Product Lifecycle Management for Shipbuilding and Offshore

CATIA DELMIA ENOVIA

Commercial ships: the backbone of world commerce

World commerce depends on commercial ships. Half of the world's estimated fleet of 96,000 ships moved approximately 24,600 billion ton-miles of cargo in 2004 – nearly 400 times as much as moved by air freight and nearly 4,000 times more than moved by rail*.

Commercial ships deliver goods, lay communication cables, ferry passengers, harvest fish and keep the shipping lanes free of ice. Even the offshore oil rigs and floating production/storage platforms used to extract oil from the deepwater oceans and stockpile it until it can be offloaded to tankers are, in effect, specialised commercial ships. Not surprisingly, global demand for ships is at an all-time high, 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 in this bounty. High demand for ships has led to increased competition for space on shipyards' schedules, especially for complex ships such as LNG, VLCC and offshore vessels. Surprisingly, however, even with substantial orders waiting to be filled, shipbuilding profits are low. Many yards are delivering ships at cost, or at marginal profit, and even subsidised commercial yards are delivering ships at prices lower than build costs.

The reasons are complex. Shipbuilders are increasingly caught between prices set at the beginning of a project and rapid price spikes for raw materials and energy. In some markets, these price spikes are aggravated by higher costs for imported machinery and onboard systems. In addition, growing worldwide shipbuilding capacity, particularly in Asian yards, is driving construction prices lower, with shorter delivery schedules. To remain competitive and improve margins, shipbuilders must confront these challenges with new business strategies.

* Source: LRFairplay 2005.

New challenges, new strategies

Pressures on costs and delivery schedules are just the beginning. Shipyards are also experiencing increased pressures from owner and operators, whose tolerance for cost overruns, delivery delays, rework and poor quality is eroding. The long-term operating profitability of a ship depends, in large part, on quality construction, maximum cargo capacity, energy efficiency and a design that requires minimal crew to operate. Today, informed owners are realising that total lifetime cost of ownership is as important as the upfront price paid, and are pressuring shipyards to deliver.

Many yards are shifting their businesses from total design-build to an assembly model where significant components are outsourced, shifting responsibility for much of the design and construction services to external experts who can better manage the tradeoffs between high quality at low cost.

All these pressures mean that shipbuilding is undergoing a fundamental business transformation. Advanced yards are combining innovative practices, enterprise IT integration, and leading PLM engineering-production solutions to develop new products, and improve customer satisfaction and competitive standing.

Innovation is no accident and turning innovative ideas into market-leading products requires flexible business processes supported by integrated PLM solutions – all built on a strong technology foundation. PLM shipbuilding solutions advance the pursuit of innovation by integrating business environments with cutting-edge tools for design, engineering and production. Both internally, and throughout your value chain, 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.

IBM understands how to make innovation drive profitability and growth, because IBM understands IT. We provide an entire business technology infrastructure including middleware, and a security-rich scalable infrastructure that allows you to build new business processes and leverage existing processes cost-effectively. IBM PLM delivers the most advanced lifecycle and discipline level applications in the industry today. At IBM, we let your business drive PLM – not the other way around.

To successfully manage these business transformations, a shipyard must become an information-based organisation that can communicate the end-to-end design and building activities across the enterprise and outside its own organisation to collaborating suppliers and consultants.

The goal is to eliminate errors and deliver a high quality ship on time and on budget. This will then continue to deliver profits to the owner for years to come by maximising performance, minimising downtime and streamlining maintenance and operation. The shipyard that can consistently deliver such vessels will stand head and shoulders above its competitors.

To succeed in these complex collaborative environments, yards need sophisticated product lifecycle information flow capabilities to:

- *Accurately assess initial requirements before committing to long lead, high capital equipment orders*
- *Efficiently balance owner and underwriter requirements*
- *Optimise processes to eliminate all unnecessary steps, minimising costs and cycle times*
- *Perform as much design work as early in the process as possible – ideally before bidding a project – to ensure the ship can be built profitably at the price quoted*
- *Manage complexity, including sophisticated onboard systems and the interdependent work of multiple subcontractors and the yard itself*
- *Eliminate rework while maximising the re-use of design elements from other projects*
- *Ensure the accuracy of design documents and bill of materials (BOM)*
- *Provide manufacturing with sufficient design data*
- *Optimise the scheduling of yard facilities.*

