Asset Management to support Product Lifecycle Management (PLM)

Leveraging Asset Management to benefit PLM projects

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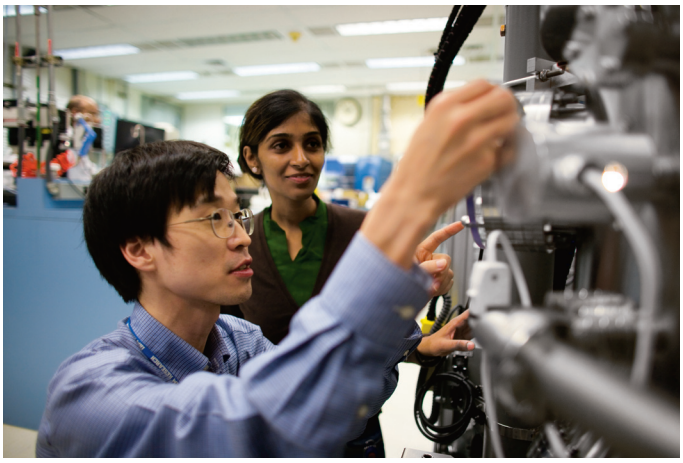
Introduction

Manufacturers in all sectors are facing increased maintenance, repair and operations (MRO) costs at their plants. These are recurring costs that impact the bottom line and directly affect profits. The largest cost increases are in energy, raw materials, health/safety/environment (HSE) regulatory compliance and from the negative impact of unscheduled production outages, often due to failure of assets.

Leading-edge manufacturers are discovering that they can improve production efficiencies and manage MRO expenditures by integrating their Product Lifecycle Management (PLM) with Enterprise Asset Management (EAM) systems. Many manufacturers are already using PLM technology to design products, test them and automate their production. This same technology can be integrated with EAM solutions, like IBM's Maximo® Asset Management to manage manufacturing assets involved in production, such as the plant itself or its equipment, like conveyors, robotic cells, CNC machines or materials handlers. For companies already employing IBM PLM for design and production, integrating EAM solutions like Maximo increases manufacturing availability of production equipment while reducing overall plant MRO costs through better service and maintenance programs.

PLM and EAM integration offers additional benefits when manufacturers engage in 'service after sales'. EAM technology can manage MRO tasks for the manufactured goods that customers buy or lease from Original Equipment Manufacturers (OEMs). Traditionally, manufacturers have relied on distributors or parts suppliers to handle customer support. Service revenues to manufacturers were minimum and mostly from supplying parts and managing warranties and product upgrades. But today, service after sales is a fast growing, high profit opportunity and many manufacturing companies see advantages to using their PLM legacy data along with EAM solutions to offer direct customer service after sale. The benefits include long-term customer relationships, additional revenue through service offerings and direct tracking of product performance and MRO in the field.

Customers benefit too, through improved technical support, higher asset availability/performance levels and options for performance enhancement, field upgrades, etc. There is an emerging trend of OEMs offering their customers for-fee MRO services – that is maintaining their goods at their customer locations, extending further their services after sales as a new business model.



Let's take a look at the synergy between EAM and PLM throughout design, manufacturing and service after sales. Good EAM starts with good systems engineering – for example, design for maintainability/sustainability and reliability which touches both the physical design of the system and the design of the EAM support processes that will be facilitated by solutions like Maximo EAM. Let's take a closer look at EAM technology and how it complements PLM at the manufacturing plant and in service after sales.

Enterprise Asset Management at the Plant

Manufacturers using Product Lifecycle Management technology are familiar with the progression of developing and selling new products. The lifecycle is an evolution from general concept to design prototype and matures through analysis and design detailing, and finally reaching production. The whole PLM effort converges at manufacturing and production, but what about the plant itself and its production assets?

EAM, like PLM, is a lifecycle progression. The EAM cycle begins with an asset service strategy and ends sometime later, perhaps as long as 30 or 40 years, when the asset is retired (i.e. aircraft carriers, nuclear reactor vessels, electrical generators or even an entire petrochemical plant). Figure 1 shows the main phases within the cycle; they are similar to PLM's cycle.

Each phase of the Asset Lifecycle is a business refinement where up-front concepts for production equipment and facility investments are amortized and realized over years of continuous operation and service delivery. The main asset lifecycle phases, shown in Figure 1, are as follows:

- *Asset Strategy phase: all activities related to asset management assessments and strategies, development of best practices, as well as development of KPI (Key Performance Indicators) and performance standards.*
- *Planning phase: development and definition of standards, portfolio asset management planning and financial impact analyses.*
- *Evaluation/Design phase: development and definition of a Capital Program assessment model, planning of Computer Aided Facilities. This may include design of the factory, processes and production equipment as well.*

