Introduction

The focus of this paper is on the major business issues faced by companies in the industrial machinery market, and the keys to success in applying PLM-enabling solutions to achieve business and market success.

The Next Industrial Revolution

The road to economic development in today’s global economy is paved with success in manufacturing. A solid domestic manufacturing base provides good jobs and a path upwards for both citizens and the countries in which they live. Manufacturing matters because it creates more economic activity inside and outside the manufacturing sector than comparable activity in almost any other major sector. As with many markets, industrial machinery companies increasingly face global competition, requiring them to optimize almost all aspects of their businesses. Successful competitive companies are using product lifecycle management (PLM) as a means to this end. 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. PLM spans from product concept to end of life, integrating people, processes, business systems, and information. PLM forms the product information backbone for a company and its extended enterprise.

The focus of this paper is on the major business issues faced by companies in the industrial machinery market, and the keys to success in applying PLM-enabling solutions to achieve business and market success.

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The (First) Industrial Revolution

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The origins of the industrial machinery industry date back to the 18th century, when such equipment was truly the engine of the Industrial Revolution. In this period there were major changes in agriculture, manufacturing, mining, and transportation, fueled by the use of early industrial machines. They powered the move from manual labor to machine-based manufacturing, starting in the textile industry. Machine technology advanced to the development of all-metal machine tools early in the 19th century, resulting in machines to make other machines. Other key innovations included using standardized parts, and bringing technologies from other domains (e.g., steam engines) to power these new machines. Overall, industrial machines enabled many parts of the world economy to move from the art of hand crafting products to the routine manufacture of consistent products.
The Global Industrial Machinery Market

Fast-forward to the 21st century and the industrial machinery market has grown to be vital to the world economy. Industrial machinery is core to the development and manufacture of products across a wide range of industries. This global market is led by companies from the United States, Japan, and Germany. Emerging economies like China see this market as key to their continued development and growth. Estimated at over $400 billion globally in 2010, the industrial machinery market is composed of a diverse set of products, including:

- Machine tools
- Heavy machinery, such as mining and construction equipment
- Farm machinery
- Packaging machinery
- Paper industries machinery
- Air conditioning refrigeration and heating machinery
- Printing trades machinery
- Food products machinery
- Textile machinery

Although diverse in function, industrial machinery companies have many things in common regarding product design, manufacturing, maintenance, and supply chain management.

**Design Process:** Industrial machines can be complex products involving many subassemblies; electronic, software, and mechanical components; and close tolerances. These products are purchased by industrial customers, and are often designed and made to order, working from a base design. These machines are major capital investments for companies with prices ranging from hundreds of thousands to millions of dollars. Suppliers of these products are under constant pressure to innovate as well as hold to high quality/performance standards and competitive costs.

**Design Chain Management:** Machine manufacturers have to share product information with their customers as well as their suppliers, as almost no industrial machinery manufacturer builds every component of every machine. Because of the global nature of the industrial machinery business, this sharing and collaboration needs to flexibly support global collaboration.

**Manufacturing:** The manufacture of these products involves complex bills of materials, and a combination of in-house and contracted manufacturing of parts and assemblies.

**Installation and Maintenance:** Because industrial machines are major capital goods and have long lifecycles, manufacturers are required to provide clear documentation of maintenance information and in many cases, actually perform the maintenance for their customers. From time to time, upgrade packages can be
made available to customers to improve performance without replacing an entire machine. When these upgrades are released, clear design and installation information is essential.

Many of today’s successful industrial machinery companies share one characteristic with those at the birth of the industry: they have adopted technologies and processes from other industries to meet pressing needs in the industrial machinery business. In this case, they looked to their customers in the automotive and aerospace industries, who were early adopters of PLM strategies and solutions. In many cases, the industrial machines they produce are just as complex and long-lived as the products those industrial machines are designed to manufacture.

**PLM in the Global Industrial Machinery Market**

Product lifecycle management has been proven in many manufacturing industries, including industrial machinery, to help companies address issues of innovation and competitive design and development. Based on data from CIMdata’s annual PLM market survey, industrial machinery is one of the largest markets for investment in PLM-enabling solutions. At the core of most companies PLM strategies are collaborative Product Definition management (cPDm) solutions, which help companies manage data from multiple authoring tools and other sources, define and manage business processes, enable collaboration across extended enterprises, and make product information easily and more consistently available to a wide range of users. In our most recent annual PLM market analysis, CIMdata estimated that global spending on cPDm solutions in industrial machinery exceeded $1.5 billion in 2010, and CIMdata forecasts spending to increase by a compound annual growth rate of over 11% in the next five years.

