Product Lifecycle Management Solutions for Process, Power and Petroleum

CATIA

ENOVIA

Plant design, construction and management

Modern plants are incredible machines. They process food, produce pharmaceuticals, purify water, bottle soft drinks and even extract minerals from ore. Their output size can be as small as microchips for computers, or as large as jumbo jet airliners, and their sites range from deep water offshore oil and gas rigs, to mountain valleys.

The Engineering Procurement and Construction firms (EPCs) responsible for the design, construction and sometimes operation of these plants face enormous challenges. Plant requirements are complex and construction sites are diverse. Design innovation is critical to deliver an optimised plant layout that improves efficiency while reducing operating costs, and which meets strict regulatory and safety standards.

EPCs must also ensure the successful management of plant and facilities data throughout a plant's lifecycle – a period of more than 20 to 30 years of continuous operation. In addition, the EPC needs to ensure the successful integration of engineering activities with business disciplines, and enable the capture of experience and best practices for reuse in future projects.

With the shift from a plant- to a process-centric engineering business model characterised by collaboration comes the move from local expertise to a global knowledge base. EPCs need to ensure that plant engineering processes can support global collaboration throughout the supply chain to maximise the potential of this knowledge.

Ultimately, designing, building and managing plants is a highly collaborative effort which demands considerable technical and business skill to be successful. To remain competitive, EPCs must confront these challenges with new business strategies.

New challenges, new strategies

EPCs 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 plant depends, in large part, on quality construction, maximum availability, energy efficiency and a design that requires minimal staff to operate. Today, informed owners are realising that the total lifetime cost of ownership of a plant is as important as the initial price paid, and they are pressuring EPCs to deliver.

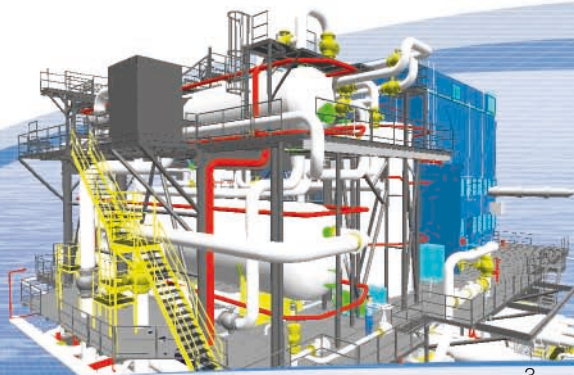
Many EPCs are shifting their businesses from total design-build to an assembly model where significant components are outsourced. This shifts responsibility for much of the design and construction services to the suppliers who can better manage the trade-offs between high quality, schedule and low cost.

Together, these pressures mean that EPCs are undergoing a fundamental business transformation. Advanced engineering firms are combining innovative practices, enterprise IT integration, and leading product lifecycle management (PLM) engineering-construction solutions to develop innovative plant designs, and improve customer satisfaction and competitive standing.

Innovation is no accident. Turning innovative ideas into market-leading products demands flexible business processes supported by integrated PLM solutions – all built on a strong technology foundation. PLM process, power and petroleum plant design solutions advance the pursuit of innovation by integrating business environments with cutting-edge tools for design, engineering and construction.

Both internally, and throughout the 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 – that is security-rich and scalable, allowing new business processes to be built and existing processes to be leveraged cost-effectively. IBM PLM delivers the most advanced lifecycle and discipline level applications in the industry today. At IBM, we let our client's business drive PLM – not the other way around.



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

The goal is to eliminate errors and deliver a high quality plant 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 EPC that can consistently deliver such plants will stand head and shoulders above its competitors.

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

- *Accurately assess initial requirements before committing to long-lead, high-capital equipment orders*
- *Efficiently balance owner requirements with best practices and regulatory compliance*
- *Optimise processes to eliminate all unnecessary steps, minimising costs and cycle times*
- *Perform as much design work and simulation as early in the process as possible – ideally before bidding for a project – to ensure the plant can be built profitably at the price quoted*
- *Manage complexity, including sophisticated plant systems, and the interdependent work of multiple subcontractors and the construction site itself*
- *Eliminate rework while maximising the reuse of design elements from other projects*
- *Ensure the accuracy of design documents and bills of materials (BOMs)*
- *Provide construction teams with sufficient design data*
- *Optimise the scheduling of the project.*