Figure 1 – Asset Lifecycle Management

- *Creation/Procurement phase: Capital Project Management, managing MRO procurement processes (including e-MRO as well as the procurement/project delivery strategy and policies). In some cases, this includes procuring materials to build or manage contractors.*
- *Operation phase: focus on processes around full asset visibility, asset performance management, i.e. relationships with or integration with manufacturing execution systems (MES), relationships (and consequences) with concepts such as Lean/Six Sigma, Total Productive Maintenance (TPM), definition and execution of Service Management processes including Service Desk capabilities. Operational processes should include both IT-embedded and IT-enabled assets and processes.*
- *Maintenance and Modification phases: managing all asset management information – use the asset information management software application to support process improvements, track quality, performance and lifecycle costs. Many companies are adopting condition-based maintenance programs, that is, maintenance operations that are triggered by a set of conditions detected by inspection or by sensors.*
- *Retirement phase: all activities involved in managing assets that are still owned, but no longer being used, including decommissioning, protection, and retirement.*

It is important to mention that all phases and activities are related to and have impact on financial management as well as technology used within the company. By managing assets across the facility, organizations can improve asset utilization and performance, reduce capital costs, reduce asset-related operating costs and improve Return on Assets (ROA) because assets are better utilized and, in some cases, they have a longer useful lifespan.

Challenges and Business Benefits

EAM technology is mature and widely used by manufacturers to manage the production facility itself, and all critical assets within it. Traditionally, PLM and EAM technologies have been used separately. But today, manufacturers see benefits to using PLM and EAM together to improve manufacturing performance and to generate new revenue through post-production customer service after sales. Here, we look at the main business drivers that are bringing these two technologies together and the benefits manufacturers expect.

Manufacturing Challenges

Today's PLM offers digital manufacturing solutions which can simulate and optimize all phases of product manufacturing, from early product design stages through final product production. Product Data Management (PDM) databases are used by PLM to manage 3D models, track alternative product configurations, audit change history and maintain the correspondence between product requirements, all technical documents created, and physical product performance.

In most cases, however, these resources are ignored by EAM systems, even when the MRO activities they manage directly impact product manufacturing. This is a significant disadvantage because the PLM system has the most complete product, process and resource definitions available. MRO also needs this same information.

There are two reasons for this gap: one is organizational and the other is technological. PLM and EAM tend to be missions of different lines of business within the manufacturing enterprise. Maintenance and operations have not traditionally overlapped product design and production. Separate information systems and business processes have evolved. The gap is even wider when MRO is outsourced and service providers have other systems that are not integrated with the manufacturer's operations.

From a technology point of view, EAM systems tend to manage transactional work orders and service contracts. They are excellent at managing large numbers of fixed and mobile assets, but they lack the analytical tools and data exchange mechanisms to interact with 3D product data information. Few EAM systems can optimize an MRO procedure that involves 3D relationships or spatially distributed resources. While EAM systems manage assets very well, few have tied engineering, manufacturing, materials logistics and MRO together in an integrated way.

Service after sales

Performance information about products in the field is difficult to find if you are a manufacturer. Many users are reluctant to provide OEMs access to their operational data. At the same time, design information about products in the field is difficult to find if you are a customer or technician performing maintenance, repair or operations on those products. Until now, sharing information between OEMs and field operations has been limited, because technical product information is generally accessible only through the systems used to design them and customers and service providers do not normally have this access.

Manufacturers have a similar problem. They do not have a view of how customers install and maintain their products. The inability for manufacturers and customers to share information and collaborate in service after sales type environments has led to inefficient field operations and under-utilization of products for customers, as well as inadequate product performance and redesign information for manufacturers. An important common issue is product performance. Often, the only view the manufacturer has of product performance is through warranty claims and parts orders.

Because usage or design issues that show up in the field are often not fed back to manufacturers, future products inherit many of the faults that have already been experienced in the field. When manufacturers and consumers cannot collaborate, warranty problems, down time, poor maintenance work and an inability of the technician to 'fix it right first time' can be the result.

The impact on manufacturers is evident too, in lower sales and profits due to warranty claims and loss of competitive leadership. There is also the simple fact that the time it takes to discover the source of a problem is much longer if the OEM does not have access to operational data – so a piece of equipment breaks 100 times over 10 years, rather than being noticed in year 1 and resolved early on.

Benefits from using PLM and EAM Together

Companies using PLM already know the benefits of having a complete 3D digital product definition and a direct way to couple product design with engineering, analysis and manufacturing. Today, PLM solutions can provide a direct link between design and manufacturing and plant MRO. IBM's Maximo Asset Management software can support the plant itself as well as the assets associated with manufacturing by directly linking to PLM's product data resources. Combining PLM with Maximo Asset Management solutions improves asset utilization, performance and reliability, and increases efficiency in planning and execution. Additional benefits are shown on the right.

