

PLM and PDM for the Engineering-Centric Enterprise

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Engineering-centric businesses face a number of challenges today, but unmanageable design and change processes don't need to be counted among them. Product Lifecycle Management (PLM) software can help businesses small and large proactively manage their mission-critical intellectual property and control their product definitions. Once custom-built for Fortune 500 manufacturers, PLM systems are now available in many sizes and flavors to meet a variety of needs.

WHAT IS PLM?

PLM is a collection of applications for defining and managing any data associated with products, from concept through retirement. Most commonly, PLM consists of authoring tools, simulation tools, and a management tool. Authoring tools include Computer-Aided Design (CAD) and realistic rendering packages; behavioral simulation tools include Finite-Element Analysis (FEA) and Computational Fluid Dynamics (CFD); process simulation tools include Computer-Aided Manufacturing (CAM); and Manufacturing Process Modeling (MPM); and the management component is Product Data Management (PDM). In its most basic sense, PLM can be a system for generating and managing drawings and other product/process documentation, but in its most evolved form, PLM can fully define and model virtual products.

The most mature components of PLM are the design and simulation pieces.

Computer-Aided Design and Finite-Element Analysis find their roots in the earliest engineering calculations performed on the first mainframes and large-scale computers. Three-dimensional CAD became popular in the 1980's and was mainstream by the late 1990's. CAD tools are largely commodity today. Simulation tools continue to evolve and provide increasing levels of accuracy for increasingly complex and lifelike situations. Process simulation tools also have a lengthy history, being developed in response to the increasing complexity of Computerized Numerically Controlled (CNC) machine tools. Each of these systems (CAD, FEA, CAM) represents an element of the content creation aspect of PLM and helps to define a product or process related to a product.

The backbone of any PLM system is the management tool – PDM. PDM systems have a lot in common with Manufacturing Resource Planning / Enterprise Resource Planning (MRP/ERP) systems, in fact. For instance, PDM manages a large number of records, typically using a relational database as the engine for search, retrieval, and linking of records to one another. PDM systems also frequently manage Bills of Materials (BOMs) and other structured relationships, like ERP. Unlike ERP systems, however, PDM is purpose-built to manage documents and files. PDM systems are particularly adept at understanding the complex file inter-relationships present in most CAD systems.

WHAT PROBLEMS DOES PDM SOLVE?

DESIGN DATA MANAGEMENT

PDM is meant to solve a number of business problems, many of which stem from the challenges introduced by CAD systems, and from the desire to automate long-standing manual processes related to document control. One of the primary difficulties that PDM systems seek to simplify is controlling the web of files created by 3D associative CAD systems. These systems generate separate files for three-dimensional (3D) parts, 3D assemblies, and two-dimensional (2D) drawings, but the files are all interconnected (drawings need the parts, etc.). Most engineering users can manage this first level of complexity, but when specific pieces of a large design are revised and the company needs to keep revision history, the file interrelationships become too much for a person to manage, and a computer system is needed. PDM provides a file vault to secure the files, a database to track all of the complex relationships and versions, and a software engine to take in and serve back groups of files in logical groupings. For example, if a user requests a particular 2D drawing, the system knows that they will also need the associated 3D part.

In addition to managing the CAD data, other associative design data can and should be managed by PDM. For instance, CNC files, tool paths, and other MPM files are directly dependent on the geometry defined in the CAD files. Changes in the product geometry should result in updates to the downstream manufacturing data, necessitating an even larger web of relationships among versions and file types that contain product information. Comprehensive PDM systems are able to understand and manage these rela-

tionships in addition to the basic CAD relationships.

PRODUCT DOCUMENTATION MANAGEMENT

Product documentation is often much more than CAD models and drawings. The specifications, calculations, and notes used in the design process are just as significant a part of the product definition as the finished design. This couldn't be truer than in regulated industries like medical device manufacturing, where a clear and accurate record of these design inputs is critical to the regulatory approval of a product. Once you have a repository for managing documents other than CAD, the possibilities really open up. Photographs, assembly instructions, and marketing documents can be revision-controlled and linked to the appropriate versions of related products within the system.

The real power of a unified repository for product documentation is evident when a business rules engine is applied to these document inter-relationships. Rules engines can enforce and automate business logic such as, "when a drawing is revised, check out the associated instruction manual." These types of rules are similar to those employed for managing CAD interrelationships, but are more flexible to meet specific business process needs.

