Selecting a PLM System to Improve Product Development Performance for Small and Medium Sized Manufacturing Businesses

A whitepaper by TechniCom and Tech-Clarity

September, 2008

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Introduction

This paper is a follow on and update TechniCom's previous paper published in February 2005. In that paper we discussed "Selecting a CAD/CAM/CAE/PDM (CCCP) system" and noted that selecting such a system is no easy task. Today, almost three and one half years later it is still no easy task to select a comprehensive engineering and product development system, yet it is crucial to the success of ANY business, be it small or large.

Our goal with this paper is to help people make better decisions when selecting software solutions to improve product development and engineering performance. This paper can provide you with a logical and orderly approach, which, if followed, will allow you to select the proper CAD/CAM/CAE/PLM system for your company. Furthermore, in this paper, different than many others we have seen, we provide guidance for mid-sized businesses rather than large-scale enterprises.

In many areas of this paper we stress the importance of making strategic decisions, both short-term and long-term. Readers should keep this in mind. Any decision making tool, be it for product development or business strategy, is only as good as long as it fits the company strategy and directions.

While this paper is sponsored (partially paid for) by PTC, the reason we agreed to write it is that PTC assured us that it would be completely unbiased -- and they have upheld this agreement. Why would they do so? Because they feel comfortable that small and medium business customers evaluating such systems will often decide upon their offerings, providing that customers have a rational approach to making such a decision. This paper provides such a rational approach. PTC and the authors know that no single solution is right for all customers.

Executive Summary

Today, it is widely realized that a comprehensive engineering and product development system can be a highly contributing factor to a company's success. Such systems are commonly called PLM (or product lifecycle management) systems.

Successful product development in today's global market requires a comprehensive engineering and product development system. PLM systems provide the foundation for companies to compete in an innovation environment demanding rapid time to market, multi-company collaboration, high product quality, and aggressive product cost. Selecting a PLM system for any business is a challenge. The systems are far more extensive than standalone CAD and Product Data Management (PDM) solutions, reaching into many aspects of the business and across multiple organizations. For smaller companies, selecting the right solution can be even greater due to limited resources available for the evaluation process. A structured, well thought out process is critical to these smaller businesses.

Instead, in many cases, selecting a PLM system tends to be done at too low a level, with poor consideration of company strategic issues, with little understanding of the product development environment and any proposed improvement, and with little idea of expected ROI or metrics. Is this a problem? Yes! If such a system is integral to your company's future product development, then a careful rational decision must be made that does its utmost to insure that such a system meets both your current and future needs.

To address the challenge of selecting a PLM system, TechniCom and Tech-Clarity describe a rational, well-organized approach to a software selection process. Selection starts with the business objectives in mind, starting with a determination of whether a new system is warranted or not. The approach encourages a business case that carefully ties the software

strategy to the strategy of the business as a whole. Without this business alignment, the selection process will likely be focused strictly on the technical merits of the software system and disregard evaluation criteria that are critical to the successful implementation (and return on investment) of the PLM solution.

After determining the need and building the business case for the new solution, the authors recommend a number of steps to organize and conduct the evaluation process. Assembling the proper team for the selection is an important step, including the development of a cross-functional team and an executive steering committee to drive the process. This team will develop and select a vendor partner and a solution based on: Management Requirements, Functional Requirements, Technical Requirements, and Integration Requirements

The paper further identifies a process to evaluate potential vendor partners, including the importance of the vendors' long-term strategy in addition to current offerings. The evaluation should include an assessment of the vendor's ability to support the company during the implementation and beyond, including an understanding of the ecosystem of partners and solutions that are aligned with the vendor. Finally, the paper identifies a number of potential solution providers and offers some advice on how much a company should plan to spend on a solution of this kind to help ensure a realistic cost for the business case.

Selecting a PLM system is an important process, and one that can provide a tremendous boost to the business if done correctly. The steps in this paper are designed to ensure that the system selected can be readily implemented to achieve business value, and tries to eliminate misperceptions and poor evaluations that could lead to late surprises in the implementation or use of the solution. By following these steps, companies can be comfortable that they will be able to achieve the top-line growth and product cost reductions they are seeking from their PLM solution.

In summary, we suggest an approach to the selection process that builds on our logical and successful recommendations in the past. To whit:

- Determine the need
- Assess where you should be
- Organize the evaluation
- Determine management requirements
- Determine functional requirements
- Determine technical requirements
- Determine integration requirements
- Evaluate a potential vendor partner
- Select a system and vendor partner
- Implement and monitor the strategy

These are explained in more detail in the sections below.

1. Defining a PLM system

As consultants who have observed and been involved with many such decisions, we know that it is a difficult process. The bigger and more complicated the company, the more difficult it seems to be. Why is that the case? Because a PLM system is the most important capability enabling modern product development. A PLM solution will require an integrated suite including a number of different tools.

The continuing onrush of both new hardware and software technology during the last few years, along with the pervasive reach of the Internet, provides us with a unique opportunity to use such a PLM system as the fundamental basis to greatly improve how your company develops new products.