Manufacturing involves systems other than PLM – for example, materials management, content/document management and workflow. When these systems are integrated through IBM's Service Oriented Architecture (SOA), manufacturers gain greater visibility and control and achieve higher levels of asset performance through consolidated business processes, standardized practices and shared data. Perhaps most importantly, this broader level of integration ensures premium performance from service providers, both internal and external, and improves customer satisfaction through superior support for service after sales activities and processes.

Let's look at the asset management capabilities of IBM's Maximo Asset Management solutions and PLM to see how they interact to deliver these benefits.

Integrating Product Lifecycle Management with Enterprise Asset Management (EAM) allows companies to:

- *Validate Engineering or Service Driven Changes and Bulletins*
- *Support repair vs. replace decisions*
- *Visualize alternate parts and related effects*
- *Track where-used and effective parts analysis throughout the product or asset life*
- *Engineer MRO tooling and methods*
- *Engineer retirement and handling procedures*
- *Collaborate across the supply chain*
- *Manage change workflow/approval process*
- *Simulate maintenance processes to optimize real sequences and to reduce down-time*
- *Simulate service procedures*
- *Optimize work sequences*
- *Issue proactive and preventive work orders to improve performance*
- *Synchronize CAD/BOM data*
- *Manage configuration*
- *Exchange As-Designed, As-Built and As-Maintained data/Bills Of Materials.*
- *Ensure safety of dangerous procedures*

IBM Maximo Asset Management (Tivoli)

The IBM Tivoli® Maximo Asset Management suite of solutions offers manufacturers full capability to manage and support the production, maintenance and retirement phase with:

- *Best practices to help improve the productivity of their critical assets and insight into the delivery of service after sales of the product. These best practices are also helping to extend asset life, optimize spare parts management, reduce emergency calls and incidents and increase planned versus unplanned maintenance.*
- *Advanced product capabilities to better support people, maintenance and services processes and technology insight into all critical aspects of each asset's lifecycle.*
- *Consideration for the stringent requirements of regulatory bodies, while also adhering to governmental or industry-standard regulation structures for industrial segments such as Aviation, Aerospace and Defense, Automotive, Industrial Machinery, Process Manufacturing, Shipbuilding and Utilities.*

Overall, the Maximo Asset Management solution portfolio offers the most complete support for visibility, control and automation of as-installed and as-maintained asset management information used in manufacturing companies. Rated the highest performing enterprise asset management (MRO) solution suite in the industry, Maximo Asset Management offers PLM users full asset and work management support.

Maximo Asset Management provides service management solutions for asset owners, operators and service providers and to all users in the supply chain. In general, it finally replaces point asset and service solutions with an enterprise solution that can also integrate with suppliers and manufacturers. Figure 2 shows the main components and solutions:

Figure 2 – Maximo Asset Management

Maximo provides solutions for:

Asset and Work Management
- *Manage assets and work*
- *Assign and manage business processes*
- *Complete workflow throughout the solution*
- *Monitor asset performance*
- *Control for asset owners, managers and service providers*
- *Manage IT associated with assets.*

Inventory and Procurement Management
- *Manage asset-centric inventory and procurement*
- *Manage inventory, vendors and purchasing*
- *Receive, issue, transfer and take inventory of material*
- *Mobility access, cell phones, scanners, RFID readers.*

Service and Contract Management
- *Service and contract management*
- *Service desk*
- *IT help desk*
- *Maintenance service desk*
- *Escalation of service requests to incidents.*

The IBM Maximo Asset Management solution has been developed using the latest technology. It is Web-architected and based on J2EE enterprise standard, and fits very well with the principles of Service Oriented Architecture (SOA). The software is, therefore, very flexible and configurable to fit constantly changing industry and market requirements.

When used with IBM's SOA infrastructure, Maximo's asset information management capabilities, PLM technical documents and graphic navigation are accessible to both user communities within the enterprise.

With EAM in mind, let's examine IBM's Product Lifecycle Management (PLM) EAM capabilities for manufacturing and service after sales.

Product Lifecycle Management

PLM solutions develop a complete digital representation of product design through manufacturing. Conceptual designs are taken from the earliest stages of customer specifications through design development, analysis, simulation and manufacturing prototyping. Each phase is an enrichment of the previous phase, as designs are refined and details added. Figure 3 shows this lifecycle.

Figure 4 shows where PLM and EAM intersect. Arrow 1 shows the central intersection where EAM Tivoli and IBM Maximo manages the assets directly associated with production. These might include machinery, like conveyors and robots or materials, spare parts or tool cribs. They can be fixed or mobile assets too, like fleets of vehicles, cranes or railroad cars. An asset also might be the physical facility itself, such as enclosed spaces or outdoor materials storage areas. Assets could also be information technology assets like networks or process control computers.