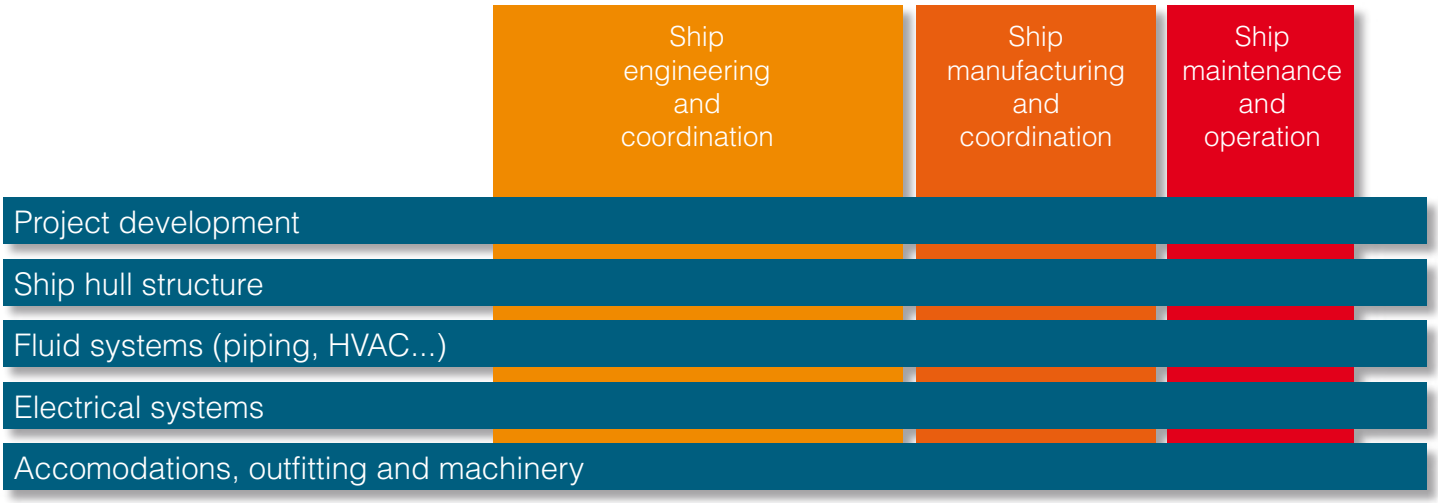
PLM: Lifecycle and discipline solutions that drive profitability

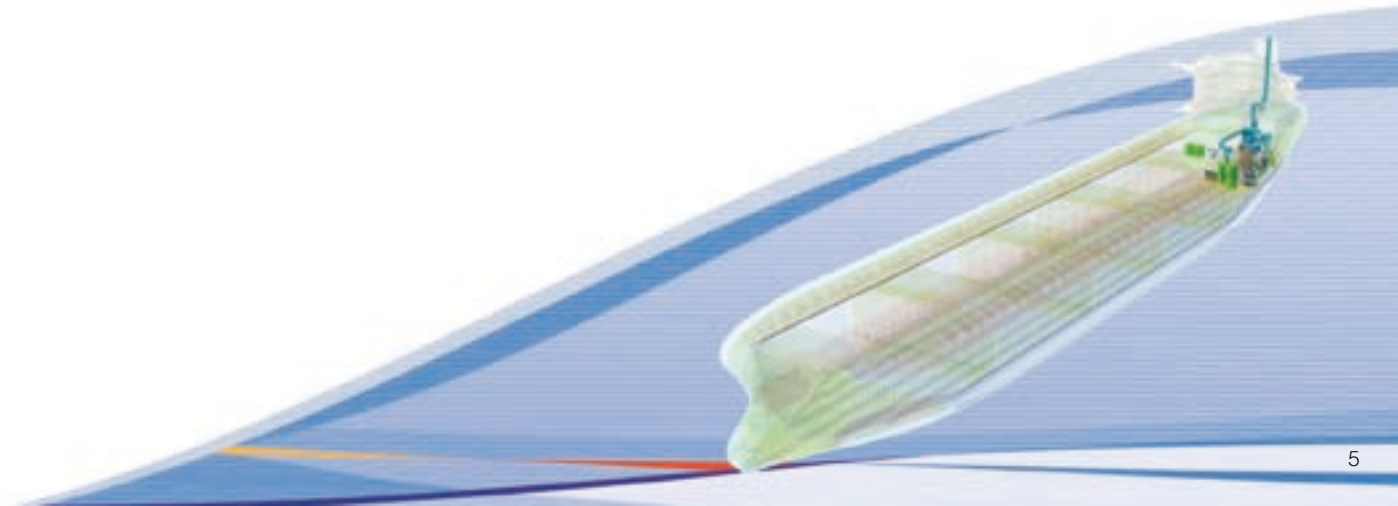
Profitable shipbuilding requires a strong decision support system that provides accurate information about the ship at each phase of development as well as at each discipline-specific level. Product Lifecycle Management (PLM) solutions for commercial shipbuilding from IBM with its strategic partner Dassault Systèmes, address information needs at the lifecycle level:

