



CIMdata

Product Lifecycle Management

“Empowering the Future of Business”

A CIMdata Report

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Introduction

In today’s challenging global market, enterprises must innovate to survive. Business innovation must occur in all dimensions—product, process, and organization—to improve competitiveness and business performance. To differentiate themselves, enterprises must capture, manage, and leverage their intellectual assets. This can best be accomplished through proper application of a Product Lifecycle Management (PLM) approach that addresses the needs of the extended enterprise. PLM is a strategic business approach that helps enterprises achieve its business goals of reducing costs, improving quality, and shortening time to market, while innovating its products, services, and business operations. CIMdata defines PLM as:

A strategic business approach that applies a consistent set of business solutions in support of the collaborative creation, management, dissemination, and use of product definition information across the extended enterprise from concept to end of life—integrating people, processes, business systems, and information.

By increasing an enterprise’s flexibility and agility to respond swiftly to changing market pressures and competitors, PLM helps companies:

- Deliver more innovative products and services
- Reduce costs, improve quality, and shorten time to market, while achieving the targeted return on investment (ROI)
- Establish more comprehensive, collaborative, and improved relationships with their customers, suppliers, and business partners

PLM solutions meld technology, methods, and best practices to address today’s rapidly changing business environments. PLM is a catalyst for change within a business—an opportunity to improve processes and organizational relationships to create an innovative, measurably improved business.

Once implemented, PLM solutions provide benefits that have demonstrated a positive impact on an enter-

prise’s top and bottom lines. PLM solutions can improve business efficiency by providing:

- Dramatic reductions in time and cost of product changes
- Significantly shorter product cycle and lead times
- Decreased scrap and rework during production
- Improved productivity in design engineering

Direct savings include reductions in the time and cost to design products, reduced inventory, and better reuse of components, shorter time to market (thus earlier time to revenue) with new and enhanced products, and reductions in the time to locate and access needed information. These and other impacts deliver improved revenues and higher profits, much like other enterprise initiatives such as enterprise resource planning (ERP), customer relationship management (CRM), and supply chain management (SCM). With demonstrated top and bottom line impacts, PLM has become a strategic business initiative equal to, or more important than ERP, CRM, and SCM. For a business to be successful in today’s and tomorrow’s global markets, PLM is not an option—it is a competitive necessity.

This paper describes key business challenges faced by today’s global enterprises and how PLM solutions have evolved to address more and more of the product definition lifecycle to enable businesses to meet these challenges. Included is a high-level PLM definition, describing its core components, and clarifying what is and is not included in a PLM business approach. The paper concludes with a further discussion of the business benefits of PLM.

Addressing Business Challenges

Businesses today face three on-going challenges: improving customer intimacy, achieving operational excellence, and providing product leadership. Improving customer intimacy requires understanding and responding quickly to current and potential customers, their needs, establishing effective relationships with them, and providing consistent, long-term customer value. Achieving operational excellence requires enterprises to focus on operating efficiently, effectively, and flexibly, working with their partners to reduce the cost and time necessary to deliver high-quality products that

meet their customer's requirements in a timely manner. Providing product leadership means delivering leading-edge products and solutions tailored to customer needs. All of these challenges require getting the right products to the right market, at the right time, for the right cost.

To meet these challenges, businesses must become more innovative. However, being an innovative business doesn't simply mean creating innovative products. It also means improving the processes a company uses to produce its products and how it supports its products using innovative approaches to the complete product lifecycle. Today, innovation is recognized as critical for a business to maintain its competitiveness in the marketplace. However, innovation must be achieved while reducing overall product-related costs across development, production, and service.

A primary business driver is increasing product complexity and customization. Not only are mechanical configurations getting more intricate, products increasingly include complex electronics and software. In addition, customers want to have "their" product or plant configured to their individual specifications. The increase in product complexity, coupled with the desire for personalized configurations, requires an enhanced ability to quickly define new product variations and options, and to be able to manage the configurations being offered. Additionally, companies must manage the "entire" product or product family, integrating elements such as product recipes and packaging to meet regional requirements and regulations.

