Design to Simplify Complexity

The maritime industry traditionally has been called conservative, painfully slow to try and adopt new technologies. But driven by regulation and economics, times are changing as ship owners in military, cruise and offshore sectors are forced to find modern solutions to modern problems. The result: ships today are far more complex systems to design, build and maintain throughout their life-cycle.

By Gregory R. Trauthwein, Editor, Maritime Reporter & Engineering News

Navy Ships

The military sector as a whole designs, builds and maintains arguably the most complex systems at sea, systems that generally are tasked to support life at sea for an extended period, work seamlessly in a network of other at-sea, airborne and landside assets, all the while carrying a lethal load of weaponry. Adding to complexity of military ship design are the need today for most navies to engineer platforms that are multi-mission, to engineer platforms designed to drive down life-cycle costs to accommodate thinning government budgets.

“Modern (navy ships) need to be functionally flexible in order to be deployed in a big variety of tasks, missions and environments,” said Robin Brouwer, senior naval architect, product manager combatants at Damen Schelde Naval Shipbuilding in The Netherlands. “First technological developments have led to an increase in the number of onboard sensors, communication and data networks, causing higher system density. But even more important, these developments have led to a considerably higher level of on-board system integration. The focus on cost reduction, both investment as life cycle cost, leads to a further reduction of crew sizes and level of on-board automation as well. The designer has to deal with this increasing amount of interfaces and often conflicting requirements in order to create a design which will work and be affordable in the end.”

Navy ships are unique also due to the relatively long development cycle, which can range from 10 years for a surface ship to up to 25 years for a nuclear submarine. Adjusting design during the process, particularly the ability to integrate changes of technology that didn’t even exist when the process began, is one of the more daunting design tasks. A long and cumbersome process, oft changing requirement and a fixed budget is the recipe for many engineering nightmares.

“First, the main thing is being able to have an integrated approach to continuously evaluate cost and operational performance of the design from the very early start of the design process,” said Brouwer. “Another issue is being able to adequately manage requirement or technical changes themselves. It is recommended to have a small multi-disciplinary team in place consisting of experienced navy officers, designers and cost engineers, being able to judge the operational, technical and financial consequences.”

Concept is put into practice daily at General Dynamics NASSCO in San Diego, a yard which deftly balances a commercial and naval newbuild order book. Though the Navy ships NASSCO builds are not combatants, they are nonetheless multi-mission platforms built to exacting U.S. Navy specification.

Most recently the yard completed and is preparing to deliver the Navy’s third Mobile Landing Platform (MLP), the Lewis B. Puller, which is the first afloat forwarding staging base (AFSB) variant of the MLP. All MLPs are built around four core capabilities: aviation, berthing, equipment staging area and command and control, and given that each variant is different each is essentially a custom ship. Impressively, the MLP series to date at NASSCO has had less than 2% rework on each, according to Kevin Graney, Vice President and General Manager. He attributes this success to three of the yards basic shipbuilding tenets: complete the design before construction begins; complete detailed planning efforts before laying the keel; and ensure that lessons learned from ship to ship are captured and rapidly implemented.

“One of NASSCO’s greatest strengths is our culture of continuous improvement,” said Graney. “A crucial part of that culture is having a systematic means to identify and adjudicate change as quickly and effectively as possible. At the centerpiece of these processes is our engineering liaison team, which leads a group called the Rapid Response Team. The Rapid Response Team is a cross-functional group consisting of approximately 10-16 individuals from our NASSCO engineering, planning, and supply chain departments. Key individuals from this team interface directly with our production personnel to identify and resolve issues. If there is an issue or even an improvement idea that requires change, the change is formally documented, resolved, and then permanently fixed for future hulls.”

Cruising Complexity

Photo: Tillberg Design International

Tipping the other side of the navy ships spectrum are modern cruise ships. “A modern cruise ship is basically a floating city,” said Tomas Tillberg of Tillberg Design International. “Regulatory requirements are one of the foundations of the designs. The interrelationship between the owner, the designer, the naval architect and the yard/contractors is another. Another key element is the timely sequence of events adhered to in designing and building a ship. The location and functionality of all spaces, their appearance and the cost of their designs are also factors in this mix. At the end of the day it’s all about offering the guest every time an experience beyond his expectations.”