- *Ship engineering and coordination*
- *Ship manufacturing and coordination*
- *Ship maintenance and operation.*

As well as at the discipline level:

- *Project development*
- *Ship hull structure*
- *Fluid systems such as piping or heating, ventilation and air conditioning (HVAC) etc*
- *Electrical systems*
- *Accommodations, outfitting and machinery.*





Lifecycle solutions

Ship engineering and coordination

Marine engineering is a highly collaborative and cross-discipline effort. As pressure increases to meet more complex design requirements, shipyards, suppliers, consultants and classification societies are turning to PLM to handle both engineering and the coordination tasks associated with it. These tasks start with early project specifications and extend through initial production planning.

Coordinating ship engineering is a daunting task, but advanced PLM database technologies – like those found in ENOVIA LCA – manage workflow and shared catalogs while communicating design changes and tracking configurations. Configuration management, advanced through intense IBM research and development activities in the aerospace and automotive industries, is a hallmark of the PLM environment. When applied to shipbuilding, these capabilities manage design variants such as sister-ships within a class, as well as alternative design options for a single vessel.

The PLM environment provides a single repository for all data, from product specification to manufacturing requirements. Project data can be shared and viewed in a variety of ways and in forms customised for various engineering disciplines. Security controls protect sensitive data and control viewing access.

The PLM environment also includes functionality developed specifically to meet the unique needs of the shipbuilding industry. Relying on a well-defined workflow, for example, the penetration management solution helps yards to automatically identify and solve penetrations in the hull structure. Clashes between structural steel and outfitting objects, such as piping, HVAC or electrical cableways, are identified and categorised by rules. They can then be processed and resolved according to the workflow of the designated design team. Clash management offers a flexible way of automating cross-discipline engineering, significantly reduces production costs and eliminates the last-minute errors that so often seem to occur with paper-based systems.

Collaboration often brings teams together from many organisations, which usually creates a need to accommodate multiple CAD systems. The multi-CAD support built into PLM allows teams to freely communicate and manage data exchanges and 3D design reviews 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.

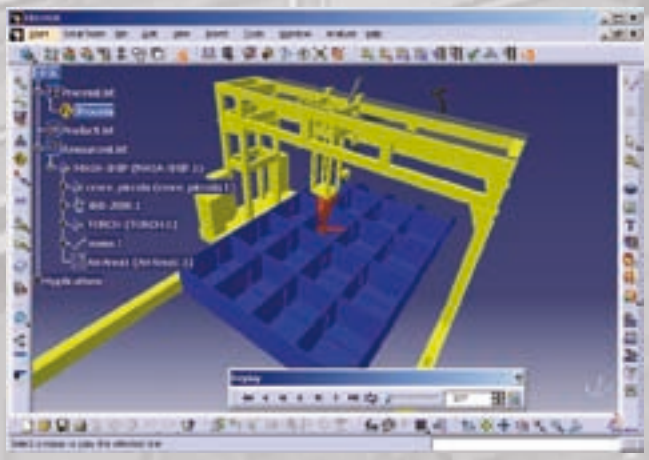
PLM's engineering and coordination solutions include:

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

Ship manufacturing and coordination

Today, shipyards are focused on managing manufacturing costs. A fully integrated PLM environment allows yards to apply a design-to-manufacturing approach, optimising the design to best utilise available production facilities. For example, the building strategy can be verified and simulated early in the design cycle, where it can benefit production planning the most.

In PLM, the manufacturing breakdown structure can be rearranged independent of the design structure, providing full flexibility to support a shipyard's preferred organisation for manufacturing. In addition, PLM offers functionality to rapidly simulate and verify different alternatives to the assembly process. This can help reduce the occurrence of production-delaying problems that typically arise when the steel is ready to cut.