Based on our long experience working with a wide range of firms across many industries, CIMdata believes that PLM and PLM-enabling strategies and solutions can help industrial machinery companies meet their key business challenges. Clearly, based on the documented history of spending by industrial machinery firms, these companies believe it, too. Companies can benefit by adopting a PLM strategy and supporting technologies, but barriers do exist. Many large industrial machinery companies have well-defined PLM strategies, but they are often not as mature in their adoption of PLM-enabling solutions as in some other industrial sectors. For example, while many firms employ mechanical computer-aided design (MCAD) tools, and manage their data and processes using cPDm solutions, they have not fully incorporated simulation and analysis (S&A) solutions in their product development lifecycles. As shown in other industries, strategic application of S&A early in the product development cycle can yield significant benefits in quality, cost savings, and time to market.

Examples of successful PLM implementations in industrial machinery often are limited to using cPDm solutions to vault product data, while leaving management of business processes to enterprise resource planning (ERP) solutions. Most ERP systems rigidly define these processes, making them inadequate to support
The power of PLM is its ability to enhance collaboration across many parts of the business and to help companies get maximum leverage from their resources. The power of PLM is its ability to enhance collaboration across many parts of the business and to help companies get maximum leverage from their resources. However, crossing these functional boundaries can create cultural and organizational hurdles that can be difficult to overcome. PLM-enabling solutions are complex technologies that can be difficult to adopt in their own right. Creating an environment that uses multiple solutions can be a daunting task. As with any strategic investment, achieving PLM objectives can potentially take significant financial and human resources. This is particularly true at smaller industrial machinery companies, who may not have large information technology (IT) budgets or staffs.

Just as in other software markets, PLM solution providers are evolving and improving their offerings to address these adoption and implementation issues. “Quick start” or pre-packaged solutions can alleviate technological and resource issues. Right-sizing applications can make them easier to digest, which can help to reduce organizational issues. As solutions become easier to buy, deploy, use, and expand, we expect adoption rates to increase across many industries, including industrial machinery.

The Next Industrial (Machinery) Revolution

Leading companies are employing PLM strategies and the necessary enabling technologies to be more effective and efficient across their extended enterprise.

The first Industrial Revolution created and drove markets for output from machines, like textiles and other manufactured products, and then increasingly by making machines to build other complex machines. This process encouraged economic development, and created market advantage by drastically lowering prices for goods. In today’s competitive market for industrial machinery, companies need every advantage to compete and win. The next industrial revolution is happening now, with companies fighting to survive and thrive in the face of global competitors and customer demand for individually customized products. Leading companies are employing PLM strategies and the necessary enabling processes and technologies to be more effective and efficient across their extended enterprise. What issues are they facing and how are these leading companies using PLM to be successful?

Winning Bids Profitably

Industrial machinery companies must quickly develop proposals for customers that meet their technical requirements, delivery schedules, and pricing constraints. While some products are made to stock, more often they are engineered to order (ETO), based on specific customer requirements. The compressed bidding time span can result in bids that win the business but end up unprofitable. One way to reduce risk is to develop machine “families” that can adapt to different requirements. Mimicking the first Industrial Revolution, which was enabled by standardized parts, industrial machinery companies often develop parts and subsystems which can be rapidly reconfigured in new and unique ways to meet new customer requirements. “While RND designs and manufactures custom
leading design solutions support this objective by providing embedded knowledge management tools that help designers and engineers create common subsystems that can readily be extended using parametric design methods. “We sell one-off units by the thousands every week and it can take up to two weeks to create each design manually—it’s time we could no longer spare,” explains David Johnson, manager of information systems at KYSOR. “David Frase and Mickey Oxford, KYSOR’s president and CIO, developed a visionary strategy for shortening design cycle time by automating the design process. We wanted to provide more accurate quotes and help save our customers money. We hoped that design automation would help us make smarter, better designs while reducing the errors and rework that can upset customers.”

