

# PLM SOLUTIONS IN SHIPBUILDING



*See what you mean*



## Setting a New Course in the Shipbuilding Industry

Across the shipbuilding industry, global demand for ships is at an all-time high. Increasing wealth, world travel and retiree population has made vacation cruises, nautical sports and boat renting more popular than ever. Demand for commercial ships that deliver goods, lay communication cables, ferry passengers, harvest fish and keep the shipping lanes free of ice is increasing rapidly. With two ships being built for every one decommissioned, ship owners and operators are profiting from the record growth in world commerce.

At first glance, it would be natural to assume that shipbuilders are sharing this bounty. However, even with substantial orders waiting to be filled, shipbuilding profits are low. Small, family-owned shipbuilders are struggling in their effort to replace the traditional way of custom yacht building by hand with industrialized methods in order to survive in this competitive landscape. Many shipbuilders are caught between prices set at the beginning of a project and rapid price spike for raw materials and energy. Growing worldwide shipbuilding capacity, particularly in Asian yards, are driving construction prices lower with shorter delivery schedule. With ship life span reaching 20-30 years, today's informed owners realize that total lifetime cost of ownership is as important as the upfront price paid, causing their tolerance for delivery delays and poor quality to erode and are pressuring the shipyards to deliver.

Shipbuilders must confront these challenges with new business strategy. The transformation from a drafting board to 3D model alone, for instance, gives marine engineers and shipbuilders almost an immediate return on investment. Many shipyards choose to outsource significant components to external experts who can better manage the tradeoffs between high quality, schedule and low cost. Shipbuilding supply-chain and construction sites are now stretched across the globe, creating communication and coordination challenges. To successfully manage this transformation, progressive shipyards and engineering companies must combine innovative practices and advanced product lifecycle management (PLM) technologies to streamline engineering-through-production processes.

Dassault Systemes (DS) understands how to help customers design and implement their unique business transformation. Whether you build aircraft carriers, submarines, cruise ships, tankers, yachts, boats, or ship components, we can help you meet your business objectives and improve your competitive standing. Both internally, and throughout your value chain, DS PLM solutions serve to enable innovation by bringing people and processes together and providing them with the resources they need to innovate and meet demanding time and cost constraints.

With DS Shipbuilding Solution, ship designers, builders and operators can:

- Design and analyze multi-disciplinary 3D data – from structure to fluid system – within a single digital mockup to ensure that the ship is built right the first time.
- Perform as much design work as early as possible – ideally before bidding a project – to ensure the ship can be built profitably at the price quoted.
- Maximize re-use of design elements, knowledge and best practices from one project to another to increase productivity and reduce product development cycle.
- Leverage a single source of product and process lifecycle information to streamline concurrent work and facilitate collaboration among all stakeholders.
- Manage complexity, including sophisticated onboard systems and the interdependent work of multiple subcontractors and the yard itself.
- Provide 360° visibility of evolving design and requirements to customers, partners and contractors to avoid scheduling delays and cost overruns.
- Increase ship and operator safety by ensuring construction, operation and shutdown sequences are fully compliant with regulatory and safety constraints.
- Optimize construction, operation and maintenance processes, eliminating unnecessary steps, minimizing cycle times and reduce lifetime cost of ownership.



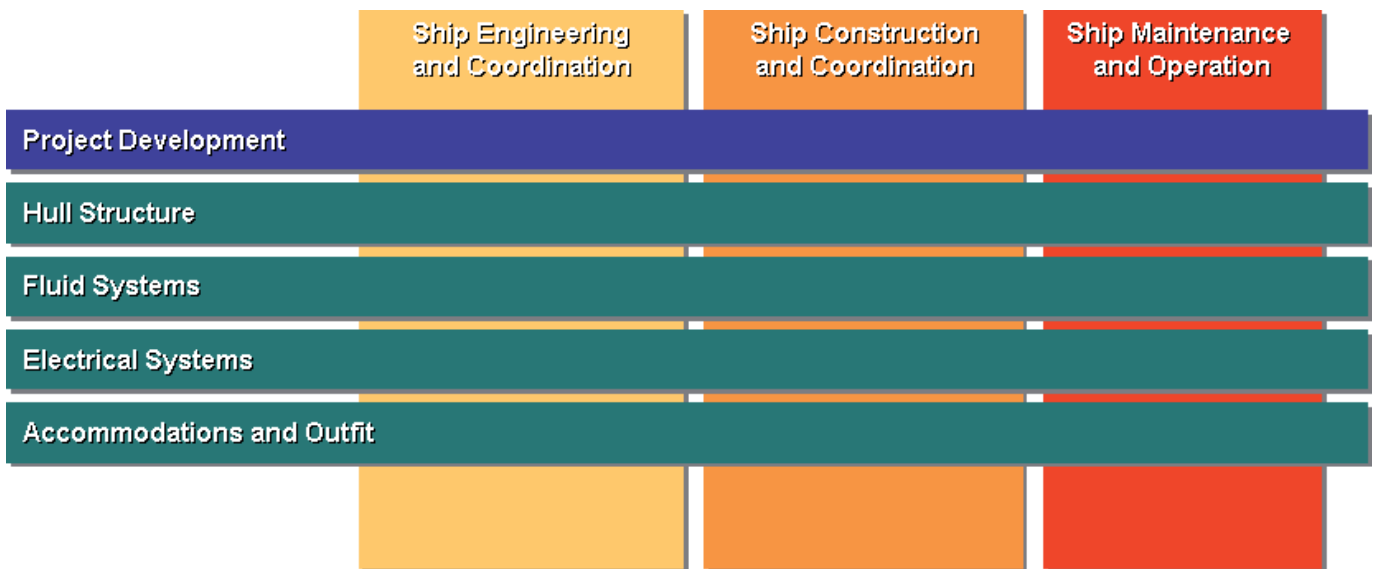
## Integrated solutions. Everyone is on-board.