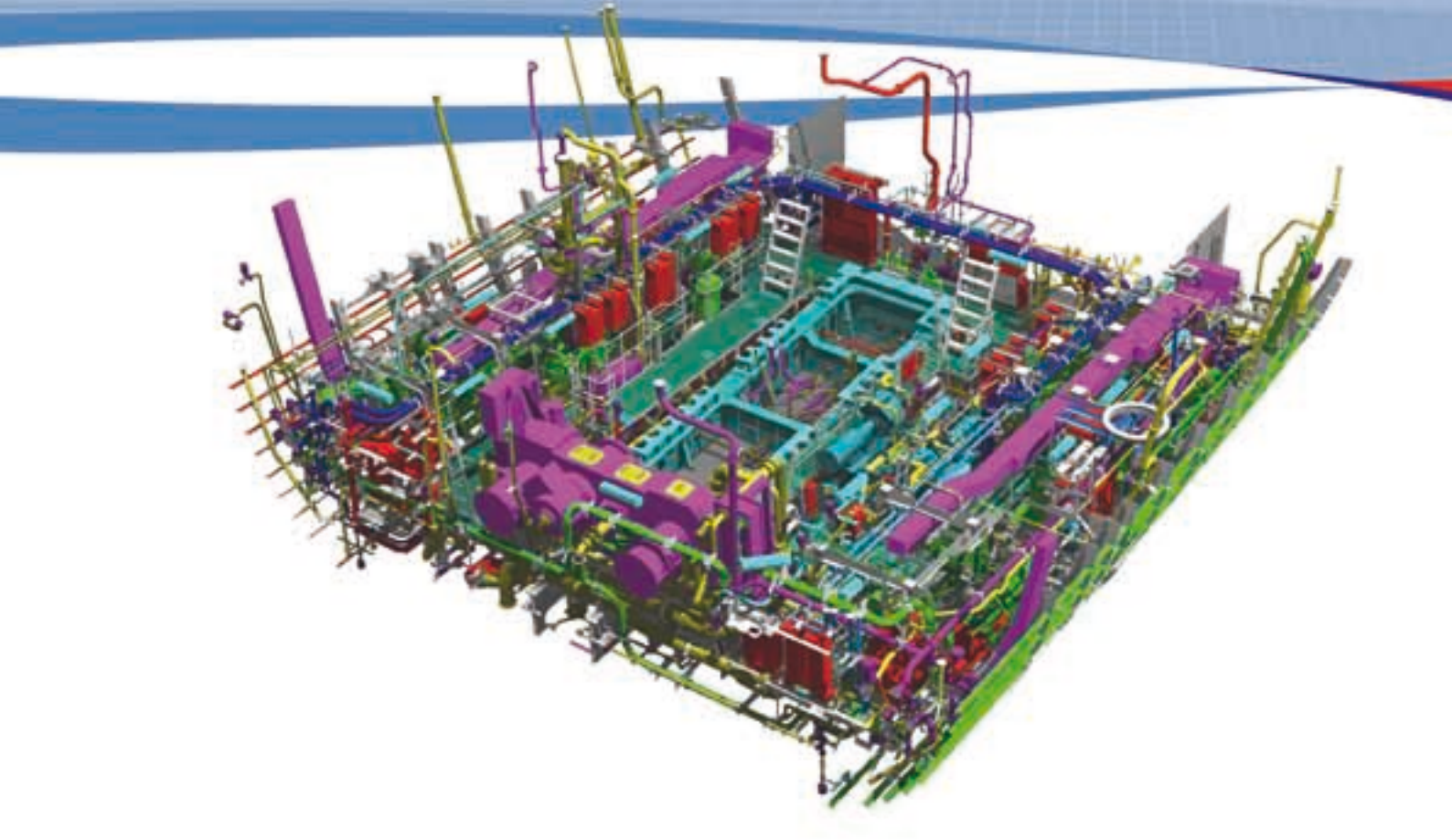


The PLM environment maintains the relationships between design data and manufacturing data, helping shipyards to track late changes and providing the tools to identify parts that may be impacted by design changes. This is possible because the PLM environment tracks not only the individual parts, but also the assembly structure to which they belong. Because all parts are included in the schedule and in planning, the impact of changes can be tracked, providing input for calculating overall manufacturing time.

This ability to manage relationships and visualise impacts is critical to the decision process for introducing and accepting changes in a design. Today, many design changes are requested by ship owners and accepted by shipyards without a full understanding of the impact on costs. Because they cannot predict the impact of changes on costs or schedules, shipyards rarely negotiate changes in their contracts and consequently the additional cost of delivering the ship is carried by the shipyard rather than the owner. An integrated PLM environment gives yards the information they need to predict the cost of changes in dollars and time, giving them the information they need to decide whether to renegotiate the terms of the contract.

