



AberdeenGroup

Enabling Product Innovation: The Roles of ERP and PLM in the Product Lifecycle

Business Value Research Series

November 2005



Executive Summary

Seeking Product Innovation

Aberdeen research shows that developing innovative products is a top priority for manufacturers today. Companies have turned away from cost cutting as their primary approach to improving profitability, and are now embracing a strategy of profitable growth. Product strategies today reflect aggressive corporate strategies, which Aberdeen has determined now focus significant emphasis on increasing product revenue in over 80% of manufacturers.

Companies are turning toward product innovation to achieve revenue growth. But innovation alone will not lead to profits. To generate a return on an innovative idea, the idea must be fully developed into a commercial offering. Developing ideas involves validating the core idea and developing it into one or more marketable products. This development process requires marketing work, design work, and potentially mechanical, electrical, software, and manufacturing engineering. When the concept has been fully defined, validated, and transformed into a product, it is then ready for commercial launch and execution from a sales, marketing, manufacturing, and logistics perspective.

Bringing Product Innovation to Market

Best-in-class companies have put in place organization and technology infrastructures to enable new product development. Improving the new product development process, as Aberdeen research has identified, correlates to tangible business improvements. Enabling technology plays a key role in making these processes effective and efficient. Aberdeen's *Product Development in Consumer Industries Benchmark* reports the following benefits from companies utilizing product development automation:

- 17.5% reduction in product costs
- 75% reduction in ECO cycle times
- 25% to 35% reduction in design cycles
- 10% to 15% reduction in time-to-volume cycles
- 30% to 40% reduction in part duplicates and introduction of new parts
- 15% to 25% reduction in part search times (improving engineering efficiency)

These operational results, in turn, translate into bottom line returns for the business.

Enabling Product Innovation

Enterprise applications play a key role in supporting and improving product development and achieving these benefits. Aberdeen's *Product Innovation Agenda* research indicates that manufacturers that are best in class in product development benchmarks are four times more likely to have integrated data, process automation, and collaboration to support innovation.



Two primary enterprise applications, Product Lifecycle Management (PLM) and Enterprise Resource Planning (ERP), play key roles in enabling companies to develop and deliver innovative, profitable products. This research investigates the ways in which companies are using these technologies to help improve their product development processes. The key findings of the research indicate:

- Over half of manufacturers see the value in a single, integrated system for product development, manufacturing, sales, and support. There is value perceived in pre-integrated solutions.
- Less than one-quarter of companies surveyed, however, are willing to accept manual workarounds and inefficiencies for partners or customers as a tradeoff for a single system. Software capabilities to support product innovation and product development outweigh the need for a single system.
- There is a clear separation and promotion process from design to manufacturing in both processes and systems. Innovation and execution are linked but independent disciplines.
- The system requirements for enterprise systems in product development and in executing a supply chain are different. PLM and ERP were developed to address different requirements in regards to:
 - Lifecycle of product data: 60% of companies begin documenting products when the concept is initiated, before formal structure is defined.
 - Product structure: Roughly two-thirds of manufacturers have conceptual and subsystem-level product hierarchies, before individual parts are defined.
 - Product knowledge: Most products are never released to manufacturing, but saving product failures capture valuable company knowledge.
 - Version control: Only one-third of companies release products in less than four iterations, generating designs manufacturing doesn't need.
 - Data types: Product development typically involves multiple documents and less structured information, driving data management challenges.
 - User population: Product development is a collaborative process, with frequent usage outside of the company's enterprise.
- In the execution cycle, companies must maintain a consistent view of products across departments, divisions, and often companies. Product data for execution often spans multiple ERP implementations, requiring a central source for product data.
- Over three quarters of manufacturers who have used PLM for more than 2 years have integrated ERP and PLM to some extent. PLM and ERP can be integrated to form a combined solution for product development and manufacturing.

PLM and ERP play different, complementary roles in product innovation and execution and are being used in conjunction with one another to help companies capitalize on the innovation opportunity.



Table of Contents

<i>Chapter One: Issue at Hand</i>	1
The Product Innovation Imperative	1
<i>Chapter Two: Key Business Value Findings</i>	3
Enabling Product Innovation	3
The Value of Integration	3
Integration – Capability Tradeoffs.....	3
Defining ERP and PLM Roles.....	5
<i>Chapter Three: Implications and Analysis</i>	6
The Innovation Cycle	6
Capturing the Design – Product Documentation	6
Achieving Innovation from Iteration	8
Creating and Utilizing Product Knowledge	10
Innovating in Teams	11
Transitioning from Innovation to Execution	12
The Execution Cycle.....	13
Establishing Control	13
Providing the Right Product Data for Execution	14
Tying Innovation to Execution – Supporting Continuous Innovation	14
Managing Change.....	15
Managing the Technical Impact of Change	16
Managing the Business Impact of Change.....	18
Establishing Roles for ERP and PLM in Innovation	19
<i>Chapter Four: Recommendations for Action</i>	20
Recommendations.....	20
Author Profile	21
<i>Appendix A: Research Methodology</i>	22
<i>Appendix B: Related Aberdeen Research & Tools</i>	23
About AberdeenGroup.....	24



Figures

Figure 1: Product Innovation in Corporate Strategies	1
Figure 2: Benefits of Improved Product Innovation	2
Figure 3: Clarity and Effectiveness of ERP and PLM Roles in Innovation	5
Figure 4: Commencement of Design Documentation by Lifecycle Stage	7
Figure 5: Product Structure Usage by Manufacturers.....	8
Figure 6: Design Iterations before Release	9
Figure 7: Percentage of Products Released to Manufacturing.....	11
Figure 8: Relative Collaboration Levels between Design and Manufacturing	12
Figure 9: Frequency and Impact of Engineering Changes.....	15
Figure 10: Managing the Impact of Product Changes on Related Items.....	17
Figure 11: Managing the Impact of Product Changes on Related Deliverables	18
Figure 12: Systems Support for Product-Related Processes.....	19

Tables

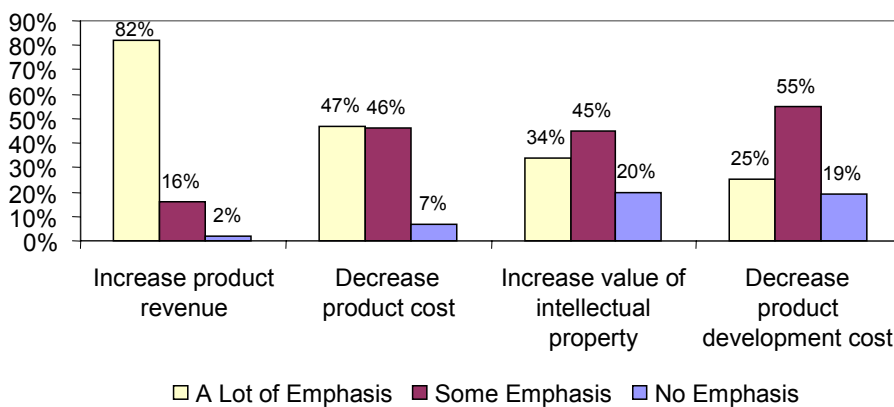
Table 1: Product Innovation Systems Integration – Capability Tradeoff	4
---	---

Chapter One: Issue at Hand

The Product Innovation Imperative

Aberdeen research has determined that manufacturing executives are aggressively looking to expand product revenue and grow their top lines. Aberdeen’s *Product Innovation Agenda Benchmark* identified that a full 82% of corporate strategies place “a lot of emphasis” on increasing product revenue (Figure 1). At the same time, 93% of corporate strategies place either “a lot of emphasis” or “some emphasis” on reducing product cost. The benchmark reports clearly highlight that companies are looking for profitable growth.

Figure 1: Product Innovation in Corporate Strategies



Source: AberdeenGroup, September 2005

To achieve profitable growth, companies are turning toward product innovation. Innovative products that are in tune with customer needs lead to higher sales volume and command higher prices. However, trends in manufacturing and design have made developing innovative products much more difficult. The product innovation environment has fundamentally changed. Manufacturers must navigate new challenges. Globalization has led to increased competition, more intense regulatory requirements, and more complex networks of manufacturers, suppliers, and designers operating in global design and supply networks. Increased product complexity has demanded the integration of mechanical, electrical, and software design elements to integrate more readily. Competition and product commoditization have led to shorter product profitability windows.