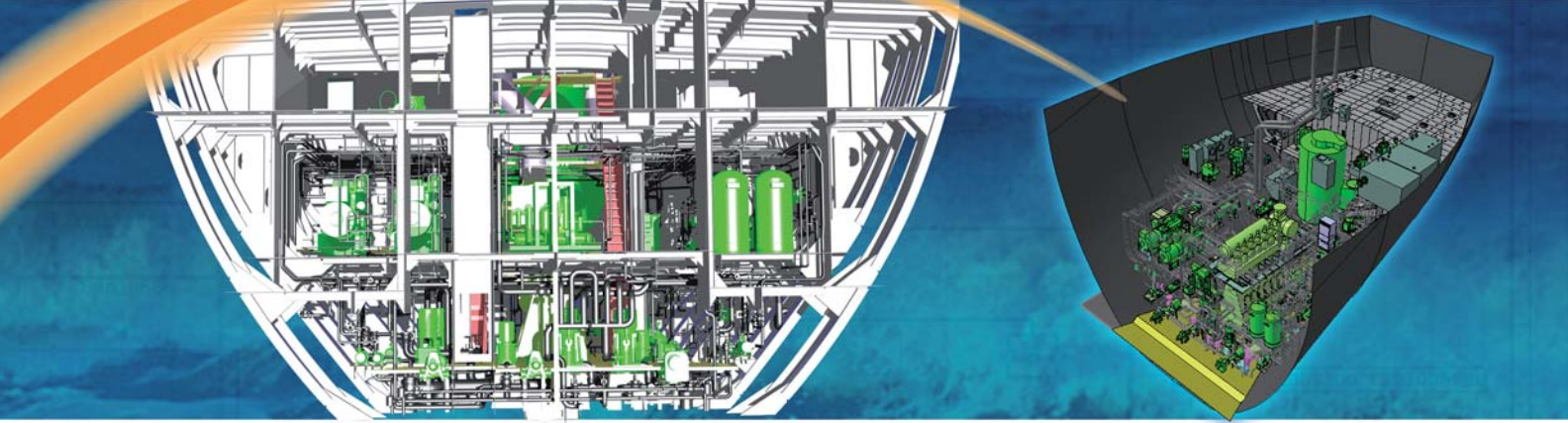
DS Shipbuilding solutions are built upon a set of integrated engineering, manufacturing, and lifecycle applications that are based on a common architecture, addressing information needs at the lifecycle phase:

- Ship engineering and coordination
- Ship construction and coordination
- Ship maintenance and operation

These solutions also address needs at the domain or discipline level:

- Ship project development
- Ship hull structure
- Ship fluid systems
- Ship electrical systems
- Ship mechanical





## Ship Engineering and Coordination

Marine engineering is a highly collaborative and cross-discipline effort. Coordinating ship engineering is a daunting task as pressure increases to meet more complex design requirements. Ongoing engineering changes – especially in cases where there are multiple configurations involved – make it difficult to keep bills of materials (BOMs) and other product data accurate and synchronized across the enterprise and the product lifecycle.

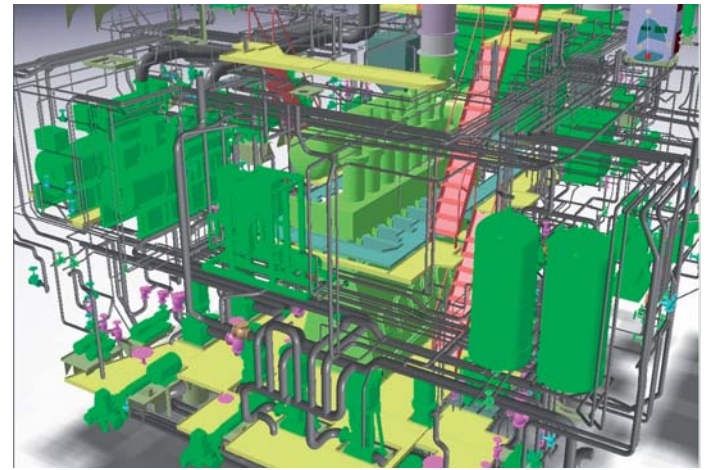
Shipyards, engineering consultants and suppliers are turning to DS PLM to handle both engineering and coordination tasks associated with it. These tasks begin with early project specifications and extend through to initial construction planning. DS PLM provides a single repository for all data, from product specification to manufacturing requirements, in order that data can be securely accessed in real-time across the enterprise or supply chain. Project data coming from various disciplines – hull structure, fluid, electrical, machinery, etc. – are captured within a unified product definition for concurrent engineering and rapid design validation.

DS PLM configuration management capability, advanced through intense research and development activities in various industries, enables companies to manage design options for a single ship or reuse design across projects. Coupled with workflow and shared catalogs, changes can be instantly communicated to related stakeholders. In contrast to practices commonly used within a traditional PDM system, in-work product structures, digital mockups and engineering BOMs can be made available to construction planner or customers before a design release, providing valuable insights to on-going project development and giving construction planning a head start.