However, competition is driving industrial machinery companies to go farther, beyond ETO, to “mass customization” or “innovate to order.” Companies also have to distinguish themselves in the bidding process by going beyond delivering reams of technical documentation and spreadsheets. One way to do this is by employing advanced visualization and digital mockup technologies. Long used to speed product development, both within one company and across the extended enterprise, these solutions allow collaborators to better understand the interrelationships between parts and assemblies, reducing the volume of engineering changes and speeding the processing of those that are necessary. “On massive, complex structures, we can’t fabricate, assemble, then realize something won’t work,” says Craig Breckenridge of Dynamic Structures. “We need to visualize how everything fits together as we design so there are no mistakes.” Using this same technology as part of the bidding process can help make new products more real to customers before they even exist. In many cases, photorealistic imaging can be indistinguishable from the real thing.

Effectively competing in global markets requires more than just selling globally. It requires global collaboration with both suppliers and customers to deliver...
products and services that exceed customer expectations. Using partners local to ones’ customers is often the only way to profit from complex technical bids. Companies in all industries need to be very flexible and agile in creating project teams in which different suppliers and partners come together based on the specific needs of a given customer. Manufacturing industries are becoming more and more like construction or filmmaking, where the requisite skills are brought together on a project or program basis, must get up to speed quickly, complete the task, and then disperse awaiting the next possible collaborative effort. Agility, adaptability, and interoperability are paramount. Effectively leveraging such far-flung engineering resources requires collaboration platforms that are easy to adopt and easy to use. Over the last several years, PLM solution providers have recognized this need, and made their offerings more flexible to support these use cases.

**Efficient Business Processes**

Winning the bid is only the first step. Companies need to be able to manage all of the information associated with the bids, their product development process, manufacturing and installation procedures, and all other related information. Ideally, that information should be “associative” so that companies can be assured that they have ready access to the complete information set for a given bid and product. This information can come from a broad set of stakeholders in the product development process, including customers, design partners, and suppliers.

To meet this need, many companies have adopted cPDm solutions to effectively manage these mountains of information. These cPDm solutions provide vaulting, workflow management, subscription/notification, and other functions to ensure that the right people get the right information at the right time in the development and delivery process. Most cPDm offerings can manage a “bill of information” (BOI), which goes beyond a classic bill of material (BOM) that typically only includes the parts in a given product. Using BOIs to dynamically link tooling, consumables, documentation, and other important information is essential to being profitable on today’s bid, and being able to use this information to support new bids tomorrow.

CIMdata’s definition of cPDm includes visualization and other collaboration technologies that make it easy to include multiple roles and levels in the decision-making process. Based on industry usage, there can be a 10-to-1 ratio of collaborators to engineers/designers. Project managers, purchasing staff, and marketing teams are just a few examples of collaborators that can get significant value from using visualization solutions to support their role in the business process. But success requires finding the right balance between cost and value received. Solutions need to cost-effectively support these extended teams, delivering the appropriate collaboration technologies at the right price point.

Companies are using cPDm solutions to rapidly develop and deploy workflows that support their necessary work processes. In many cases, these workflows will match current processes, but successful companies take this opportunity to try to improve the status quo by defining more efficient and effective processes.
Unfortunately, this is where companies can get into trouble. Developing, testing, and deploying workflows may require specific technical skills. Companies often rely on consultants or other service providers, driving up total cost of ownership. Based on historical data from our annual PLM market survey, companies spend about 60% of their cPDM dollars on services and 40% on software, primarily due to process and integration changes. In some cases higher services ratios are necessary. PLM solution providers have addressed this limitation with pre-configured offerings that can speed adoption with limited services required. Indeed, our PLM market survey and work with end user companies adopting PLM technologies has shown that these ratios have decreased over the last few years because of such efforts. Solution providers have continued to innovate to make their offerings even easier to buy, implement, and use. For example, more PLM solution providers are offering hosted and cloud-based solutions, using deployment models that have proven successful for other enterprise software providers like Salesforce.com in customer relationship management (CRM).

**Installation, Commissioning, and Maintenance**

There is one big difference between industrial machinery companies and some other industries that implement PLM strategies. Defining, designing, building, and shipping equipment is not enough. When industrial machinery companies say “lifecycle,” it means much more than in some other industries. Customers are buying machines that must be installed in their plant, commissioned as ready-for-productive-use, and then supported over a long period, often many years. In fact, industrial machinery companies can build customer loyalty (and increased services revenues) by providing superior support over the life of their machines.