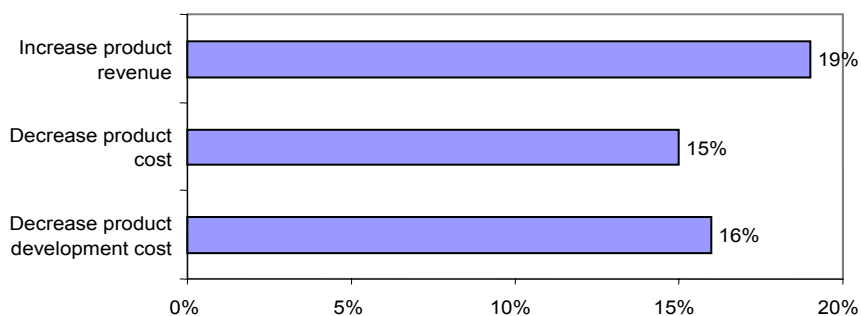
The conundrum is that although the environment is more challenging, businesses want to improve revenue and cost performance. The improvements can only come from improving product innovation, product development, and engineering operations. Operational improvements vary by company, but manufacturers report that improving the following key performance metrics results in improved innovation performance:



- Time to market
- New product success rate
- Percent of revenue from new products
- Process cost reduction
- Total material cost reduction
- Number of new products per year
- Defect rates
- Lead time for custom orders
- Frequency of engineering changes
- Number of new patents
- Percent parts reuse
- Time to volume production
- Engineering change cycle time
- Warranty claim rate
- Frequency of regulatory or non-compliance events
- Engineering change error rate
- Number of physical prototypes required

Benefits are being achieved by improving operational performance despite the challenges. Companies that have invested in improving product innovation processes have achieved double-digit improvements in product revenue, product cost reduction, and product development cost decrease (Figure 2). 84% of companies see gains in more than one aspect of innovation performance. Product innovation is providing operational improvements with bottom-line impact.

Figure 2: Benefits of Improved Product Innovation



Source: AberdeenGroup, September 2005



Chapter Two: Key Business Value Findings

Enabling Product Innovation

Improving innovation performance provides strategic benefits resulting in profitable growth. To improve performance, business has to be done differently. Enterprise software is an enabler used to implement and sustain process changes that lead to better performance. In other words, new systems help to support new ways of doing things. Product innovation is a “team sport.” To accelerate and improve product development, companies are approaching innovation with more parallel activities, involving multiple departments earlier in design, working with experts scattered in disperse networks, and including input from suppliers, customers, and other third parties. To accomplish this, companies must have strong data management, collaboration, project control, and communication capabilities.

Product innovation improvement comes from better information and improved coordination. Aberdeen research has shown that best-in-class innovators are four times more likely to have centralized data and product knowledge than the industry norm. They are also four times more likely to have integrated process automation and collaboration solutions. Enterprise applications are providing the support for improved innovation performance.

The Value of Integration

Manufacturers would ideally like to have a single, integrated system to manage product-related processes. Integrated systems reduce risk, decrease the need for integration, simplify training, reduce support complexity, and provide a better total cost of ownership. Countless conversations with CIOs and IT leaders have emphasized the desire for a common system, less complexity, and more integration. Many companies have incorporated standards in order to consolidate systems.

It is clear that companies recognize the value of an integrated system. What is often unclear is their willingness to make trade-offs between integration, product capabilities, and vendor expertise. For many manufacturers, the decision on how to support their product innovation processes is not straightforward. There are few integrated systems that cover product innovation and product development as a whole, let alone an integrated system that also covers manufacturing, sales, distribution, logistics, and service.

Integration – Capability Tradeoffs

Recognizing the value of better innovation and the desire for integrated systems, Aberdeen surveyed a sample of approximately 65 manufacturers in order to understand the roles of ERP and PLM in product innovation. Aberdeen found that the majority of companies surveyed, as expected, place “a lot of value” on a single, integrated system for product development, manufacturing, sales and support (Table 1). Another third of respondents indicate that there would be “some value,” with very few indicating “no value.” Given the opportunity, respondents would prefer a single, integrated solution.



Manufacturers are not very willing to give up functionality in return for a single system, however. More than one-third of respondents say that they are not willing to trade any functionality whatsoever; that the integrated system must be “equal or better.” Another third of manufacturers indicate that they are willing to accept some workarounds and inefficiencies, but only for internal users. Less than one-third are willing to trade off functional capabilities when the workarounds or inefficiencies impact external partners or customers, although some (less than one person in ten) are willing to trade “significant” functionality.

When put to the test, the desire for a single system is outweighed by the need for functionality. This finding was relatively consistent across job functions, including CIOs and IT leadership. Similarly, companies were asked whether they would be willing to trade business process expertise for integration, with only slightly higher willingness to trade expertise for integration.

Table 1: Product Innovation Systems Integration – Capability Tradeoff

Criteria	Response	Response	Response	Response
Value of single, integrated system for product development, manufacturing, sales and support	“A lot of value” 56%	“Some value” 36%	“No value” 8%	----
Amount of functionality willing to trade for value of one integrated system	“A lot, will trade significant functionality in order to have pre-integrated solutions” 8%	“Some, will accept manual workarounds and inefficiencies for both internal users and external partners or customers” 14%	“Some, will accept manual workarounds and inefficiencies for internal users” 39%	“None, must be equal or better” 39%
Amount of business process expertise willing to trade for value of one integrated system	“A lot, we have internal resources that can handle the challenge” 13%	“A lot, we can find external consultants that can help” 16%	“Some, having one vendor is worth trading services expertise” 37%	“None, must be equal” 34%
Amount of business process expertise willing to trade for value of one integrated system	“A lot, we have internal resources that can handle the challenge” 13%	“A lot, we can find external consultants that can help” 16%	“Some, having one vendor is worth trading services expertise” 37%	“None, must be equal” 34%

Source: [AberdeenGroup](#), November 2005

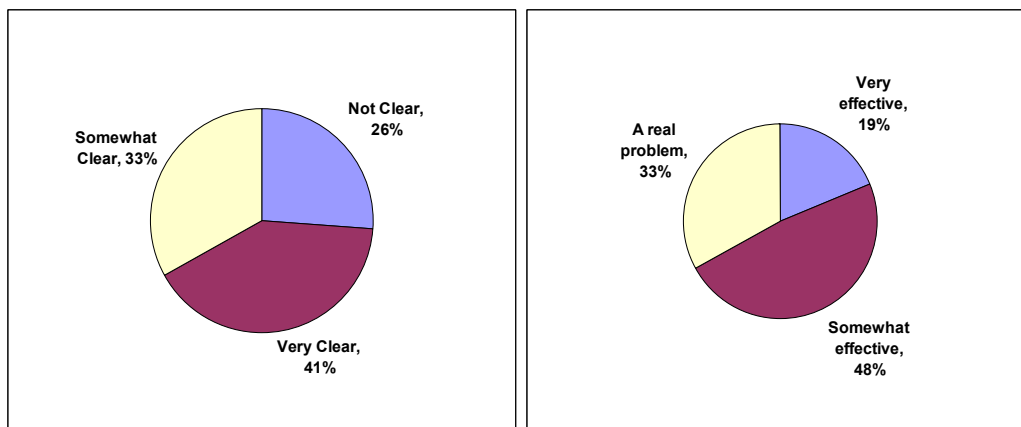
Defining ERP and PLM Roles

Not all companies have the same product innovation needs. Functional tradeoffs may be different based on industry, geography, and even corporate strategy elements. Not surprisingly, companies are using the different software suites in varying ways and amounts. There is no “one answer” to the way ERP and PLM are being deployed, meaning that companies have had to define the roles that ERP and PLM will play and how they will complement each other accordingly.