PROCESS MANAGEMENT

File management (even complex file management) is only the tip of the iceberg of what PDM can do. Another common problem faced in small and large businesses alike is the intractable nature of paper change processes. Change control is challenging when done optimally, but can be a disaster when big drawing packets with multi-page Engineering Change Order (ECO) cover sheets sit on the desks of various members of the design team.

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PDM provides tools for creating electronic forms (ECO cover sheets) and for automatically routing documents through email-like tools. By managing change processes inside the PDM system, users have a central place to determine if a design is under change and avoid having multiple copies of large drawing attachments in their email. Change data is searchable, organized, and available for later analysis to locate bottlenecks, to highlight problem areas, and to maintain an auditable product record / design basis, which is often critical in regulated industries.

PRODUCT STRUCTURE AND BILL OF MATERIAL MANAGEMENT

Certain flavors of PDM address another important business problem: maintaining Bills of Materials (BOMs). Experienced designers and engineers know that CAD can rarely be used to model/represent the full engineering BOM (EBOM); there are things like grease, paint, small hardware, and other things that just don't make sense to model. Similarly, Manufacturing and Operations people know that the EBOM is rarely equivalent to the manufacturing BOM (MBOM).

MBOMs are typically much flatter structures, or "kitted" to better serve the needs of users on the shop floor, but there is a lot of time wasted, and a lot of errors made, in translating from the CAD BOM to the EBOM to the MBOM. In addition, changes in any one of those structures can take days or weeks to update in the other structures when automated tools are not available. Advanced PDM systems provide BOM management tools that allow item masters to be authored and BOMs to be managed in a way that relates back to the CAD design. These capabilities, however, have to be integrated downstream with ERP to avoid that last level of duplicate data entry.

SELECTIVE DATA SHARING AND PUBLICATION

PDM systems can address other business challenges as well. For instance, some systems have the ability to expose/publish specific data out to suppliers and partners via portal interfaces. Through these tools, external resources can work with your data but in a protected and secure manner. There are different approaches to sharing the data, however. Some systems allow suppliers and partners to login directly, and access to specific objects is limited through system security. Another prevalent option in PDM today is publishing data to a separate system, such as Microsoft SharePoint or another enterprise portal created specifically for partners. Although synchronization must be carefully managed in a publication scenario, this architecture can offer significant security benefits just as firewall placement and hardware segmentation can further secure your systems.

PROJECT MANAGEMENT

Other PDM systems provide project management capabilities, tying assignments and timelines to product definition deliverables (i.e., the specification will be done by John by the end of next week, and then the conceptual model will be created by Sue after that, etc.). Gantt charts, project timelines and task assignments can be managed, and often synchronized with project planning applications like Primavera and Microsoft Project. Some PDM platforms extend project management to include tools for capturing ad hoc project data, such as issues lists. Issues are maintained in the system as the most granular form of activity and assignment. For example, a customer request for a color change is recorded as an issue and is managed in the system with an assignment and due date. In many systems, issues

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can then be attached to project tasks or routed through workflow processes to provide additional levels of flexibility and control.

NICHE CAPABILITIES

There are a number of PDM offerings that focus on specific industry verticals, or niche functionality. For example, some PDM systems allow users to perform Systems Engineering functions, capturing customer requirements, tying them to internal specifications, and then using those specifications to drive the engineering design in a very controlled way. Others have modified product structure management capabilities for continuous (non-discrete) products, commonly known as “recipe management.” Of course, many PDM systems have their own specialty by discipline. Some are specialists at mechanical CAD (MCAD), others are best at electrical CAD (ECAD), while still others provide excellent cross-functional tools for full mechatronic (electrical, mechanical, and software machines) development.

A SOLID APPROACH TO DEPLOYING PDM

If PDM sounds like something you need, the next logical question for a growing business is how to leverage the technology without making a huge financial expenditure. That is the challenge facing the large PLM vendors today. Historically PLM systems cost millions of dollars to deploy because originally they were essentially toolkits, which highly trained consultants used to create customer-specific applications. Companies such as Dassault, Siemens, Parametric Technology (PTC), Autodesk, Oracle, and SAP have worked for years to perfect and extend their PLM capabilities for the largest manufacturers, such as Chrysler, Intel, Boeing, and John Deere.

