



SCHOOL OF PUBLIC POLICY

FFG(X)—the Bidding Decision

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Part I

June 2019

Ah, you're here. Hopefully you have some idea of what you're doing. Alright—let's get to the point.

"Yes, what is it that I'm supposed to be doing? The CFO just told me to show up at—"

—It's FFG(X). The frigate. We're thinking of bidding Type 26.

"Frigate?"

Frigate is a term of art in naval architecture. Traditionally it meant mid-sized sailing vessel with 20 to 50 cannons. By the Second World War it meant small escort ship. Today it means almost anything, except that it's generally between 3000 and 8000 tons, and carries a helicopter. It's a general-purpose naval vessel meant to hunt submarines, ward off air attacks, and sink enemy shipping. The US Navy wants to buy about 20 new ones, in a program it's calling Eff-Eff-Gee-Ecks. They could buy fewer; they could buy a lot more. It's supposed to be less expensive than their Arleigh Burke-class destroyers, and more useful than those little crappy ships they've been buying of late.

"Destroyer?"

A bigger ship with the same missions, basically. Bigger means more expensive. Smaller means more ships. More ships means a few might survive a massive Chinese missile barrage. Or not. But that's not our issue. What we need to know is whether we should bid Type 26.

"What's Type 26?"

That's the ship we designed for the Royal Navy. The first, HMS Glasgow, is under construction on the Clyde, but she won't be ready until 2023. She'll be the first of a class of eight. We've also sold the concept to the Australians, who want nine, and the Canadians, who want fifteen. All told, the 26 will be a 32-ship program—unless we can bag the Americans too, and then we're talking at least 52 ships, and that's real money.

"So what's the problem?"

This case study was developed as a basis for classroom simulation and discussion. Some details have been simplified or changed to facilitate that process. © James Hasik, 2023.

One problem is that the US Navy has already handed design contracts to five companies, at \$15 million each. We put forth a proposal, but we didn't get a contract. It's possible that they passed on us because our ship isn't in the water. That was supposed to kill us in Canada, but it didn't.

"But that doesn't mean that we're out?"

We just didn't get our design underwritten. Strictly speaking, nothing prevents us from jumping in at this point. And actually, it's four companies—Lockheed Martin dropped out. They couldn't upgrade their little ship into something substantive. And all those contract awards were before the Canadian announcement. The Americans don't need to choose from amongst the four remaining, but we can imagine that at least one of them is something close to what they want. How many of the bids are stalking horses is anyone's guess. The draft RFP has been out for some time. The final RFP is expected any day. After that, bidders will have a month or two to respond. Contract award should be next spring, maybe summer.

"Right—what do you need from me, and when?"

Number Three is arriving here in Washington a week from Monday, to talk with the US team about our options for several programs. This one is at the top of his list. We have the hottest-selling frigate in the world right now, and the US Navy has the hottest program. We could get them together. I need a brief before brunch on Sunday morning next; it's this and the Times crossword, so keep it short and simple. Write as if you were addressing a small child, or a golden retriever. Make that Saturday midnight next—I don't want this to be late, and I won't sound foolish when I brief the man.

"But what specifically?"

Fundamentally, should we bid? Bidding is not costless, right? I'll need your analysis of the requirements, the politics, and the competitive and strategic issues. Perhaps something about where should we build the things. Most importantly, how to price them. There's no point in this if we can't make money at it.

"We don't know where to build them?"

In case you missed orientation, we don't have our own construction yard in the United States, and the US Navy is legally prohibited from buying warships built outside the country. So that's a problem too. We have repair yards in Virginia, Florida, and California, but converting one of those to a ship-building yard would be a costly undertaking. We have at least three other options. One, we find an idle facility. Philly Shipyard is one that comes to mind, so look at that. Two, we convince one of the American bidders that his bid is stupid, and that he'd be better off getting behind Type 26. Three, we convince one of the American yards in the competition to take us as an alternative. That might not work, but it was more-or-less Fincantieri's plan before Lockheed Martin dropped out.

Oh, and one more thing. Show me the numbers. I need a model. This is business, and London doesn't make decisions on handwaving. Tell me what the other yards will bring, and how they might price it.

Part II

July 2019

The US Navy in the Post-Post-Cold War

In 2015, after years of observing a continuous increase in the size of the Chinese Navy, the US Navy began thinking about options for expanding its own fleet of surface ships. Its 65 Arleigh Burke-class destroyers were powerful individual units, of 9,000 tons, designed largely to escort aircraft carriers and convoys. Burkes were built at two yards: Ingalls Shipbuilding, a unit of Huntington Ingalls Industries (HII), in Pascagoula, Mississippi; and the Bath Iron Works (BIW), a unit of General Dynamics (GD), in Bath, Maine. Each ship carried the well-respected Aegis air defense radar system, 90 vertical launchers for air-defense missiles, 16 anti-ship missiles, and a 127 mm cannon for close-in defense. All had a flight deck, and those in the later tranches had a hangar for a single helicopter. However, the namesake ship had been commissioned in 1991, and the whole class was to have gone out of production by 2012. The follow-on concept, the 14,000-ton Zumwalt class, was deemed too expensive, at more than \$4 billion each, excluding development costs. So, building Burkes was restarted in 2013, at somewhat more than \$2 billion each.