Many companies struggle with unclear and ineffective roles between ERP and PLM. Confusion over terminology causes a lot of the trouble. There is no single definition of PLM and current PLM suites differ in scope from each other, which is typical in an immature market. Adding to the confusion, some ERP vendors list PLM as a module of their offerings. Avoiding the acronyms, manufacturers must look for ways to improve product innovation, product development and engineering and then select the appropriate systems to support them. Understanding real business needs helps to define the right role for each. Companies must determine the right support from PLM and ERP for their own businesses by educating themselves on the needs and benefits of improving their product innovation processes.

There is clearly room for improvement in the clarity and the effectiveness of the roles. Only one-quarter of respondents said their enterprise systems’ roles are “very clear,” and almost half of respondents said that the roles are not effective (Figure 3). Manufacturers must continue to educate themselves on PLM process and software capabilities and continue to refine the roles of their enterprise applications to meet their needs.

Figure 3: Clarity and Effectiveness of ERP and PLM Roles in Innovation



Source: [AberdeenGroup](#), November 2005

To better understand the roles each should play in innovation, companies must understand the distinct differences between product development and supply chain execution. The key differences are the amount, kind, and format of data required for each task and how iterative and collaborative the processes are. The following sections on “The Innovation Cycle” and “The Execution Cycle” will provide details of these differences and the implications for systems usage. These differences must be supported with the appropriate technology solutions.



Chapter Three: Implications and Analysis

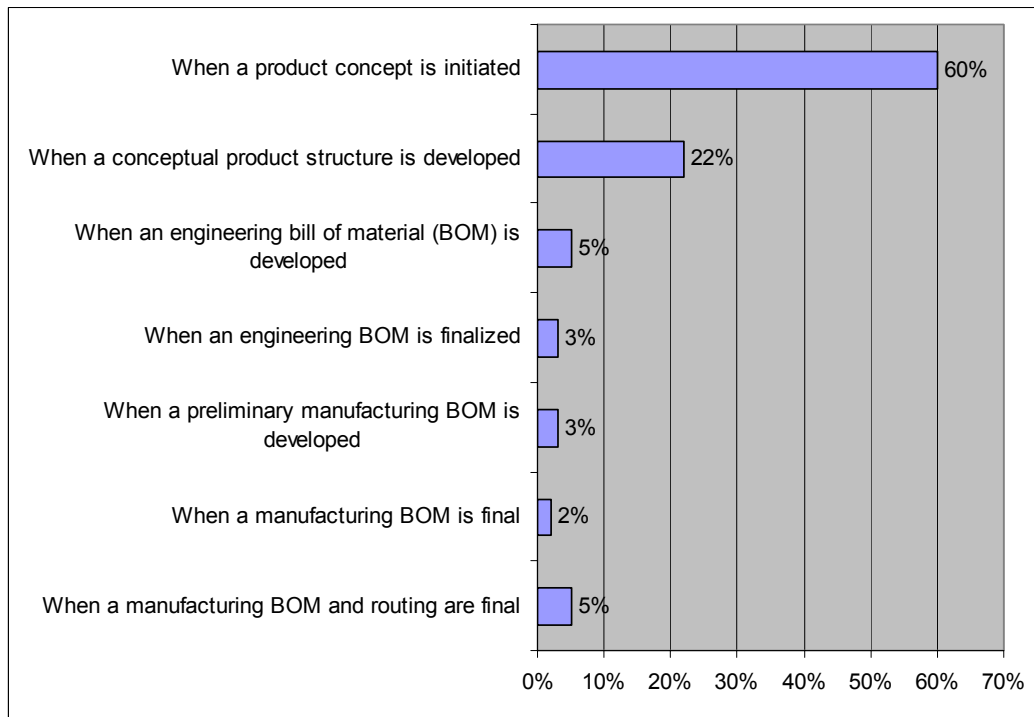
The Innovation Cycle

To understand system requirements, one must first understand the processes that the application supports. Product innovation is a creative process starting with concepts, ideas, and requirements. These concepts are captured and organized around project and products to put them into the context of the product development process. As early product ideas are formed, product design documentation gets underway. The first product concepts may only define major systems and how they interact, or rough concepts of the product geometry. Design information evolves at different steps of the lifecycle as information and the structure of the product become more complete. The product will typically pass through a number of engineering stages and be touched by many individuals, including engineers as well as non-technical resources like Marketing. Throughout the design process, additional input from suppliers, manufacturing, procurement, regulatory, and other departments is incorporated until the product is fully defined, validated and ready for launch.

Capturing the Design – Product Documentation

Aberdeen research discovered that design documentation starts very early in the design process, at conceptual levels, before distinct parts or assemblies can be identified. Many companies capture different forms of product structures as the design progresses from loose concepts to a tightly defined manufacturing specification. Figure 4 details the stage at which companies begin developing design documentation, which clearly shows that companies begin documentation very early in the process. Over three-quarters of companies start design documentation by the time a conceptual product structure is developed.

Figure 4: Commencement of Design Documentation by Lifecycle Stage



Source: AberdeenGroup, November 2005

By the time a product is approved and ready for manufacturing, the product structure will be reorganized to reflect production and assembly processes. For example, assemblies will be redefined to reflect not the logical design structure of the product, but how the product will physically be produced and assembled in execution. Manufacturing information such as process routes and tooling information will be added by manufacturing engineers. Details will be added that include manufacturing and planning information such as costs and scrap factors. All items, including consumables and fasteners, will be detailed if not previously identified. Figure 5 highlights the different types of product structures that are developed during design by the manufacturers surveyed.

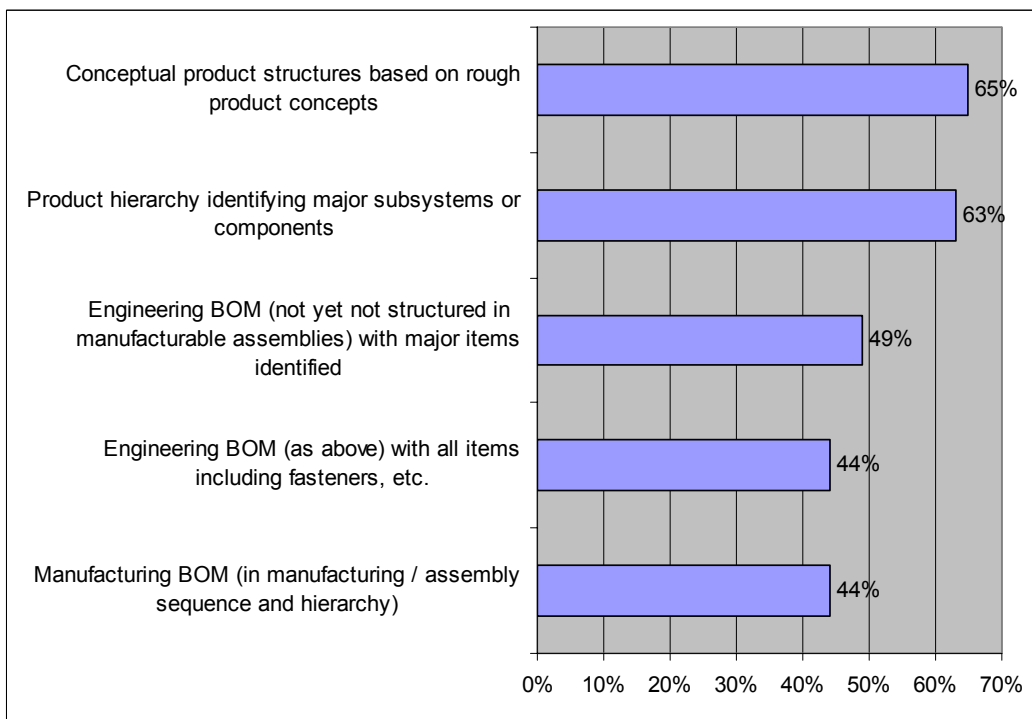
Many companies employ a sequence of different design structures along the development lifecycle. The list in the chart is a subset of what many manufacturers will develop, identifying some of the major product structures that will be developed during the design phase.