DS Ship Engineering and Coordination solution PLM environment also includes functionality developed especially to meet the unique needs of shipbuilding industry. Relying on a well-defined workflow, for example, there is a process to automatically identify clashes in the hull structure, which can be solved as penetrations for routing piping, HVAC or electrical cableways. This advanced type of clash

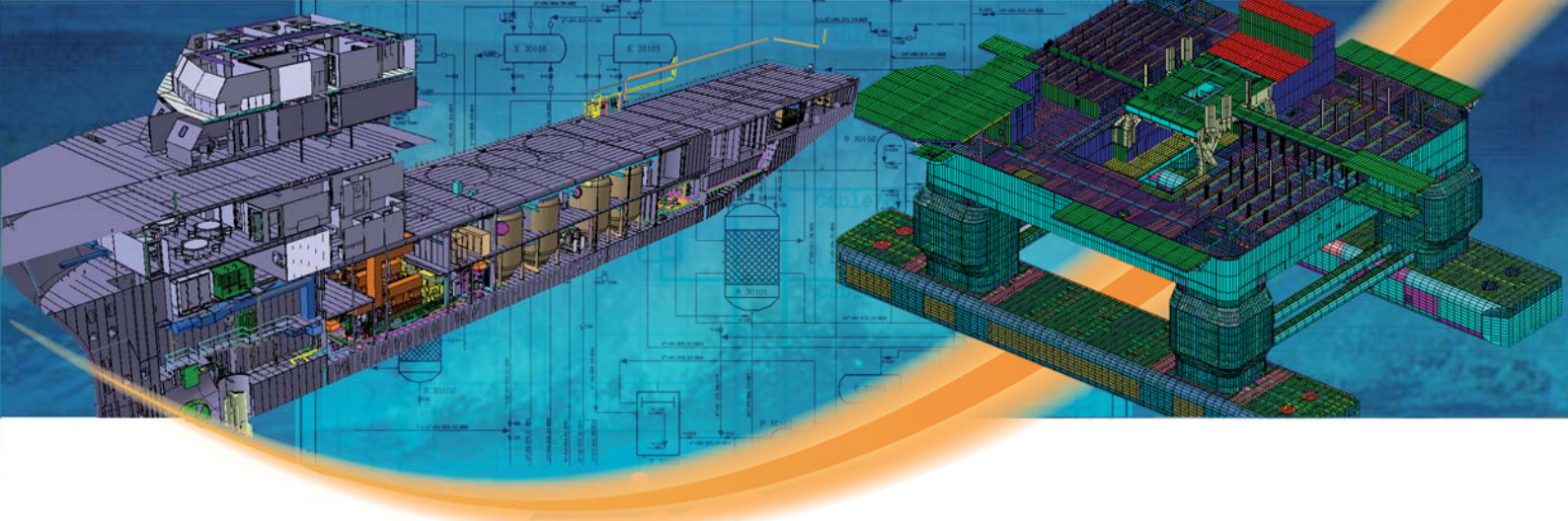
management offers a flexible way of automating cross-discipline engineering and eliminates last minute errors that so often seem to occur with paper-based or disparate systems.

As customers are bringing in teams from many organizations, there is usually a need to accommodate multiple CAD systems. Multi-CAD support is built into our solutions so that teams can freely review and exchange data while tracking changes and configurations across multiple CAD systems. These functions are available to a broad range of mechanical CAD systems including PTC, UGS, AutoCAD, and shipbuilding specific software such as AVEVA Tribon.



Ship Engineering and Coordination solution includes:

- Design change and configuration management
- Workflow management
- Engineering BOMs
- Penetration and clash management
- User, team, and organization information flow
- Product structure and work breakdown
- Multi-site collaboration
- Multi-CAD management
- Catalog Management



## Ship Construction and Coordination

In an industry where many projects experience tremendous cost overruns and schedule delays, shipyards are more focused than ever in managing construction costs. A typical construction involves innumerable elements that must be stringently coordinated and executed in order to complete a project on time and within budget. Whether the ship is a tanker or a cruise ship, interconnected activities must be carefully planned to reach the safest, fastest, and most optimum sequence.

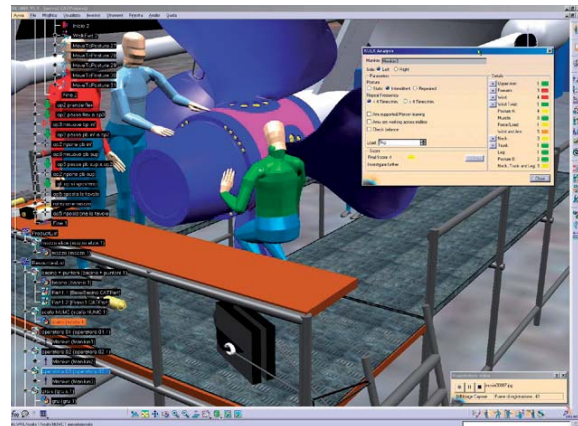
Shipyards rely on DS fully integrated PLM environment that supports design-to-construction approach in order that both design and construction processes can be optimized concurrently and in ways that would best utilize available resources. DS PLM virtual construction portfolio offers extensive capabilities unmatched in the industry. Virtual construction involving planning, scheduling, sequencing and simulation can be defined to reduce the occurrence of construction-delaying problems that typically arise when the systems and machinery are ready to be placed.