The Navy was also buying two classes of “littoral combat ship” (LCS), designed for coastal patrol around the world. The *Freedom* class was built by a team of Lockheed Martin and Marinette Marine, in Marinette, Wisconsin. The *Independence* class was built by Austal USA, in Mobile, Alabama. Marinette’s parent company was the Italian shipbuilder Fincantieri, and Austal (“Australian Aluminum”) was based in Perth, Western Australia. Ships of both classes displaced about 3,500 tons, and were equipped similarly. Initially, heavy weapons were limited to one 57 mm and two 30 mm automatic cannons, Hellfire anti-tank missiles, and a 21-cell Rolling Airframe Missile launcher (a US-German project of Raytheon and Diehl BGT Defence), all for close-in defense. By 2019, each ship would also carry 16 Naval Strike (anti-ship) Missiles, from Norway’s Kongsberg. Unusually for ships of that size, both classes traded away weapons and fuel for horsepower: the ships were not of long range, but had top speeds of about 44 knots.

Each LCS had room for two helicopters, and the trimaran *Independences* had a particularly large flight deck, supporting two helicopters simultaneously, or multiple drones. Beneath that deck, the *Independences* had an equally large “mission bay,” with enough room for the ships to serve as drone motherships or high-speed transports for marines. The *Independences* were built from aluminum, which would be more susceptible to structural damage in combat. The *Freedom*s were sturdier, but unresolvable problems with their propulsion systems would lead the Navy to withdraw the first five after as few as five years in service. At about \$600 million each, both the *Independences* and the *Freedom*s were much less expensive than a *Burke*, but they were also much less capable against an adversary with large volumes of long-range weaponry.

A frigate

By 2016, the US Navy was actively considering whether its coastal-patrol LCS designs could be rethought as more powerful, ocean-open fighting ships. Naval officials began circulating the idea as that of a *frigate*, a common concept around the world, but one that had greatly evolved over time. From the 17th through the 19th centuries, frigates were full-rigged sailing warships with a single gun deck, and designed for scouting, escort and patrol. They could supplement the larger and more powerful ships-of-the-line, but not stand against them in battle. By the latter half of the 20th century, frigates were still open-ocean escort ships, but powered by gas turbine or diesel engines, and carrying various load-outs of missiles, automatic cannons, torpedos, and submarine-hunting helicopters. For the US Navy, since the 1960s, a frigate was officially

considered a special-purpose ship, devoted to either defense against submarines or aircraft, while a destroyer had strong capacities against both. For most other navies, the distinction between a destroyer and a frigate was not entirely clear: both types could be meant for fighting enemy surface ships, submarines, *and* aircraft.

The US Navy had procured multiple classes of frigates since the Second World War, and most notably, the *Oliver Hazard Perry* class. Ultimately, two firms with three different yards built 55 *Perrys* in the United States. Of those, 51 entered service with the US Navy, another four with the Royal Australian Navy (RAN). A further eight ships were built in Taiwan for the Taiwanese (Republic of China) Navy, six in Spain for the *Armada Española*, and two more in Australia for the RAN. All the US *Perrys* were decommissioned by 2015, but 34 continued in service with the navies of Bahrain, Chile, Egypt, Pakistan, Poland, Spain, and Taiwan.

By 2017, the US Navy's thinking had advanced past a reliance on two LCS designs. In May of that year, at the annual meeting of the United States Naval Institute, Acting Navy Secretary Sean Stackley told reporters that the Navy planned an open competition for a wholly new frigate:

It's going to be a best-value type competition, so cost and capability will be factors... I expect there to be a range of designs... If you're an existing builder, you are in a competitive position because you have a hot production line, you've got mature costs. Now their challenge is integrating new capabilities... Definitely, the competition will be open to foreign designs.

Stackley noted “some caveats.” All contenders would need to meet US requirements, especially for survivability. All would be expected to give the Navy the technical data rights needed to maintain and modernize the ships. In accordance with US law, they would need to be built in US shipyards.

Frigates on the global market

In July 2017, the Navy released a request for information (RFI) for a ship it designated the *FFG(X)*. In the US Navy's scheme, “FF” indicated a frigate, and “G” indicated a ship equipped with a long-range radar and guided missile system for area air defense. “X” meant of initially undetermined design. That is, between 2015 and 2017, the Navy had changed its approach from a smaller and special-purpose “FF” to a larger and broader-purpose “FFG”. The increase in size was largely due to the addition of the area air-defense system, which required a large radar and missile magazine.

Rear Admiral Ronald Boxall, the Navy's director of surface warfare, explained that the thorough RFI was intended as a “dialogue with industry to get the most capability for the best price,” and to avoid “sticker shock.” At the time, the international market for frigates with such broad capabilities was largely taken up by five designs. Exhibit A provides photographs and artwork.

The FREMM was actually two closely-related designs from two cooperating firms. Italian shipbuilder Fincantieri offered a 6,700-ton *Fregata Europea Multi-Missione*, and the French firm DCNS offered the 6,000-ton *Frégate Européenne Multi-Mission*. FREMMs were serving in the Italian (having been ordered in 2005), French (2005), Royal Moroccan (2007), and Egyptian (2015) Navies. FREMMs were produced in both Italy and France, and discussions had commenced about building further ships locally in Egypt.