It is important to understand the structure and timing of this information when considering the roles of ERP and PLM. Much of the information captured early in the lifecycle is not directly usable by manufacturing until individual parts, assemblies, and production sequences are known. This is valuable information about the product and the design intent, but not valuable to the manufacture, sale, or distribution of the product until its final form. Maintaining product knowledge and making it accessible during the product innovation process is very important, but access to that information provides little value to manufacturing resources. Instead, it increases the potential for confusion or the introduc-



tion of errors due to clutter. Because of the processes they were designed to serve, PLM systems are intended to manage early product structures and design information, where ERP systems may have trouble capturing a product structure before part numbers are defined.

Figure 5: Product Structure Usage by Manufacturers



Source: [AberdeenGroup](#), November 2005

Achieving Innovation from Iteration

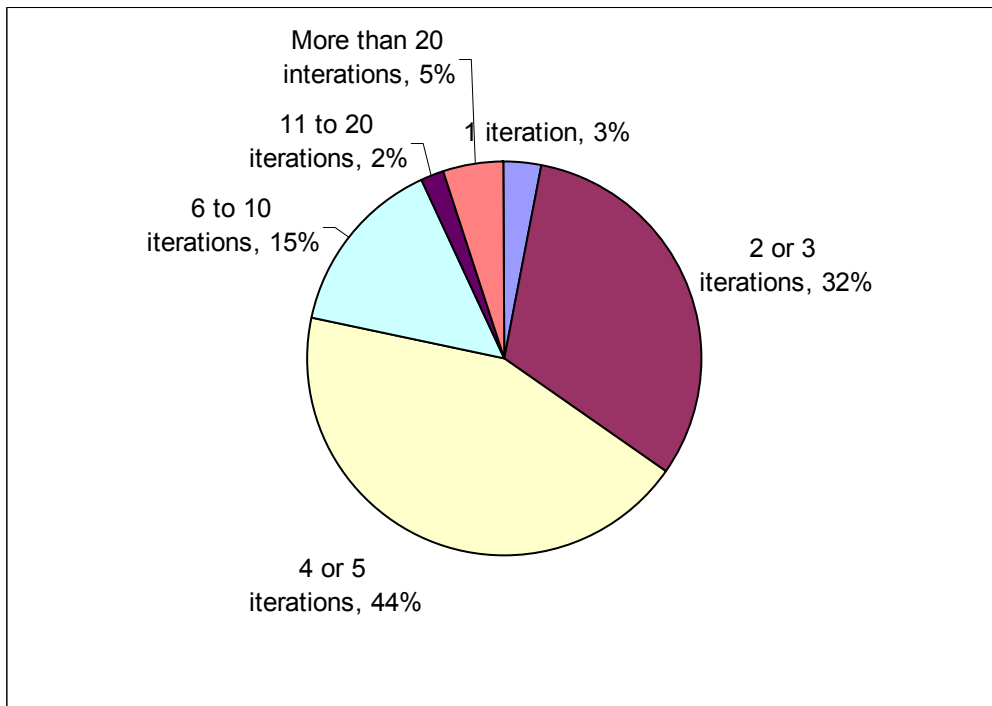
Innovation is characterized by trial and error. The optimal product design is rarely achieved with the first attempt. The classic example is the invention of the light bulb, which is said to have come after two years and thousands of failed attempts. In the same way, most product designs are achieved by designing, testing, and redesigning using different approaches. In the same way that many products are never released to manufacturing, most iterations of a product design never see manufacturing. In fact, only about one-third of companies claim to release products in less than four iterations (Figure 6).

Many designs, in fact, are not complete products, but capture the thought process at a point in time. As much as design follows a logical pattern, design is not linear but cyclical. The innovative process is characterized by hunches, testing, and redesign. This creative process may include potential new materials, or experimental parts that are considered and then discarded. Managing this process requires some level of flexibility, while keeping the overall process in control. When a design approach is taken based on an

analysis or review, it is important to know why that path was chosen later – whether re-designing this product or designing something similar.

It is important to understand iteration when discussing the roles of ERP and PLM for two reasons. As with products that aren't released and design-related documentation, iteration generates large volumes of information. This data is highly valuable to innovation but potentially distracting and or confusing during manufacturing. Iteration also brings up the topic of control. Executing a supply chain in a cost-effective manner requires tight control and strict repetition of operating procedures. Predictability in the process, adherence to procedure, and visibility to results are key to quality and efficiency. The innovation process requires control as well, but in a more flexible way. In order to maintain some control of part proliferation, the definition of a new material that may never be used again should not be at the whim of an individual engineer. Nor should defining an experimental item require the full breadth of data required for production parts. It is not necessary to add the same rigor that would be required to add a part to an ERP system to manage execution, requiring all accounting and planning information to be added as an example. When selecting the roles of ERP and PLM, manufacturers need to ensure that they enable – not limit – innovation while still maintaining control of the product development process.

Figure 6: Design Iterations before Release



Source: AberdeenGroup, November 2005



Creating and Utilizing Product Knowledge

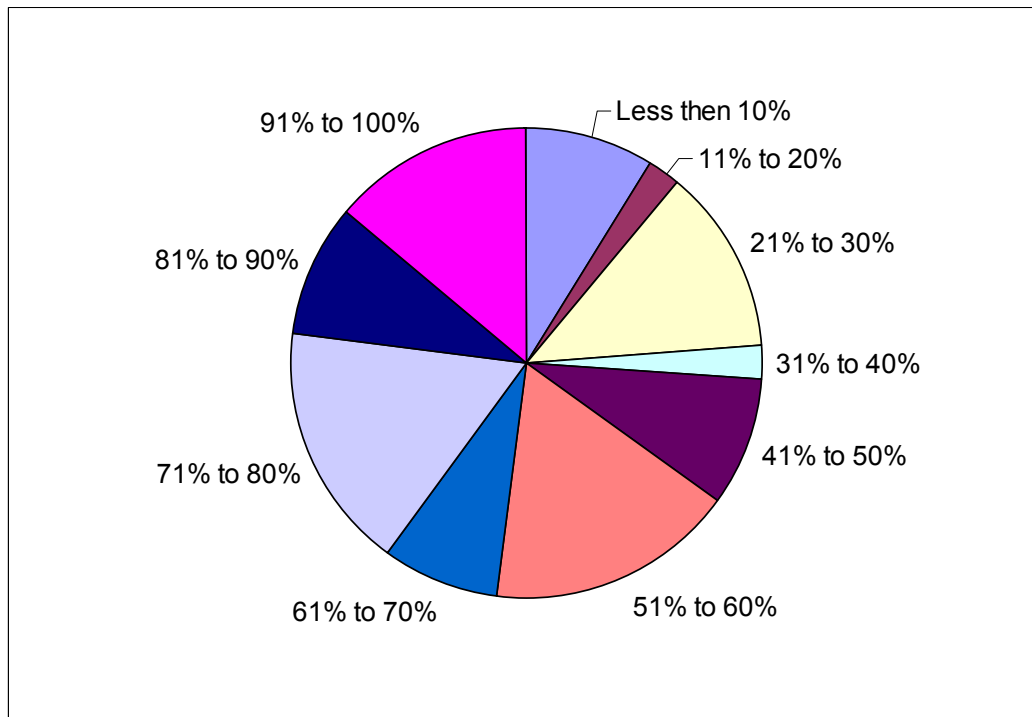
The volume of design documentation can grow very large and cumbersome, but that is only partially due to varied forms of product structures. In addition to product structures, companies track market requirements, test results, marketing surveys, project documents, 2D or 3D CAD models, electrical designs, project data, reviews, approvals, and a host of other forms of information. Most of this information captures valuable knowledge about the product, the design intent and the history of lessons learned during the product development process. In the innovation cycle, creative processes both use and create product knowledge. This information, like conceptual product structures, is relatively useless in the execution cycle with the exception of the final, approved manufacturing specifications.

