CONF-971071--2 SAND97-1926C

USING PDM TO CREATE A VIRTUALLY INTEGRATED MANUFACTURING ENTERPRISE

Neil Lapetina, (505) 844-2993
nalapet@sandia.gov
Sandia National Laboratories
LM Energy & Environment Sector
Defense Programs Products and Services Division
PO Box 5800
Albuquerque, NM 87185-0873

Greg Neugebauer, (505) 844-3264
glneuge@sandia.gov
Sandia National Laboratories
LM Energy & Environment Sector
Electronics, Materials, & Components Engineering
PO Box 5800
Albuquerque, NM 87185-0521

Abstract

In late 1993, our mission expanded from engineering design to also encompass production of neutron generator devices. We completed a gap analysis of the tools needed to support this emerging production assignment and, as a result, introduced a Product Data Management (PDM) system. This implementation includes basic PDM features, Web access, interfaces to our production floor and suppliers, and other utilities. We carefully strategized, piloted and assessed the integration of the PDM system into our business. Our efforts have prepared us to enter the next tier to further integrate our key operational resources to include our external suppliers.

Introduction

Our Laboratory mission broadened from engineering design to prominently include production of neutron generator devices in 1993. To support this new mission, we made a commitment to implement modern, agile manufacturing information systems to enable the best service to our customers as illustrated in Figure 1. We completed a gap analysis of what tools would be needed to support this emerging production assignment. At the time, we tailored our information systems infrastructure to support primarily the design role. Our existing engineering information systems provided a primitive user interface with limited desktop access and captured only design information with limited capacity for production information. These systems required the use of clerks and message-based communication technology to serve as an interface between design information and the end users. As a result, getting information in and out of this system often took days to weeks and required engineers to expedite their requests for information.

Gap Analysis

In this gap analysis, we also had to consider the fact that our key operational functions (engineering, production, purchasing, quality, etc) are geographically dispersed. The solution must allow these functions to work together on the design and release of the product. This solution must also allow information to be centrally controlled, but allow for distributed access and for data owners to keep other functions up-to-date with respect to changes to the product and process definition.

With this vision that we operate as a virtually integrated manufacturing enterprise, we addressed this gap by implementing a Product Data Management (PDM) system for our Product Realization Teams (PRTs) to manage both their design and fabrication information. PDM is a tool that helps Sandia's PRTs achieve concurrent engineering and manage data through the conceptual, development, production, and customer service phases. PDM keeps track of the wide scope of information needed throughout our product's life-cycle, making correct data accessible to authorized people and systems. Product changes will occur earlier in the life cycle if PRTs are encouraged to share data and documents in a PDM environment.

PDM Supporting the Business

Figure 1 shows how PDM currently fits into our business. Principle customers are italicized.

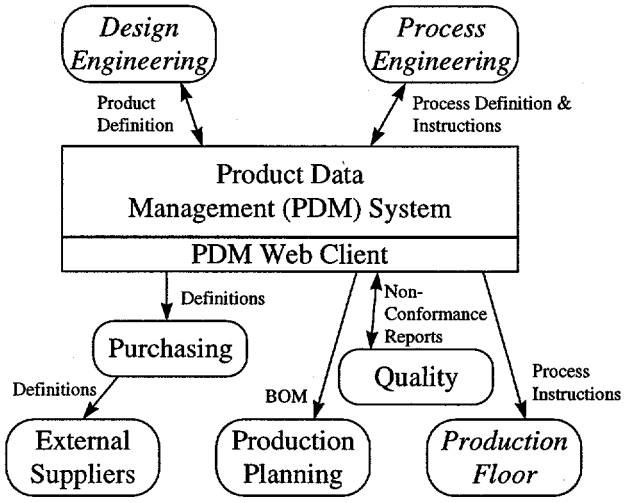

Figure 1

Design and process engineering files product and process definition, respectively, into PDM. Process engineering also files process (production floor) instructions in PDM. Once in PDM, other functional groups can then access this information for their operations. This includes purchasing, production planning, quality, production floor and even our external suppliers.