PLM: Lifecycle and discipline solutions that drive profitability

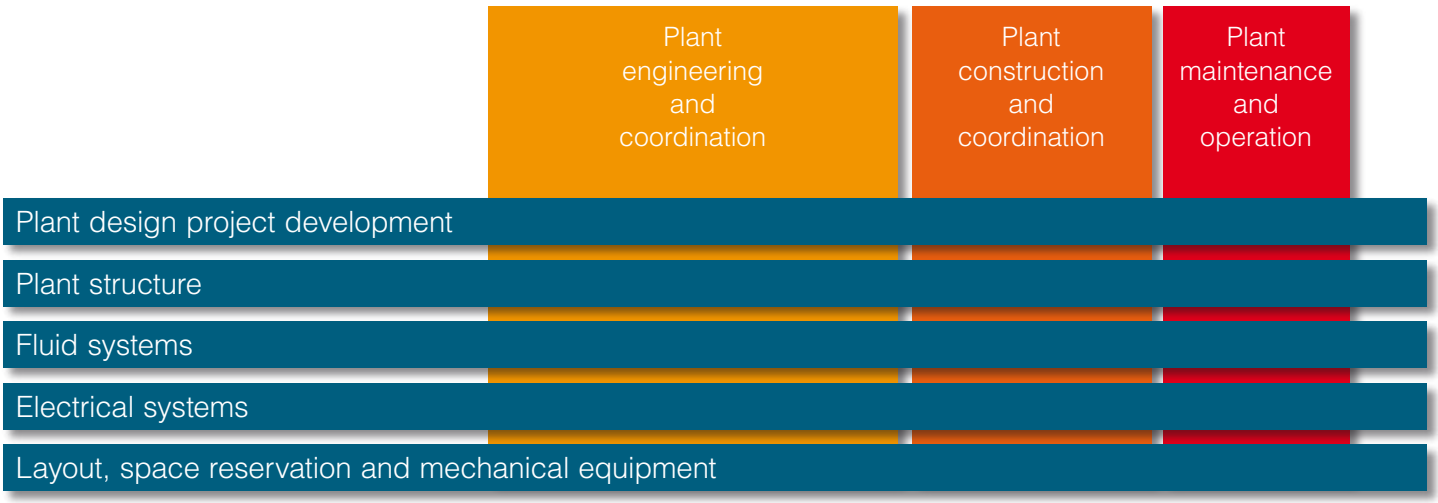
Profitable process plants and offshore facilities require a strong decision support system that provides accurate information about the plant at each phase of development.

PLM solutions for process, power and petroleum industry plant design from IBM and our strategic partner Dassault Systèmes address information needs at the lifecycle level:

- *Plant engineering and coordination*
- *Plant construction and coordination*
- *Plant maintenance and operation.*

These solutions also address needs at the discipline level:

- *Plant design project development*
- *Plant structure*
- *Fluid systems*
- *Electrical systems*
- *Layout, space reservation and mechanical equipment.*



Lifecycle solutions

Plant engineering and coordination

Plant design is a highly collaborative and cross-discipline effort. As pressure increases to meet more complex process requirements, EPCs, suppliers, consultants and regulatory groups are turning to PLM to handle both engineering and the coordination tasks associated with it. These tasks begin with early project specifications and extend through to initial construction planning.

Coordinating plant design is a daunting task, but advanced PLM database technologies – like those found in ENOVIA VPLM Lifecycle Applications (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 plant design, these capabilities manage design variants, such as shared designs across plants, as well as alternative design options for a single plant.

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 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 process, power and petroleum industries. For example, the penetration management solution relies on a well-defined workflow to help EPCs automatically identify and solve interferences and clashes in the plant.

Clashes between structural steel and mechanical equipment or lineal systems like heating, ventilation and air conditioning (HVAC), piping or electrical cableways are identified and categorised by rules. These may then be processed and resolved according to the workflow of the designated design team. Clash management offers a flexible way to automate cross-discipline engineering, while significantly reducing construction costs and eliminating the last-minute errors often associated with paper-based systems.

Collaboration can bring teams together from multiple organisations. This 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 interface with a broad range of mechanical CAD systems, including PTC, UGS and AutoCAD.

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.*

Plant construction and coordination

Today, EPCs are focused on managing construction costs. A fully integrated PLM environment supports a design-to-construction approach, optimising both the design and construction processes. For example, the building strategy can be verified and simulated early in the design cycle, when it can be of greatest benefit to the overall design process.

In PLM, the construction breakdown structure can be rearranged independent of the design structure, providing full flexibility to support an EPC's preferred organisation for construction. In addition, PLM offers functionality to rapidly simulate and verify different alternatives to the construction sequence. This can help reduce the occurrence of construction-delaying problems that typically arise when the structural systems and large equipment are ready to be placed.

