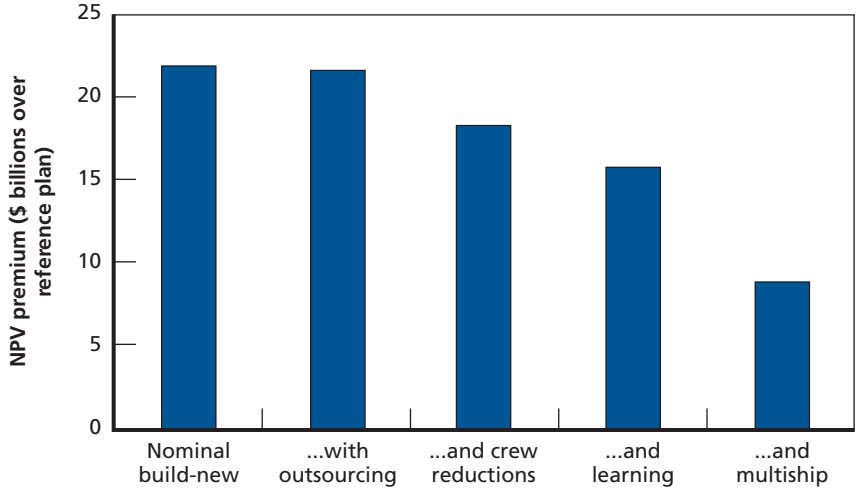
[a]Numbers represent total fleet/operational fleet.
[b]Numbers represent nominal cost premium (additional saving).

- Learning: A faster build schedule could allow for lower costs on repeated production tasks. We assumed for the build-new strategy a slight advantage over the lack of learning we assumed (from historical precedent) in the reference case.
- Additional crew reduction: The Navy postulates a crew reduction of as many as 800 for the CVN 21 versus the *Nimitz* class. We adopted 800 as the reference case reduction and postulated that an additional 200 crew members could be removed with aggressive measures to reduce ship manning.
- Outsourcing: We assumed a small increase in outsourcing over what is expected, for a modest labor cost savings on the work outsourced.

The cumulative effect of these savings on the original, nominal build-new plan are shown in Figure S.4. The relative effects of the measures are in the order listed above, with multiship buys having the greatest effect and outsourcing the least. Together, these cut the build-new plan's 12-percent cost premium by 7 percentage points, or more than half. Applying these measures to the variant build-new options also cuts their costs by 5 to 7 percent, as indicated by the parenthetical numbers in Table S.1. We regard these cost reduction measures as ambitious but feasible. By adopting them and by eliminating the CVN 72 RCOH (see top right cell in Table S.1), the Navy could modernize faster at hardly any cost premium.

The trade-off between faster modernization and a smaller operational fleet can be quantified in terms of future operational CVN 21 ship-years. Those ship-years can then be multiplied by a factor indicating the ratio between a CVN 21–class ship's capability and a *Nimitz*-class ship's capability, and future operational *Nimitz*-class ship-years can be added in. The result, which needs to be discounted for comparison with discounted costs, is the present value of future operational ship-years, weighted to favor CVN 21–class ships: a measure of the fleet's value to the Navy. The value is higher if the fleet converts more quickly to CVN 21s or if the number of operational ships is typically larger.

Figure S.4
Aggressive Cost Reduction Can Cut the Nominal Build-New Cost Premium in Half