The good news is that such PLM systems today offer enormous power at very reasonable costs. The challenge, and where you can make a difference for your company, is that PLM systems now reach into many more corners of a company, and as such need careful planning. At one time, CAD systems were the sole domain of engineering, for use in developing and documenting new products. The other departments, such as manufacturing, testing, procurement, and suppliers, received this data, used it and modified it independently of the original data. Alas, if your department couldn't read the data, you needed to rebuild it in whatever format pleased you, leading to all kinds of problems. Data re-creation errors, duplicate data, outdated data, disconnected data, and no easy way to update after the data changed were only some of the problems. This mirrored the way companies worked in the days of slow speed, paper based systems.

In the last decade, however, many forces have changed the way we need to work today. Among these are the need for speed in bringing products to market; the need for world class quality; the requirement to operate in a global economy where customers, vendors, and even engineering can be anywhere in the world; and cost, where customers can compare prices anywhere in the world by simply browsing the Internet.

Comparing PDM and PLM

PLM and PDM (product data management) differ in that PDM normally focuses on design data management, while PLM tries to manage product data from birth to death, thus the term product lifecycle management. PDM typically manages the product structure or the Engineering Bill of Material (EBOM) only. PDM usually includes versioning. More advanced offerings may also add engineering change orders (ECO) management and its related workflow control. Since most companies have developed their workflows over time, each tends to have unique processes for controlling and managing changes to products, either released or in development products. In the past, product development organizations took longer to bring out a product and often these developments were controlled at a single location. Thus it was possible to manage product structures and their related bills of material manually or with home grown systems, even with spreadsheet software such as Microsoft Excel. *Today's rapid development cycles and global development facilities require better methods.*

Another contributing factor is Engineering change orders (ECOs), which were always complicated to evaluate and approve. If an ECO occurred prior to production only engineering was impacted. ECOs occurring after production are much more costly and tougher to evaluate because production changes, inventory, field replacements, and documentation must also be considered. Manual tracking and approval of ECOs proves to be error prone and a major bottleneck.

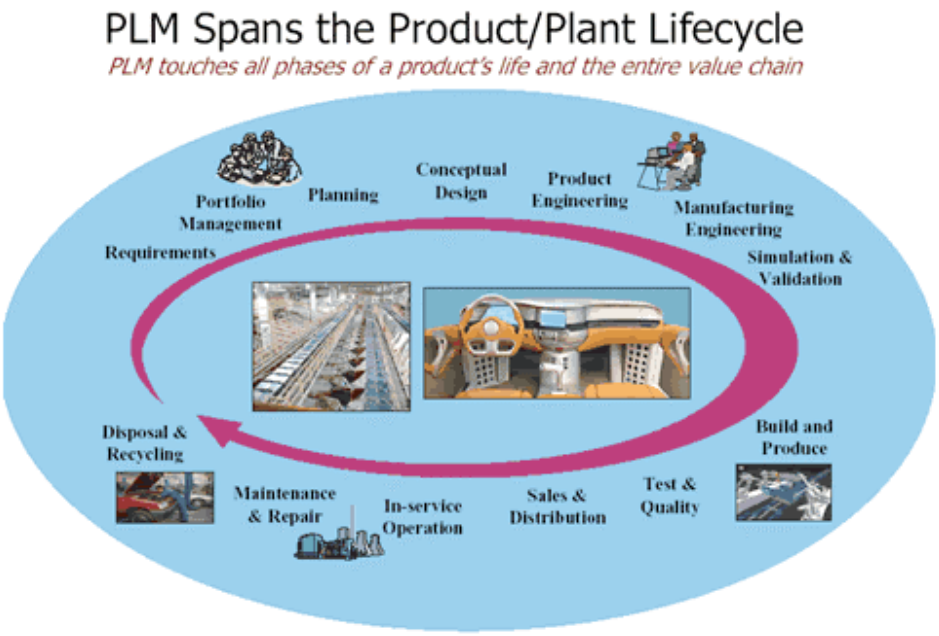
Beyond simple PDM systems, a PLM system expands support for product development to a broader audience and encompasses a much richer product definition. Today's PLM system supports concurrent design and product data transparency so that downstream departments such as Sourcing, Manufacturing, and Quality have advanced visibility to product designs. This allows them to prepare in advance to ramp the product up to full volume production at high quality. Ideally, this provides the opportunity to provide input to the design to prevent design flaws that cause extra cost or poor quality, supporting Design for Manufacturability, Design for Quality, and other similar initiatives that are aimed at getting the product "right the first time." PLM also encompasses more than just the engineering specifications of the product, and considers other elements of the "whole product" including sourcing information, quality plans, product documentation, costing, and more. By integrating the technical and commercial aspects of the product, PLM systems allow for a much more integrated product development process.

With modern technology improvements in computer capabilities, CAD systems, and global networking coupled with a global economy, multi-sourcing, and reduced time to market requirements, companies of all sizes can no longer operate with older PDM systems. Small and mid-size companies face the same challenges as do large global companies, yet often do not have, nor can they afford to have extensive IT (information technology) resources.