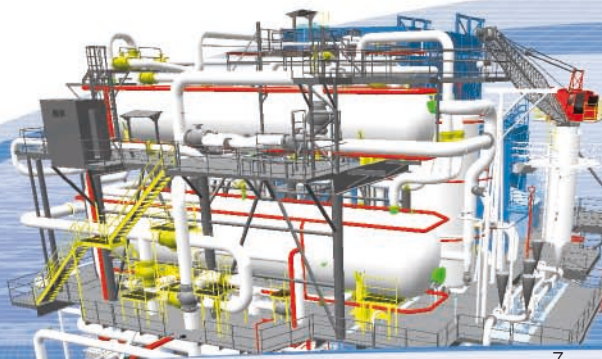
The PLM environment maintains the relationships between design and construction data. This enables EPCs to track late changes, while providing the tools to identify parts that may be impacted by design changes. The PLM environment tracks not only the individual components, but also the assembly structure to which they belong. As all components are included in the schedule and planning, the impact of changes can be tracked, providing input to calculate overall construction time.

The 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 plant owners and accepted by EPCs without a full understanding of the impact on costs. Unable to predict the impact of changes on costs or schedules, EPCs are not equipped with the information they need to negotiate changes in their contracts. Consequently, the additional cost of delivering the plant is carried by the EPCs rather than the owner.

In an integrated PLM environment, EPCs have the information they need to predict the cost of changes in time and money, giving them the information they need to decide whether to renegotiate the terms of the contract.

Plant construction and coordination solutions in PLM include:

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



Plant maintenance and operation

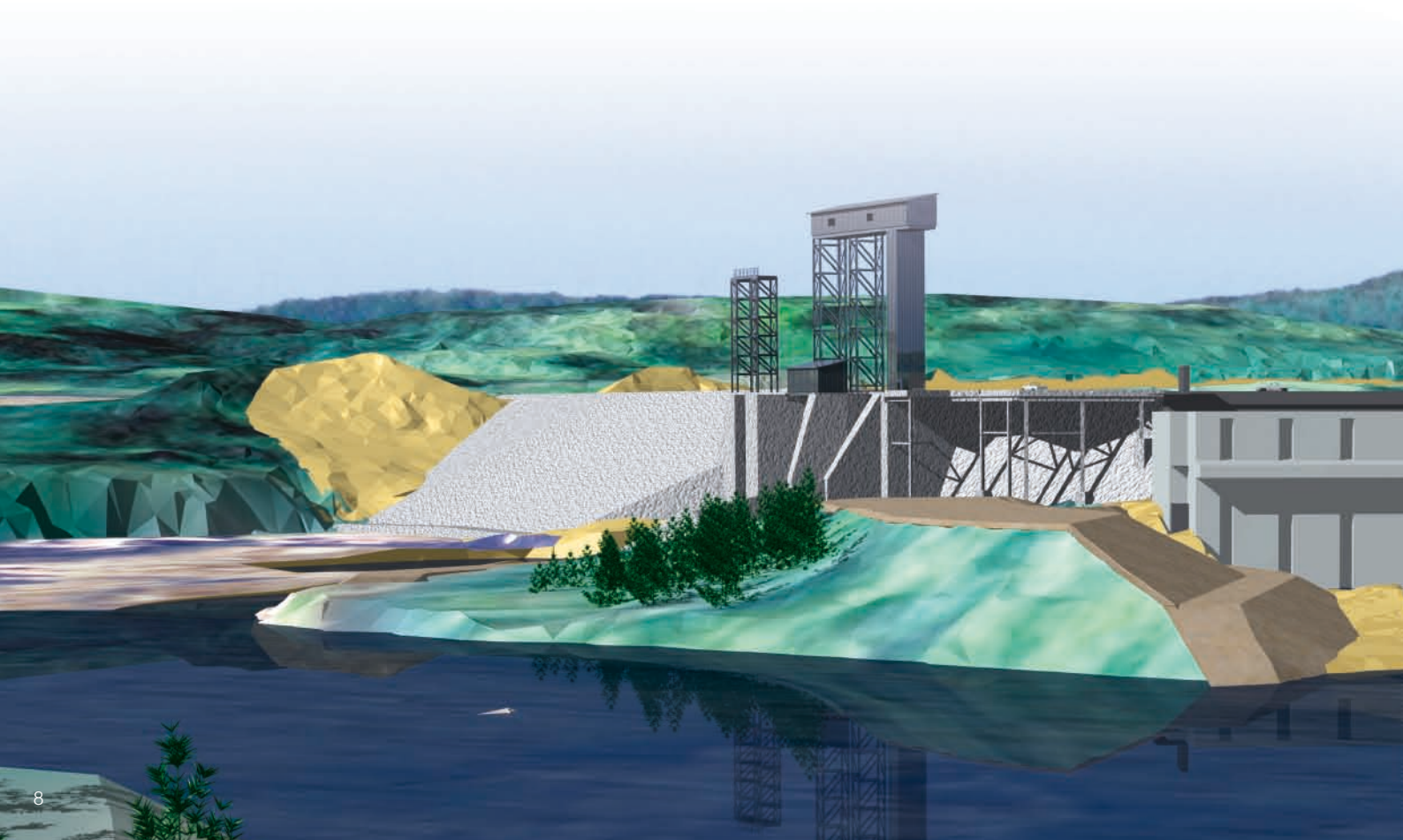
A plant is a product with a 20 to 30 year lifespan. The process of designing and constructing a plant captures and produces records of tremendous potential value to owners and operators, including original system specifications, regulatory compliance, equipment attributes and systems arrangements. This data, when retained with the repair records, technical documents, and maintenance and operations records, is a vital asset.