The second tie-in, arrow 2 in Figure 4, is EAM support for PLM service after sales. Here, the asset is the manufactured good that the manufacturer's customer has either purchased or leased. In some cases, the manufacturer may be remotely operating the product. A third tie-in, arrow 3 in Figure 4, occurs where EAM provides feedback to PLM's Concept phase. Here, the MRO experience from service after-sales influences the early conceptual design of new products. If a previous manufactured good performed below expectations or there were other customer support issues with installation or ease of maintenance, this can be taken into account in PLM's new product portfolio planning and concept phases.

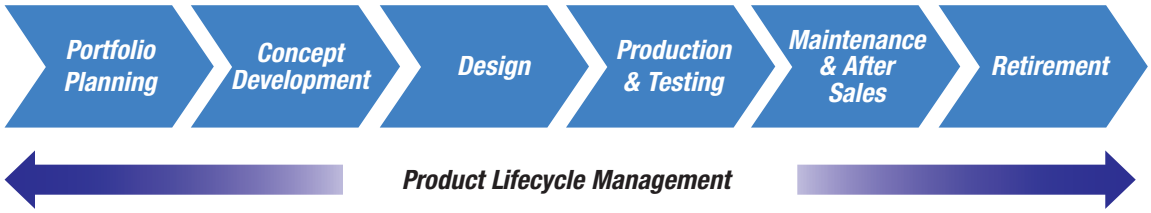


Figure 3 – Product Lifecycle Management Phases

With these three PLM-EAM intersection points in mind, let's take a look at three PLM functional areas that support them:

- *Enterprise Product Data Management (PDM)*
- *Digital manufacturing*
- *Technical documentation authoring.*

IBM addresses these functional areas with PLM application software. IBM and Dassault Systèmes has a portfolio of PLM offerings to address these critical PLM functions: these are ENOVIA™ MatrixOne™, DELMIA™and 3DVIA™. IBM also has the capabilities to integrate the PLM and EAM applications using SOA software and process technology, services expertise and hardware infrastructure.