This solution includes scheduling with tools such as Primavera and MS project, equipment placement, human simulations including aspects such as vision, display and motion. As all components and humans are included in the planning, initial requirements, costs, and construction time can be estimated quite accurately prior to capital orders.

DS PLM environment maintains the relationships between design data and construction data. This helps yards track late changes, identify parts that may be impacted by design changes and study the impact of the changes on construction. This integrated PLM environment gives yards the information they need to predict the cost of changes in dollars and time so that they can decide whether or not to renegotiate the terms of the contract.

Although interconnected and change controlled, the construction and maintenance structures and sequences can be rearranged independent of the design structure, providing full flexibility to support the preferred organization to carry out the construction. Since changes are inevitable in the real world, DS PLM offers functionality to rapidly assess different alternatives to the construction process and 'build-around' so that the revised plan will be a smooth and efficient as possible. This can help reduce the occurrence of construction-delaying problems that typically arise when the steel is ready to cut.

Upon completion of the design and virtual construction, ship design, ship details and specification data are transferred to workers in form of easy to follow instructions that include 3D replay of the sequence to help minimize errors and trainings.



Ship Construction and Coordination solution includes:

- Work and process flow
- Production planning and scheduling
- Production work instructions, documentations and simulation
- Production simulation
- In-process product modeling
- Manufacturing BOMs
- Production machinery and layout optimization



## Ship Maintenance and Operation

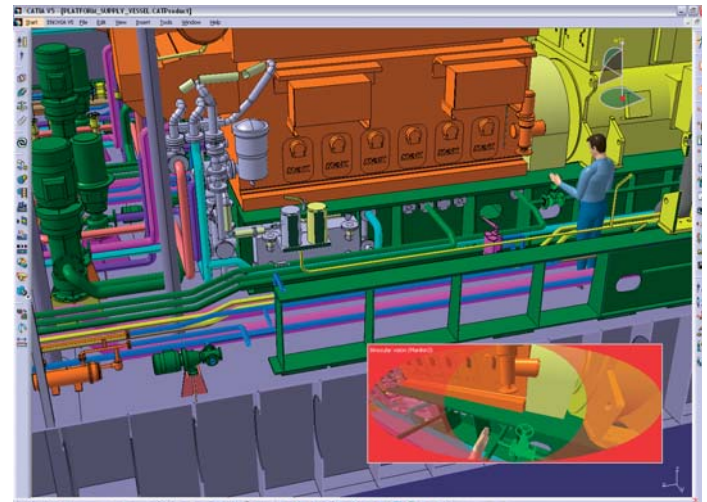
A ship's lifespan may reach 20-40 years. Informed ship owners realize that total lifetime ownership costs of a ship is just as important as the initial price. For commercial ship owners, having a ship out of service for a few days may result in millions of dollars of revenue lost, a tremendous impact on already volatile profits. More than ever, owners are pressuring shipbuilders to deliver products designed with long term operational and maintenance efficiency in mind.

In DS fully integrated PLM environment, operational and maintenance processes of a ship are optimized early during design development. Engineers can leverage safety rules and environmental protection requirements that have been entered into the system to ensure that ship operation and maintenance sequence are safe for operators. This solution includes human simulations including aspects such as vision, display and motion. As components and the human aspects are included in the planning, operational and maintenance sequences can be optimized for safety, costs and time.

The process of virtually defining a ship captures and produces records of tremendous potential value to owners and operators, including original system specifications, classification documents, equipment attributes and machinery arrangements. This data, when maintained along with the repair records, technical documents, and maintenance and operations records, is a vital asset.

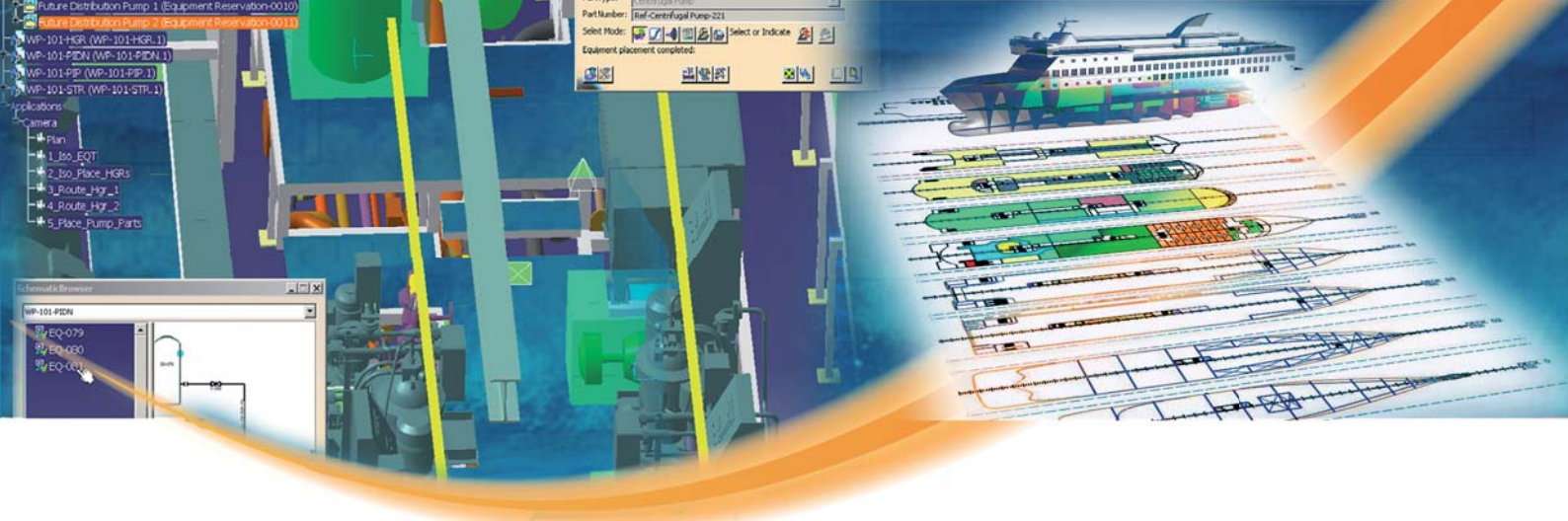
The benefit of maintaining and re-using this information throughout the lifecycle of a ship is obvious. DS PLM therefore offers shipbuilders an opportunity to extend their current business by offering owners and operators well-defined data for use in ongoing operations. In operating commercial ships, especially those for transporting hazardous materials, many well documented processes must be executed to satisfy different organizations, from safety to security to maintenance operations such as equipment overhaul and replacement.