A major challenge in this objective was to make this information easily available to users, including product engineers, process engineers, shop floor operators, planners and schedulers and buyers. As the primary users of this information, shop floor personnel wanted a user-friendly system.

DISCLAIMER

Using the Web browser from their standard PC desktop, users have on-line access to drawings and specifications. Online access is available to Production Planning for Bill of Material (BOM) data, which is required for their planning. Likewise, online access is available to Production Operations for process instructions and to Buyers for preparation of purchase orders. We also configured PDM to enable Quality to more effectively manage nonconformance reporting (NCR) and resolution.

As a result, the manufacturing division is now one of our strongest advocates of PDM. This is a shift from our initial expectation that engineering and design would be our strongest proponent of PDM.

The introduction of PDM system into our business today enables more effective configuration management of product and process definitions and near real-time implementation of engineering changes. All PRT members now have direct, on-line access to information needed for their work; connecting geographically-dispersed functions is a major step towards achieving virtually integrated manufacturing. By taking the clerks out of the loop, getting information in and out of the "system" has been reduced from days/weeks to minutes/hours. In doing so, we still have a high degree of confidence that what we make and buy is what was designed and ordered.

Business Needs Driving Implementation Strategy

We systematically introduced PDM into our operations. It began with a management investment in a dedicated Integrated Product & Process Development Team. An early viability evaluation resulted in a management commitment to transition from our old engineering information system to a single PDM system, bridging engineering and manufacturing. PDM addressed the business needs that included consolidation of existing systems, application performance, and data viewing/ease of use. We developed business processes to understand the existing and desired conditions. We intentionally emphasized short term initiatives that were achievable within a one-year period.

We completed a readiness assessment audit that authorizes the fabrication and certification of product based on information stored within the PDM system. The PDM readiness record documented the critical aspects of the system. The review ensured that appropriate resources, backup, training, documentation, performance, reliability, and functionality existed to move this system into a production environment.

We assembled an information systems infrastructure composed of high availability vault and application server hardware, high-bandwidth networks, and a standard desktop configuration. The extended PDM support staff include technical representation from engineering, corporate information services, production products & services, and the PDM department. The technical support team is collocated throughout the manufacturing enterprise and provides comprehensive service to PDM users.

Taking our lead from Geoffrey Moore, author of the book *Inside the Tornado*, initial implementation began with a pilot project around a single product group. Our focus was to deliver substantial impact and improvement to a product line with fixed schedule and resource commitments to confirm the projected benefits in a production setting. As users within the community can attest, the technology drew attention from both product development and information integration practitioners. Pragmatics were convinced that PDM served a role and addressed a business need. Their endorsement substantiated the anticipated benefits.

The strategy of "build it and they will come" proved to be a tactical success. Without the aid of an established corporate-wide information architecture, we assumed many risks.

PDM proved its mettle: Other product teams embraced this technology, which is now a part of our corporate standard. Unique for Sandia is the coalescence of the entire product structure with design analysis and fabrication data on a single information system. The PDM support team is poised to support operational plans and business practices on diverse product lines.

Filling the Gap

Ease of Use: Management expected a modern manufacturing information system to allow easy and timely access to manufacturing and product information at the desktops. The PDM implementation team, working with a key supplier, negotiated and contracted an agreement for a Web interface within 2 months. In the following month, the team delivered a functional prototype, which formed the core of our Web interface.

The PDM Web interface, using a Netscape browser, provides a standard viewing environment with most of the functionality commonly used by the commercial client software and a significant reduction in complexity for the user. Check-in/Check-out of existing files and database search based on common or custom attributes is available. Our PDM support group developed PERL and HTML programming skills and provide extensibility of this technology.

Reduced Costs: In addition to providing a more convenient browsing capability, the Web interface dramatically reduces the cost of accessing manufacturing data. Under the Web client, a software license is necessary only when the user is querying the system or downloading documents from the server. The license is returned to the available pool when the user completes the transaction. Typically, a license is only needed for 20-30 seconds, thus maximizing the availability of the software to the enterprise.

Functional organizations are using the PDM Web interface beyond our original predictions. Incoming Inspection, Purchasing, Quality, Environmental Safety and Health, and others are actively requesting PDM access.