Ship manufacturing and coordination solutions in PLM include:

- *Work and process flow*
- *Production planning and scheduling*
- *Production work instructions, documents and simulation*
- *Production simulation*
- *In-process product modelling*
- *Manufacturing BOMs*
- *Production machinery and layout optimisation.*



Ship maintenance and operation

A ship is a product with a 20 to 40 year lifespan. The process of shipbuilding captures and produces records of tremendous potential value to owners and operators, including original system specifications, classification society 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.

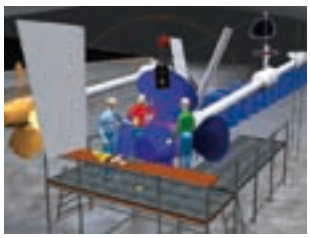
The benefit of maintaining and re-using this information throughout the lifecycle of the vessel is obvious. PLM therefore offers shipyards an opportunity to extend their current business by offering owner and operators well-defined data for use in ongoing operations. By re-using the product-structure template to organise the data set, the information becomes accessible to operations personnel. Databases can be then replicated and shared and new information can be added to meet operational requirements.

In operating a complex vessel, many well documented processes must be executed to satisfy different organisations, from safety and security to maintenance operations such as overhauling the main engine. The PLM environment has the ability to store and manage both processes and best practices and to simulate these processes to optimise operation of the vessel. 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 solutions available in PLM include:

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





Discipline solutions

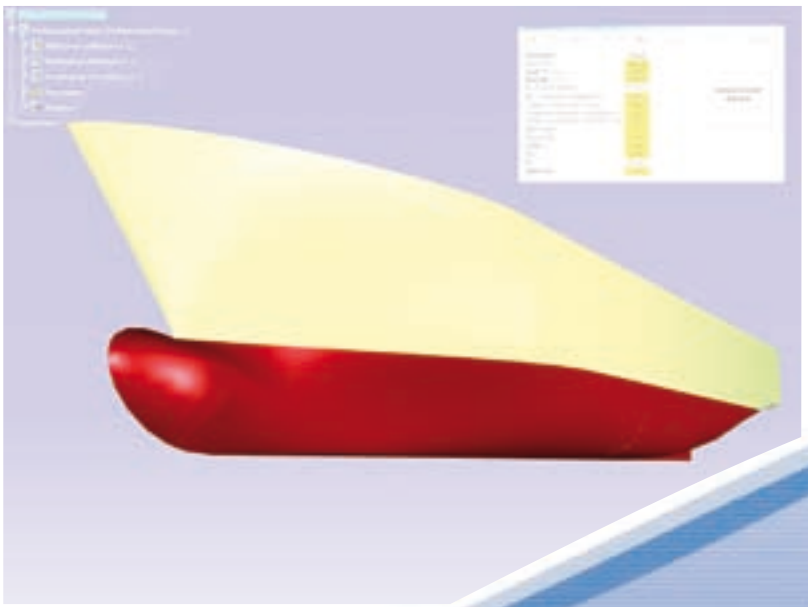
Ship project development

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 minimise 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 visualise complex areas. Applications that link system specification and mission requirements also can 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 modelling capability found in the 3D modeler of CATIA V5.

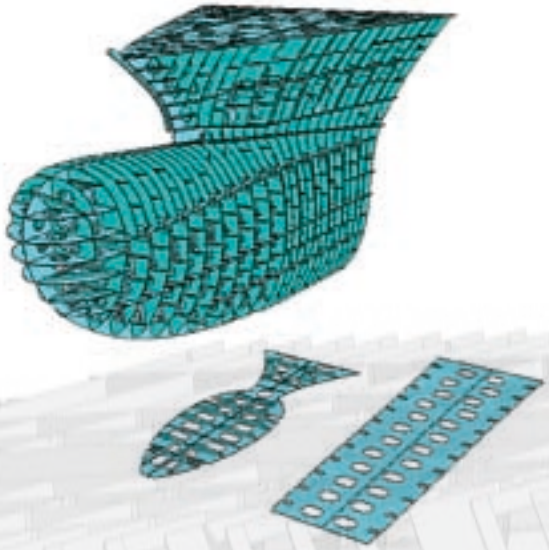
The ship project development solution in PLM meets requirements in the following areas:

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



Ship hull structure

Ship hull structure is one of 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 solution from IBM and Dassault Systèmes has been developed in cooperation with shipbuilding industry leaders. This insures that applications follow professional practice and meet the requirements of yards and classification societies.

User productivity is key in structural design and detailing. Cut and paste – not only of objects and parts, but also of design intent, such as openings – greatly reduces the time required for design. Intelligent templates allow designers to capture and re-use knowledge and design in an integrated, organised and controlled way. 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 integrated solves or, if yards prefer, CATIA V5 can export data in a variety of industry formats to tools such as MSC-Nastran, ANSYS or others.