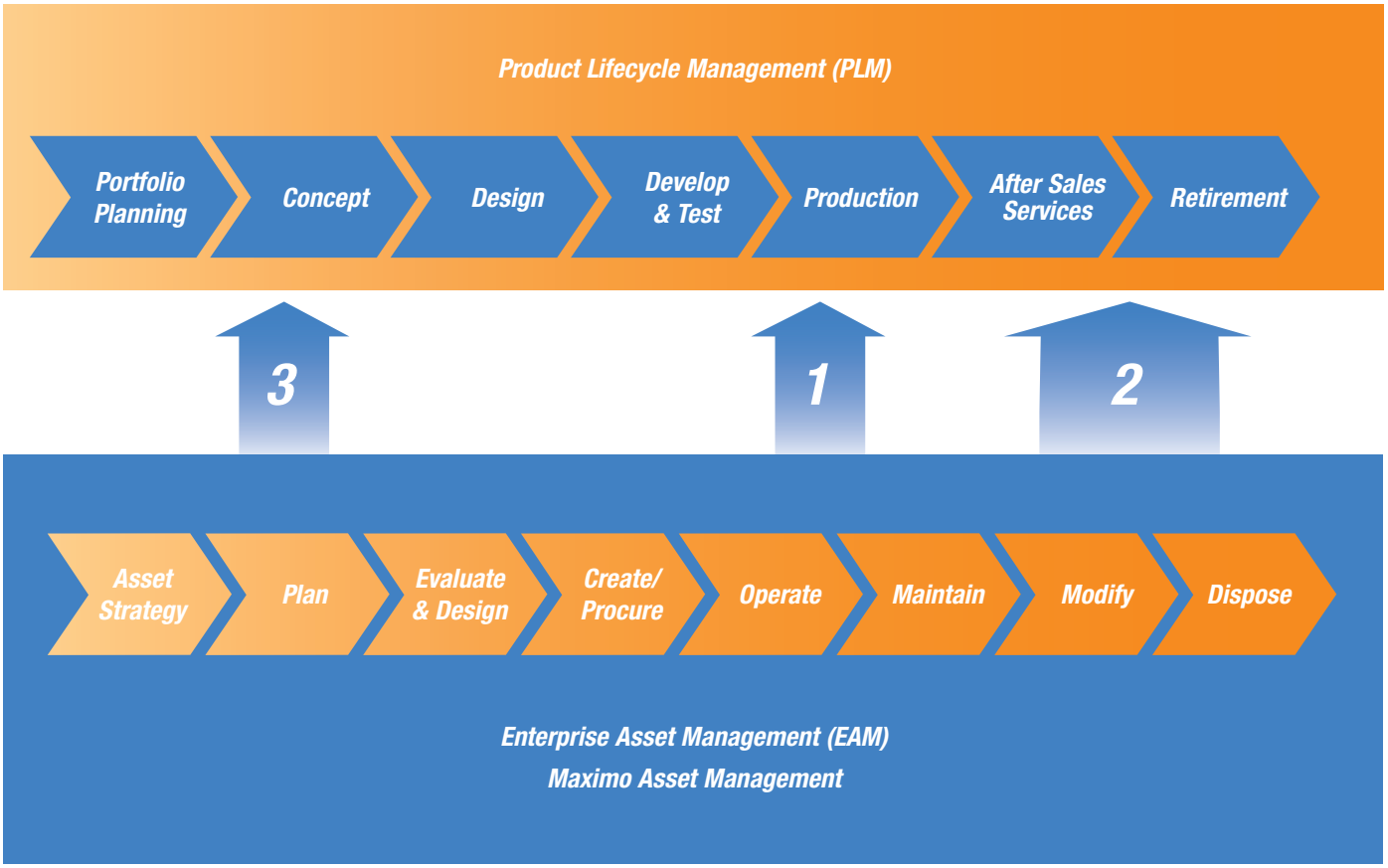


Figure 4 – PLM and EAM Intersections

Enterprise PDM

ENOVIA MatrixOne is IBM's advanced PDM technology for integrating the enterprise's business process with all information surrounding the product's design and production. This includes all product, process and resource information captured by PLM as well as it's ERP, procurement, supply chain management and customer requirements.

ENOVIA MatrixOne is the primary link between PLM and EAM. ENOVIA MatrixOne also manages all manufacturing and engineering bills-of-material (Manufacturing BOM, Engineering BOM etc.). These BOMs create very important parts relationships and show how products are broken down into components and assemblies. Both are critical for MRO. In addition to creating and managing BOMs, MatrixOne provides collaborative portals where suppliers can interact with the product design and parts catalogs they reference. EAM systems like Maximo Asset Management tap into ENOVIA MatrixOne's data repository by way of WebSphere® which facilitates broad and managed access through portals and an Enterprise Service Bus which we describe shortly.

Digital Manufacturing

Digital manufacturing uses advanced 3D systems to virtually define, plan, create, monitor and control all production processes, from early process planning and assembly simulation to final testing, quality assurance, packaging and shipping.

IBM's DELMIA digital manufacturing solutions are a major resource for manufacturing in combination with EAM, because complex MRO tasks can be completely simulated and validated before they are passed to EAM systems for ongoing maintenance and operations. DELMIA's 3D work instruction authoring solutions can define work tasks and work flow related to every step of manufacturing and MRO associated with the plant, its equipment or the manufactured product itself. DELMIA is particularly important because it can perform analysis on different MRO scenarios and propose an optimal solution for the plant's general layout, equipment or processes affecting production, or for MRO tasks related to the manufactured product. Most EAM systems lack these analysis and optimization capabilities.