The benefit of maintaining and reusing this information throughout the lifecycle of the plant is obvious. In this way, PLM offers EPCs an opportunity to extend their current business by offering well-defined data for owners and operators to use in ongoing operations. By reusing 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 address operational requirements.

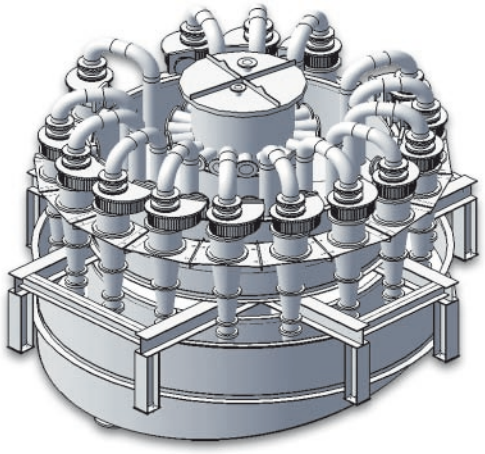
In operating a complex plant, many well-documented processes must be executed to satisfy different organisations. These include safety and security, as well as maintenance operations such as equipment overhaul or replacement. The PLM environment can store and manage both processes and best practices, and simulate these processes to optimise operation of the plant. In cases where new and unproven tasks must be conducted, a digital mockup can prove beneficial in planning and testing different alternatives.

Plant maintenance and operation solutions available in PLM include:

- *Systems diagrams, including Piping and Instrument Diagrams (PID), schematics and electrical one-line-diagrams*
- *Operations and maintenance simulation*
- *Equipment and systems inventories*
- *Engineering document and specifications management.*