DS PLM environment has the ability to store and manage both processes and best practices to reuse in future projects and to simulate these processes to optimize operation of the ships. By re-using the product structure template to organize the data set, the information becomes accessible to operations personnel. Databases can be replicated and shared and new information can be added to support operational requirements. In cases where new and unproven tasks must be conducted, for example, a digital mockup can be of great value in planning and testing different alternatives.



Ship Maintenance and Operation solution includes:

- Systems diagrams
- Operations and maintenance simulation
- Equipment and systems inventories
- Equipment replacement
- Engineering document and specifications management

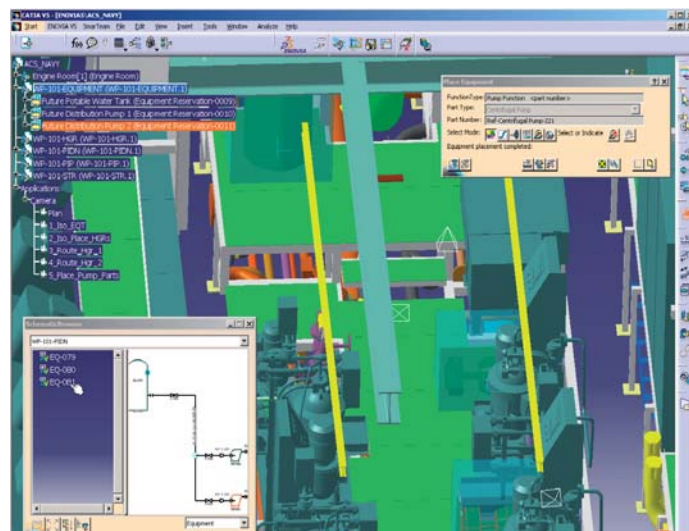


## Ship Project Development

Developing a new ship project, whether it is a variation of an existing design or an entirely new concept, requires an integrated approach. Typically, the time available to develop a proposal that satisfies not only the customer (ship owner) but also complies with classification and safety rules is extremely limited. Yet the design must have enough details and information to minimize unknown factors that may impact the cost of producing such a ship or vessel.

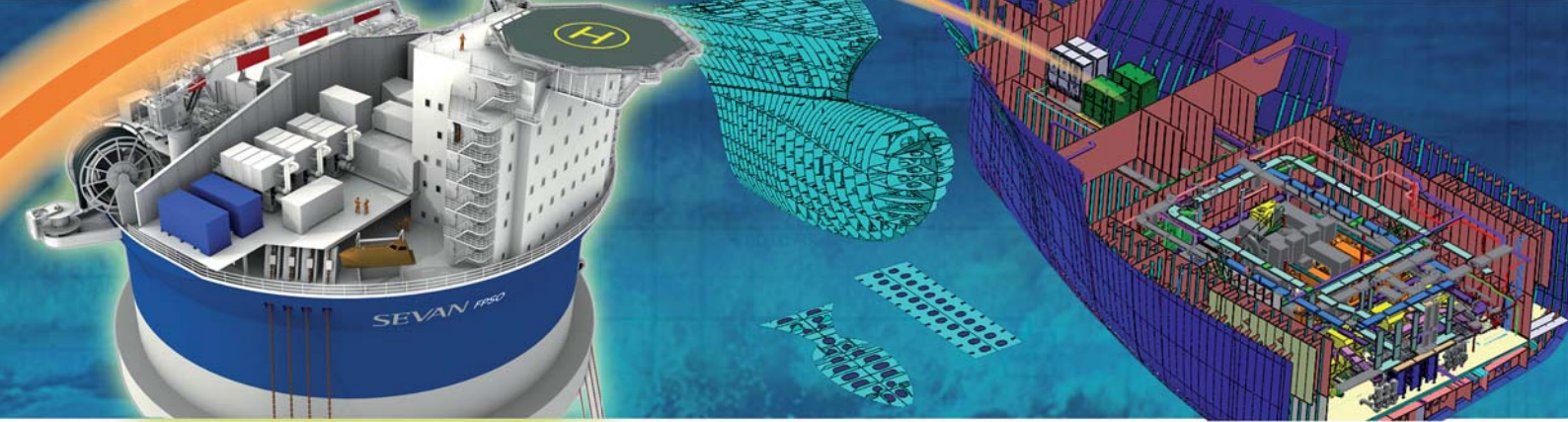
Shipbuilders are discovering that 3D digital mockup tools produce superior results over 2D drawing approaches. Digital mockups help partners communicate and visualize complex areas. DS digital manufacturing solution enables the seamless interchange between manufacturing and design engineers. 3D has become the communication medium for business today and tomorrow. For engineers, managers and customers to see a digital model and lifecycle simulation of a ship before production begins is not only an unforgettable experience but essential to eliminate miscommunication and errors.