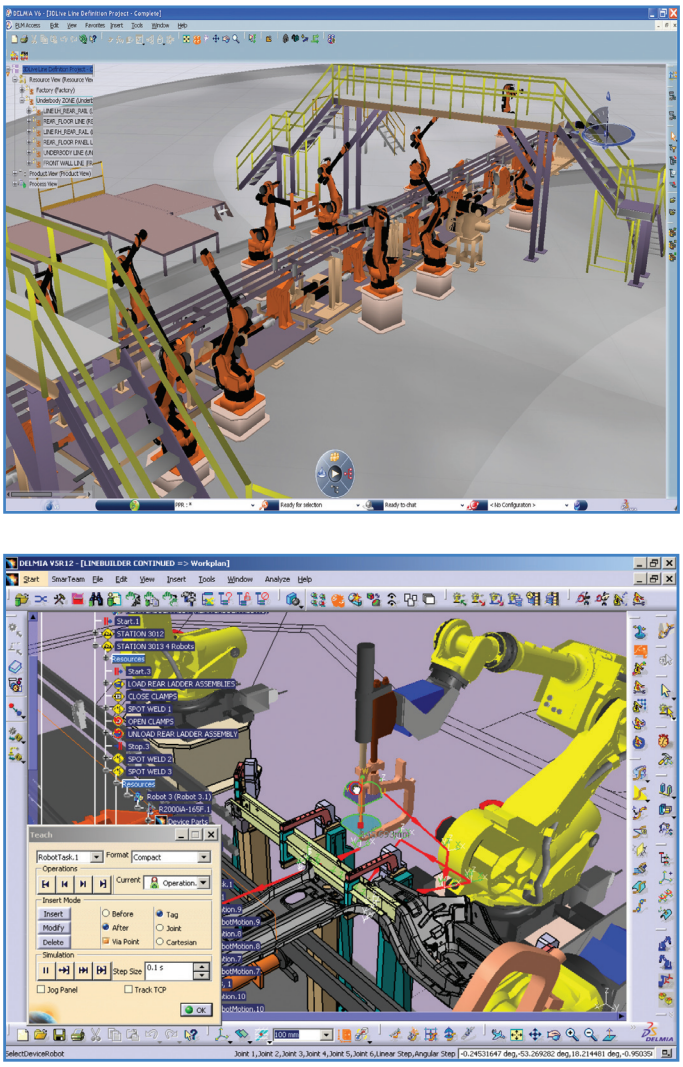


Figure 5 – Examples of DELMIA Manufacturing Simulation

Technical Documentation

Manufacturing processes and product configurations are dynamic. Frequent change is often the norm. Maintaining current technical documentation is a significant challenge. PLM's 3DVIA Composer solution addresses this problem. When used with DELMIA, 3DVIA Composer associates technical documentation directly with the digital manufacturing process. Technical documents are linked to product, process and resource definitions. When process or product configurations change, technical documentation changes, too. Figure 6, to the right, shows samples of 3DVIA illustrated bills-of-material, exploded parts diagrams and technical drawings. Animations of assembly or disassembly sequences and animations also are possible.

Automated process and product technical documentation is a significant benefit to both manufacturers and customers alike, and an essential component in service after sales activities. EAM systems like Tivoli and IBM Maximo can tap into 3DVIA documentation at any point in the process to support MRO activities.

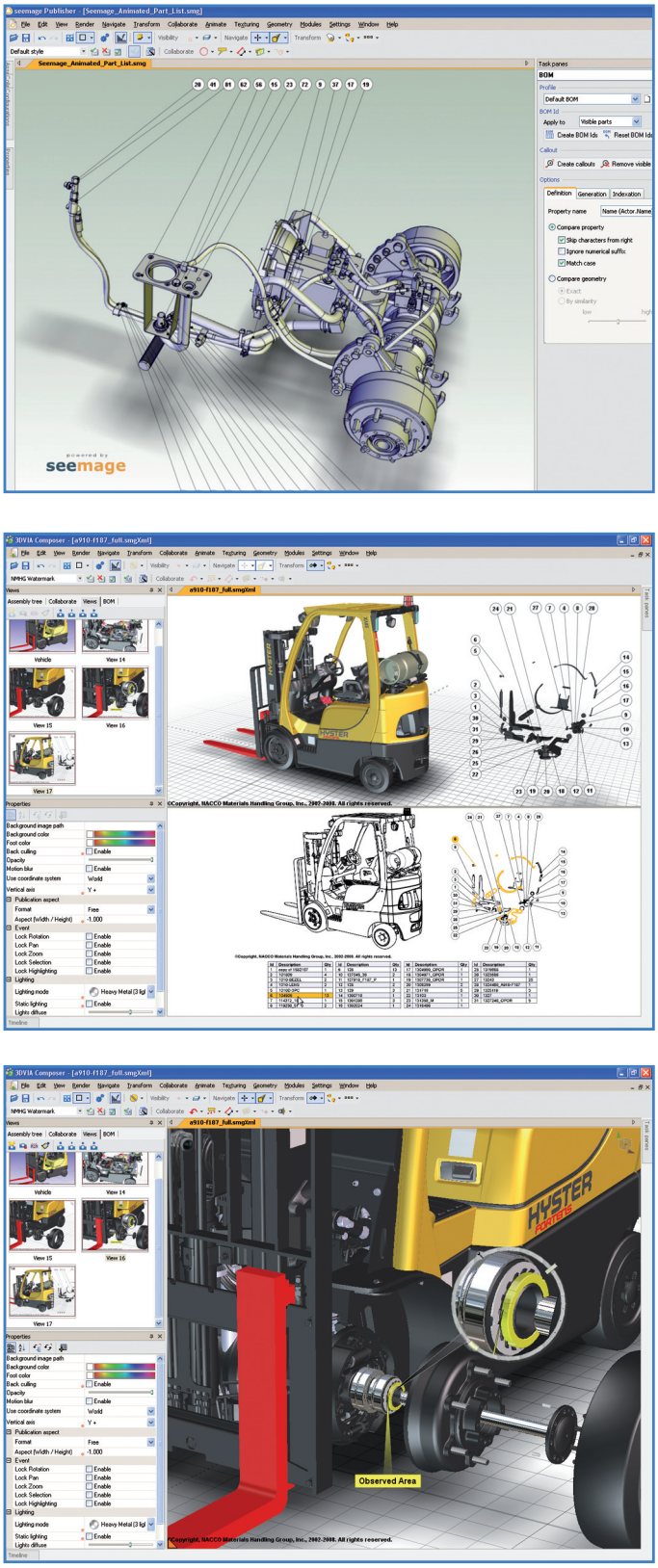


Figure 6 – Examples of 3DVIA Technical Documentation

Service Oriented Architecture

Manufacturers have a choice in how they implement PLM and enterprise-wide EAM solutions. One approach is to implement point-to-point data exchanges between PLM and Maximo Asset Management. This might be the most expedient implementation, but it is not the best way to leverage EAM data when other business processes need access to the same data.