Defining PLM for this paper

PLM is, number one, a process of guiding a product from concept through retirement and, number two, a process to deliver the most business value to an enterprise and its trading partners, says Marc Halpern, of Gartner Research. He goes on to say "For engineering and design, PLM is about creating the product, giving that product some definition that can be manufactured. For marketing, PLM involves the business intelligence and portfolio management tools needed to create and evaluate product strategy and product portfolios. PLM also helps marketing with product details for labeling, advertising, sales collateral, and so on."

The following chart from CIMdata (www.cimdata,com) depicts a PLM scope.



CIMdata goes on to describe two big buckets. Authoring tools is one bucket. These are the applications that create designs and definitions, and analyze data, including CAD/CAM for mechanical designs, electronic design automation (EDA) for electronics, computer-aided software engineering, and computer-aided engineering (CAE). Collaborative product definition management (cPDM) is the other bucket, which includes workflow, vaulting, visualization, configuration and change management, project and program management, and portfolio management. Everything but authoring tools.

As an alternate view, AMR Research (www.amrresearch.com) identifies five core PLM components. The first two are fairly mature as they are where PLM started: product data management (PDM) and collaborative product design (i.e., the different tools for actually interacting with all participants in a design process). The remaining three are direct material sourcing, customer needs management, and product portfolio management.

Daratech's (www.daratech.com) view is that companies need a way of controlling the design data they create, namely a vault. They should add some basic management mechanisms to control design work, such as revision control, signoffs, configuration management, and change authorization. In addition, they should have some collaboration tools for, at the very least, the ability to hold design reviews with dispersed work teams.

For the purposes of limiting the scope of this paper we will focus on the upper half of this chart, specifically: planning, conceptual design, product engineering, manufacturing engineering, simulation and validation, and the release of the manufacturable product data.

Today's integration technologies such as SOA[1] should ease entry into the remaining downstream activities in the bottom half of the above chart.

2. Determine the Need for a New or Expanded PLM System

Develop a business case for upgrading or replacing the existing system that evolves to a product lifecycle management (PLM) system from a base PDM (engineering data management) approach. In order to do so, you will need to map how well the existing system fulfills your business plan. What are the gaps between what you want to accomplish as a business and what the existing systems are able to support? Are you paying too much for support of point solutions or custom systems? Do you have the integrated solution that your business demands?

Most companies that have not invested in the new generation of solutions for developing and engineering products suffer from inefficient and non-integrated systems. For you to operate as a leading company you will need to make the evolution from standalone tools to integrated suites. For you to properly plan (and justify) your efforts you need to determine where the gaps lie. These are the business-level gaps, and should be reflected in business level metrics to support your new business strategy. Once this is done, you can specify the fundamental requirements for new system that fills those gaps and can grow for the future.

Answer these questions to see if you need to change or improve:

- When did you last update your system for product development? Was it within the last 3 - 5 years?
- Are your engineers/designers primarily designing using 3D?
- If you are an ETO or MTO company, are you using automated product configurators or

[1] "**Service-oriented Architecture (SOA) defined,**" a paper by Raymond Kurland, October, 2007, published at www.cad-portal.com

automated design software?

- Are you happy with your product quality?
- Are you happy with your product development times and the time it takes to bring products to market?
- Do you respond to a high percentage of RFP's in a timely fashion?
- Are your development and go-to-market costs in line with your competitors?
- Are you able to interact with global suppliers in the design phase as well as you should be?
- If need be, can you exchange design data with your customers and/or suppliers? In this exchange, can you retain security on your key product data?
- Are your engineering and manufacturing bills of material kept synchronized?
- Can you effectively access and use portions of prior designs in new products or projects?
- Do your overall product related company metrics compare favorably with others in your industry?

If you answered "No" to **any** of these questions you are operating with a deficient PLM system. We suggest that you read through the following steps carefully to determine whether to improve what you have or to change systems and what benefits you can expect.

3. Organize the Evaluation

A good evaluation is based on a strong plan and a strong team. Understand in advance the approach that you will take to the evaluation, the selection of the new system, and the approval of the new system.

- Cross-functional team. Your system will touch many aspects of your business. New approaches to developing products demand a much broader level of participation than past approaches. Make sure your team has representatives from Engineering, Product Management, and the Program Office (if you have one). But also include Procurement and Manufacturing representation. Also, consider including Sales if your business involves any make to order (MTO) on configure to order (CTO) products. Remember that the people you want from each department must be respected. You need to ask departmental management for people you "can't afford to spare" for the project, not someone that is transitioning out of the company or on a performance plan. Respect is critical.

- Steering Committee. You will also want to support this team with a strong steering committee. This committee should be made of respected business leaders that can make decisions that stick, and should represent major functional business areas in the same way that the team does.