While the information about design intent and the development process may not be important to execution, it is critically important to innovation. If a problem arises with the product at a later time, being able to review the steps in the design process can provide valuable insight. Or if a similar product needs to be developed, the existing product can be used as a starting point for the new one. Being innovative doesn't always mean creating a brand new idea. Often, innovation comes from applying an existing approach to address a new challenge or using an existing solution in a new way. To engineer innovative products, engineers don't have to discover a new scientific principle; they just have to solve the problem effectively.

Failed products, if knowledge is captured appropriately, are still valuable learning experiences. Often knowing the reasons behind decisions will prevent re-examining options previously discarded. A product that was discarded due to a technical limitation, for example, may become a viable product based on new technology from a supplier. There is a large amount of value and intellectual property developed in the design process. This information is often difficult to reuse, however, because it is largely unstructured. If this information is readily accessible to other designers, and readily searchable, then it is valuable and will promote reuse of ideas and concepts. Reuse is very valuable because it creates new value from a previous investment in research and design. Many products that begin design are never released, but the design process has generated valuable information that can be reused. This is incredibly important when considering that half of companies surveyed indicate that fewer than 60% of the products that begin design are eventually released (Figure 7).

Understanding knowledge management and reuse is important when considering the roles of ERP and PLM. Innovation-generated information is typically less structured, and often resides inside of documents as opposed to a form that fits cleanly into a database table. The format and volume of information in the innovation cycle is much better suited to a knowledge management structure than a relational database, although metadata that categorizes and makes unstructured data easy to find and use may be well suited to a more rigid data structure. PLM solutions are designed to manage a combination of structured data, unstructured data, and metadata.

Figure 7: Percentage of Products Released to Manufacturing



Source: AberdeenGroup, November 2005

Innovating in Teams

Innovation is a team sport. As design and profitability windows have decreased, the need to incorporate input and feedback from internal and external sources in advance becomes critical. There is no longer time to address manufacturing or packaging concerns when the product is already designed. The time to rework the design is no longer available, let alone the expense. Aberdeen research has highlighted the value and trend toward incorporating regulatory requirements and sourcing considerations earlier in the design process. Product innovation typically involves more interaction than execution, with about half of respondents saying that they have “much more interaction in design than in manufacturing” (Figure 8).

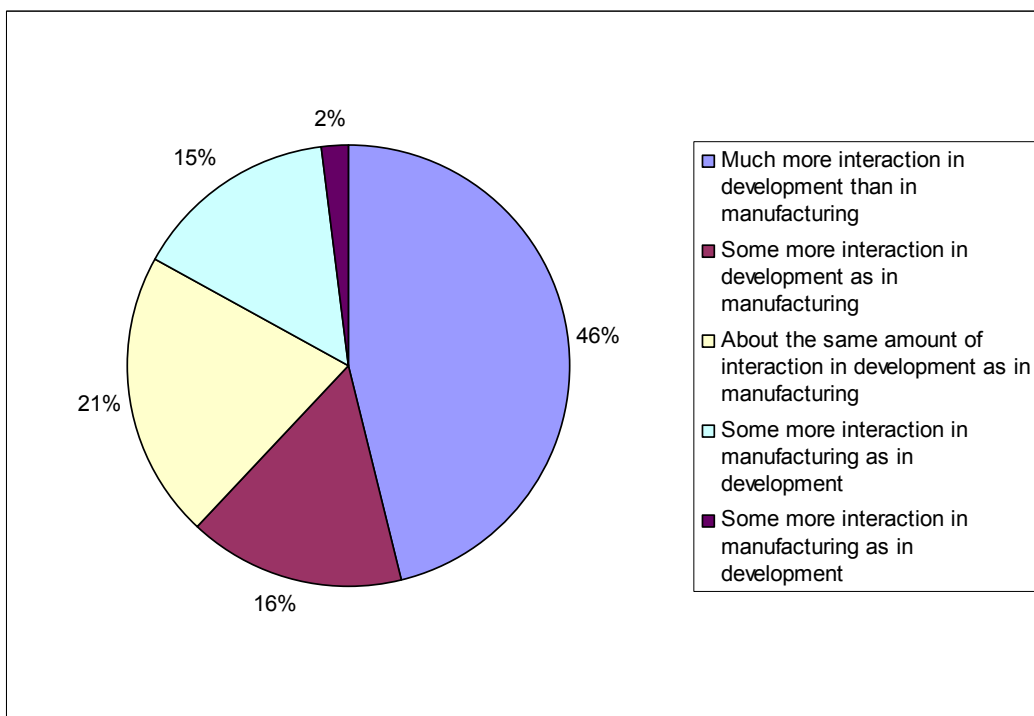
Frequently, products are now being designed concurrently with suppliers’ design of required components, requiring much more fluid communication and visibility to design changes up and down the supply chain. Execution involves many parties as well, including outsourced manufacturers, distribution channels, logistics and others. Typically, however, the information shared during the execution phase is more transactional in nature as opposed to creative and unstructured.

Understanding design collaboration is important when determining the roles of ERP and PLM systems because innovation requires the involvement of many individuals, many of whom are not frequent users of the system. In addition, the interaction frequently involves reviewing designs or documents that are in frequent revision. Collaboration capa-



bilities should support users across multiple disciplines, and provide the appropriate product or project context to ensure that information shared is relevant to the reviewer and displayed in a form that they can relate to. In addition, product innovation typically involves sensitive data and intellectual property, so collaboration platforms must respect that security of information being shared outside the firewall. PLM systems are designed to provide collaboration in the context of product innovation, product development and engineering.

Figure 8: Relative Collaboration Levels between Design and Manufacturing



Source: [AberdeenGroup](#), November 2005

Transitioning from Innovation to Execution

Innovation without execution is irrelevant. Unless a company is in the business of licensing technology or selling patents, manufacturing, distribution, and logistics must play their role to realize a return on innovation. Most companies report a clear separation from product development and execution, with a clear “handoff” or “promotion” process. Forty-seven percent of companies surveyed have clearly defined ownership and handoff points, while another 38% have loose guidelines for transfer from design to manufacturing. The handoff indicates that there is a clear boundary between the design phase and what is released to manufacturing. This logical separation is reflected in enterprise applications as well. Most companies reported having a promotion process from design systems to manufacturing, although many had loose guidelines for execution of that handoff.



The logical boundary between design and production, or innovation and execution, makes sense. Considering the small percentage of products that are actually released to manufacturing, the number of design iterations required before a manufacturable item is released, the differing formats and types of information generated at different stages of design, and the different types of unstructured documentation generated during design, only a small percentage of the information from the innovation cycle is useful to manufacturing and execution. Cluttering the ERP system with this information could potentially cause performance problems, and lead to errors if the wrong information is accessed. While past revisions and data for products that never made it out of the conceptual stage are a valuable asset to innovation, they are a liability to execution and would be distracting at best. Therefore, a clear separation of data and a structured promotion process is more appropriate. This can be particularly true for distributed manufacturing environments where the company, suppliers and contract manufacturers are likely to have different ERP implementations.

The Execution Cycle

The execution cycle differs from the innovation cycle. Managing a supply chain requires up to the minute information on product demand, supply, and available capacity. Without accurate inventory and order information, customer expectations is missed and demand goes unfilled. Planning requires accurate information or planning results are of little value, resulting in missed expectations, poor utilization and increased cost. Competition has forced manufacturers to tighten their supply chain processes to remove excess inventory and other waste. Managing the execution process involves analyzing performance and making timely corrections. Managing execution requires translating operational performance into financial accounting, and demands accuracy and detailed information. Otherwise, the financial data will not provide the insight and level of detail required for process improvement. Execution demands precision and control.

Establishing Control

The major theme for ERP is control. Costs are very important to manage, and manage tightly so manufacturers can understand where money is being made or lost. Customer satisfaction relies on the ability for manufacturers to provide the right product, at the right place, at the right time. In addition, the product must also have the appropriate documentation and paperwork. ERP also manages large volumes of data, which are typically transactional in nature and fit well into a relational data model because they consist of repetitive instances of the same information, such as a sales order. There is a lot to control within the execution cycle, and ERP systems have evolved to handle these requirements well.