Discipline solutions



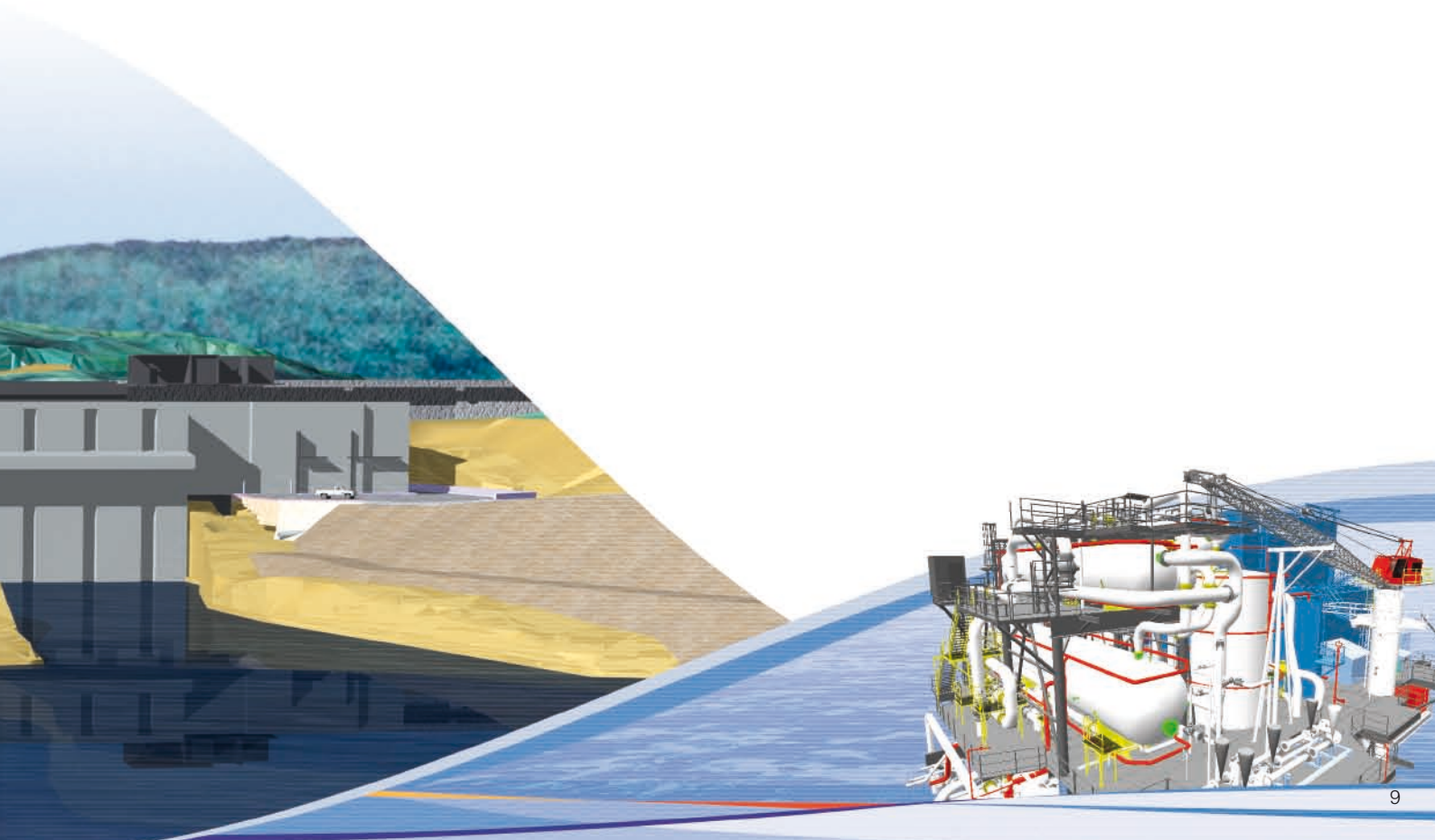
Plant design project development

Developing a new plant 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 design proposal that satisfies not only the plant owner or operator, but which also complies with regulatory groups, is extremely limited. That design also needs to contain enough information to minimise the possibility of any unknown factors that may impact the cost of constructing such a plant.

EPCs are discovering that 3D digital mockup tools produce superior results over 2D drawing approaches. Digital mockups help partners to communicate and visualise complex areas. Applications that link system specification and process requirements can also serve as efficient tools for developing the plant's basic layout in a safe and efficient way. Site conditions and existing facility descriptions can be imported from industry applications, such as AutoCAD. They also can be designed using the advanced surface modelling capability found in the 3D modeler of CATIA V5.

The plant project development solution in PLM meets demands in the following areas:

- *Requirements management*
- *Functional/logical design*
- *Physical design allocation*
- *Space reservation and routing*
- *Test and validation*
- *Conceptual design*
- *3D general arrangement*
- *Parametric layout*
- *Simulation and rendering.*



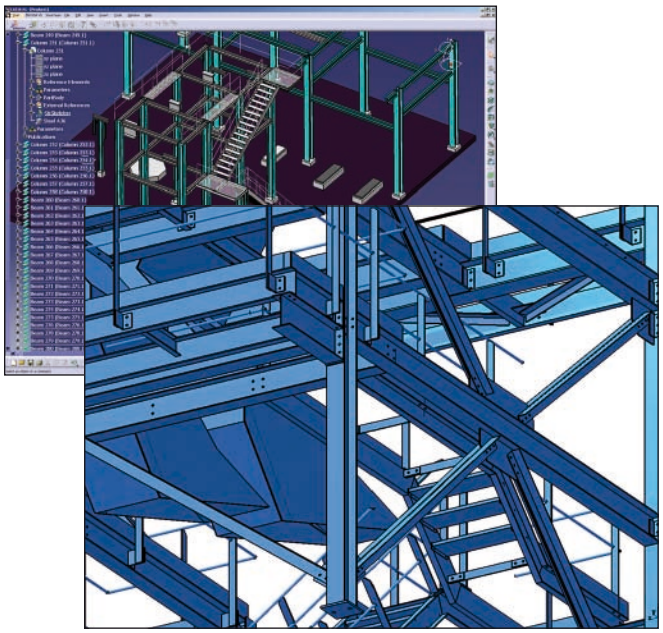
Plant structure

Plants typically involve large and heavy equipment and their structures must often be built around this. Plant structure and the coordination of construction with plant equipment is one of the most important considerations in plant design.

Unlike generic CAD solutions, the solution from IBM and Dassault Systèmes has been developed in cooperation with leading EPCs. This close alliance ensures that all applications follow professional practice and fully meet the unique requirements of the EPC.

User productivity is key in structural design and detailing. Copy 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 reuse knowledge and design in an integrated, organised and controlled way.

The plant structure solution supports a smooth transition from general arrangement (the output of the project development phase) to the basic design, where rules and strength calculation are required. Finite Element Model (FEM) analysis can be completed via integrated solves. Alternatively, if users prefer, CATIA V5 can export data in a variety of industry formats to tools such as MSCNastran, ANSYS, or GTSTRUDL.