In the past decade, many business investments, such as ERP, addressed improving operational efficiency. Those investments continue today with an expanded focus on using product definition information more effectively in both production and operation of a product or plant in service. Effectively leveraging supply chain partners for both design and production efficiency continues to grow in importance in achieving operational excellence.

Achieving product leadership focuses on revenue generation from a steady stream of innovative, new products. Today, enterprises must bring innovative products to market more effectively and more quickly to maximize customer interest and sales. The pressures to reduce time, improve product quality, and lower costs haven't gone away; they are being reaffirmed and folded into programs that focus on delivering the "right" product. To continue to expand, product leader-

ship companies must continue to enter new markets with innovative products. This requires leveraging and reusing the product-related intellectual capital created by business partners working together across the extended enterprise value chain.

Globalization is an overarching reality that spans each of these business drivers. To be successful in global markets, organizations must develop and apply a diverse set of skills and business processes. Global enterprises must:

- Make effective use of a widely-distributed worldwide organization, creating a virtual value chain with no time, distance, or organizational boundaries
- Ensure that corporate acquisitions and mergers work together
- Create and enable virtual product teams composed of people that are spread around the world
- Leverage the intellectual assets in these dispersed teams and organizations
- Enable 24 x 7 development and product support using global teams

These drivers are putting increasing pressure on organizations to invest in solutions that include technologies, methodologies, best practices that can help them improve their ability to focus on product innovation, leverage business partners, and compete more effectively in the global market place.

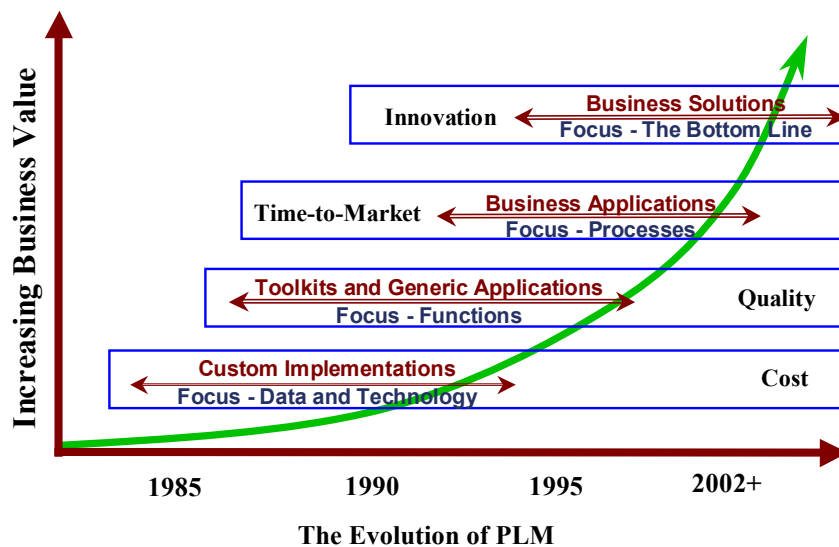
The next section describes how the terminology and technology of PLM evolved to address these vital business issues.

The Evolution of PLM

The term "product lifecycle management" emerged after nearly twenty years of market and technological evolution. In the mid 1980's to early 1990's, there was confusion as to what to call product-related information, particularly engineering information. As the data came to be referred to generically as product data, the term product data management (PDM) emerged. CIMdata heavily promoted both the term and the nascent industry through publications and educational events. Both users and solution providers embraced PDM and used the term for many years. In fact, PDM remains a foundation component of PLM. Over the last several years, more acronyms created confusion in the market, as people began to consider the product lifecycle and collaboration—PDM, cPDM, CPC. These terms

overlap and carry multiple meanings. PLM has emerged as the term used to describe a business approach for the creation, management, and use of product-associated intellectual capital and information throughout the lifecycle.

PLM has evolved in much more than terminology. There has been a continuous evolution of what PLM represents, as illustrated in the figure below. Fifteen years ago, custom implementations focused on precise applications wrapped around primarily engineering design data. In the late 1980's, the major emphasis was on how to manage engineering drawings, with limited solutions primarily sold to managers in engineering departments.