- Provide potential vendors with your requirements, have them show you your data and processes as they exist today and how they can exist tomorrow. It's OK to have vendors show you general demonstrations, you can learn a lot from them. But you should also see your data and your business reflected in the system before committing.

- Check references. Find companies like you that are running the vendors' software. The vendors will provide references, but you should also find some on your own. Consultants can often help here by tapping into their networks.

- Special considerations for mid-sized businesses. Make sure the references are your size, and understand how much their implementation cost in terms of investment and resources.

4. Determine Management Requirements

The final stage in the selection process of a PLM system identifies key requirements that the system must meet. Such requirements are an outcome of deciding upon the primary goals and the critical business aspects that will be improved, and what time frame according to the implementation plan. You can expect to have the system for at least five years; picking the right system can have an enormously positive impact on your competitiveness.

The requirements for the new PLM system can be divided into management requirements and technical requirements. *Companies have a tendency to make such a decision based solely on technical merits. We strongly urge management to be involved in assuring that the business aspects not be ignored.* We suggest the following as management requirements to be considered. You should add your own, depending upon your business situation.

- The benefits of the proposed overall system solution will meet my business objectives and be a cost effective solution at all stages of implementation. Some potential benefits to consider can accrue from: more competitive products, lower priced products, better quality products, faster to market with new products, higher profit margin, maximum design reuse, and lower scrap rates.
- Management should feel confident that their personnel can implement the solution in a timely fashion and that it will deliver the desired results.
- Management should feel comfortable that they have or can develop a long-term relationship with the software vendor and have good local support.
- There is an availability of local skilled users and consultants to augment company skills.
- The system can be run successfully in the event of personnel changes.
- Consideration should be given to exchanging data or inter-operating with evolving vendor/supplier/OEM/purchasing and outsourcing relationships.
- The system should allow future flexibility if the company operations change.
- Take into consideration that the data and designs generated by the system may need to survive and be useful for many years.
- Because of the long duration of the vendor relationship, the software vendor viability and product leadership are critical. Management should have an excellent comfort level that any selected vendor will continue to be an industry leader.
- Your competitors are using similar systems effectively.
- There should be excellent references of the specific software vendor in similar businesses to yours.
- The vendor/sales agent provides good availability of technical support for software errors, training, and assistance with proper software usage.

PLM system complexity should match business complexity

To assess what type PLM system you will need it is important to understand the nature of your business in regard to potential PLM system complexity. In general, the more complex your company, the more complex the systems needed to support your operations. You will find that some PLM systems are more comprehensive than others in terms of their growth capabilities, their scalability, and their application or initiative coverage. Unlike PLM systems of yore, now comprehensive does not necessarily mean more costly and difficult to install and maintain. Don't let this deter you. If you have a complex problem, then do not expect to realize your expected benefits with a limited solution. If your needs call for a more comprehensive system, then consider one. The reverse is also true. Your goal is to get a system that fits your needs. The following are some of the things to consider when judging your company complexity. Each item lists possible answers in increasing complexity order.

- Manufacturing locations –one location, a few, or many
- Complexity of products – simple products with few subassemblies with few supplier parts; modest number of supplier parts; products with many engineered parts, multiple subassemblies and extensive supplier parts
- Variety of products – limited, medium, or large variety
- Product types – standard products, configure to order, engineered to order
- Sensitivity of products - to price, to physical factors like weight or strength
- Use of suppliers and supplier interactions –uses only standard off the shelf, some custom designed supplier parts, extensive custom designed supplier parts
- Customer/Supplier relationships – independent or customers dictate documentation and designs in specific formats
- Design locations - one, a few, many
- Existing CAD systems – single vendor, multiple vendors
- Need to import CAD from other systems – limited, extensive, extensive and need to synchronize with external customers or suppliers
- ERP system is installed and operational and manages the production cycle - no, yes, automatic interface desired
- MES (manufacturing execution systems) installed – no, yes, automatic interface desired
- Design thru manufacturing process - design only, manufacturing only, design thru manufacturing
- Size of IT staff - small or non-existent to a few
- Data management existing now - file system only, central vaulted storage with limited access, corporate wide controlled vault with full collaborative capability
- Documentation required to customers – little other than drawings and material lists, full 3D data, interactive assembly instructions
- Product life cycle - very short <12 months, short 12 to 24 months, medium term 24 to 48 months, long 48+ months
- Corporate structure or corporate complexity - stand alone company, part of a division of a corporation, division of corporation, multi-division corporation operation

For this evaluation, independent consultants can prove particularly useful. They will be able to provide industry expertise as well as an independent view of how well your existing systems "measure up" to industry leaders. Another good source of information might be to use vendor or reseller consultants, or tools such as PTC's Product Roadmap, a well-defined approach to selecting business alternatives and their resulting system requirements.

5. Determine Functional Requirements

Now that you have a business strategy in place and have determined the need for a new system, it is time to start laying out requirements. Where should these requirements come from? You can find RFP (request for proposal) templates in a number of places, and some vendors may even provide you with one. These tend to be bottoms-up requirements, and can be very detailed. Start with your business strategy and develop a set of high-level requirements. Base these high level requirements on what you want to accomplish in your business, and ensure the software is designed to support you.