The PLM steel structure solution has been specifically designed to allow the overall structure to be divided into construction volumes, or zones, at any time prior to construction. This allows contractors to select the right zone at the optimal time, while enabling designers to achieve the best possible assembly breakdown structure.

Since design intent is captured at the basic design level, the zone-split process can capture and resolve a large part of the work that has traditionally been completed manually in the detailed design phase.

Not every structural situation can be solved with a standard detail. PLM offers knowledge templates to automate many difficult cases, while maintaining all project specifications. In addition, efficient interactive tools are provided to create individual details that still carry the full specification-driven implementation. Copy and paste interactions allow the designers to reuse and interactively adapt design detailing.

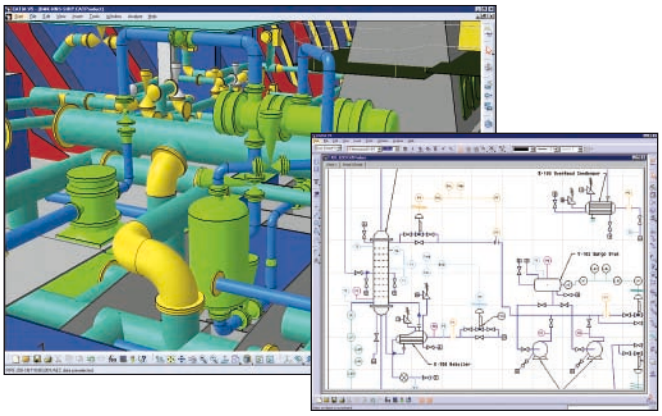
During the detailed design level, additional data is produced to represent the different stages of each part. These stages can include variables such as special plate profile or beam cutting. For non-traditional steel work, PLM provides interfaces to ALMA where nesting and specialty plate steel cutting can be performed, demonstrating the openness of the IBM PLM V5 platform.

The plant structure solution covers all functions, from basic design through to the final steel cutting stage, and comprises the following offerings:

- *General steel frame layout and zone-split*
- *Structural foundation and secondary structure*
- *Steel frame structure detailed design*
- *Special section structure lofting, including template creation*
- *DPM for construction assembly simulation*
- *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 reuse of the zone-split schema. Originally defined for the plant structure break down, the zone schema is used at this stage to decide how piping and other systems should be spooled. This helps improve construction planning by associating system components and BOMs with particular zones of the plant.

The basic design is organised in a single view of zone assemblies. As a result, detailing is highly automated and can take advantage of the knowledge defined and saved in the specification catalogs. In addition, logical diagrams and design rules help to automate component placement and catalog component selection. This allows designers to spend more time on optimal layouts and reuse practices which proved successful on previous projects.

Detailed design activities are actually preparation for construction 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.

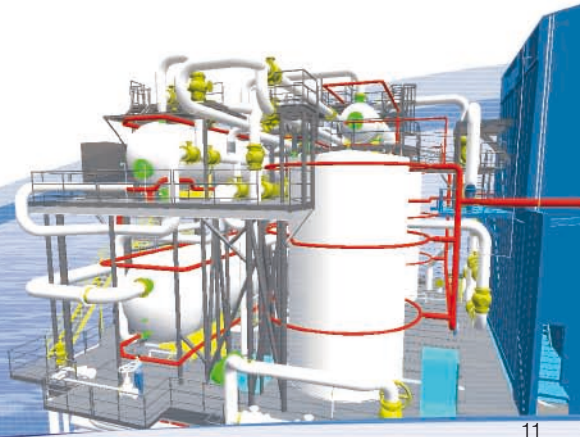
CATIA V5 fully supports industry requirements, including symbolic general arrangement drawings. These specialised documents meet technical standards and employ standard graphic symbols with automatic text annotation features.

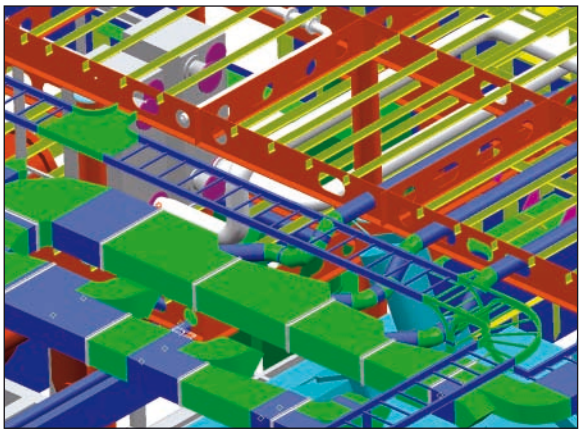
All plant fluid systems follow the same logical breakdown structure as the plant's structural zone plan. This benefits users because final plant construction sequences applicable to the zones also apply to fluid systems, enabling enhanced levels of sub-assembly completion.