The Álvaro de Bazán (or F-100) class was a 5,800-ton ship from the Spanish shipbuilder Navantia. The ships had been designed from the start to accommodate the American Aegis system, which was a standard in the US and several other navies. Five F-100s had entered service with the Spanish Navy, starting with the namesake of the class in 2002, and the last in 2012. Another two were in service more recently with the RAN, with a third due in 2020, as the *Hobart*-class destroyers. Navantia had

cooperated with an Australian shipbuilder to construct the ships locally. A further five F-100s had been built in Spain as the *Fridtjof Nansen* class of frigates for the Royal Norwegian Navy. In November 2018, the fourth of that set, HNoMS *Helge Ingstad*, rolled over and partly sank in a fjord after a collision with a cargo ship.

The MEKO A-200 was a 3,700-ton ship from Germany's Thyssen Krupp Marine Systems. The current design was an evolution of a concept (the MEKO 200) which had been in service with eight navies, starting in 1987, and which was still under construction. MEKOs were a frequent choice for navies seeking modern capabilities on a budget. The MEKO 200 design had served as the basis of the ANZAC class of frigates for the Royal Australian Navy and the Royal New Zealand Navy, but its small size provided uncomfortable seakeeping in the Southern Ocean. The RAN's succeeding *Hobart* and Type 26 (see below) ships would be much larger.

The Arrowhead 140 from Britain's Babcock International was a 6,500-ton design based on the *Iver Huitfeldt*-class frigates, in service with the Royal Danish Navy since 2011. The Arrowhead would be in competition to become the Type 31 General Purpose Frigates for the Royal Navy. The team to customize the design for British requirements, and build the ships in the United Kingdom, was assembled in May 2018 by Babcock International, and included Thales Group (France) Harland and Wolff (UK/Northern Ireland), BMT (UK), Odense Maritime Technology (Denmark), and Ferguson Marine (UK/Scotland).

The Type 26 was a relatively new design from BAE Systems. At 6,800 tons, it was the largest frigate on the international market. The ship had room for 24 vertical launch cells for the new British-built Sea Ceptor air defense missile, and another 24 Mark 41 cells for missiles made to American designs. The ship also featured a mission bay, akin to that on the littoral combat ships, though somewhat smaller. The ship had already been chosen by the Royal Navy (in 2010), the Royal Australian Navy (in 2018), and the Royal Canadian Navies (also in 2018). However, building for the Royal Navy did not start until 2017, and at a slow pace, so the first ship, HMS *Glasgow*, would not be launched until 2022.

Requirements for the FFG(X)

To meet the rising Chinese threat, the Navy wanted construction soon. After two decades of difficulties procuring ships, the Navy wanted to reduce risk. These demands together meant that the eventual request for proposals (RFP) would call for no new technologies or even systems in the design of the FFG(X). This ships would rely on off-the-shelf or government-furnished equipment (GFE), specified by the Navy, around which the chosen shipbuilder would build its ship. The frigates would find and track aerial targets with a scaled-down version of Raytheon's Air and Missile Defense Radar (AMDR), already chosen as a successor to the Aegis on other US Navy ships. Electronic warfare would be undertaken with the venerable but continuously upgraded SLQ-32 suite. Air defense and anti-submarine missiles would be accommodated with a Mark 41 vertical launch system (VLS). Designs would require eight to sixteen anti-ship missiles in a separate, standard deck launcher. For close-in defense, the frigates would depend on two weapons: a 21-cell Rolling Airframe Missile launcher, and a single 57 mm automatic cannon from BAE Systems Bofors, of a Swedish design built in Kentucky. All these weapons were widely in service with navies around the world. Exhibit B provides further detail. The Navy estimated that the cost of all this equipment would be \$260 million.

For the ship itself—the hull and the mechanical and electrical components (HME)—the Navy would require a “parent design.” As Stackley had noted two years prior, foreign designs would be permitted, and foreign subsystems largely permitted, as long as the ships were constructed in the United States. The US Navy and the US Coast Guard had experience with this approach. The Navy's *Osprey*-class mine hunters (881 tons)

were larger versions of the *Lerici* class, designed by Italian shipbuilder Intermarine, and serving in six navies. The Coast Guard's *Sentinel*-class fast response cutters (353 tons) were a version of the Damen Stan series of patrol vessels, designed by the Dutch shipbuilder Damen Group, and serving in over a dozen navies and maritime constabularies. The US Navy had not, however, previously purchased a large warship this way.

The Navy sought 20 frigates. The service would request Congressional funding for the first in fiscal year (FY) 2020 (which would begin on 1 October 2019), and would anticipate delivery in July 2026. For the following 18, the Navy planned to request money for two frigates in each succeeded appropriation from FY 2021 through 2029. The Navy would seek the 20th in FY 2030, but possibly more thereafter, or even sooner.

Conceptual design contracts

In February 2018, in accordance with a draft RFP for the eventual ships, the Navy awarded conceptual design contracts to five firms or teams, for just under \$15 million each. This was hardly enough money to design a warship, but it was just enough to provide indication of what the design might be. The concepts would also provide the Navy with preliminaries details on where and how the ships would be built. More than five firms had bid for contracts. While the Navy would not disclose the identity of unsuccessful bidders, Thyssen Krupp announced shortly thereafter that the Navy had rejected its offer to refine the design of the MEKO A200. Two of the contracts were for ships that were clearly already in service, and another two were for adaptations of littoral combat ships. A fifth remained a mystery.