In addition, the easy-to-use Netscape interface simplified training and eliminated the refresher training resulting from a new release of the commercial client application. We offer conventional PDM training through internal resources at no cost to the customer. Training is a prerequisite for account and password eligibility, except for Web viewing access where a brief procedure is required reading.

Documentation: Crucial to the roll-out of the PDM system was the development of our documentation, which included specific PDM conventions, procedures, and training to facilitate standardized use. Many of these documents are on-line in an HTML format for ready access.

Information/Data Focus: The middle initial "D" in PDM is truly being transformed from Document to Data. We are using our system to collect nonconformance reports as they occur for material inspection and processing. We routinely report information related to possible deviations from drawing specifications; these reports include the names of our suppliers, the workcenter, open date, and several other parameters. This functionality provides a feedback loop for problem isolation and process improvement.

Other Utilities: Demand for additional PDM functionality is persistent. Audio and video files can also be stored and retrieved, positioning the enterprise for multimedia work instructions in the future. Web-based document number generation utilities that place standard template files in the proper PDM database location are operational.

We established a simplified electronic routing system of documents to ensure that Environmental Safety and Health, as well as our Product Quality Department, approves and releases appropriate documents. We employ electronic routing (workflow) to ensure that the PDM data is eligible for entry into our corporate archive systems while changes are being incorporated into the original documents. This parallel process will improve data integrity and expedite release of the documents and meta-data into other corporate systems.

Metrics: We collect metrics to monitor and prioritize development activities. We use metrics to predict and justify information systems infrastructure upgrades and anticipate future loading on the system. Sample metrics are provided in Figures 2 and 3, which show the increasing popularity and demand of PDM in our business operations.

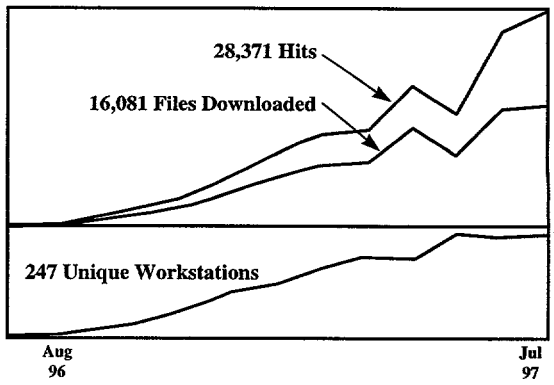

Figure 2

Total Files Managed by PDM

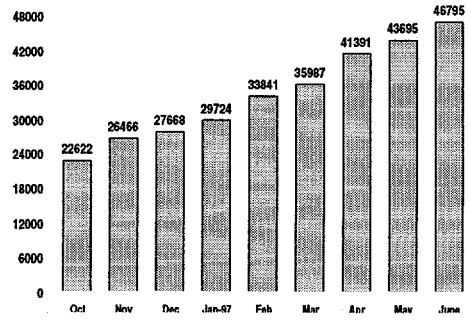

Figure 3

Next Tier

Our efforts have prepared us to take PDM implementation to the next tier. Our vision is to further enhance PDM's functionality and integration to further enable concurrent engineering and to address our longer-term interoperability issues. This may include deployment of a corporate-wide PDM system with increased functionality. We are at a stage where our demands are outpacing our PDM capabilities. These issues include integration of engineering changes and effectivity between our PDM, material requirements planning (MRP), and manufacturing execution systems. Our vision is that once data is entered into PDM, it never has to be reentered again regardless of which system uses the data. We also look to use PDM to improve our supplier partnerships and performance.

To enhance PDM's functionality, we are considering a more comprehensive workflow capability to accelerate and monitor the release and approval process for PDM drawings and documents.

Figure 4 shows how PDM might be integrated with our manufacturing execution system (MES). Our vision is to integrate these systems, as well as to incorporate functionality from other systems (e.g., production floor data collection), such that Production Operations conducts their work through a single user interface.