DELMIA products support manufacturing processes, including assembly. More detailed processes, for example pipe bend simulation, can be conducted to verify whether a given spool can be manufactured, or whether adjustments are required before part manufacture will be practical.

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

- *Piping and Instrumentation Diagrams (PID)*
- *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

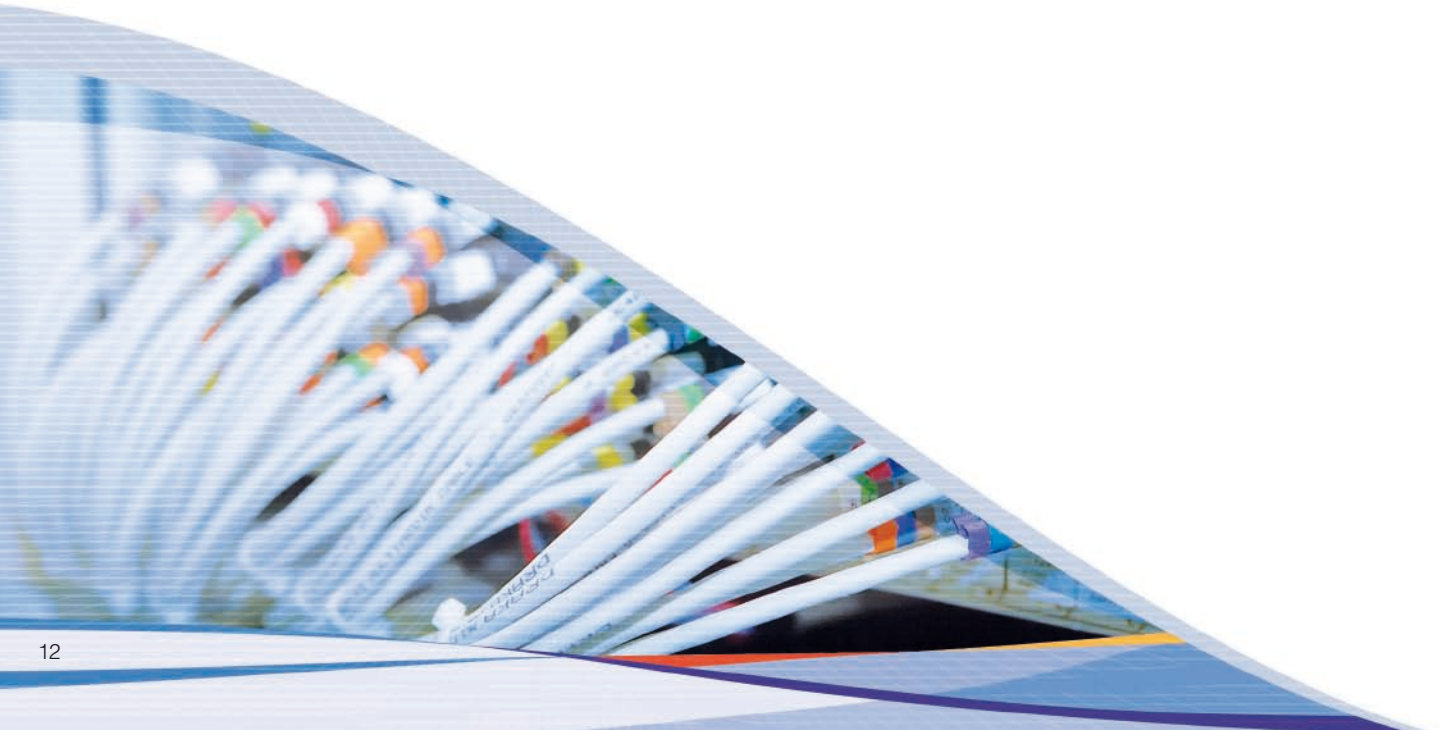
CATIA V5 delivers unique solutions to address the complex electrical design requirements of today's plants. Capabilities range from simple diagrams to major cable pulls. Depending on the design strategy used by an EPC, CATIA V5 supports designs that use ladders, cable trays and conduits, as well as direct routing through hangers when space is limited.