DS provides applications that link system specification and mission requirements to serve as efficient tools for developing the ship's basic layout in a safe and efficient way. Ship hull forms can be imported from industry applications such as NAPA or FastShip. They also can be designed using the advanced surface modeling capability found in the 3D modeler of CATIA V5.



Ship Project Development solution includes:

- Requirement management
- Functional/logical design
- Physical design allocation
- Space reservation and routing
- Test and validation
- Conceptual design
- Naval architecture software integration
- 3D general arrangement
- Parametric hull form
- Simulation and rendering



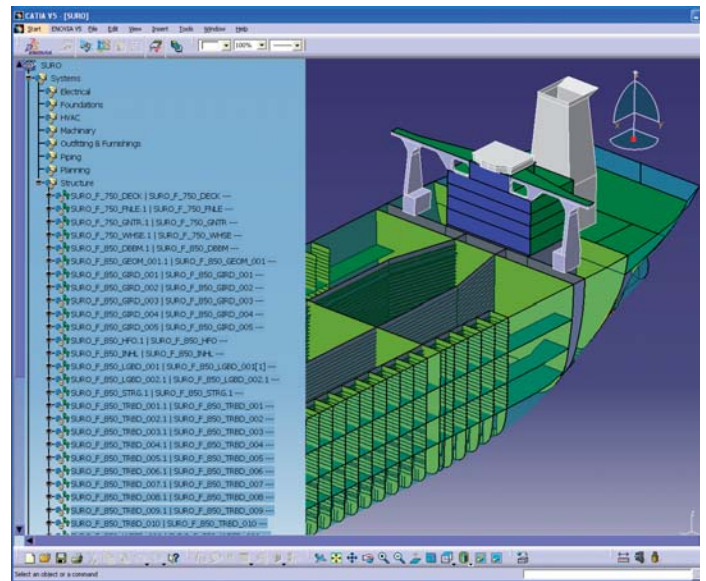
## Ship Hull Structure

Ship hull structure is the most important considerations in shipbuilding. This also is a key area where the CAD tool typically requires the most adaptation because ship hull structure presents challenges unique to the shipbuilding industry. Unlike generic CAD solutions, the Ship Hull solution from DS has been developed in cooperation with shipbuilding industry leaders. This ensures that applications follow professional practice and meet the requirements of yards and classification societies.

Hull Structure solution provides intelligent templates that allow the designers to capture and re-use knowledge and design intent to greatly reduce the time required for design. The hull structure solution supports a smooth transition from general arrangement (the output of the project development phase) to the basic design or class design, where rules and strength calculation are required. FEM analysis can be carried out either by CATIA or through interoperability with commercially available solvers such as MSC-Nastran, ANSYS or others.

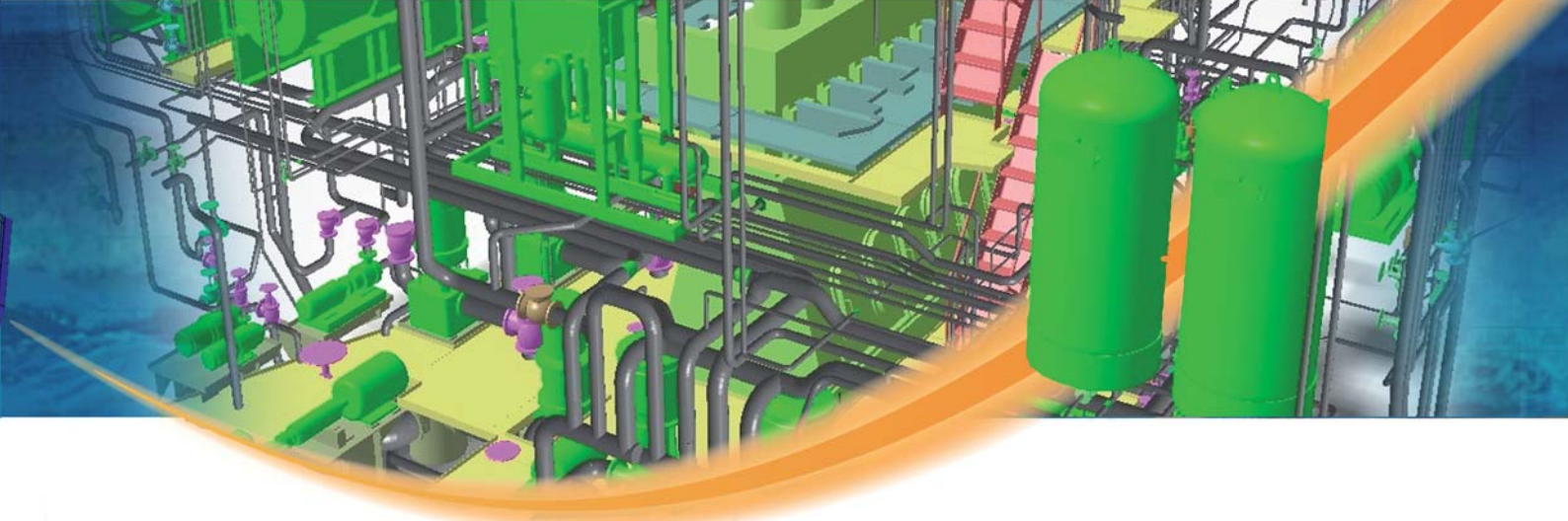
In Hull Structure solution, knowledge templates are provided to automate many difficult cases while maintaining all project specifications. As not all hull structural details are standard so the solution provides efficient interactive tools to create individual details that still carry the full spec-driven implementation. Copy and paste interactions allow for reusing of existing design components to rapidly complete the detailing.