Custom implementations evolved to tool kits and generic applications that automated some typical functions. As the solution providers gained experience implementing their tools in different industries, their offerings evolved into delivering focused business applications. These applications provided standard data models, predefined workflow templates, and other functions necessary to solve some business problems. Today, the focus is on complete business solutions that address top and bottom line issues. These solutions incorporate best practices to allow organizations to migrate their business processes toward de facto industry standards. This evolution has changed not only the level of managers that buy these solutions; it has changed the issues that are driving these investments and, more importantly, it has changed the manner in which these solutions are acquired and implemented.

As part of this evolution, the view or definition of the “product lifecycle” has also changed. Fifteen years ago, the “lifecycle” focused on the design engineering activity, as the tools concentrated on CAD data management. In the late 1980's, that perspective began to expand to include workflow and processes across the product lifecycle, i.e., to share information and processes between different design activities.

In recent years, when organizations invested in PDM and early PLM, the buyers were typically mid-level managers, or occasionally, some high-level managers in IT, engineering, manufacturing, or other functional groups. Because of its expanding scope and impact on the extended enterprise, today's PLM solutions are

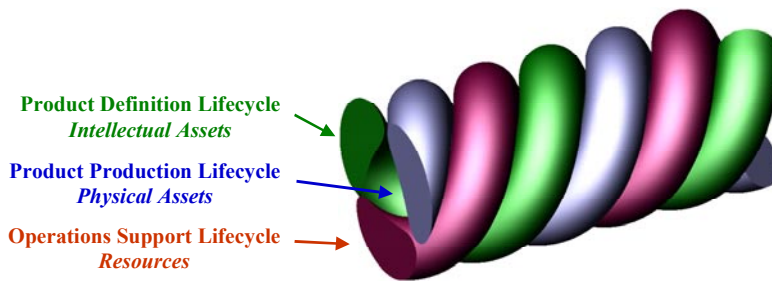
viewed as enterprise solutions, strategic to improved business performance. Strategic business investment decisions, regardless of size, are being reviewed and approved by C-level management, by—CIOs, CTOs, CFOs, and even CEOs. Other senior executives, such as senior vice presidents of major business units or functional groups (e.g., engineering and manufacturing) may also be involved. For senior managers, their investments must be focused on solving specific business problems, leveraging other opportunities, and taking advantage of previous investments within their organizations.

Now that PLM has emerged as an enterprise solution, it is important to understand how PLM fits with other enterprise solutions that manage product information and operations. The next section describes this relationship in more detail.

The Role of PLM

Precisely what product-related lifecycles are companies seeking to manage with today's PLM solutions? CIMdata defines the overall product lifecycle as comprised of three major, interacting lifecycles:

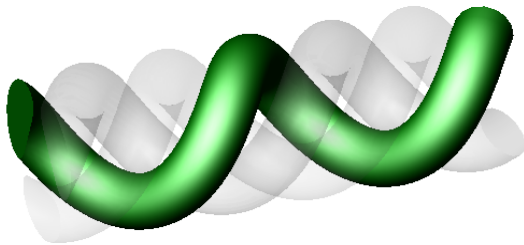
- Product Definition
- Production Definition
- Operational Support



Major Enterprise Lifecycles

It is important to understand the scope of these within the context of the entire product lifecycle. Within any industrial enterprise, the overall product lifecycle is comprised of these three primary and tightly intertwined processes as illustrated in the above figure. Each lifecycle encompasses the processes, information, business systems, and people involved in delivering the related business functions.

In the PLM context, the primary of these is the product definition lifecycle—the creation and management of intellectual assets. As with the overall product lifecycle, this lifecycle begins at the earliest point of customer requirements and product concept, and extends until the product is obsolete and field support has ceased. It includes the definition of the complete product, from mechanical and electronic components, to software and documentation.