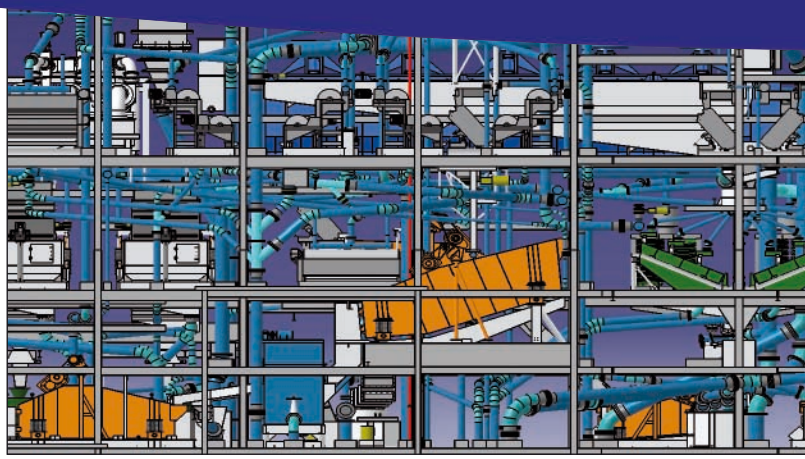
CATIA V5 electrical diagram software integrates with EDSA electrical simulation applications from EDSA Micro Corporation. This allows electrical designers to simulate short circuits and manage load capacities. Using its network of diagrams, CATIA V5 allows users to manage and route large networks of 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 construction by zones, trays and hangers can be structured within the same assembly structure as the physical parts. This enables higher levels of supplier coordination, component delivery and palatising ready for installation. 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, conduits and hangers*
- *Cable and wire routing*
- *DPM assembly*
- *Work instruction extraction (cable lists)*
- *Power distribution, simulation, load analysis and outage analysis.*

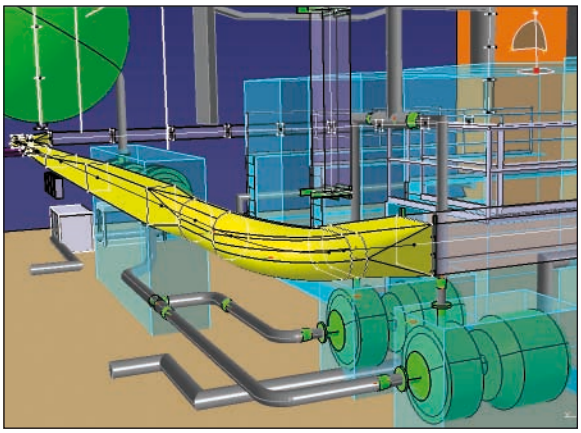




Layout, space reservation and mechanical equipment

As the demand for flexibility in engineering continues to rise, the need for mechanical CAD in the design of plants and offshore facilities is increasing. Due largely to a 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.

Some EPCs need to design and construct not only the plant itself, but also some of the equipment used within that plant. For those EPCs, CATIA V5 is particularly beneficial as it enables them to design multiple products while supporting just one global PLM environment. This can reduce system operation and maintenance costs, as well as training costs as engineers are required to learn just one user interface and toolset, regardless of discipline.



In mechanical design, where forged and machined parts are produced, DELMIA products manage manufacturing processes. These include work flow, equipment optimisation, stock management and numerical control (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*
- *DELMIA DPM machining, NC milling and lathe machining*
- *Manufacturing drawing generation.*

The proven, real-world solution…
PLM solutions for EPCs developing plants for the process, power and petroleum industries are extensive and cover the full range of disciplines needed at every stage of a plant's lifecycle. Best of all, however, IBM plant design solutions have been developed and proven in plant operations by some of the world's leading EPCs and owner operators:

Farnham & Pfile uses the virtual product design capabilities of CATIA and ENOVIA VPLM to design and build advanced coal-processing plants. Together, these solutions enable engineers and clients to collaborate at regular intervals inside a perfect 3D rendering. PLM has reduced supplier costs by 30 percent, while increasing the ability to quickly and effectively resolve potential problems in complex projects earlier in the process.

At **Hydro-Québec**, CATIA V5 and ENOVIA SmarTeam enables enhanced collaboration with partners, and accelerated problem resolution during the project development stage – from analysis and optimisation of variants, to engineering validation respecting design intent. Engineers can better integrate data from multiple disciplines, including mechanical equipment, fluid and electrical systems, and concrete and steel structures, in a single development environment. This supports shorter deadlines, enhanced quality and design, and improved cost control.

Sevan Marine incorporates CATIA V5 in the design and analysis of advanced offshore stabilised platforms, and uses ENOVIA SmarTeam for collaboration and data exchange. IBM PLM helps Sevan find the most efficient way of reusing parts and knowledge from other projects while working with shipyards and equipment suppliers who build their platforms. Basic design can be completed in just a few weeks by a small team of engineers. Conceptual design time has been reduced by up to 70 percent.

… from your proven, real-world partner: IBM

Designing and building process plants and offshore facilities is possibly one of the largest, most complex undertakings in the modern world. Not just any company can build a plant or facility – and not just anyone can support the companies that build them.

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

At IBM, we realise that technology must constantly evolve to meet your needs. IBM is committed to the continuous improvement of our plant design solutions. IBM and Dassault Systèmes continue to work in collaboration with EPCs and owner operators 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

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