During the detailing stage, additional data is produced to represent the different stages of each part. These stages can include variables such as profiles before bending or shell plates before rolling and heating. For steel work such as nesting and steel cutting, an interface to ALMA is provided, demonstrating the openness of our solution.



Ship Hull Structure solution includes:

- Hull structure basic design, including, ship block-split
- Structural foundation and secondary structure
- Hull structure detailed design
- Hull structure lofting, including template creation
- DPM for assembly
- ALMA integration for nesting and steel cutting



## Ship Fluid System

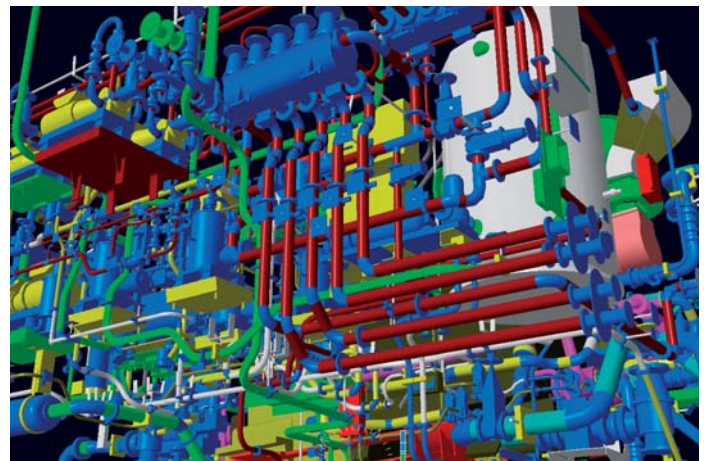
The Ship Fluid System solution provides a full complement of traditional piping and HVAC design functions. System diagrams provide logical process definitions and convey specifications for both piping and HVAC routing. The software allows users to define connections across disciplines. These connections can be analyzed and tracked within the PLM environment, which facilitates tracking of design modifications.

Moving from the basic design, where the main layout is decided, the solution allows the re-use of the block schema. The block schema was defined for the hull structure break-down, but is used at this stage to decide how piping and other system should be spooled, which improves production planning.

Because the basic design is organized in a single view of block assemblies, detailing is highly automated and takes advantage of the knowledge defined and saved in the specification catalogs. In addition, logical diagrams and design rules help automate parts placement and catalog component selection. Detailed design activities are actually preparation for production because critical manufacturing data for pipe bending and flanging is being captured. This allows designers to spend more time on optimal layouts and reuse practices proven successful on previous projects.

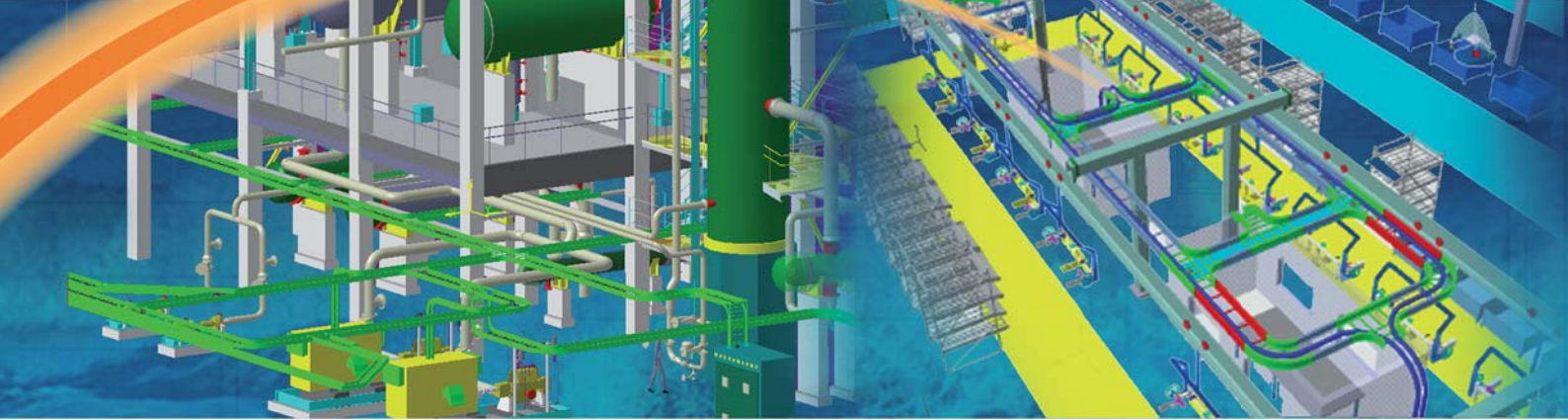
Detailed design activities are actually preparation for construction because critical manufacturing data for pipe bending and flanging is being captured. DS PLM can also interface with standard isometric diagramming applications, like ISOGEN from Alias.