Product Definition = The Intellectual Product

Product definition is not just the upfront engineering design. It also includes the entire set of information that defines how the product is designed, manufactured, operated, or used, serviced, and then retired and dismantled when it becomes obsolete. This product definition is continually updated throughout the entire lifecycle. Product definition is an intellectual property of a business; an intellectual asset that must be created, captured, maintained, and leveraged. To make the problem more difficult, this information resides not just within an individual business entity, but also through-

out the extended enterprise, including suppliers, business partners, and customers. In the early 1980's, industrial companies began to look at information, their intellectual capital, as an asset and, therefore, value it. PLM is a continuation of that theme because enterprises now recognize that the product definition itself is a tremendous intellectual asset to their business.

The second lifecycle, product production, focuses on the deliverable product—typically a physical asset such as a car, toy, appliance, airplane, or plant. This lifecycle includes all activities associated with production and distribution of the product. ERP systems are the primary enterprise application that addresses product production, focusing on how to produce, manufacture, handle inventory, and ship.

The third major process is the operations support lifecycle. This focuses on managing the enterprise's core resources, i.e., its people, finances, and other resources required to support the enterprise.

For an enterprise to succeed, there must be close coordination and communication among all three lifecycles. A close and collaborative effort is required to create the seamless product lifecycle needed to bring innovative products to market effectively. The enterprise faces several challenges:

- Developing an improved focus on product development and definition, learning to best capitalize on its intellectual assets
- Enabling integration among its people and organizations and create collaboration across the three lifecycles
- Effectively sharing product definition information throughout the extended enterprise throughout the life of the product or plant
- Seamlessly integrating with its suppliers to make them a logical extension of the enterprise for maximum collaboration and innovation

Management of the product definition lifecycle and its close integration with other major lifecycles is not a new concept. In fact, it has been around for many years. Over the last several years, industry's ability to achieve this concept has improved dramatically with the availability of a wide range of new technologies and approaches that facilitate collaborative work efforts across extended enterprises.

Defining PLM

CIMdata defines PLM as:

- A strategic business approach that applies a consistent set of business solutions that support the collaborative creation, management, dissemination, and use of product definition information
- Supporting the extended enterprise (customers, design and supply partners, etc.)
- Spanning from concept to end of life of a product or plant
- Integrating people, processes, business systems, and information

It is important to note that PLM is not a definition of a piece, or pieces, of technology. It is a definition of a business approach to solving the problem of managing the complete set of product definition information—creating that information, managing it through its life, and disseminating and using it throughout the lifecycle of the product. PLM is not just a technology, but is an approach in which processes are as important, or more important than data. It is critical to note that PLM is as concerned with “how a business works” as with “what is being created.”

Three core or fundamental concepts of PLM are:

1. Universal, secure, managed access and use of product definition information
2. Maintaining the integrity of that product definition and related information throughout the life of the product or plant
3. Managing and maintaining business processes used to create, manage, disseminate, share and use the information.

While information includes all media (electronic and hardcopy), PLM is primarily about managing the digital representation of that information.

Based on user experience over the years, PLM solutions can support a broad range of “products.” Examples of “products” include manufactured products, such as automobiles, computers, refrigerators, mobile phones, toys, and airplanes. Many products today also contain software, firmware, and electronic components whose data must be managed. Some organizations have long-lived assets that need to be managed such as utility distribution networks, e.g., power, telecommunications, water, gas, and cable TV, or facilities like plants, drilling rigs, buildings, airports, harbors, railway sys-

tems, and logistics warehouses. Other “products” include bridges, highways, and other civil engineering projects. Organizations across many industrial sectors have successfully used PLM solutions to manage product information across the lifecycle for all of these “products.”

In the 1990’s, this lifecycle view expanded from managing primarily the mechanical elements of a product’s definition to include the electronics and software elements that have become a greater portion of many products. That expansion continued to push the perception of what “design” encompassed. PLM includes management of all product-related information from requirements, through design, manufacturing, and deployment. This information ranges from marketing requirements, product specifications, and test instructions and data, to the as-maintained configuration data from the field. The PLM solution links information from many different authoring tools and other systems to the evolving product configuration. At the same time, the lifecycle began to include production-focused attributes and information.