From an innovation perspective, control is also important. Clearly the intellectual property contained within a PLM system should be tightly controlled. The innovation process must be controlled as well, but the level of control which is required to plan and execute a global supply chain may not be appropriate for the creative environment within product innovation. An example of unnecessary control overhead would be adding all of the required data for an active item to an experimental item. There is value in identifying the item, but requiring the full information needed to control a part in the execution cycle would inhibit innovation. In this instance, an item might be brought in and discarded be-



cause it didn't meet the needs. That knowledge, however, should be captured for future reference. But the item should not become additional clutter in the execution system.

Providing the Right Product Data for Execution

Having the right product information to support procurement, sales, manufacturing, distribution, logistics, and accounting is critical to execution. Although the information needed by manufacturing is a small subset of the original design data, the accuracy and availability of that information will significantly impact execution. The presentation and structure of the data may be different, such as the engineering bill of material (EBOM) and the manufacturing bill of material (MBOM) that are each designed to serve a different purpose, but the information must be in synch.

When determining the roles of ERP and PLM systems, it is important to ensure synchronization of released product data with the execution systems. ERP-PLM integration is becoming more prevalent. Survey respondents that have been using PDM or PLM for more than 1 year report integration in a number of areas, including:

- Item Definitions (71%)
- Bills of Material (82%)
- Engineering Changes (46%)
- Costs (60%)
- Sales History (46%)
- Quality / Defects (43%)
- Product Specification (43%)
- Item Lookup (36%)

The relatively high percentage of companies that have integrated ERP and PLM indicates both the need for integration and also that the challenge of integration can be met effectively.

Tying Innovation to Execution – Supporting Continuous Innovation

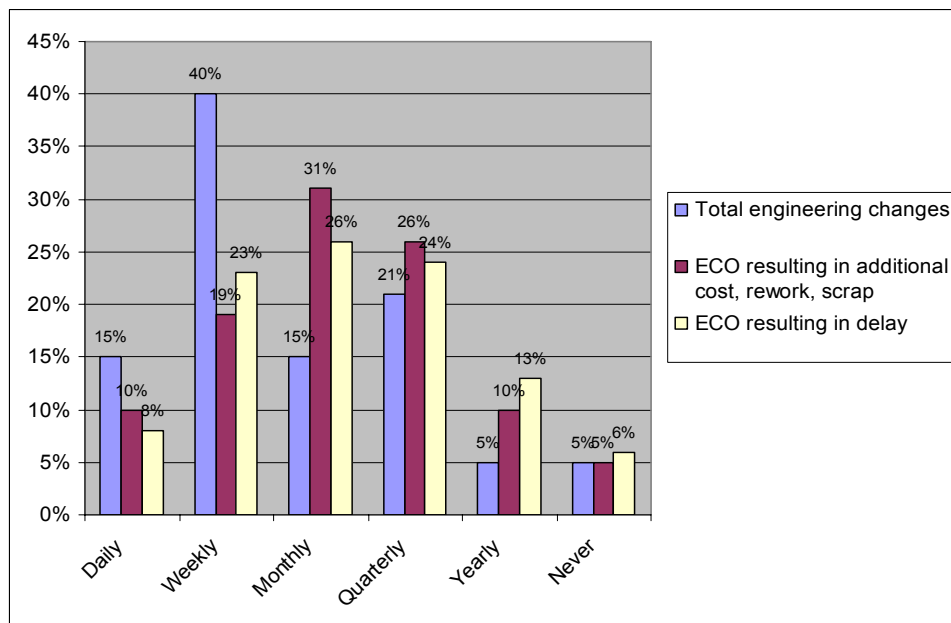
Keeping data in synch between product innovation and execution is not a one-time event, however. Innovation doesn't end at the first release of a product. Products are changed in order to satisfy quality, cost, competitive, regulatory, supply, and other improvements. In a dynamic environment, managing the change process becomes very important in order to prevent scrap, quality problems, and excess cost. Changes are not necessarily a bad thing, the company strategy may be to continuously innovate and offer improved products to customers. But engineering changes are notorious for creating confusion and problems. Change must be managed; it is where innovation and execution collide. Managing change is one of processes that is worthy of particular attention when considering the roles of ERP and PLM. Not only does this process require synchronization between ERP and PLM, it is one of the key areas where ERP and PLM both appear to address the same issue, but do so with very different approaches leading to different results.

Managing Change

The first challenge in managing change is to understand the impact of the change. In a complex product or series of products, a change typically has downstream impacts on other products. Even for simple products, a change in the product design may require a change to related technical documentation, work instructions, marketing material, or other downstream deliverables that are based on the product design. Understanding the impact of a change means understanding all of the relationships that the change will impact. In addition, the change will have a business impact that must be understood. The impact on suppliers, customers, costs and production should be understood and optimized.

This is a challenge for many companies. Aberdeen research identified that some companies experience engineering changes on a daily basis, and most experience them on at least a weekly basis (Figure 9). Unfortunately, many companies also experience additional costs from rework and scrap on a daily or weekly basis because the engineering changes are not well communicated and executed. Over half of companies surveyed experience engineering changes resulting in additional cost, rework, or scrap on at least a monthly basis. In addition to direct cost, product changes are frequently delayed which results in a delay in responding to the need for the change, whether market or financially motivated. A similar number of respondents also indicated that they experience delays in implementing engineering change orders (ECOs).

Figure 9: Frequency and Impact of Engineering Changes



Source: AberdeenGroup, November 2005



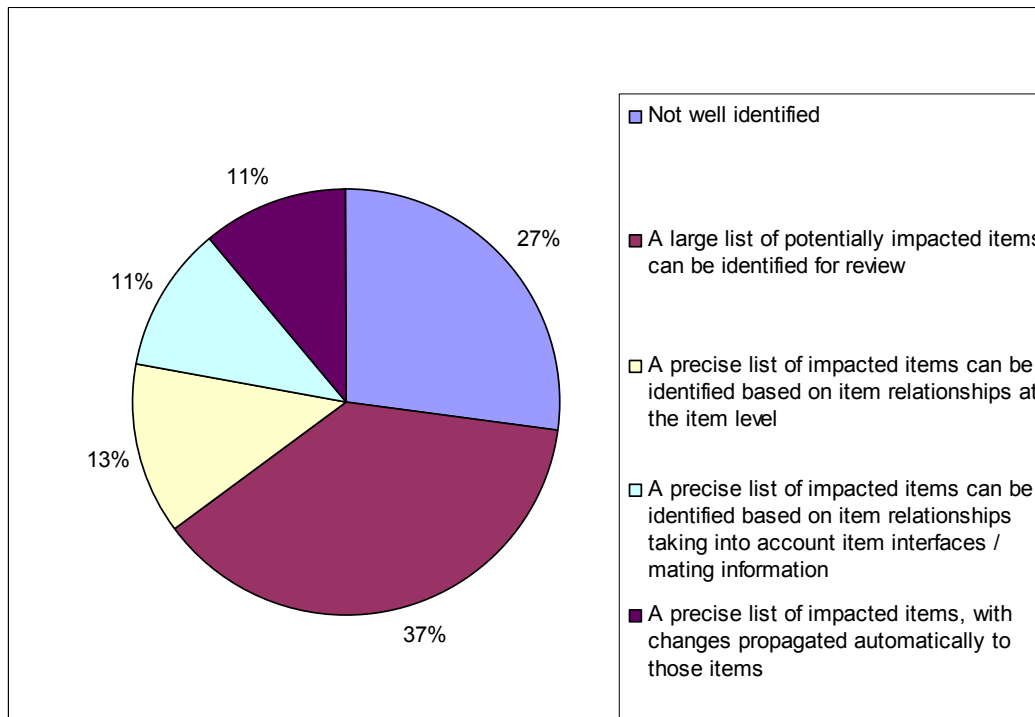
Managing the Technical Impact of Change

The first step in avoiding costly problems from engineering change is to identify the technical impact of the change. Few changes impact a single item without having an impact on related items. When a change is made, any items that contain the newly revised part or assembly should be analyzed. These “parent” items can be found by querying the BOMs. A simple “where-used” of an item or assembly can show where it appears in higher level bills of material. Each of those parent assemblies will be impacted by the change. But what will the impact be? Will the parent item need to be redesigned or simply referenced as the next revision to indicate the existence of the changed item? Will other peer-level items need to be changed as well? “Where used” should identify all of the potentially impacted parent items, but it will require manual effort to review each design to see if the parent item or any of the peer items need to be redesigned.