There are clearly some basics that must be in place for the system to function. Most systems will have these, and it will not help you differentiate solutions. To start with, we suggest that you look at the business initiatives you need to support, any special requirements demanded by your industry, any regulatory requirements your system must fulfill, requirements driven by the size of your business, and special considerations for your business.

- Requirements by business initiative. It is important to understand these in advance in order to pick the right solution and vendor partner. If the solution doesn't address the right scope of functions, then you will likely have to develop custom systems to extend the core. Consider what the system needs to do in order to improve your product profitability and competitive position, and list those. Even if only a limited scope is planned for the initial implementation, consider the need for these in the future. Some initiatives to consider include: collaboration with customers and partners, product portfolio management, product modularity, design reuse, standard product development processes, reduced physical prototypes, reduced production scrap and rework, and lean engineering.
- Industry requirements. Some industries require dramatically different capabilities, while other industries simply put higher emphasis on specific elements of the solution. For example, the aerospace industry needs much greater traceability on configuration management than a less regulated industry. An apparel company needs to understand product line planning much differently than other industries. An entire chapter could be written for each industry, but one important way to evaluate this is to set a requirement that the system is being used successfully in your industry.
- Regulatory requirements. Some industries and businesses are also subject to specific regulatory requirements. These can include document retention policies, security approaches, and other demands. Check with a consulting company and some of your peers to understand what these are. Check with your customers, to see if they have any specific regulatory (or non-regulatory) requirements for your system.
- Special considerations for small to medium-sized businesses. As a smaller business, you will not want to develop your system from the object model up. Look for proven templates that cover both the common workflows your business will need to support as well as the data that supports it. Unlike some other enterprise applications that come with a fixed data model, PLM offers enough flexibility to alter this without modification. But be careful to avoid specifying a brand new system. Start with a template (for your industry, hopefully) and build or modify from there as necessary.

- Special considerations for your business. What makes you unique? Remember, innovation and product development are key to your success. Don't hamper that part of your business. If there are unique ways in which you calculate specifications or collaborate with suppliers, make sure you understand them and how the system will support them.

6. Determine Technical Requirements

Beyond the functional capabilities of your system, you should consider the impact of the product architecture and its technical underpinnings. If the product meets the functional needs but won't perform or drives unnecessary inefficiency or cost, the overall implementation and benefits will be at risk.

As a start, we urge that you re-examine your existing authoring system, keeping in mind many of the requirements below.

- System architecture - the system should be scalable (has the power to grow without changing systems) to meet both current and intermediate future needs. Scalability should include an understanding of your products (product complexity, design approach, number of components) as well as your design process (number of Engineering users, number of non-Engineering users, desired level of collaboration and partner involvement). The system should be fully associative so that changes to one geometric form update all other related files and documents. Most important, since you will have significant intellectual property in the system, it must be reliable. The quality of the system design must be modern, web based, have a solid underlying data structure, and support SOA.
- Hardware and network requirements – the hardware environment should provide for scalable architecture. Upgrading hardware should not require substantial, if any, downtime. Users should plan for a multi-site architecture that is immune to geographic specific interruptions. Ideally, multiple sites should each be individually capable of operating the entire operation, under short notice. This probably means automatic off-site backups, data redundancy, and network duplication
- Geometry creation and manipulation - all required geometry should be able to be easily created and modified; the geometry also should allow for all necessary information for manufacturing; productivity, usability, and reliability are of primary importance.
- Assembly creation and manipulation - even your largest desired assemblies should be able to be easily created and viewed with adequate performance. Important characteristics of assemblies include easy placement of parts, interference checking between parts, ability to create lightweight assemblies and envelopes of assemblies, the ability to manage various techniques for managing multiple configuration options, the ability to facilitate teams working concurrently on different parts of the assembly and ease of creating and maintaining Bills of Materials.
- Creating and maintaining engineering drawings - should be fully associative and easy to create and maintain from the 3D representation; they should meet the required drawing standards; allow full and complete annotations for production and allow markups.
- Manufacturing and tool design - should allow production-level NC milling and turning toolpath generation; analysis of the manufacturing results from the model; toolpath generation as automatic as possible; support manufacturing engineering planning within the same model format; allow two way support for tolerance analysis. Should also allow all the required tooling to be designed and, if applicable, support mold design and analysis, and progressive dies.
- Simulation and analysis - allows analysis from simple to complex FEA analysis, has automatic mesh generation via preprocessing, includes post processing for easy analysis of the results, and supports many types of analysis directly from the model.