Fincantieri: FREMM. Alone amongst the FFG(X) concepts, the US FREMM would not carry a hull-mounted active sonar for acoustically localizing submarines at short range, but only (as required by the RFP) a towed-array passive sonar for listening for submarines at long-range. Attacking submarines would depend more heavily on the embarked helicopters and vertically-launched anti-submarine rockets (VL-ASROCs, guided missiles which carried torpedoes). With a combined diesel-electric and gas turbine (CODLAG) power plant, it also offered the greatest electrical power generation, which would be useful for future installation of energy weapons. The ship was the largest subject of a conceptual design contract, and was widely considered impressive by American naval officers. Fincantieri's chief representative in the United States, retired Vice Admiral Richard Hunt, had also signaled early and repeatedly that the company would convey to the Navy full data rights to the entire design (see below). The ships would displace 8,000 tons, and presumably be built at Marinette in Wisconsin. However, that yard at the time had facilities for *Freedom*-class ships, which were just over half the size.

GD/BIW and Navantia: F-100. As all extant versions of the *Álvaro de Bazán* class largely featured US systems, the American and Spanish shipbuilders were offering the design that required the least customization to meet the US Navy's expectations. The power plant was a fairly standard combined diesel and gas turbine (CODAG) arrangement. The corporate relationship had existed for almost 20 years, as the F-100 was the product of a teaming arrangement, called the Advanced Frigate Consortium, Navantia's predecessor Izar, formed in 2000. The ships would displace 7,000 tons, and be built in Maine.

Lockheed Martin: Freedom Frigate. Lockheed Martin was a major producer of naval weaponry and combat systems, and an original prime contractor in the LCS program. What it lacked was a shipyard. As Fincantieri Marinette actually built the LCS, it would build the "Freedom Frigate," as a major subcontractor, if the Navy chose that design. While the *Freedom*-class was problematic for the Navy, it had lots of them and lots of experience with them. Power and propulsion were also the standard CODAG. Further, the Freedom Frigate seemed to have much in common with Lockheed's offering to the Royal Saudi Navy, originally conceived in 2011. In October 2015, the Saudis requested four, 4,000-ton,

“multi-mission surface combatants,” equipped with eight-cell Mk-41 missile launchers and a scaled-down Aegis radar system. The ships were on contract in March 2018, with construction at Marinette due to start in October 2019. The US frigates, however, would be much larger: 6,500 tons.

Austal: “Austal Frigate”. Austal’s offering was the clear departure from the pack. All other ships were traditional steel monohulls. Like the *Independence*-class LCS, Austal’s frigate was a (scaled-up) aluminum trimaran. This afforded much more deck space, for a flight deck capable of handling two manned helicopters and two drones, as well as 16 anti-ship missiles (twice the threshold requirement). Power and propulsion were combined diesel and diesel (CODAD), which eased maintainability overseas. Much of the naval establishment in the US, however, had qualms about the damage resistance of aluminum hulls. The ships would displace 5,800 tons, and be built in Alabama.

Hill/Ingalls: unknown. Ingalls Shipbuilding won a conceptual design contract, but without an announcement of what that design was. The Navy provided no details in its announcement of the five contracts either. Indeed, Ingalls was the only contractor that did not present a model or even a drawing of its FFG(X) at the Surface Navy Association symposium in Crystal City, Virginia, in January 2019. At previous trade shows, the company had shown a design it termed the “Patrol Frigate,” a version of its 4,500-ton *Legend*-class National Security Cutter (NSC) built for the US Coast Guard. Despite repeated press inquiries, the company declined to elaborate in any way on what it would be offering for FFG(X). Speculation also swirled around Hill’s long experience building *Burkes*, and the notion that the yard had conceived a scaled-down “frigate version.” However, if the Patrol Frigate were the basis Hill’s offering, it would have the longest range of any of the competing designs: 8,000 nautical miles. Regardless of design, the ships would be built in Mississippi.

In January 2019, the Navy revised its draft request for proposals (RFP), to double the number of required vertical missile launch cells, from 16 to 32. In May 2019, Lockheed Martin withdrew from the competition. During the conceptual design phase of the program, the company had passed two design reviews with the Navy, but eventually concluded that its ship could not be sufficiently expanded to accommodate the greater requirements.

Evaluating offerings

On 20 June 2019, the Navy released its final RFP. The Navy would provide a fixed-price, incentive-fee (FPIF) contract, a standard approach in naval shipbuilding for new classes. The Navy’s financial inspectors would audit the shipbuilder’s costs during construction, and the service would share in the cost under-run or over-run. The RFP requested a proposal from the contractor as to sharing percentage, but a fifty-fifty split was common.

The initial contract would provide for a single ship, followed presumably by options for the next nine. The Navy would award based on its assessment of five factors (see below) and the average price offered for the first ten ships. However, the Navy would not be absolutely committed to any ship after the first. The Navy had only thrice prior purchased its ships in bulk, in what the military termed “block buys.” The Navy would also include \$125 million for detailed design of the ship, though this sum was considered too low for that work.

The RFP explained that the Navy would assess each offer according to five factors. Each contained *threshold* and *objective* criteria, effectively the minimum quality the service sought against any factor, and the maximum quality that it would desire against that factor.

1. *Ship design*—the maturity and completeness of the design in the bid package, in all its attributes.