Although getting a potentially large list that needs to be reviewed manually is a step in the right direction, it would certainly be better to understand the “where used” in context. This will help limit the list of items to be reviewed to the most likely candidates to need changes. Understanding the impact on parents and peers requires knowledge of the nature of the relationship between the items and assemblies. Do the parts mate? Might they interfere? By understanding the relationship between the parts, a much smaller list of items that need to be addressed can be summoned. PLM systems can hold this information based on the relationships within the designs themselves. About two thirds of companies can only identify a large list of potentially impacted items, or do not have a good way to identify the impact of changes at all (Figure 10).

A smaller number of survey respondents (22%) can identify impacted items based on item relationships taking into account item interfaces and mating information. This puts these companies at a competitive advantage when managing change, because they can pinpoint the impact of change more accurately. Beyond identification, ideally the relationship can be altered automatically based on the changed item, and the change propagated to all necessary parent items. Exceptions, such as clashes, could be highlighted automatically. Only 11% of respondents were also able to propagate the changes automatically to impacted items, which should allow them to avoid the cost and errors associated with manual and update. Although it was not specified in the survey, it is expected that those companies are still manually reviewing the changes before approving the revised designs.

Figure 10: Managing the Impact of Product Changes on Related Items



Source: AberdeenGroup, November 2005

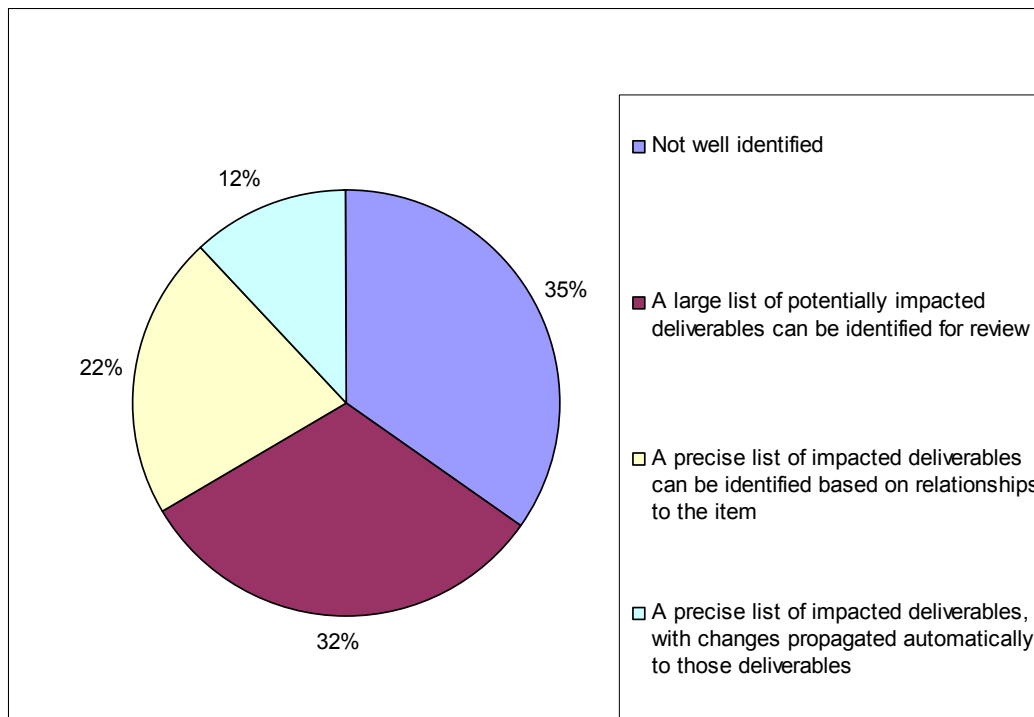
Beyond finding the items that have been changed, it is also important to find the deliverables that have been impacted. After a product is designed, design information is used to create drawings, technical documentation, marketing content, process instructions, and other derivatives. These derivatives embody the design and extend it to serve other purposes such as sales or service. Unfortunately, the relationship between the design and the derivatives is often severed when the deliverable is created. As the design changes, the impact analysis of the change must be extended to these deliverables.

If the linkage between the design and the deliverable is maintained, then an impact analysis can determine whether or not the derivative should be updated. By maintaining the relationship at a document to item level, impact analysis becomes easier. Only about one-third of respondents could identify a precise list of the impacted deliverables (Figure 11). As with designs, the ideal scenario is to identify the downstream information that is actually impacted based on their relationship with the change, identify those impacts, and then propagate the changes automatically. To do this means that not only does the link between the deliverable and the design need to be maintained, it needs to be dynamic. An example of this would be for an approved design change to automatically generate a new image in the marketing collateral or service manual and create a revised version of the deliverable. Only 12% of respondents reported the ability to propagate changes to deliverables. Is it important to remember the number of designs and derivative documents can be very large, making the transition to automatic updates — instead of time-consuming and error-prone manual reviews — a clear area for improvement and competitive advan-



tage. PLM solutions are designed to provide the data and tools required to identify and manage the technical impact of change.

Figure 11: Managing the Impact of Product Changes on Related Deliverables



Source: [AberdeenGroup](#), November 2005

Managing the Business Impact of Change

Identifying the technical impact of change results in updated product designs and documentation. The change does not provide value until it goes into effect. Most businesses have a separation between the time that the designs are updated and the time the change is executed. After the change is reviewed and signed off from a technical perspective, the implementation plan must be determined. The introduction of these changes to manufacturing and procurement has a business impact that must be properly managed and communicated to prevent quality failures, scrap, rework, or missed shipments. The timing should be based on optimizing value based on current business conditions, taking into account supply and demand, levels and locations of inventory, costs, planned production, planned purchases, quality goals, and current demands for the product.

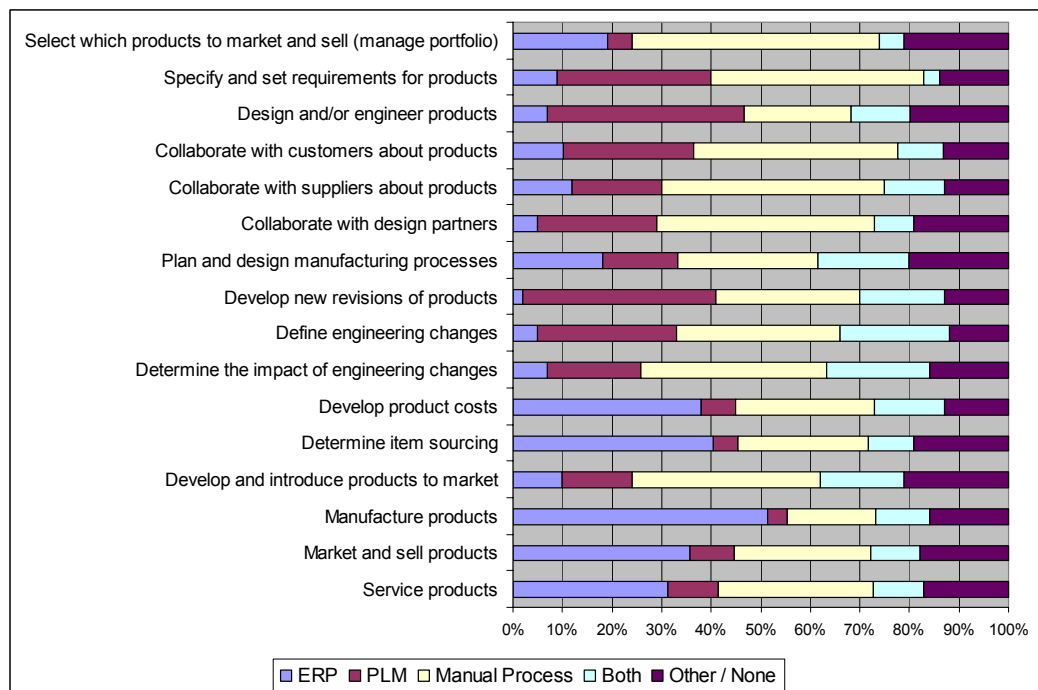
The information to determine the business impact of change resides in the ERP application and is critical to making the optimal decision on when to introduce an engineering change. Without that information, the impact of making a change based on a set date — the date when existing inventory is consumed — at a particular serial number, or for a particular production run, could not be understood. In addition, engineering changes of-

ten must be communicated to (and sometimes approved by) manufacturing, purchasing, suppliers, customers, and others – many of whom use different execution systems. This change could be defined and communicated by the PLM system, but it will need to be executed by ERP in order to put the change into the context of the current manufacturing plans, purchase orders, and sales orders.