- Extended or Third Party Applications - system has a wide variety of native or integrated applications to extend system to fit user needs; applications of interest should seamlessly integrate with system; and ideally third party support should originate with system vendor. System vendor supports an open philosophy so third party applications can easily be added.
- Interfacing/communication - supports all required industry standards for translating product data between systems; supports Web-based viewing and model synchronization (assuring that you are working on the latest model); has tools for Internet based concurrent engineering; integrates and communicates with primary systems (CAD, CAM, CAE, ERP, SCM, CRM, MES, etc.)
- Product Data Management - installs easily as add-on if desired to improve on file based management; supports data vaulting and change control easily; allows for use of user-defined and standard attributes for finding and storing non-geometric data; maintains relationship among all CAD/CAM/CAE files; allows storage or connection to non-CAD data.
- Collaborative design – Supports new product introduction, change management, concept development, detailed design, product validation, variant design, design collaboration, design outsourcing, component management, technical illustrations; provides engineering management control of processes.
- Graphics/display - all models should be able to be visualized easily with excellent performance; have reasonable hardware requirements.
- User interface - should be easy to learn; easy to remember; consistent across functions (at a minimum by user role); be customizable; have good help documentation and training tools; be obvious to use.
- Search – Search should be based on indexing and provide rapid results.
- Systems issues - excellent disaster recovery mechanisms; easy to install and customize; company hosted or externally hosted; internal resource requirements needed – administration, backups, software upgrades; software maintenance needed and cost of such; support provided by vendor.

7. Determine Integration Requirements

Your new system will not work in a vacuum. There are a number of special requirements that go beyond functional and technical specifications of the individual components. How will this system support tasks that cross applications, either within the solution itself or into your ERP or manufacturing systems?

- Integration between engineering and product development functions - Today's product development processes involve both engineering and downstream departments. Does the design process fit in well with the overall project context? Is it possible to understand both the commercial considerations of product development (costing, sourcing) along with the technical aspects? If not, manual processes may be required to prevent a disjointed view of the product, or risk a purely engineering-centric development process without buy-in from downstream departments.
- Integration across the full product suite - Is the solution itself integrated? Are the different "modules" or functions in the system built on a common architecture or pre-integrated? Do they share a common data model and/or database? If not, additional work will be required to support product development by cross-functional teams.

- Integration to enterprise applications - How will products be released to manufacturing? How will change orders be evaluated and executed? If you are using an ERP system, are you prepared to support manual integration or develop your own approach if the vendor does not provide it?

These capabilities span both functional and technical considerations, and in today's environment must be called out for special attention.

8. Evaluate a Potential Vendor Partner

Your software selection needs to consider more than the software. Consider the fact that you are not only selecting a software solution, but you are also selecting a business partner. Before you select a system, you need to understand your company. Some things that you should consider:

- Vendor Strategy. This is not a short-term decision, and should be based not only on the software that the company has in place today, but also the future direction and strategy of the prospective vendor partner. Understand the company's philosophy towards supporting your business.
- Industry Support. Does the vendor support your industry? For example, do they have many customers that are similar in nature to your company? If so, future enhancements will likely be beneficial to your company.
- Vendor partnership approach. How does the vendor work with customers? Do you have a voice in the user community that will help influence product and company direction?
- Support requirements. For example, if you are a global business you should ensure support is offered (directly or through a partner) in the geographies you require. If you are a large business and can afford the risk of supporting the software yourself, then this may not be as big a concern. But for small to medium sized businesses, the support infrastructure of the vendor (and the vendor's ecosystem of partners) can be critical.
- Financial Requirements. Do you require financing? Are they willing to work within your budget? Can they offer a "software as a service" approach if you desire one?
- Vendor Ecosystem. Consider the company that your prospective vendor keeps. Examine the complementary software partners and consulting partners that are aligned with your prospective vendors.
- Market Position. The software vendor's revenue or growth should place it in a leading position; good reference sites should be available; the vendor should have regular and well attended user-group meetings.

You may want to filter vendors early based on high level partnering requirements, regardless of their software. You may want to avoid the risk of your company "falling in love" with a system only to discover that the vendor can't support your business.

The following table lists select vendors of PLM software.

Table of select vendors and their PLM software offerings

Vendor	Primary Products	URL	Company Revenue
Collaborative PLM Only			
Aras	Aras Innovator	www.aras.com	Private
Arena Solutions	Arena PLM On-Demand	www.arenasolutions.com	Private
Oracle	Agile PLM	www.oracle.com	$22 Bill, Agile revenue unstated
SAP	SAP PLM	www.sap.com	$17 Bill
Softech	ProductCenter PLM	www.softech.com	Private
Integrated CAD and collaborative PLM			
Autodesk	Productstream	www.autodesk.com	$2+ Bill
Dassault Systemes	Enovia Smarteam, Enovia MatrixOne, Enovia VPLM	www.3ds.com	€1.325 bill
PTC	Windchill	www.ptc.com	$1 Bill
Siemems PLM Software	Teamcenter	www.siemens.com/plm	Unstated; $1.2 Bill Est; Siemens $115 Bill
SolidWorks	PDMWorks Enterprise	www.solidworks.com	Subsidiary of Dassault Systemes; $260 Mill est.