2. *Objective performance*—how the design addressed the objective and threshold performance criteria. Range and margins could become a heavily weighted factors if all others are equal. All designs would need to meet the threshold requirements. Those exceeding thresholds would receive extra credit, but no further credit would be granted for exceeding objective levels.
3. *Schedule, production, approach, and facilities*—how the firm or team was equipped to handle the construction of a tranche of ten multi-thousand-ton warships, including its projected capacity, manufacturing processes, and infrastructure.
4. *Data rights*—the full details of the design, and a contractual promise to grant the Navy permission to use the data. The RFP expected a full technical data package (TDP) that would allow the Navy to maintain and modify the ships. The RFP requested, but did not demand, a full set of technical data rights (TDRs) that would allow the Navy to hire another yard to build the ships, should it wish to later expand production. The Navy would also consider the bidder's apparent willingness to comply, and any obstacles to doing so.
5. *Price*—evaluated at the ceiling price of 125 percent of the target cost, plus any additional equipment beyond the required package of GFE. As the contract would be FPIF, the RFP also called for disclosure of expected costs—and thus targeted profit margin. The Navy would allow a profit margin of up to 15 percent, but would claw back anything in excess of that. On the other side, the Navy would not subsidize cost overruns of greater than 25 percent beyond the cost—not price.

As part of its fiscal year 2020 appropriation, the Navy was requested \$1,281.2 million to procure the first FFG(X). Thereafter, the service anticipated a cost before inflation of \$900 million each, in a range of \$800 to 950 million. The Navy expected that the “basic construction cost” of each frigate, which was largely HME, and before weapon systems and government-furnished equipment, would be about \$495 million. The contract would provide escalation clauses for unforeseen increases in the price of raw materials and labor.

The Navy would evaluate each factor in two ways: with a qualitative *rating of outstanding, good, acceptable, marginal, or unacceptable*; and with an assessment of the *risk* around that rating of *low, medium, or high*. Sufficiently approaching enough objective requirements would net the design a good or even outstanding rating. The Navy was not particularly clear about just how it would assign those ratings.

The RFP further stated that the first two factors would be of roughly equal importance. Each of the first two would be more important than the third, and the third more important than the fourth. Together, these first four factors would be slightly more important than the price. Any rating of unacceptable in any category, however, would disqualify the entire offer.

Bids due

Offers were due on 22 August 2019. Teams had 63 days in which to finalize their designs and price their ships. Teams which had not received conceptual design contracts were still eligible to compete. The Navy planned that it would commission an independent cost estimate of the several bids, to begin in January 2020, to ascertain whether the prices were realistic. Contract award was planned for July 2020.

Exhibit A: Photographs and Renderings



USS *Independence* pierside at Naval Air Station Key West, Florida, in 2010. Photo by Nicholas Kontodiakos, and courtesy of the US Navy.



USS *Freedom* on sea trials off the coast of Southern California in 2013. Photo by James R. Evans, and courtesy of the US Navy.



The *Legend*-class National Security Cutter USCGC *Hamilton* and the Turkish MEKO-type frigate *Turgutreis* in the Black Sea in 2021. Photo courtesy of the US Navy.



The *Iver Huitfeldt*-class frigate *Niels Juel* of the Royal Danish Navy underway in the Red Sea in 2019, as part of the French Navy's *Charles de Gaulle* carrier strike group. Photograph by Joshua R. Leonard, and courtesy of the US Navy.