Cruise ships that have grown in size and complexity exponentially since the industry was born in the early 1970s, when the 18,000-ton Song of Norway featured 400 state rooms offering hundreds of passengers a brief respite to warmer weather. Modern ships are literally 10 times larger, the ship itself becoming the destination, packed with entertainment options and revenue generating sources, powered by an increasingly sophisticated marine machinery network.

Designing and building modern cruise ships– the largest that can cost more than $1 billion per ship – is a combination of technological advance and the evolution of cruise shipbuilding know how that seamlessly melds to deliver new generations of ships every five to seven years.

“I think the key is managing the complexity effectively,” said Harri Kulovaara, EVP, Maritime, Royal Caribbean Cruises Ltd. Managing in such a way that everyone working on the project is aligned behind the same vision. They all know what needs to be done. They all are working from the same menu. It may sound simple, but it is the most challenging portion of the entire process.” Kulovaara should know, as he oversees the newbuild activity for Royal Caribbean on the corporate level for more than 20 years, an indelible figure in cruise circles currently responsible for newbuild programs at shipyards in Germany (Meyer Werft), Finland (Meyer Turku) and France (STX).

Adding to the complexity is the fact that each ship series of three to five is essentially a custom design and build project. “I think design tools and simulation tools are technologies that have had the greatest impact. Simulation tools particularly: today we can create the room in less than a week, and walk in that room and see it in 3-D and understand how it works,” said Kulovaara. “With simulation tools, in less than a month we can create the mathematical models where we can run the ships into various ports, conduct maneuvering tests, see how the winds are blowing across the decks, and to see how we need to position wind protection. In real time we can handle tremendous amounts of information and design alternatives; we can see it and all involved can communicate in real time. The evolution of design tools, simulation tools, computer aided design tools and process management tools that have really made a difference.”

Drilling Deeper


Photo: Damen

Despite the recent plunge in global energy prices that has effectively shuttered a number of offshore energy projects for the short term, offshore energy as a whole has enjoyed a historic decade-long run, bringing with it a fleet of increasingly large, capable and complex offshore vessels.

The initial driver for the fleet renewal was fairly straight forward, as the industry emerged from a nearly two decade slump starting with the calamitous plunge of oil prices in the early 1980s. As the market steadily clawed its way back to profitability, the existing fleet was old and ill-fitted to operate in the emerging ‘deepwater’ fields which brought exploration and production projects to 10,000 feet of water and deeper. A fleet of new vessels had to be built which were able to operate further from shore in deeper, more volatile waters, able to support the new platforms with increasingly large quantities of drilling supplies, stores and people. New technologies, including diesel-electric propulsion, dynamic positioning systems and massive new winch and rope technology designed to handle heavier loads at deeper depths all added dramatically to the complexity of offshore service vessels, complexity that is tackled first at the design level.

A pioneer in the field is Guido Perla of Guido Perla Associates based in Seattle. Perla is a renowned designer and authority in the offshore service vessel sector, credited with helping to bring diesel-electric propulsion in the maritime sector into the

mainstream, and with more than 160 offshore vessels built around the world under his guise in the past decade, about 20 boats for Larry Rigdon and Rigdon Marine, and more than 100 for Bourbon. While he laments the increasing costs of modern software for ship design, he admits it is to be credited for helping to makes complex vessels more efficient to design and build. “Before computerization we would do many more things by the seat of our pants,” said Perla. “With computers, we can do things faster and more precise. It also adds to the beauty of the design. A ship is a 3D object, and when I say a ship is beautiful, it doesn’t matter what angle you view it from … it looks good.”

Perla said 3D visualization is the key, as the designer can visualize the vessel prior to the construction phase, giving the ability to analyze and refine the structure to make the work more sophisticated, efficient and cost-effective. “You are getting more boat for your money than you did 20 years ago, and it is all because of the technology available to design and build the boat.”