9. What a new system should include and what it should cost

What a new system should include

The following items are a short list of the major items that you should plan on for your new system:

- New or upgraded (or existing if you already have a fabulous CAD/CAM/CAE system) software for design, manufacturing, analysis, data management, and advanced specialty applications as needed.
- New or upgraded collaborative design software including vaulting; advanced functions to automate and track the workflow for such processes as ECO's, product release and other items of workflow control; management reporting of product and programs status.
- External Internet access to design and product data with sufficient security.
- Training of users and support personnel.
- Customization of the new software or special programming.
- Conversion of existing design data - only if absolutely necessary or beneficial. Don't convert it all. Just what you need.
- New computer hardware.
- Rethinking of your processes and a probable reorganization. You will definitely need to rethink your information and product flows to take advantage of the system benefits.
- Better communications (high speed network and Internet access).
- Server(s) to store collaborative product data.
- A rethinking of your paper approval and engineering change procedures.
- As wide as possible access to the design and product data. Generally access should be planned for three types of personnel: data authors, approvers, and viewers. While authors of CAD type data will require specialized software, approvers and viewers should be able to use web-based software at much lower cost.
- External consulting for implementation and on-going improvements.

What it should cost

We recommend that you update to the latest Microsoft Windows system, with the fastest hardware you can afford. Don't try to skimp here - for about $3000 you can get an excellent workstation.

Unless there are unusual circumstances, most small-medium businesses can have their design requirements met by mid range CAD software, which generally costs between $4000 USD and $8000 USD per seat plus about 25% of the acquisition cost for annual software maintenance. Plan on equipping all persons who create or change design data with a seat. Lower cost alternatives are available but usually have limited functionality. In our opinion, these costs are so far below engineering personnel costs that it becomes unimportant compared to the expected benefits. If this is not the case for your business, then you need to rethink the benefits.

Limited analysis software may be available free for the most basic analysis (linear - stress). To simulate products more in-depth, you may want to consider advanced analysis software, able to dig deeper, which starts at about $5000 per seat. A few seats are generally enough.

Manufacturing software generally concerns itself with programming NC toolpaths for milling machines or lathes. Such software starts at $5,000 for milling, somewhat less for turning. Don't forget to ask the software provider whether special postprocessors are required and what they might cost.

Collaborative design software allows all approved persons access to the product data. These costs vary widely and unless you have only one or two users and want to rely on standard file management software, you should plan on using the PLM software we have discussed above. *The ability to manage engineering data effectively, particularly as it changes, will be a critical underpinning of a modern architected system!* Costs should range from $500 to $2500 per active user for the initial software cost plus annual maintenance.

Consulting and training from the vendor or reseller should be built into the anticipated costs. This will obviously vary depending on the number of people and their skill levels in your organization. Make sure you have allowed enough time and education to make the transition. Also, consider having a "leader" or highly skilled person for each functional area, to advise and assist others. Some vendors also offer "fast start" programs to get their PLM systems operation quickly. These bundled approaches often include software, training, customization, and data conversion and are an excellent way to get started and up to speed quickly, thus realizing your ROI and the projected benefits faster. Don't be surprised to be spending upwards of $100,000 for startup consulting and training.

You will have to also allow for lost time until your personnel are up to speed on the new system.

10. Select a System and Vendor Partner

When you reach this stage, you should have decided upon the major opportunities available by improving your product innovation, product development, and engineering operations. You should have defined the primary goals and the critical business aspects that will be improved. You should also have an understanding of how to sequence the implementation. The system selected must be scalable for all stages of the implementation, both in regards to functionality as well as usage volume. It can be expanded, but its overall functionality and architecture should suffice for all stages. Pick a solution that you can live with for some time to come, the solution's capabilities and product roadmap must line up with your strategy, and ideally be a step or two ahead of your current needs.

You now also know the requirements the system must meet, both management and technical. Now it is time to select a system to solve those issues. Here are the steps:

- Confirm or refine the management, functional, technical, and integration requirements.
- For each requirement, provide its related benefit. If you cannot determine a benefit then the requirement is not important enough. Delete it. This avoids being buried by a huge list of technical requirements with only minor importance. We suggest limiting the critical requirements to less than 20 in each of the four categories.
- Prioritize the requirements, management and technical, using benefits to prioritize the requirements. Lacking detailed benefits for each requirement, you might also consider prioritizing the requirements by grouping them into 4 groups categorized as: must have, important, like to have, could live without.

- Allocate the budget.
- Solicit detailed proposals from a few vendors (maximum of 3). Remember that you are not only selecting a software solution, but you are also selecting a business partner. As stated before, you may want to filter vendors early based on high level partnering requirements, regardless of their software. For example, if you are a global business you should ensure support is offered (directly or through a partner) in the geographies you require. If you are a large business and can afford the risk of supporting the software yourself, then this may not be as big a concern. But for small to medium sized businesses, the support infrastructure of the vendor (and the vendor's ecosystem of partners) can be critical. You may want to avoid the risk of your company "falling in love" with a system only to discover that the vendor can't support your business.
- Test that the proposed systems meet the functional, technical, and integration requirements through operational tests and piloting.
- Test that the proposed system passing the functional requirements meets the technical requirements. Consider using either one or more of the following techniques: a benchmark, a paper analysis, or installing trial systems in-house with a properly trained internal person aided by a vendor support person. You might instead consider "loaning" a system and using vendor supplied on-line training augmented by local support. The latter is a good way to evaluate what post installation support might be like. Keep in mind, however, that users trained on a particular system tend to become zealots for that system.
- Evaluate the ability to meet the requirements.
- Select the winner.