All ship fluid systems follow the same logical breakdown structure as the ship's structural block plan. Users benefit because final ship assembly sequences that apply to the block also apply to fluid systems. More detailed processes, such as pipe bend simulation, can be conducted to verify whether a given spool can be manufactured or whether adjustment will have to be made before manufacturing of the part will become practical.



Ship Fluid System solution includes:

- Piping and instrumentation diagram
- HVAC diagrams
- 3D functional design
- Piping detailed design
- Piping manufacturing extraction (spool drawing)
- HVAC detailed design
- HVAC manufacturing drawing extraction
- Support and hangers design



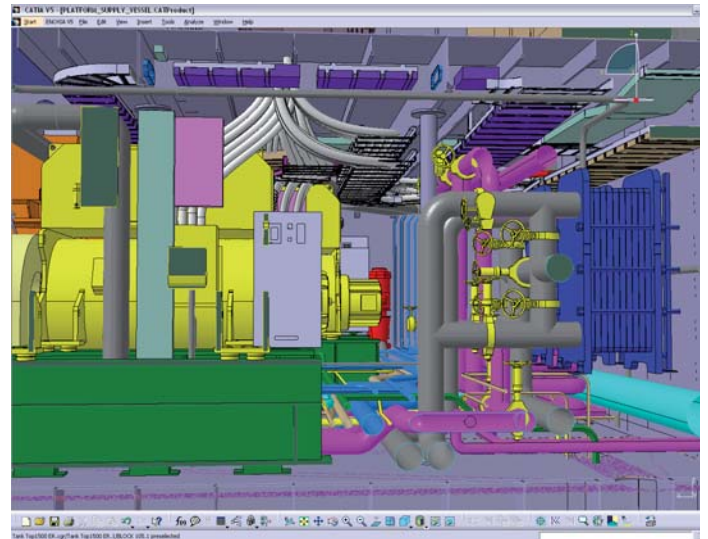
## Ship Electrical Systems

Electrical systems on today's ship have become increasingly complex. Originally a small part of on-board systems, they have evolved into one of the most important tools for integrating communications, navigation, ship operation and control.

DS delivers a unique solution for ship electrical design, with capabilities ranging from simple diagrams to major cable pulls. Depending on the design strategy used by the shipyard, DS supports designs that use ladders and cable trays, as well as direct routing through hangers when space is limited. Specialized waveguides, required on Navy vessels, are also integrated into the Ship Electrical Systems solution.

Leveraging the integration with EDSA electrical simulation application, Ship Electrical Systems solution allows electrical designers to simulate short circuits and manage load capacities. By using its network of diagrams, users can manage and route very large network of cables using a dedicated cable database implementation. Cables are routed as the realization of the logical design in the diagram, taking the pathway of 3D hanger layout into account. The ability to maintain the cable data in the same PLM environment as the rest of the design data provides unique integration.

To support the assembly of ship blocks, trays and hangers can be structured within the same assembly structure as the rest of the physical parts, allowing more pre-outfitting. For actual cable pulls, cable lists can be produced from the PLM environment to support the work instructions.



Ship Electrical Systems solution includes:

- Electrical diagram
- 3D cableway layout
- Detailed design with ladder, trays or hangers
- Cable and wire routing
- DPM assembly
- Waveguide design
- Work instruction extraction (cable lists)
- Waveguides



## Ship Accommodations and Outfit

DS has a strong background and long history of customer successes. Mechanical CAD is important in the design of cruise and Navy ships, but is growing in importance for commercial shipbuilding and the offshore industry as the demand for flexibility continues to increase

Thanks in large part to its strong history in industries such as automotive and industrial products, DS supports a large range of CAD translators and industry exchange standards, including STEP and IGES. This makes design re-use easier than if the software had been designed exclusively for shipbuilding and offshore industries.

Some shipyards have the need to design and produce not only the ship, but some of the equipment used on the ship. For those yards the benefit of DS PLM is especially high, as they can design multiple products while supporting only one global PLM environment. This reduces both the cost of maintaining and operating the system, but also training the workforce as designers need to learn just one user interface and toolset, regardless of the discipline.

In mechanical design, where forged and machined parts must be produced, DS PLM manages manufacturing processes, including workflow, equipment optimization, stock management and NC programming.



Ship Accommodation and Outfit solution includes:

- 2D layout for 3D designers
- Assembly and part design
- Surface and shape modeling
- Sheet metal design and production
- Composite design and production
- DPM machining, NC milling and lathe machining
- Manufacturing drawing generation

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**About Dassault Systèmes**

As a world leader in 3D and Product Lifecycle Management (PLM) solutions, Dassault Systèmes brings value to more than 100,000 customers in 80 countries. A pioneer in the 3D software market since 1981, Dassault Systèmes develops and markets PLM application software and services that support industrial processes and provide a 3D vision of the entire lifecycle of products from conception to maintenance. The Dassault Systèmes portfolio consists of CATIA for designing the virtual product - SolidWorks for 3D mechanical design - DELMIA for virtual production - SIMULIA for virtual testing and ENOVIA for global collaborative lifecycle management, including ENOVIA VPLM, ENOVIA MatrixOne and ENOVIA SmarTeam. Dassault Systèmes is listed on the Nasdaq (DASTY) and Euronext Paris (#13065, DSY.PA) stock exchanges. For more information, visit <http://www.3ds.com>

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