The PLM hull structure solution has been specially designed to allow the block-split to be done at any time prior to production. This allows shipyards to select the right split at the optimal time and allows designers to achieve the best possible assembly breakdown structure.

Because design intent is captured at the basic design level, the block-split process will be able to capture and resolve a large part of the work that traditionally has been done manually in the detailed design phase. But not every structural situation can be solved with a standard detail and PLM offers knowledge templates to automate many difficult cases while maintaining all project specifications.

Not all structural details are standard so the solution provides efficient interactive tools to create individual details that still carry the full spec-driven implementation. Once again, copy and paste interactions allow designers to re-use and interactively adapt design detailing.

During the detailed design stage, additional data is produced to represent the different stages of each part. Stages can include variables such as profiles before bending or shell plates before rolling and heating. For nesting and steel cutting, PLM provides interfaces to ALMA further demonstrating the openness of IBM PLM Version 5 platform.

The ship hull structure solution covers all functions from basic design to the final steel cutting stage and is broken down into the following offerings:

- *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.*

Fluid systems

The 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 analysed 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 systems should be spooled, which improves production planning.

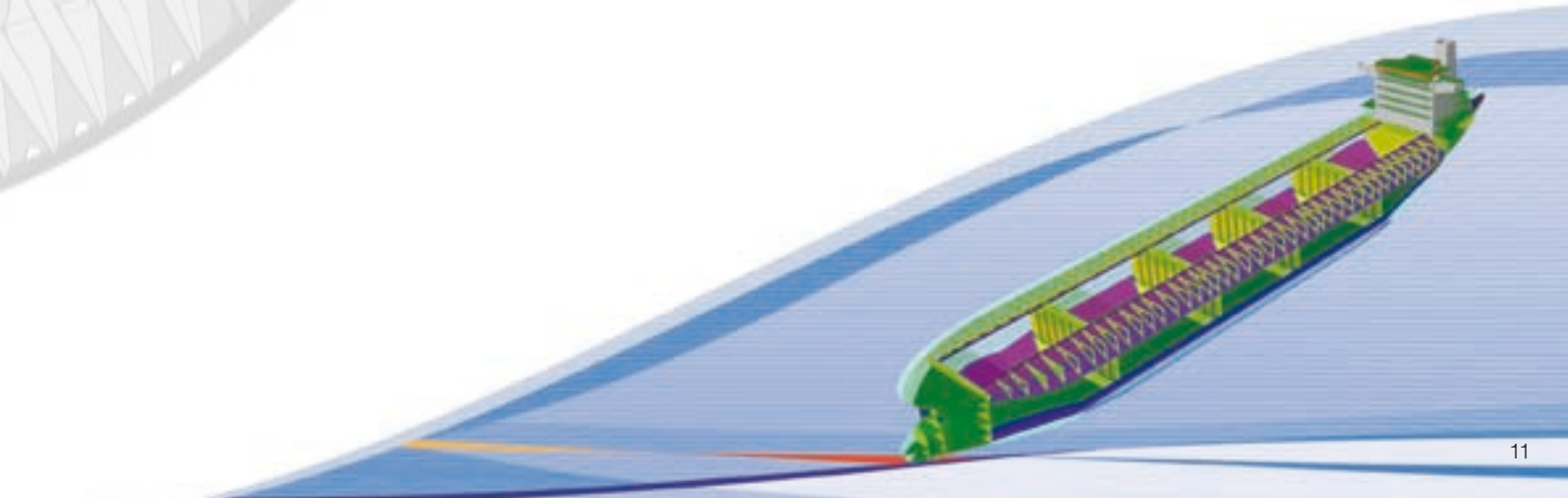
Because the basic design is organised in a single view of block assemblies, detailing is highly automated and takes advantage of the knowledge defined and saved in the specification catalogs. Logical diagrams and design rules help automate parts placement and catalog component selection. This allows designers to spend more time on optimal layouts and re-use practices which proved successful on previous projects. Detailed design activities are actually preparation for production because critical manufacturing data for pipe bending and flanging is being captured. PLM piping solutions can also interface with standard isometric diagramming applications, like ISOGEN from Alias.