Today, PLM encompasses significant areas of process. It’s not just program and project management processes. It is also the processes required to manufacture the product or plant, operate it in the field, and dispose or decommission it at the end of its useful life. PLM solutions help define, execute, measure, and manage key product-related business processes. Manufacturing and operational process plans are also now viewed as an inherent part of PLM. Processes, and the workflow engines that control them, ensure complete digital feedback to both users and other business systems throughout each lifecycle stage.

CIMdata’s world-class PLM model, shown in the figure below, describes the technology, management, and process components of an enterprise PLM solution. Across the bottom of the model are technology foundation components that are an integral part of any PLM solution. Solution providers use these foundation elements to construct core functions, such as design automation (e.g., the authoring and analysis tools and processes used to create, simulate and analyze a product or plant), product structures and Bills of Materials, workflow and process management, and information and content management and vaulting. These core functions are inherent capabilities contained within PLM solutions.



CIMdata's World-Class PLM Model

Note that in CIMdata's PLM definition, product data authoring and analysis tools are included as part of the PLM environment. This is a different approach than in other previous market descriptions, such as PDM or cPDM. Creation of product definition information and related intellectual capital includes authoring and analysis tools for mechanical design (e.g., CAD/CAM, CAE, and other MDA tools), electronics design (e.g., ECAD and other EDA tools), and software design (e.g., CASE). In addition, technical publication applications used to create the documentation used to define and support the product throughout its lifecycle are within the scope of PLM.

Solution providers use core functions to build functional applications such as workflow and configuration management. To CIMdata, business solutions are built using functional applications and incorporating best practices, methods, and processes pertinent to an enterprise's market and specific industrial sector that can be fine-tuned to meet enterprise requirements.

Given this broad definition, it is important to be clear on which elements are included within PLM solutions and which are not. Using CIMdata's definition, PLM includes, but is not limited to:

- Management of:
 - Product data and information—both its content and context
 - The design chain
 - Documents and their associated content (all types, formats and media)

- Requirements (functional, performance, quality, cost, physical factors, interoperability, time, etc.)
- Product and project portfolios and product families
- Assets, e.g., plant machinery and facilities, production line equipment
- In-service information supporting service after sales
- Program and project management
- Visualization and collaboration
- Component supplier management
- Digital manufacturing
- Product definition information authoring
- Product analysis, validation, and simulation
- Technical publications such as:
 - Service manuals
 - User guides
 - Assembly instructions

The definition and use of product information is still evolving. For example, the in-service or service after sales operations, maintenance, and service activities are now included within the scope of PLM. In some industries, the service component is the primary driver for PLM ROI and benefits. In the aerospace and defense industry, much of the profit enterprises make is not from the original design and sale, but from maintaining aircraft and engines for the product's thirty plus year lifespan. Other products, such as elevators, must be maintained for over fifty years. The real profit is in the overall lifetime service; of course, this requirement extends to other types of "products." For example, petrochemical plants and offshore drilling rigs must be maintained for decades to maximize efficient production.

Supply chain management, which is primarily focused on ordering and procurement logistics, begins at the front end of the product lifecycle because, in many industries, the same partners that produce parts or components for a product are being delegated responsibility to participate in the design of those parts and components. Collaborative product development (also called design chain management) or management of the intellectual supply chain is becoming as important, or more important than the logistics and production supply chain. Design chain partners must be able to quickly and effectively share and leverage each others resources, knowledge, products, and where appropriate, intellectual capital. PLM encompasses and enables management of the intellectual property created and

shared among design chain partners. Integration of design processes fosters innovation for all organizations throughout the design chain.

A major evolution in PLM over the last two years, is a recognition that defining the manufacturing processes required to produce a product are just as critical as defining the mechanical, electronic, software, and documentation configurations. Leading solution providers are incorporating manufacturing processes and digital manufacturing into their PLM Offerings today.

Overall, PLM is an initiative that encompasses all of what is within design and development, added program management, and is expanding out into maintenance and support. While PLM encompasses many areas, it is important to understand what PLM is not. PLM does not include other major enterprises solutions, such as CRM, ERP, and logistics-based supply chain management. It also does not include systems supporting other major business functions, such as marketing and sales, distribution, human resource management, and finance. However, each of these and other major business areas interacts with multiple PLM components and the overall PLM solution.