Suggested technical requirements are highly dependent on your industry and where your company fits in the value chain. How your company weights the technical requirements will prove to be critical in the selection. Don't forget the need to provide a benefit for each requirement. Certain departments will have different priorities for the same item. You will need to allow for this.

11. Implement and Monitor the Strategy

Even the best selection process in the world will prove useless if the system is not properly implemented. Critical to a successful implementation are developing a strategic implementation plan and allocating the proper people, time, and budget.

While implementation is beyond the scope of this paper, we offer a few pieces of wisdom:

- Assemble a cross-functional implementation team, with representation from inside and outside of Engineering
- Review the strategic goals and associated benefits of the PLM Vision with the team members.
- View the implementation as a program. Divide the implementation into a few (3 or 4) manageable steps, each with a defined, measurable benefit, but that provide a tangible step towards the PLM vision.
- Allocate the proper resources and budget to accomplish each phase.
- Appoint a specific executive with responsibility for each phase.
- Prepare a reasonable work plan, with planned contingency for risk

- Provide the proper conceptual, business process, and software training for the users
- Monitor and measure the results based on PLM project goals
- Be mindful of slippages and address the reasons rapidly
- Always be ready to re-assess your progress -- **don't forget** that after the goals are known and eventually the engineering tools (CAD/CAM and PLM among others) are selected and installed, the metrics must be continually monitored to assure that management objectives are being met, and to take corrective action if not.

For small to medium businesses, the implementation can be even more challenging. You likely don't have resources dedicated to process improvement or a "center of excellence" where you investigate and experiment with new processes and tools. At this critical point, you need to make the hard decision to make the right resources available. Look to the evaluation team as a guide, hopefully these people were not the people that every department could spare. They were respected leaders of the business from different functional areas. As you begin your PLM journey, recognize that the implementation team has the future of the business in their hands, and don't under invest in talent.

Remember this adage: Good luck always seems to come to those who are properly prepared!

12. About the Authors

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Raymond Kurland is president of TechniCom Group LLC and its principal consultant and editor. His firm, founded in 1989, specializes in analyzing MCAD and PLM systems and has been involved in reviewing and comparing such software since 1987. Ray frequently consults with both vendors and users. Ray has degrees in Engineering from Rutgers University and from NYU. His career included stints with Bell Telephone Laboratories, IBM, and Dassault Systemes. Ray can be reached at rayk@technicom.com. For more information about TechniCom Group and other software reviews please visit www.cad-portal.com.

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Appendix A: Testing and evaluating how proposed systems meet the requirements

We propose that you use an objective scoring methodology that allows measuring the extent to which each proposed system can meet your company's requirements, enabling you to objectively distinguish between competing systems. Our experience proves that this method can eliminate many of the subjective valuations often used, avoiding nasty surprises in the implementation process.

A matrix scoring methodology, if used with the proper weightings for your company needs, can be highly effective. It is often desirable to add, for each requirement, its priority (weight), and vendor compliance (we suggest using a scale of 0 to 10, with 10 being perfectly meets the requirement and 0 being totally non-compliant). If you are having trouble objectively entering the weights, consider using outside resources. Weighting these requirements will depend upon your industry and where your company fits in that industry value chain. For example, a company producing automotive dies will have different requirements than will a company producing automotive engines, even though they are in the same industry. Likewise, a company producing low cost consumer products will be far different than a company producing high cost white goods such as refrigerators.

As stated before, to evaluate compliance score, consider using either one or more of the following techniques: a benchmark, a paper analysis, or installing trial systems in-house with a properly trained internal person aided by a vendor support person. You might also consider "loaning" a system and using vendor supplied on-line training augmented by local support. The latter is a good way to evaluate what post installation support might be like. Keep in mind, however, that users trained on a particular system tend to become zealots for that system.

Management Requirements	Importance (Weight) (0-100)	Vendor Compliance (0-10)	Score (weight*compliance)
Requirement A			
Requirement B			
Requirement C			
. . .			
Total Management Score			
Technical Requirements	Importance (Weight) (0-100)	Vendor Compliance (0-10)	Score (weight*compliance)
Requirement A			
Requirement B			
Requirement C			
. . .			
Total Technical Score			

Use as many requirements as is necessary. Ensure that the importance weighting numbers in the importance column total to 100. Compliance score reflects how close the tested system comes to compliance for each requirement with a weight. If desired, management and technical requirements can be combined.

We welcome all advice and comments about these techniques. Feel free to write the authors at: staff@technicom.com.