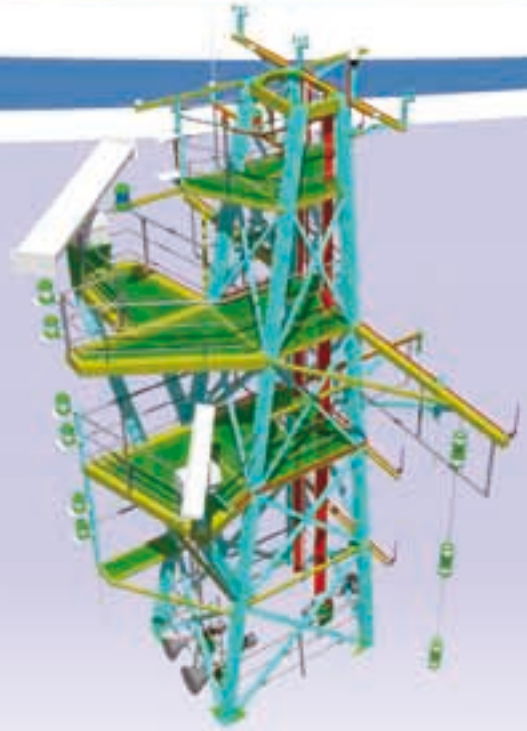
CATIA V5 supports industry requirements, such as symbolic general arrangement drawings. These specialised documents meet technical standards and employ standard graphic symbols with automatic text annotations features.

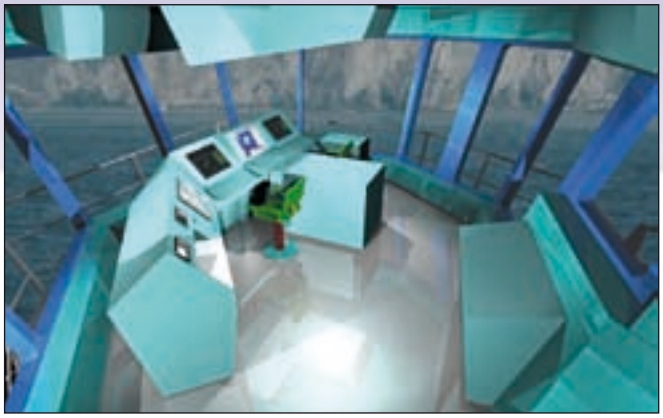
All ship fluid systems follow the same logical breakdown structure as the ship's structural block plan. Users benefit because final ship assembly sequences that apply to the blocks also apply to fluid systems. This allows much higher levels of sub-assembly completion. Products from DELMIA support manufacturing processes, including assembly. More detailed processes, such as pipe bend simulation, can be conducted to verify whether a given spool can be manufactured or whether adjustments will have to be made before manufacturing of the part will become practical.

The fluid systems solution is split into sub-solutions that follow the natural design progression used in the industry, including:

- *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.*







Electrical systems

Electrical systems on today's ships 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.

CATIA V5 delivers unique solutions for electrical design, with capabilities ranging from simple diagrams to major cable pulls. Depending on the design strategy used by the shipyard, CATIA V5 supports designs that use ladders and cable trays, as well as direct routing through hangers when space is limited. Specialised waveguides, required on Navy vessels, are also integrated into PLM.

CATIA V5 electrical diagram software integrates with EDSA, electrical simulation applications from EDSA Micro Corporation. This allows electrical designers to simulate short circuits and manage load capacities. By using its network of diagrams, CATIA V5 allows users to manage and route very large networks of cables using a dedicated cable database implementation. Cables are routed as the realisation of the logical design in the diagrams, taking the pathway or 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 the 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.

Electrical system modules include:

- *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.*

Accommodations, outfitting and machinery

CATIA V5 has a strong background and long history of customer successes. Mechanical CAD is important in the design of cruise ships and Navy ships, but is growing in importance for commercial shipbuilding and the offshore industry as the demand for flexibility continues to increase.