Despite the significant number of features offered by these leading vendor’s

PDM offerings, most businesses need a limited subset of that “perfect world” functionality at first with the ability to grow into other areas as the business develops and needs arise. Fortunately, PLM vendors have recognized this and most of them now offer pre-packaged versions of their PDM tools in which industry best practices have been baked in and a number of configuration options have already been set. Beyond purchasing an “express” version of PDM, businesses can do other things to ease into such a system. Specifically, these elements are helpful in keeping a PDM deployment manageable:

- 1. Choose a partner with experience.** A lot of people still try to save money by self-implementing PDM, and they end up making the same mistakes which consultants made their first week on the job. Experienced consultants accelerate the learning curve and help avoid the pitfalls that are likely to appear. Further, you don’t buy PDM just for the tools; you hope it improves your process. To get a new perspective on your process, consider getting help from people who work with business processes every day.
- 2. Get your house in order.** If CAD files and data are spread across user machines and network drives, start to collect it and clean it. If no one is sure where the latest version of something is, run that to ground before you try to load your information into a system. Rationalize your data by checking to make sure that the same metadata values are populated on all files. The cost of loading legacy data into a new PDM system increases with every exception to the rules that describe your data. A rule, for example, might be: all AutoCAD files have the drawing number in the filename, except those created from 1996 through

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2002, and except those acquired during the merger in 1999.

3. Have a strategic vision for the system.

You should know what you want the system to do five years from now, even though you will only work on one area in the next six months. “Keeping the end in mind,” as Steven Covey, author of *The 7 Habits of Highly Effective People*, says, will allow you to control scope throughout the project. If someone on the project team wants to add this or that, you can redirect by reminding him that either A) we’ll get to that in a later phase, or B) we need to focus and finish this phase to get to other parts of the project.

4. Implement in phases and solve your largest problems first.

If getting control of CAD files is the biggest issue today, undertake a three to six-month phase to solve that problem and let workflow, BOM management, and supplier collaboration wait. By taking on a manageable objective and succeeding at it quickly, you’ll build momentum and user support that will be invaluable to later parts of the project.

CHOOSING A PLM / PDM SYSTEM FROM THE GROUND-UP

In a Greenfield approach, it is important to weigh the significance of the various PLM elements for your business. For instance, CAM may be more critical than CAD, and PDM may be a minor player if the ERP system is particularly strong. Take care to remember that a PLM decision is not driven entirely by engineering. Too often, organizations choose a PLM platform based on the preferences of Engineering, because they consider PLM to be an Engineering function. In reality, most departments/functions within the organization touch PLM and should

have a hand in selecting and defining the system.

Another issue to consider in software selection is whether a monolithic (integrated suite) approach or a best-of-breed approach will be pursued. Given the rapid rate of change for features and functionality in PLM tools, best-of-breed is rarely the preferred approach, and most companies select one of the four major vendors’ platforms. On that point, it is worth noting that not all PLM of the four major players have complete PLM offerings and consequently vendor alignment can be a critical strategic decision.

Even when a monolithic approach is selected, it is important to remember that corporate merger, acquisition, and divestiture strategies can cause significant departures from the plan. For example, acquiring a sister company with a large CAD investment in a competing PLM platform could quickly change the long-term PLM strategy of a company. Continuing on the topic of monolithic, integrated systems, two recent entries in the PLM arena, Oracle and SAP, tout the value of treating PLM as an extension of ERP rather than its own collection of authoring and management tools. For some businesses, this is a rational viewpoint, but many consider these vendors to be independent PDM vendors rather than true PLM companies.

Once a selection team has been assembled and relative priorities have been defined, a short list of vendors can be compiled for further review. If the PLM system complexity hasn’t already been set at this point, the team should decide what is most appropriate; basic tools, mid-range tools, or comprehensive tools. A quick survey of the current market segmentation is on the following page.

