A tangled situation

Today, shipbuilders are faced with unprecedented pressure to increase ship efficiency and reduce emissions in order to comply with more and more stringent environmental regulations. In addition, the slowdown in the global economy is having a direct impact on the demand for maritime transportation, with a rippled effect in the newbuild market, where increased competition is forcing shipbuilders to reduce delivery times and lower ship lifecycle costs. Finally, as the demand for more versatile and high-tech vessels increases across all segments of the marine industry, shipyards are having a rough time managing and mitigating the risks associated with increasing levels of design complexity.

The design and engineering phase typically represents 5 to 10 percent of the overall production cost of a vessel, and yet has an impact on about 85 percent of the construction costs. It is also during this phase that ~90 percent of the vessel performance is determined. Getting things right from the inception of the project has become more critical than ever to ensure success. But in a climate of uncertainty caused by new regulations, the emergence of new fuels and unstable markets, how can shipbuilders position their processes to mitigate risks and respond quickly to requirement changes? How can they deliver smarter, better, faster, greener designs quicker and at a lower cost than ever before?
What is needed is a fully integrated solution

The ropes of naval architecture
Ask any naval architect to explain the ship design process and they will refer to the well-established design spiral. The design spiral is the basis of ship design as we know it. Introduced by MIT Associate Professor of Naval Architecture J.H. Evans in 1959, it gives a systematic approach to refining the design of a ship for a specific set of requirements using iterative sequences of design tasks.

These sequences correspond to the various phases of ship design, commonly known as:
• Initial design (also referred to as concept or preliminary design)
• Contract design
• Functional design (also known as basic design)
• Detail and production design

With each sequence (or cycle of the spiral), the degree of complexity increases as the design definition evolves and the number of design possibilities decreases until the final design is achieved at the core of the spiral. This sequential, logical approach has made the design spiral a gold standard of naval architecture and has been used as such for over six decades.

Ship designers have understood that to manage complexity, accelerate innovation and ultimately remain competitive, they need to digitalize their current processes. As a result, they are investing in digital tools that aim to increase efficiency at each step of the design spiral; for example, computational fluid dynamics (CFD), finite element analysis (FEA) and 1D system simulation software. These digital tools have yielded some noticeable improvement, yet this improvement is limited.

Unraveling the spiral
This is because the foundation of the process is flawed. The design spiral is based on assumptions, and while it looks logical, it is not efficient. It is made up of separate steps, each potentially involving a different team, and each focusing on one niche aspect of ship design and performance. Those teams generally use different tools and data sets. This often results in collaboration bottlenecks and data silos. By upgrading disparate manual processes to better performing, niche digital tools, shipbuilders are perpetuating non-agile, nonoptimal workflows.

In addition, shipping has evolved a lot since the design spiral was first introduced 60 years ago: not only are today’s ships a lot more high-tech than they used to be, but class rules and safety regulations have become a lot tighter. The resulting complexity has put the design spiral to the test and highlighted its limits as more requirements need to be meet, more systems need to be optimized and more analyses need to be performed. Having to run any design modification through each step of the design spiral is both time-consuming and inefficient.

The ship design spiral is the basis of shipbuilding as we know it. The ship design is refined with each cycle until the final design is achieved at the core of the spiral.
This higher level of complexity is not only impacting the equipment and systems required onboard the vessel (such as hybrid powertrains, navigation and communication systems, cables, control systems, etc.), but also the number of suppliers involved and the amount of information to be managed and communicated between these parties. To increase total enterprise productivity, planning appropriately and adopting the right tools and systems is critical.

A new spin for the future of ship design

What is needed is not a series of specialized digital tools, each covering a different step of the design and engineering process, but a fully integrated solution that enables seamless process execution from initial design to detail and production design. Adopting a digital thread approach to ship design and engineering enables shipbuilders to remain in control of the design spiral. By bringing all their multi-discipline design processes into one single, centralized environment, they are allowing globally distributed teams to work with a common set of data, tools and processes, thereby breaking down multi-domain silos, increasing overall project efficiency and improving business agility.

This requires implementing a comprehensive digital twin of the vessel to manage its mechanical, electrical and software features in a single collaborative environment. This single source of truth will ensure the various design teams and suppliers always have access to the most up-to-date design data for improved collaboration and optimized end-to-end process execution.

Another key element enabled by adopting a digital twin and digital thread approach is boosting innovation with simulation. Simulation-driven ship design plays a key role in this new paradigm. Deploying automated multi-domain design space exploration and optimization allows ship designers to understand, explore, optimize and test virtually any aspect of ship performance, from individual components and subsystems to the full ship system. This leads to increased confidence in the vessel performance from the earliest phases of design, and significantly reduces development time since a process that previously would have taken weeks can now be completed in a matter of days.

Finally, having a centralized system to manage lifecycle and BOM requirements, traceability, weight and configuration as well as adopting an integrated approach to engineering lifecycle management (with capabilities such as integrated requirements management and secure supplier collaboration) further increases overall enterprise productivity with better process orchestration.

Conclusion

As the demand for greener and smarter vessels increases, shipbuilders need to find new ways to boost innovation and manage the rising complexity of modern designs. Only with a fully integrated, collaborative environment will shipbuilders be able to consistently reduce overall development time, risks and costs, and satisfy their customers’ requirements for a lower total cost of ownership without compromising vessel performance, safety and reliability.