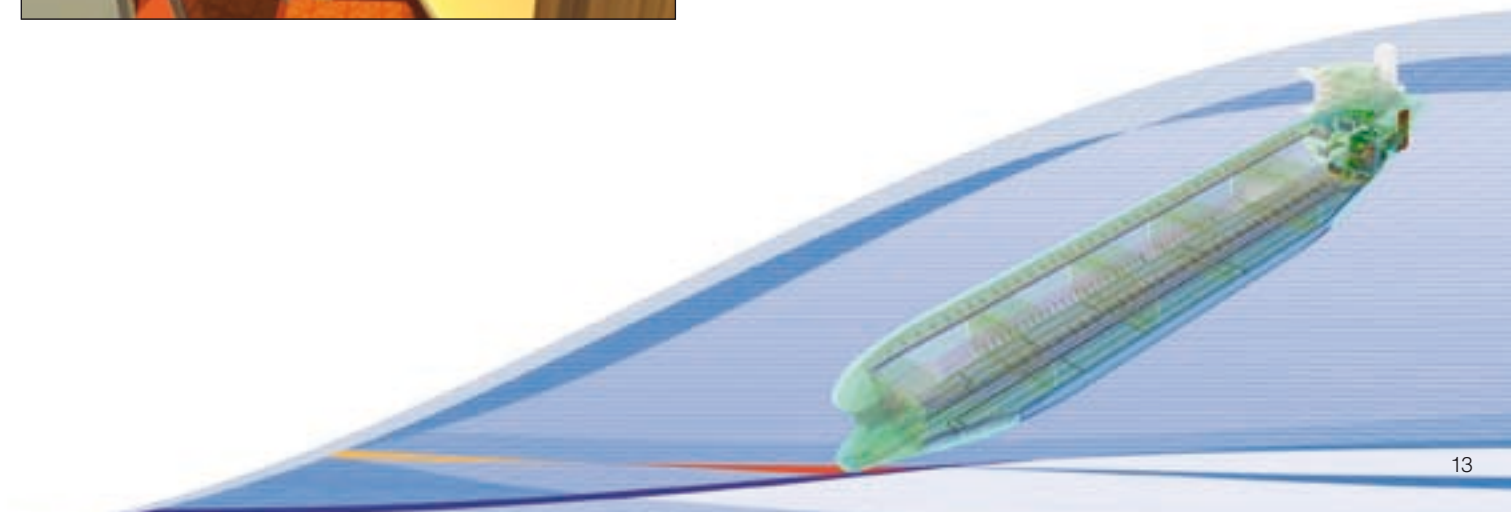
Thanks in large part to its strong history in industries such as automotive and industrial products, CATIA V5 supports a large range of direct CAD translators and industry exchange standards, including STEP and IGES. This makes design re-use easier than if the software had been designed exclusively for 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 CATIA V5 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 discipline.

In mechanical design, where forged and machined parts must be produced, DELMIA products manage manufacturing processes, including work flow, equipment optimisation, stock management and NC programming.

Specific mechanical design modules include:

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



The proven, real-world solution…
PLM solutions for shipbuilding are extensive, covering the full range of disciplines needed at every stage of a ship's lifecycle. Best of all, however, IBM shipbuilding solutions have been developed and proven in actual yard operations by some of the world's leading shipbuilders and naval architects:

Sevan Marine incorporates CATIA V5 for design and analysis of advanced offshore stabilised platforms and uses SMARTEAM for collaboration and data exchange. IBM PLM helps Sevan find the most efficient way of re-using parts and knowledge from other projects while working with yards who build their platforms. Sevan Marine can now do basic design in just one week with a handful of engineers. PLM reduces conceptual design time by up to 70 percent.

DELTAMARIN has documented lead time savings of two to six months during the design phase by creating a complete 3D model at the first stage of a project. Having a well-coordinated model available at the signing of a new building contract saves coordination time later and reduces content, contract and design discussions as work progresses as the same model can be used for calculating essential design parameters and for extracting subcontractor and supplier inquiry models.

At **Meyer Werft**, 3D models have been used to eliminate costly physical scale models of complex areas and to analyse and review construction in a virtual environment, allowing the development of building and erection sequences.

Collaborative work tools have also allowed **Electric Boat** and **Northrop Grumman Newport News**, which are co-building the entire NSSN-class submarine, to divide the construction of key modules. This avoided duplicating the learning curve and saved US taxpayers an estimated $700 million. **Northrop Grumman Newport News** has also fully integrated its ERP and PLM system as a result.

… from your proven, real-world partner: IBM

Designing and building a modern ship is one of the largest, most complex undertakings in the modern world. Not just any company can build one – and not just anyone can support the companies that build them. Just as no one else can match the skill and know-how that you bring to a project, no one else can match the skill and know-how that IBM puts at your disposal.

IBM has more experience with large and complex projects than anyone in the business. Our track record of success speaks for itself. We have the people, experience and resources to ensure your success, because we understand both the complexity of building collaborative systems for design and production and the complexity of the global marketplace in which you compete.

We also realise that technology must constantly evolve to meet your needs, so IBM is committed to continuous improvement of its shipbuilding solutions. IBM and Dassault Systèmes continue to work together with shipbuilders worldwide to expand and deepen our solutions.

For more information contact your IBM Representative, IBM Business Partner, or visit the IBM PLM Web site at:

ibm.com/solutions/plm

IBM Corporation
Software Group
Route 100
Somers
NY 10589 USA

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