Service Oriented Architecture (SOA) is a Web-based application framework that takes business solutions and breaks them down into individual functions and processes called services. SOA integrates PLM and Maximo services through a central Enterprise Services Bus (ESB), a share point where their data exchange conventions are defined. SOA Web services are independent of the applications and the computing environments they require. In this way, SOA hides the complexity of the application environments it integrates. The value of the ESB is that it makes application data available to any other application tied into the same SOA framework. Additional point-to-point exchanges are no longer needed – SOA's ESB services provide the necessary access. These applications might be front- or back-office applications like supplier relations, e-procurement, inventory control or supply chain collaboration. They might include simple Web browser applications that view data through one of SOA's services portals.

SOA is a significant concept and IT framework for any manufacturer leveraging PLM and Maximo for enterprise wide advantage.

Practical PLM/EAM Scenarios

This paper has identified a series of manufacturing and customer support challenges facing manufacturers today and has provided an overview of two key technologies – PLM and EAM – that manufacturers are using to meet these challenges. The following scenarios suggest ways integrated PLM EAM technologies solve practical MRO problems. The first follows a service call affecting the production line in a manufacturing plant. PLM and Tivoli Maximo minimize production disruption. The second shows service after sales responding to failing equipment aboard a plane. Advanced warning and prepared ground service minimize the disruption of a replaced part.

Manufacturing Scenario

A fault from an Electrical Control Unit (ECU) for the motors powering a plant's central conveyor line is detected by process monitoring software, which brokers all critical plant equipment over the plant's local area network (LAN). An 'event' notice is instantly dispatched to Maximo where an operations manager must determine if the fault is a false alarm, a new alarm or a recurring problem. The motor's calibration and instrument reading, also monitored by Maximo via the LAN, confirms that the fault is real. Maximo has compared the ECU's signal history with the manufacturer's specifications, and while it remained within performance limits, it is likely to fail soon.

Plant operators issue a high priority work order through Maximo, alerting the on-duty field technician to the problem. The technician uses his Personal Digital Assistant (PDA) to review the work order, identify the ECU's unit number, physical location, safety notifications and a brief description of the fault type.

Maximo automatically prepares an audit report of the ECU's previous maintenance and performance. Maximo determines from its ERP system interface that there is no warehoused replacement ECU, however, a direct query of engineering change bulletins within the ENOVIA MatrixOne system indicates that other manufacturers have equivalent parts and one is readily available in the plant's own warehouse. The ENOVIA MatrixOne system also indicates the supplier has a field performance upgrade that improves the current ECU's operational characteristics.

Meanwhile, the technician locates the faulting ECU and takes the motor off-line by locking out its power system, a standard safety procedure appearing in his PDA checklist. The technician uses his laptop to access the ENOVIA MatrixOne system to retrieve design specification, installation, configuration and testing procedures. ENOVIA MatrixOne informs him there is an optional performance enhancement service bulletin and compares output signals with the failing ECU. After consulting with operations, he applies the optional upgrade to bring the conveyor motor back into a no-fault operating condition.

The technician downloads the performance package from ENOVIA MatrixOne to the ECU along with the vendor's recommended testing and startup procedures. The installation and pretest are quickly completed. He refers to the standard restart procedures and brings the conveyor back on line. Then the ECU is monitored locally to insure that the startup sequence has not stressed the ECU or motor beyond performance standards.

The technician uploads from Maximo the ECU's operational history and diagnostic outputs at the time of the fault to PLM's ENOVIA MatrixOne system. The ECU's manufacturer will investigate the circumstances to determine if there is a fundamental design flaw. The service request is closed out and standard operations resume.

Service after sales

An aircraft communicates with a ground station using one of several existing technologies, and indicates that a specific asset is not operating within its design specification. Downlink information is automatically brokered and sent to the subscribed ground support staff (e.g. Maintenance, Engineering, Supply, etc.). The aircraft is equipped with self-monitoring systems and knows when to transmit health data to maintenance and operations subscribers.

Through Maximo Asset Management, the managers for maintenance and supply receive an urgent alert about the problem over Short Message Service (SMS) messaging. The Manager does not have to look for information – it is pushed to him as required.

Based on Maximo's service manager, a certified mechanic is assigned to the work order and collaborates with Engineering to make the necessary repair. Maximo's Mobility server provides communication support to staff PDAs and toughened PCs. The service team accesses technical documents and recommended repair sequences through PLM's ENOVIA MatrixOne PDM system.

The parts OEM Service engineer collaborates with maintenance staff to leverage common maintenance management data services and streaming video related to the part's replacement and calibration. These were produced by DELMIA simulation and 3DVIA see Figure 7. Maximo accesses technical documents through ENOVIA MatrixOne to verify installation and removal scenarios. Rich media collaboration between the OEM service engineer and aircraft maintenance makes it possible to quickly resolve the maintenance issue. SOA's Enterprise Service Bus provides the backbone for communication between all the teams involved.