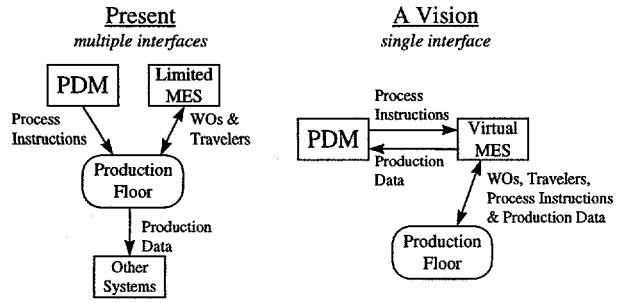

Figure 4

Figure 5 shows how PDM might be utilized to further integrate engineering changes into our MRP and MES systems. We would like to configure PDM such that as it receives engineering change notices, it is capable of automatically updating our manufacturing execution system with the process-related changes (e.g., process instructions and routings) and our MRP system (e.g., BOM changes and effectivities).

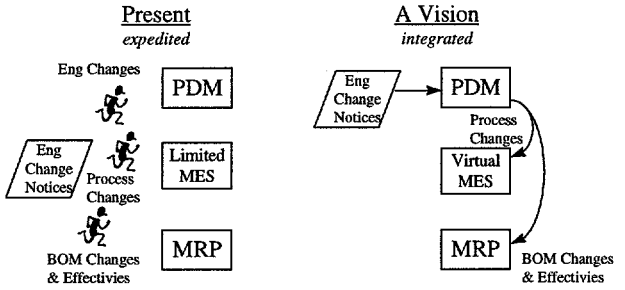

Figure 5

Common Object Request Broker Architecture (CORBA), technology will enable the integration previously described. It will provide assistance to exchange information transparently, unrestricted by where data is located on the network, the types of hardware and operating system platforms on which they execute, or differences in data representations between platforms and the network transports used to communicate with them. A Product Realization Environment (PRE) project at Sandia is emerging with a framework to wrap applications for interoperability. [PRE is being submitted as a separate paper to the IPPD Symposium.]

Extranet technology will enable external suppliers to have on-line access to our product definitions. This technology also enables our suppliers to place change and/or other related requests into an electronic in-basket. We are prototyping methods to post PDM data on an external commerce Web server that employs Kerberos authentication services for key suppliers. This should reduce time-to-bid and time-to-fabricate and also provide up-to-date information to our commercial suppliers with adequate security. Automated event triggers occurring on our internal PDM system will spawn processes to create Web-viewable formats and export the results through our corporate firewall to an external Web server for authorized users. Access is restricted to partitions on the Extranet server, providing a controlled data environment. See Figure 6.

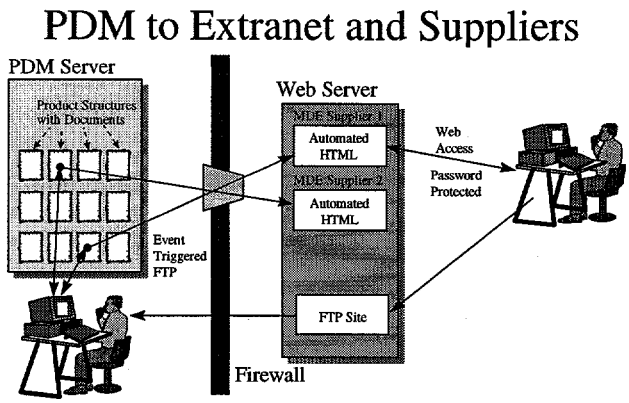

Figure 6

Primary Author's Biography: Neil Lapetina joined Sandia in 1981 and held various systems and production engineering positions. He received his master's degree in mechanical engineering from the University of California (Berkeley) in 1983 and earned his APICS certification, Certified in Integrated Resource Management (CIRM), in 1997.

Acknowledgments

The authors greatly thank Gary Beeler, Gary Laughlin, and Gary Ferguson for their vision, leadership, and commitment to implement a modern manufacturing information system, which includes PDM. Lew Butler and Lorraine Sena-Rondeau sustained and organized this information systems infrastructure and collectively with Eric Thulin, Laura Halbleib, and Brad Buikema provided exceptional guidance, technical contributions, collaboration, and customer support over the past two years. Mike Tebo also provided editing and technical assistance for this paper.