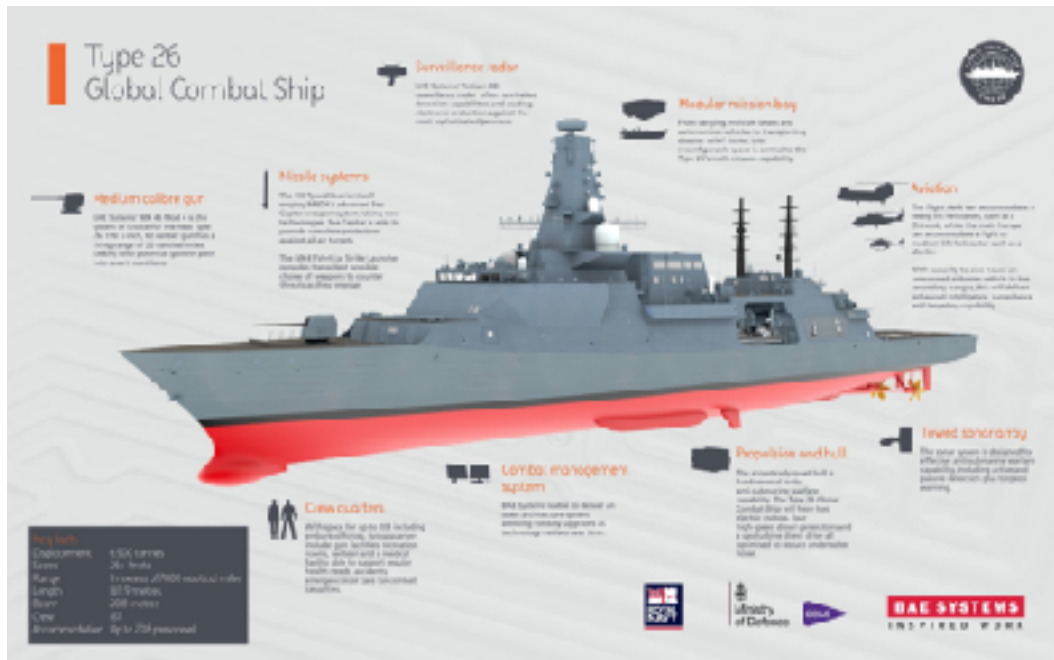
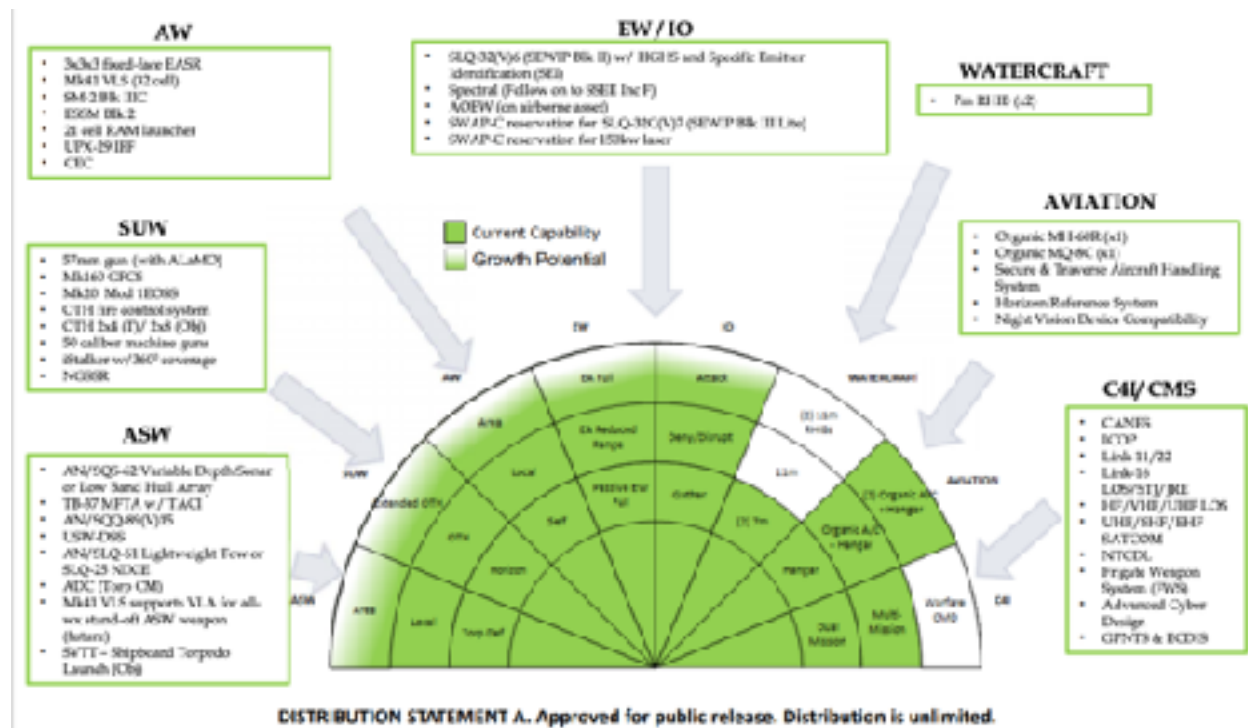


Diagram of the Type 26 frigate, for Royal Navy service. Courtesy of BAE Systems.



The Arleigh Burke-class destroyer USS Donald Cook leading the frigate Álvaro de Bazán in 2005. Photo by Nathan Laird, and courtesy of the US Navy.

Exhibit B: GFE and other systems required in each FFG(X)



Part III

August 2019

"Dick Shipman!"

I am! What do you need, shipmate?

"I heard you're the one to ask about pricing in naval procurement."

Ships? I know a few things...

"Maybe a few more than a few. You come well recommended: naval architecture at MIT, operations research at Naval Postgraduate..."

I'm only self-taught in economics too, but I have a team. Seriously—what do you need to know?

"It's FFG(X). We're thinking about bidding. Bids are due soon. We need to decide, and wrap this up. The key question is pricing. What will the other bidders bid?"

So the rumors are true. Type 26 is a heck of a ship. Admirals like it about as much as the FREMM. It won't be cheap, though.

"Leave that to us. What I need to understand is how I can predict what cheap means in this market. If we can't chase that price profitably, we won't bid. On the other hand, if cheaply priced means cheaply built, we figure that we can price higher and win. Make sense?"

Assuredly. It's actually just a simple spreadsheet exercise. You could write some code—in Python, R, whatever you prefer—but your boss might not relate to the output. So we keep it familiar.

Let's start with the RFP. I've read much of it; my team has summarized it. Actually, we've started this exercise, figuring that someone would ask. You know the factors, the assessment ratings, the risk thing, right? We have mapped that into a table, here. I've summarized the names of the factors for brevity, dude. We've also the red-teaming and the black-hatting and all that, to figure out what we think of all the concepts, as well as the designers and the yards supporting them. Rather than write down adjectives, we've just converted the words to numerical scores. We will need those eventually, so that we can calculate averages. Otherwise, we're just staring at words.

Ship & Builder	Trimaran/Austal		F-100/BIW		FREMM/Fincantieri		Unknown/Ingalls	
Factor	Grade	Risk	Grade	Risk	Grade	Risk	Grade	Risk
Design	2	High	3	Medium	3	Medium	?	?
Performance	2	Low	3	Low	4	Low	?	?
Construction	3	Medium	3	Medium	2	Medium	3	Low
Data rights	3	Low	3	Low	4	Medium	3	Low
Price	?	?	?	?	?	?	?	?