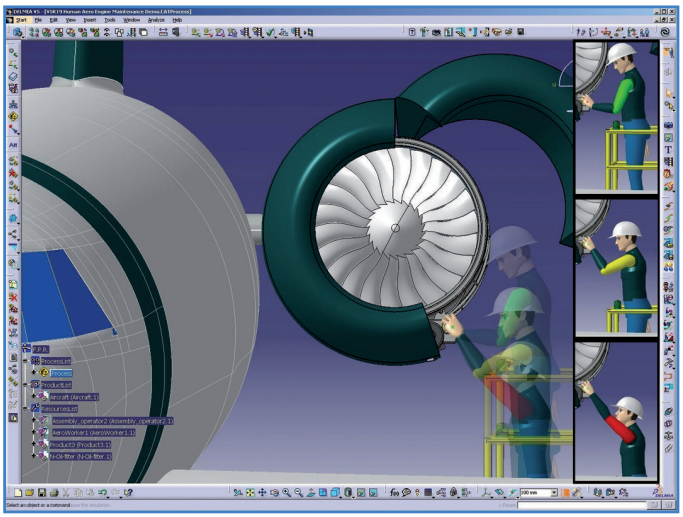


Figure 7 – Aircraft Maintenance Operation

The replaced part contains hazardous materials and special disposal procedures are called for. Supply personnel are advised on how to dispose of it through HAZMAT and SLA. The part has RFID tags and is tracked by scanners throughout the enterprise. Maintenance and service staff have full access to part information and relevant processes for part handling/ disposal. RFID and HAZMAT information is managed by Maximo Asset Management and RFID tag readers.

Engineering and Procurement Exception processes are kicked off. Warranty and other maintenance/supply related alerts are automatically transmitted to the appropriate alert subscribers.

Summary

The first goal in discussing Enterprise Asset Management (EAM) and Product Lifecycle Management (PLM) is to help achieve a better understanding of the real challenges and opportunities that exist in the management of capital-asset investments. The second goal is to provide a vision of the benefits that can be realized when EAM and PLM are integrated. These benefits are:

PLM and EAM integration completes the expanded lifecycle

- *Extending PLM with IBM's Maximo Asset Management software allows companies to integrate management of product development activities with management of actual product instances during their service life.*
- *Manufacturers gain access to customer as-installed and as-maintained product configurations and maintenance service information and can improve customer support and extended service after sales business models, like optimization and performance services, remote operations and condition based maintenance. For product users, improved access to product and performance information, parts and systems upgrades and metrics for performance based contracts increases up time and product utilization.*

Many PLM customers are also using Maximo Asset Management and have a growing interest in leveraging PLM in a broader enterprise strategy

- *Industries like Construction & Engineering, Aerospace & Defense, Automotive, Industrial Products, Electronics, Life Sciences and Process Industry companies have discovered that it makes good business sense to extend their current PLM solutions, or future PLM initiatives, with major PLM vendors that are alliance partners with IBM.*
- *Maximo Asset Management through a Service Oriented Architecture (SOA) enables technology to improve design quality and grow services revenue. Customers also see the benefits of having control over their field MRO and recognize that careful management will improve their bottom lines.*
- *Improving your customer's utilization of your products through new maintenance, repair and operations service after sales is better for your customers and makes good business sense for your company.*

PLM and EAM integration provides manufacturers (service after sales) with key information

- *By providing manufacturers and owners/operators with a shared view of key information relevant to the integration of PLM and EAM allows full access to As-Maintained Bills of Material (BOMs), as well as product configurations useful for assessing a change request or validating that a change has been incorporated in the field. It also improves communication between engineering and service teams to enhance the capability to provide maintenance services to customers.*

PLM and EAM integration provides Owner/Operators better access to information

- *The integration of PLM and EAM provides owner/operators with up-to-date product information to make better decisions regarding the state of specific product instances, e.g., repair vs. replace, alternate parts, where else used, etc. Furthermore, it is possible to simulate maintenance processes in 3D to optimize real-life work sequences and reduce product down-time.*

For more information, see IBM Web sites:

PLM Solutions

ibm.com/software/plm/industries

Tivoli software and IBM Maximo Asset Management Solutions

ibm.com/software/tivoli/solutions/asset-management

Acronym List

ALM	Asset Lifecycle Management
BOM	Bill of Material
CAD	Computer Aided Design
EAM	Enterprise Asset Management
ERP	Enterprise Resource Planning
HSE	Health, Safety and Environment
LAN	Local Area Network
MRO	Maintenance, Repair and Overhaul (or Operations)
OEE	Operational equipment Efficiency
O/M	Operations and Maintenance
PDM	Product Data Management
PLM	Product Lifecycle Management
SOA	Service Oriented Architecture
SCM	Supply Chain Management
ROA	Return on Asset

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