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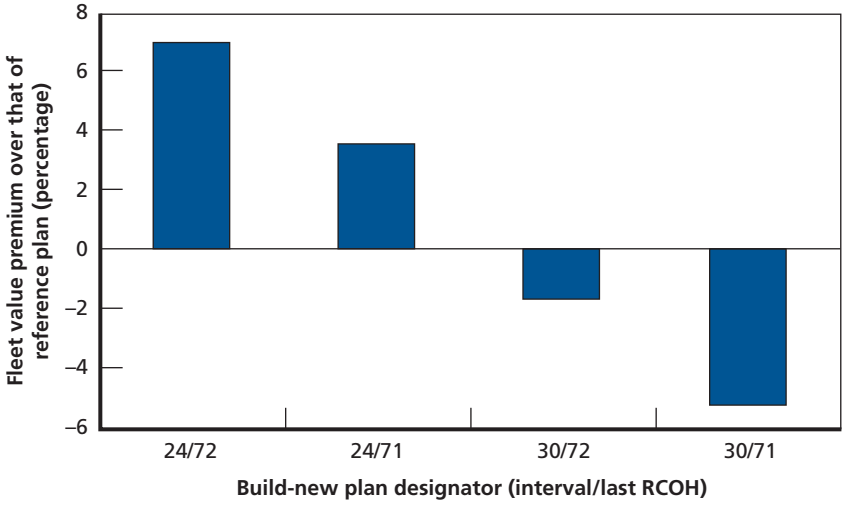
It was not within the scope of this report to predict a most likely CVN-21:*Nimitz* capability ratio. However, we examined several possibilities to get a sense of the fleet value premiums achievable. If, for example, the Navy were to view a CVN 21–class ship as 30 percent more capable than a *Nimitz*-class ship, the nominal build-new plan would result in a 7 percent fleet value premium over the reference case (see Figure S.5). That is, the fleet would have an average operational capability 7 percent higher (in discounted terms) than it would if the reference plan were followed. That may be compared with the 12 percent (or 6 percent) cost premium from Table S.1. Eliminating the CVN 72 RCOH, as noted above, virtually eliminates the cost premium if aggressive cost reduction is pursued. Figure S.5 indicates a fleet value premium of 4 percent. Whether these are good investments or not depends on the importance the Navy attaches to fleet value premiums of those sizes.

Figure S.5
Build-New Options with a 24-Month Production Interval Generate Greater "Fleet Value" than the Reference Plan or 30-Month Plans



NOTE: CVN 21 capability increment = 30%
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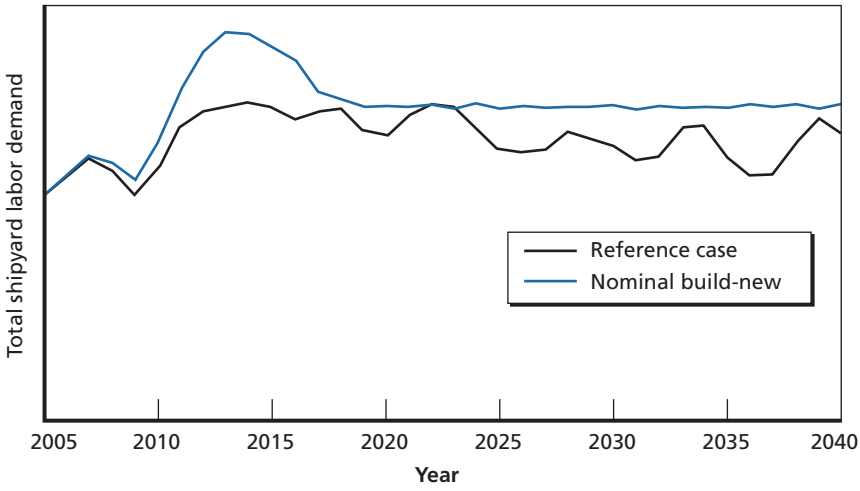
No industrial-base impediments hamper implementation of any of the build-new options defined here. A significant short-term transient in the shipyard labor profile occurs (see Figure S.6, 2017 and before), peaking at 24 percent over the reference plan. This demand must be managed, but the build-new strategy affords an opportunity for greater long-term workforce stability (after 2017). This is true as well for the variant build-new options, although for those both the peaks and the long-run average demands are somewhat lower than in the nominal build-new option.

Some facility upgrades are needed at the shipyard, but there appear to be no critical problems there. Suppliers of parts for the nuclear-propulsion plant will need to undertake some modest upgrades. The challenge there, however, is not really capacity but timing. If a build-new strategy is to be implemented so that the second CVN 21–class ship is started in 2009, propulsion plant supplier upgrades must begin promptly (i.e., long lead item procurement must

begin in FY 2005 to support an FY 2009 ship). Vendors of nonnuclear components are generally in place and capable of meeting the higher production rate.

Figure S.6
Build-New Strategy Requires Managing a Labor Demand Peak Until 2017



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