For example, CRM, which typically focuses on managing sales and order processes, may be used to gather customers' product requirements. While portfolio management and product or customer requirements are part of PLM, the traditional CRM technologies are not. However, there is a significant level of information and process interaction between the two solutions. PLM integrates with CRM systems to:

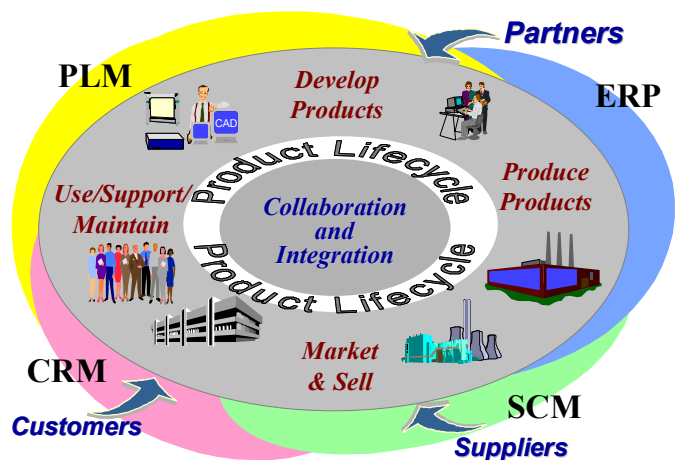
- Provide product definition information used in sales and service, e.g., product options and variants, cost for custom orders, etc.
- Feed product definition information directly to sales configurators
- Obtain customer requests for product improvements, new requirements, and problems that require product changes to correct
- Provide tracking and traceability of customer requirements throughout the product lifecycle
- Manage innovation opportunities including portfolio analysis and evaluation of opportunities against target customer and market segment definitions

- Conduct campaign management as a basis for the marketing planning that runs in parallel with product development to ensure a successful product launch (i.e., shorter time to market)

The same is true for ERP—it is integrated or interfaced with PLM. ERP has traditionally dealt with the product production lifecycle. Over the last several years, the focus shifted from ERP to other enterprise solutions such as SCM, CRM, and now, PLM. As part of the continuing evolution, new solution providers are beginning to deliver products that combine some ERP and some PLM capabilities into one offering. Other business functions, such as the logistics of supply chain management, logistics itself, marketing and sales, distribution, HR, and finance are not part of the basic PLM capabilities, but they all interact at multiple points along the product lifecycle or with components of a comprehensive PLM solution.

The figure below depicts the relationships between these enterprise solutions. Product businesses have at their core the intellectual assets describing their products. Typically, PDM solutions were used to manage product development and design work-in-process. Once a product could be released to manufacturing, ERP took over.

Supply chain management was often used by procurement to support the production function. Once the product was in the field, CRM systems helped manage the customer relationship. As described in the previous sections, today's businesses require enterprise solutions



Relationships Among Enterprise Solutions

that can integrate all of this disparate information to optimize product development, production, and deployment. CRM data must be used to embody today's customer requirements into the next product generation. To save money, SCM systems must be active from the beginning of the product definition lifecycle, saving procurement time and money while supporting the product development process. Business partners, suppliers, and customers must all have visibility into this information to optimize their decision processes to benefit the enterprise. PLM is becoming the overall view port or portal into such product definition information and processes, providing collaboration and integration functions to synthesize information residing in CRM, SCM, ERP, and other business systems to enable new, complex business solutions.

Benefits of PLM—Improving Business Performance

A PLM solution is a powerful business and technology approach that has been shown to deliver substantial benefits to organizations taking advantage of it, but PLM is not an end in itself. PLM solutions include a set of enabling technologies that support implementing management programs and procedures. PLM solutions may be used to implement or support programs such as globalization, collaborative product development (product design collaboration among partners), and other business initiatives.