	Company	Brand	Basic	Mid.*	Comp.**
CAD	Dassault	SolidWorks		✓	
		CATIA			✓
	Siemens	Solid Edge		✓	
		NX			✓
	PTC	CoCreate		✓	
		Pro/Engineer			✓
	Autodesk	AutoCAD		✓	
		AutoCAD Mechanical / Electrical			✓
		Inventor			✓
Oracle	NONE				
SAP	NONE				
PDM	Dassault	Workgroup PDM	✓		
		Enterprise PDM		✓	
		ENOVIA SmarTeam		✓	✓
		ENOVIA MatrixOne			✓
		ENOVIA VPLM			✓
	Siemens	Insight	✓		
		Teamcenter Velocity		✓	
		Teamcenter Engineering		✓	✓
		Teamcenter Enterprise (others)			✓
	PTC	ProductPoint	✓		
		Pro/Intralink	✓		
		Windchill PDM/Link		✓	✓
		Windchill			✓
	Autodesk	Vault	✓		
		ProductStream		✓	
	Oracle	Agile PLM		✓	
SAP	SAP PLM		✓		
FEA	Dassault	SolidWorks Simulation		✓	
		CATIA Analysis		✓	
		SIMULIA (formerly ABAQUS)			✓
	Siemens	Femap		✓	
		NX Nastran			✓
	PTC	Pro/Engineer Mechanica		✓	✓
	Autodesk	ALGOR		✓	✓
	Oracle	NONE			
SAP	NONE				
MPM	Dassault	CATIA Machining		✓	✓
		DELMIA			✓
	Siemens	NX Machining		✓	✓
		Tecnomatix			✓
	PTC	Pro/TOOLMAKER		✓	
		Pro/E Complete Machining			✓
		Pro/PROCESS			✓
	Autodesk	NONE			
Oracle	NONE				
SAP	NONE				

* Mid-range

** Comprehensive

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Once these various filters have been applied, the selection team should be choosing among no more than three platforms. The decision then becomes a weighted analysis of factors such as:

- Key features
- Financial considerations (up-front licensing, annual fees, license portability, etc.)
- System usability
- Long-term viability of the vendor (PLM is a 5-10 year software investment)
- Vision and leadership of the vendor
- Speed/complexity of system implementation
- Supporting community (consultants, educated users, etc.)

CHOOSING PDM TO COMPLEMENT OTHER PLM INVESTMENTS

For many engineering-centric businesses today, a PLM strategy is evolving organically through the installation of point software solutions (like CAD and FEA), but these businesses are yet to make a comprehensive decision about a PLM platform. In these cases, the relative weight of selection criteria can become skewed to address the existing landscape. For instance, a PDM system's multi-CAD capabilities might be critical for managing heterogeneous CAD tools already in use, or for managing new tools acquired through merger activity. Alternately, the speed of the implementation may be less relevant because the current environment is complex enough that a complicated deployment is required and expected. Below are some common approaches to the challenge of selecting PDM when other PLM investments are already in place:

- Selecting a “preferred” enterprise PLM vendor despite the heterogeneous environment, and slowly driving to a homogeneous platform.
- Embracing the best-of-breed approach and selecting company-wide PDM based on the optimized balance of features, usability, and financial impact.
- Pushing PLM decisions down to the department or workgroup level and using other business systems to unify product data at a more superficial level (front-ending heterogeneous PLM with SharePoint or other enterprise portal software).

SPECIAL CONSIDERATIONS

For some companies, the PLM decision does not follow the mainstream approach described previously. There are a number of other independent CAD, PDM, FEA, CAM, and MPM platforms worth considering in these cases. An abridged list of interesting independent software platforms is listed below with a short description of why they are notable in the industry.

- CAD – SpaceClaim: First in a new breed of direct-editing 3D modelers
- CAD – VX: Inexpensive yet capable imitation of SolidWorks, Inventor, and Solid Edge
- CAD – Google Sketchup: Software as a Service CAD tool
- PDM – Aras: Open source PDM
- PDM – Arena: Software as a Service PDM

CONCLUSION

PLM is a complex business system, at least as complex as product development and change management processes. Just because the software is complex and multi-faceted doesn't mean that its deployment has to be lengthy or its cost has to be outrageous. More and more small businesses are benefiting from the value of PLM by considering carefully which pieces of PLM to take, and by deploying the tools carefully.

ABOUT RAZORLEAF

Razorleaf is a services provider that helps companies become market leaders through the measured application of technology and best practices to existing business processes.

[Razorleaf](#) specializes in process analysis, implementation, training and support of enterprise technologies including Design Automation (DA), Enterprise Portal (SharePoint), Product Data Management/Technical Data Management (PDM/TDM), and Product Lifecycle Management (PLM) solutions.

With over 100 active customers and more than 200 implementations, our experienced team offers expertise in leading software from Oracle, Autodesk, Conisio, Dassault Systemes, DriveWorks, Microsoft, PTC, RuleStream and ShareVis. The company is headquartered in Ohio with satellite offices in Arizona, Florida, Georgia, Maryland, Michigan, Minnesota, New York, North Carolina, Pennsylvania, Texas, Virginia, and Wisconsin.

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