Establishing Roles for ERP and PLM in Innovation

The analysis supports Aberdeen’s belief that managing product innovation and product execution are different, and that the differences in business processes drive different requirements for the enterprise applications that support them. While there is no “one size fits all” answer for the roles of ERP and PLM, it is clear that PLM solutions have been architected to meet the special needs of product innovation, product development, and engineering. Manufacturers should clearly define the roles that these enterprise applications play in their businesses based on the individual company and its goals for product innovation. The roles may vary by business process, and in some cases functions may be split between both ERP and PLM. Figure 12 identifies the wide variation of usage roles indicated by survey respondents. Another interesting finding that is evident on this chart is that there are still a lot of manual processes remaining, indicating an opportunity for improvement for many manufacturers.

Figure 12: Systems Support for Product-Related Processes



Source: AberdeenGroup, November 2005



Chapter Four: Recommendations for Action

Recommendations

- **Utilize PLM and ERP** – Manufacturers looking to improve profitability and grow in the current, challenging innovation environment should investigate using PLM solutions in combination with ERP solutions.
- **Clearly identify roles** – Identify which business processes will be supported by PLM and ERP, and define complementary roles that leverage the strength of each solution.
- **Make a clear integration capability decision** – When deciding on whether to use PLM solutions, recognize the value of integration, including lower risk and integration expense.
- **Don't sacrifice your real needs** – When defining roles, understand the importance of the capabilities that each solution can offer and don't sacrifice innovation for integration.
- **Integrate** – Integrate product innovation and execution processes and systems, including formal promotion and change management processes.
- **Act** – Companies with complex products, short product lifecycles, frequent engineering changes, or global value chains will have higher demand for PLM capabilities. Aberdeen research shows that companies that organize and automate product innovation, product development, and engineering processes are better positioned to achieve best-in-class operational innovation performance.



Author Profile

Jim Brown
Vice President and Service Director
Global Product Innovation and Engineering Research
AberdeenGroup

Jim Brown leads AberdeenGroup's Global Product Innovation and Engineering research. Its goal is to provide fact-based research and experienced analysis that advises executives on how to achieve maximum product profitability and corporate value by employing optimal approaches and enabling technology to identify, specify, engineer, develop, and continuously improve innovative, high-value products.

Jim founded research and consulting firm Tech-Clarity, acquired by Aberdeen in May 2005, which researched and communicated the business value of PLM- and enterprise-related software solutions. Jim began his professional experience with roles in manufacturing engineering and software systems at General Electric before joining Andersen Consulting (Accenture), where he focused on enterprise software applications. Jim is a frequent author and speaker on applying software technology to achieve tangible business benefits. He has also served as the PLM analyst for Technology Evaluation Centers and The PLM Evaluation Center, and has been an executive at several software companies. His research has been published internationally.



Appendix A: Research Methodology

Between August and September 2005, AberdeenGroup examined the relative roles of PLM and ERP applications in approximately 65 manufacturing companies to understand the roles of enterprise solutions supporting product innovation, product development and engineering.

Responding companies completed an online survey that included questions designed to determine the following:

- The characteristics of their innovation environment that would lead to the need for PLM solutions to augment ERP, including questions about the volume of design and product information and the amount of collaboration performed
- The frequency and impact of engineering changes, and the capability to identify and address the downstream impacts of change
- The existing usage of applications to support innovation

The study aimed to identify the current roles and uses of ERP and PLM in product innovation and the implications that current innovation environments have on these roles

Responding enterprises included the following:

- Job title: The research sample included respondents with the following job titles: director or manager (35%); senior management (17%); CIO/IT leader (8%), vice president (6%); engineer (12%), internal consultant (9%); staff (3%), and other (9%).
- Job function: The research sample included respondents from the following functional areas of responsibility: information technology (31%); product development / management / strategy (25%); product design or engineering (12%); procurement (6%); manufacturing engineering (5%); marketing (5%); logistics or supply chain (5%); finance (5%); customer service (3%); sales (5%).
- Industry: The research sample included respondents predominantly from manufacturing industries. At a high level, the respondents represented: discrete manufacturing (52%); consumer products (26%); process manufacturing (14%); services (5%), and others (3%).
- Company size: About 35% of respondents were from large enterprises (annual revenues of more than \$1 billion U.S.); 32% were from mid-size enterprises (annual revenues between \$50 million and \$1 billion); and 32% were from small businesses (annual revenues of \$50 million or less).



Appendix B: **Related Aberdeen Research & Tools**

Related Aberdeen research that forms a companion or reference to this report includes:

- Product Innovation Agenda Benchmark (September 2005)
- Product Development in Consumer Industries Benchmark (June 2004)
- The Design for Compliance Benchmark Report (November 2004)
- Formula-Based Product Development (November 2004)

Information on these and any other Aberdeen publications can be found at www.aberdeen.com.



About AberdeenGroup

Our Mission

To be the trusted advisor and business value research destination of choice for the Global Business Executive.

Our Approach

Aberdeen delivers unbiased, primary research that helps enterprises derive tangible business value from technology-enabled solutions. Through continuous benchmarking and analysis of value chain practices, Aberdeen offers a unique mix of research, tools, and services to help Global Business Executives accomplish the following:

- IMPROVE the financial and competitive position of their business now
- PRIORITIZE operational improvement areas to drive immediate, tangible value to their business
- LEVERAGE information technology for tangible business value.

Aberdeen also offers selected solution providers fact-based tools and services to empower and equip them to accomplish the following:

- CREATE DEMAND, by reaching the right level of executives in companies where their solutions can deliver differentiated results
- ACCELERATE SALES, by accessing executive decision-makers who need a solution and arming the sales team with fact-based differentiation around business impact
- EXPAND CUSTOMERS, by fortifying their value proposition with independent fact-based research and demonstrating installed base proof points

Our History of Integrity

Aberdeen was founded in 1988 to conduct fact-based, unbiased research that delivers tangible value to executives trying to advance their businesses with technology-enabled solutions.

Aberdeen's integrity has always been and always will be beyond reproach. We provide independent research and analysis of the dynamics underlying specific technology-enabled business strategies, market trends, and technology solutions. While some reports or portions of reports may be underwritten by corporate sponsors, Aberdeen's research findings are never influenced by any of these sponsors.



AberdeenGroup, Inc.
260 Franklin Street
Boston, Massachusetts
02110-3112
USA

Telephone: 617 723 7890
Fax: 617 723 7897
www.aberdeengroup.com

© 2005 **AberdeenGroup, Inc.**
All rights reserved
November 2005

Founded in 1988, **AberdeenGroup** is the technology-driven research destination of choice for the global business executive. **AberdeenGroup** has over 100,000 research members in over 36 countries around the world that both participate in and direct the most comprehensive technology-driven value chain research in the market. Through its continued fact-based research, benchmarking, and actionable analysis, **AberdeenGroup** offers global business and technology executives a unique mix of actionable research, KPIs, tools, and services.

The information contained in this publication has been obtained from sources Aberdeen believes to be reliable, but is not guaranteed by Aberdeen. Aberdeen publications reflect the analyst's judgment at the time and are subject to change without notice.

The trademarks and registered trademarks of the corporations mentioned in this publication are the property of their respective holders.