This makes the need for accurate, associative documentation that supports installation and operation even more crucial for industrial machinery companies. They need to be able to access this information rapidly to provide high-quality, accurate installation, commissioning, and maintenance instructions. As discussed earlier, cPDM solutions can provide that solid baseline of product information. A number of PLM solution providers are linking multiple information resources with easy-to-use publishing solutions to help companies readily create this highly valuable documentation. Some are going beyond traditional manuals or even web pages to use advanced visualization and simulation solutions, to make these processes more realistic for installation and service professionals, and for customers themselves.

PLM solution providers are also moving into mobile applications, providing powerful tools in handheld devices to support new uses by remote workers. For example, cameras can be used on site to help assess as-maintained configurations, to help get vital equipment back online as rapidly as possible. With many companies adapting their business strategies, looking to earn significant revenues from services over a product’s life, having strong capabilities in this area becomes even more important.
Choosing a PLM Solution Provider

The purpose of this paper was to make the case that PLM strategies and enabling technologies can help industrial machinery companies thrive in their highly competitive global market. Based on CIMdata’s market research the industrial machinery industry has collectively made a large investment in PLM-enabling technologies. Given the growth in the industry, and the issues companies face, CIMdata believes there is more room for improvement in business processes, enabled by appropriate technologies. Industrial machinery companies still have more to learn to go from art to practice to science. There is much knowledge to still be leveraged from other industries, as well as the knowledge embedded in PLM-enabling solutions offered by the leading PLM solution providers.

But where to turn for the solutions needed to pursue such strategies? Over its nearly thirty-year history, CIMdata has worked with industrial companies to define PLM strategies and to select and adopt the right technologies to effectively implement those strategies. To support our consulting work, we have conducted market research on the global PLM market, and work closely with the leading companies in that market. In our research, we often talk about “mindshare leaders,” the companies that quickly come to mind when businesses think about PLM solution providers. Over the last few years, CIMdata has expanded that group to add several companies who, based on their actions and market results, have evolved to merit serious consideration by businesses looking to enhance their PLM strategies and enabling solutions. One such company is Autodesk. Based on market research, companies know and trust Autodesk for quality solutions. But they do not often think of Autodesk with respect to PLM.

While known for AutoCAD, their best selling CAD solution, Autodesk has invested heavily in organic development and strategic acquisitions over the last several years to build a vital, competitive portfolio of PLM-enabling solutions that address key business issues. Autodesk’s broad solution portfolio can help IM companies address all of the challenges outlined in this paper. For example, they have been one of the leaders in investments in cloud-based offerings, and recently announced an innovative cloud-based solution to supplement Autodesk Vault, which has been gaining traction in on-premise MCAD data management. Many of their acquisitions have been in the S&A space, where they have built a broad portfolio covering most analysis domains. Importantly, as Autodesk has developed and acquired new, advanced technologies and solutions, they are striving to make those solutions more easily adoptable by industrial equipment companies of all sizes. Consistent with its overall approach to the market, Autodesk has focused on providing interoperable solutions that are configurable without extensive and ongoing services engagements.

Industrial machinery companies looking to implement or enhance their PLM strategies to address the challenges of the next Industrial (Machinery) Revolution should look for themselves to understand how Autodesk and their solutions can help position industrial machinery companies and their customers for ongoing success.
About CIMdata

CIMdata, a leading independent worldwide firm, provides strategic management consulting to maximize an enterprise’s ability to design and deliver innovative products and services through the application of Product Lifecycle Management (PLM) solutions. Since its founding nearly thirty years ago, CIMdata has delivered world-class knowledge, expertise, and best-practice methods on PLM solutions. These solutions incorporate both business processes and a wide-ranging set of PLM enabling technologies.

CIMdata works with both industrial organizations and providers of technologies and services seeking competitive advantage in the global economy. CIMdata helps industrial organizations establish effective PLM strategies, assists in the identification of requirements and selection of PLM technologies, helps organizations optimize their operational structure and processes to implement solutions, and assists in the deployment of these solutions. For PLM solution providers, CIMdata helps define business and market strategies, delivers worldwide market information and analyses, provides education and support for internal sales and marketing teams, as well as overall support at all stages of business and product programs to make them optimally effective in their markets.

In addition to consulting, CIMdata conducts research, provides PLM-focused subscription services, and produces several commercial publications. The company also provides industry education through PLM certification programs, seminars, and conferences worldwide. CIMdata serves clients around the world from offices in North America, Europe, and Asia Pacific.

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