We think that Austal's trimaran is not the best idea for a frigate, and it's not clear how they double the size. There are arguments for fleet commonality with the Independence class, but the more commonality, the more risk in the departure with the design. So, low mark, high risk. The ship will likely do what it says, so low risk there, but it won't do much if someone so much as sticks a knife through it. So, not good. Austal has the most productive shipyard in the US—though that's a low bar—but it's a small yard, so it's not clear whether they can do what they say. So, good mark, medium risk.

Then there are data rights. Pretty much everyone will give the Navy most things. The Italians are promising the kitchen sink, but one always has to wonder about export controls. So that's that line.

Let's tack back to the real frigates. Our bias in the competition is towards larger, tougher ships. You get optionality for future weapons and systems. The Navy wants to change a whole bunch of things from the European designs, so medium risk. As I've said, the admirals I've chatted up really like the FREMM. Fincantieri and the Italian government—primary shareholder, by the way—did a great job of getting one of theirs up and down the east coast for tours. So, high mark, no question. The only question is building it in Wisconsin. That will require a big expansion of that yard. It's a facility for Freedoms. Bath, on the other hand, is a totally adequate yard for this.

"That's still a lot of question marks."

There's a lot we don't know. We don't even know what Ingalls is bidding. As strategy goes, I love Hill's silence. If they're baking up some new idea for the frigate after years of promoting that Patrol Frigate, this could turn out to be a huge head-fake. So we hesitate to give it any grade.

But price we can address. Basically, there are at least two ways we can deal with it. The first is to give it the same adjectival rating as the four qualitative factors. The RFP doesn't say that's what the Navy will do, and it seems a little odd. How would we break that down? We could start with the Navy's public statements about the anticipated price range: hoping for \$800 million each, but willing to tolerate \$950 million each. That's a \$150 million spread. We could build a little table with that:

Price range	Adjectival rating	Numerical score
Less than \$800 million	Outstanding	4
Between \$800 million and \$850 million	Good	3
Between \$850 million and \$900 million	Acceptable	2
Between \$900 million and \$950 million	Marginal	1
Greater than \$950 million	Unacceptable	0

"Simple enough."

Exactly. Too simple. It's actually unhelpful. Why force-fit categories onto numerical ranges, just to convert them again to numerical scores? And is \$851 million really the same as \$899 million, while \$901 million is so much worse?

"That doesn't make sense."

No. We have to hope that the Navy isn't that woolly-headed. The alternative is to think like marketing analyst, and create a price-for-quality supply-and-demand diagram. The source selection people may or may not do

that explicitly, but they'll likely at least do something like that implicitly. So, we calculate an average qualitative score for each entry, according to the factor weightings, and we plot that.

"That makes more sense, but what are the weights? I have to do something with that ratings table."

Indeed. All this starts a briefing slide, but thinking in PowerPoint can be fatal. Again, some people in the Navy might try grade the papers that way, but their source selection committee might also have enough engineers and applied economists that someone will want to make sense of all that. So let's start by quantifying the weightings.

"This is more important than that, which is more important than the other thing... What is all that?"

You get it. Navy is being deliberately obfuscating here, because the admirals don't want to be held to a calculation that some GAO auditor can check. We need to make an estimate of how they will actually think. The RFP just says that Design = Performance > Construction > Data. It's rough, but for a first pass we could say that Design is 35%, Performance is 35%, Construction is 20%, and Data is 10%. You can change that later, if you get the sense that some other numbers are better. Just make sure that they add up to 100%.

"Obviously. Well, this looks good for the Italians. What's next?"

Ship & Builder		Trimaran/Austal		F-100/BIW		FREMM/Fincan.		Unknown/Ingalls	
Factor	Weight	Grade	Risk	Grade	Risk	Grade	Risk	Grade	Risk
Design	35%	2	High	3	Medium	3	Medium	?	?
Performance	35%	2	Low	3	Low	4	Low	?	?
Construction	20%	3	Medium	3	Medium	2	Medium	3	Low
Data rights	10%	3	Low	3	Low	4	Medium	3	Low
Weighted avg.	100%	2.3		3		3.25		?	

We need to think the cost structures of the various yards, and the cost of the ships they want to bid.

"If I didn't work for a government contractor, I'd say that price should depend on value, not cost. Or maybe I'd say that if I just worked at Transdigm..."

Also right! But it does here, for two reasons. Let's be honest: shipbuilding is a low-margin business, so you always need to think about underlying costs before pricing. It's maybe even more important that the Navy is going to audit the builder's costs as part of the cost-sharing arrangement. The Navy is going to see the profit margin in the proposal, so we can expect that every bidder will be reticent about going too high.

Our research suggests that the labor and overhead rates of the yards are pretty comparable. The big difference is Austal—it really does have the most productive shipyard in the US. It even offsets the cost of aluminum, which as you probably know, is a lot more than steel. So that goes on the cost side of the problem as well. Marinette is pretty efficient too; Bath less so. Even so, everyone has gotten better than the Navy expects; these are semi-proven designs, so for a change, we expect no fiascos. There will be learning curves, non-recurring engineering, and a lot more detail, but let's simplify the costing to get straight to the pricing. Seriously, the Navy should be happy.

Avg. cost per ship (US \$ MM)	Trimaran/Austal	F-100/BIW	FREMM/Fincan.	Unknown/Ingalls
Tonnage	5,800	7,000	8,000	?
Basic construction cost per ton	\$0.045	\$0.052	\$0.045	?
NRE spread over ten ships	\$20	\$20	\$20	\$20
GFE	\$260	\$260	\$260	\$260
Additional costs	\$20	\$0	\$40	?
Total	\$561	\$644	\$680	

“The Italians look less impressive now—but those are costs, not prices. We need margins, right? Or rather, target profits—it’s FPIF.”