Further, implementation of PLM solutions provides a catalyst for change within a business. To take full advantage of PLM, business processes and organizational structures and relationships must be examined and best practices that leverage PLM technologies need to be applied. Such changes address both internal business processes and how an enterprise will interact with its business partners, suppliers, and customers. In today's increasingly distributed, global and collaborative business environments, PLM is the vehicle to create and maintain an innovative business—one that competes effectively in all of its markets.

Business performance benefits can result from improvements in many areas, including market position, customer satisfaction and retention, and the environment. PLM enables performance improvements by helping enterprises manage all classes of product definition information and associated business processes. As a foundation infrastructure, it can become a practical enabler and a means of support for key manage-

ment initiatives that can make or break an enterprise. Without PLM, some of these initiatives will be difficult to achieve, especially if ones competitors are deploying PLM solutions to achieve similar objectives.

PLM solutions can also improve the enterprise's capability, efficiency, and effectiveness as an organizational unit. Benefits result from improved corporate communications, responsiveness of the organization to change, and using PLM to support concurrent engineering and other industrial best practices.

Benefits also accrue from applying enabling technologies to integrate mechanical and electronic design automation environments, ERP, SCM, CRM and other systems. These technologies can also increase the security of access to, and distribution of product definition information—protecting the valuable intellectual assets upon which an enterprise's competitive position is built.

PLM solutions bring benefits to an enterprise's product or service performance in terms of lower costs, higher plant uptimes, quicker delivery, and higher quality. PLM solutions help an organization address customers' needs more effectively, overcoming the competition as a result. Product and service quality as perceived by the customer is of paramount importance in today's business climate. In this important area, PLM solutions help enterprises provide faster response to customer queries, more efficiently design personalized products, leverage previous designs and components, and reduce the number and severity of errors and product changes, to name just a few.

Additionally, PLM solutions improve an individual's performance by managing not only product definition information, but by guiding and facilitating their tasks through well-defined business processes and workflows. PLM solutions have a very positive effect on process efficiency and effectiveness by supporting and encouraging work in a more structured manner and providing the right information, at the right time, to the right people.

PLM solutions touch every aspect of an enterprise. The ability to effectively integrate and use product definition information is important to sales and service, marketing, production planning, plant operations, customers, and suppliers. All disciplines need detailed, timely knowledge of what products are being designed and produced.

By increasing an enterprise's flexibility and agility to respond swiftly to new changes or new markets and competitors, PLM helps enterprises:

- Deliver more innovative products, services, and marketing—improving customer intimacy
- Reduce costs, improve quality, shorten time to market and ROI—increasing revenue and profitability
- Establish more comprehensive, collaborative, improved relationships with their customers, suppliers, and partners—ensuring long-term corporate viability

PLM solutions have a positive impact on an enterprise's bottom line. Examples of specific benefits achieved by enterprises that have deployed PLM solutions include:

- An ~40 percent improvement in product change cycle times
- A 15-30 percent reduction in prototypes
- A 40 percent reduction in lead times
- A 25 percent productivity increase in design engineering
- Reduced development time for a household product by 75 percent—from 18 months to 4 months
- Reduced time to cost a product from 5 days to 5 minutes
- Reduced an engineering review process by 83 percent—from 12 day to 2 days

These quantifiable improvements and cost savings resulted from PLM implementations. PLM solutions provide an improved ability to create cross-organization innovations through information sharing. Based on current implementation results, CIMdata estimates this can potentially deliver 5 to 10 percent revenue uplift. Benefits from PLM solutions fall to an enterprise's bottom line. Results like those identified above, and the associated savings and business performance improvements, have helped increased net profits for organizations ranging from 10 percent to more than 100 percent.

Conclusion

CIMdata believes that PLM is much more than a technology or software product. PLM is a strategic business approach to empower the business, to enable product and process innovation, and enhance both top and bottom line business performance. It includes technology, processes, best practices, and other elements that provide a complete solution to business problems.

For a business to be successful in today's highly competitive global market, PLM is not an option—it is a competitive necessity.



CIMdata, Inc. • 3909 Research Park Drive • Ann Arbor, MI 48108 USA
Tel: +1 (734) 668-9922 • Fax: +1 (734) 668-1957 • <http://www.CIMdata.com>