Right. So let’s put this into a combined table. We’ll guess at a 10 percent target profit, just in the first iteration. The price points actually sit almost on a straight line. You can do the arithmetic from here. Each additional grade point for overall quality will probably require about another \$136 million per ship. One might try to claim that the F-100 is the best value-for-money, but this whole model is quite inexact. That would be a reach. This is just a guide for your thinking, not a substitute for it.

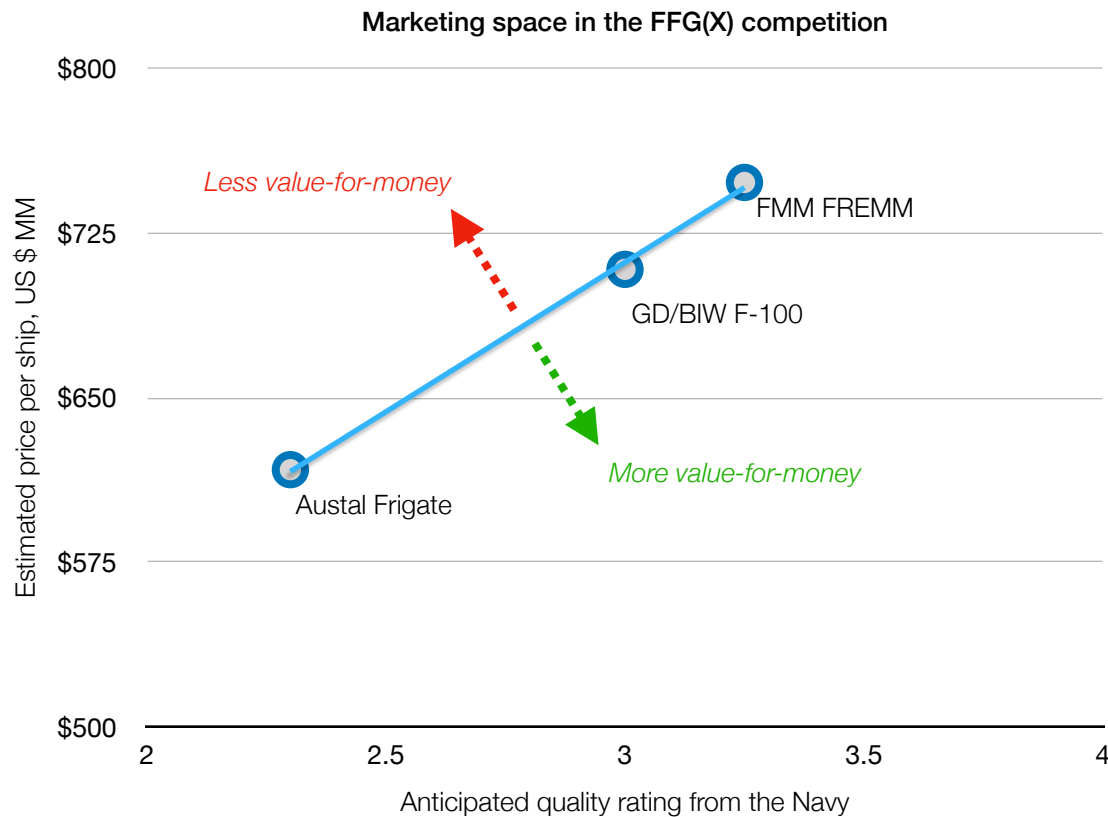
Ship & Builder		Trimaran/Austal		F-100/BIW		FREMM/Fincan.		Unknown/Ingalls	
Factor	Weight	Grade	Risk	Grade	Risk	Grade	Risk	Grade	Risk
Design	35%	2	High	3	Medium	3	Medium	?	?
Performance	35%	2	Low	3	Low	4	Low	?	?
Construction	20%	3	Medium	3	Medium	2	Medium	3	Low
Data rights	10%	3	Low	3	Low	4	Medium	3	Low
Weighted avg.	100%	2.3		3		3.25		?	
Cost (US \$ MM)		\$561		\$644		\$680		?	
Target Profit		10%		10%		10%			
Target Price		\$617		\$708		\$748			
Realized Cost									
Realized Profit									

“This all makes sense. If you want more in a ship, you need to pay for it. Just don’t take the whole thing too seriously. All models are wrong; some are just more wrong than others. Great. We can graph this. Figure out our positioning.”

Definitely. Follow the green arrow, or at least sit on the blue line, if you really want to bid. The Navy probably won’t pay more for less. But there’s lots more. Make sure that your costs come in below that blue line! The Navy’s cost sharing has limits. So model them stochastically to see what might happen. Remember those risk ratings? Think about what to do with those. Think about what profit margins Austal and Fincantieri might seek. GD and HII have plenty of work at their yards, but the smaller yards have thin order books after the

LCS program ends. They might be motivated. Fincantieri is majority state-owned, and the bid might have political backing in more ways than one. Model that as well. And getting back to HII, that's a real wildcard.

Do all this, and then try to figure out what price you'll need for a good change of winning. You'll get some interesting sigmoids if you plot them. S-curves, they say in business. Go, think about this. Talk to me this afternoon. I'll be in the conference room. Right now, I need a coffee.



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