

Integrated Product Development

WHITE PAPER

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Joe Barkai
March 2008

MANUFACTURING IN THE GLOBAL ECONOMY

In today's high-paced competitive marketplace, product companies must have an intimate understanding of customers, markets, and competitors, as well as demonstrate technology and quality superiority. But the key to achieving product excellence is anchored in the ability of product companies to continually distinguish themselves in the market by delivering new and innovative products and services, with unprecedented quality, speed, and precision and at acceptable costs.

As product companies find out, oftentimes the hard way, technology superiority can no longer guarantee success, and the path to product excellence requires overcoming organizational hurdles that are increasingly exacerbated by rapid transition from local to global economy and the increased reliance on partnerships and outsourcing. Manufacturing firms that have not embraced the inevitable and failed to evolve their internal product development and launch processes to support the new reality discover that the lack of process maturity and discipline, often accompanied by inadequate IT systems, severely impedes their ability to reach the right product decisions.

Product and service excellence demands not only that companies perfect the product development and manufacturing processes but also that they be able to perpetually shape and improve them throughout by composing an integrated product development framework that continually identifies and brings forth the best concepts, innovation, and product improvement ideas that make them highly competitive on the global playing field.

PRODUCT DEVELOPMENT PRACTICES

The development of a complex product, that is, the process of taking a product from concept, through design and manufacturing, to launch and after-sale service, is a complex, multistage process.

The traditional product design process is a single-threaded, forward-feeding process with well-defined interfaces and quality gates that allows a minimal number of changes at each phase. Typically, each of the intermediate phases includes one or more evaluation stages (gates) to determine if the phase has been completed and the process can progress to the next stage, or if the stated goals of the phase have not been met, the problems must be identified and rectified and the activity must be reiterated.

The linear product development process employed by many companies typically engages stakeholders and decision makers only when the information they need becomes available. For example, assembly line design and tooling does not start until the product design is close to completion. The rationale is quite obvious: Tooling is a very expensive and time-consuming process that manufacturing would rather do only once. Similarly, supply chain and procurement get busy and negotiate financial terms and logistics only when the design is finalized.

This strategy establishes a structured product development process that is mostly forward-feeding and is reiterated only when a problem is detected. But it also means that functional stakeholders cannot get involved in the process until their area of responsibility becomes active, at a point where their voice is not always heard and their needs are prohibitive or will delay the launch of a product. This pushes the identification of many design deficiencies and manufacturing problems downstream until the corresponding downstream activity starts working.

The result of this suboptimal process is that all too often products are late to market and do not achieve the level of quality the market demands, and manufacturers end up paying dearly in warranty claims, recalling products, and redesigning products and manufacturing processes. Often, in their haste to correct a design problem, they do not fully test the new design, only to find that the modification created new problems that are even more expensive to resolve.

A significant body of research exists that demonstrates that engineering changes become more expensive and harder to incorporate the later they are implemented. Product companies need to detect design flaws and rectify them earlier in the process at substantially lower costs, before they are locked in.

Who's In Charge?

The traditional spotlight on technology and engineering superiority made many R&D and engineering departments the focus of attention and the center of gravity in developing new products. As we discussed earlier, this technology-centric view that concentrates almost exclusively on early design and engineering activities can delay the

discovery of downstream setbacks, such as in manufacturing and service, that are remedied at high costs or possibly relegated to a "known deficiency" that will not be corrected.

But in addition, product companies that rely exclusively on technological superiority tend to underestimate the strategic role of the marketing organization. It is the marketing organization's role to define and prioritize technology innovation and product features from the vital perspective of market needs and competitiveness and to ensure that they are optimally aligned with the company's overall product portfolio.

IT Perspective

The fragmented product development process is deeply rooted in the organizational structure and internal processes of many product companies. Knowledge workers have honed their technical capabilities over many years, creating islands of expertise and erecting silos that represent core competency more than product development activities. As tradition has it, they are recognized and rewarded based on these capabilities. Moreover, these communities of practice have encouraged the creation of IT environments that are fine-tuned to support individual task performance, adding yet another layer of bricks to the silo walls.

Product companies with long traditions, such as the automotive industry, suffer the consequences of fragmented IT systems, some dating back to the mainframe era. Many companies in all industry sectors have long and extensive histories of mergers and acquisitions that seldom included IT standardization and consolidation.

INTEGRATED PRODUCT DEVELOPMENT

Product companies need to be extremely effective in their ability to integrate the views and needs of all product functions and participants. This integration recognizes, up front, that often there are incompatible business goals, conflicting designs and constraints, and competing solutions. Because the cost of design changes increases exponentially over time, an integrated product development approach attempts to reconcile considerations that are at odds before design features are locked in.

For example, improving the reliability and durability of a product may require sourcing higher-cost components, which will increase the manufacturing and selling cost of the product. In industries that require uncompromised reliability, this is the only acceptable approach. But in other cases, the design team may be able to control the product costs and still achieve the anticipated uptime and total cost of ownership by improving built-in diagnostics and plan to deliver fast-response repair service. Or, the designers may modify the product enclosure and internal structure so that the operator can perform some simple repairs,

reducing the dependency on dispatched field service. This redesign may add some cost to the manufacturing process but will keep the product's selling cost within target and may even provide an opportunity to generate additional revenue from parts sales.

Best-in-class product companies go through this type of intricate decision process continually, adjusting and aligning design, manufacturing, supply chain, service, and, essentially, every business activity to reach a globally optimized product design. These companies recognize that struggling to reduce initial costs may delay time to market and poor quality may tarnish the brand. Conversely, improving quality at all costs may be counterproductive, if customers do not recognize the high quality and are willing to pay a premium for it or if the quality of competitive products is significantly lower.

These companies also realize that this is a continuous process that is driven first and foremost by market expectations and competitive landscape that may change overnight because of an unexpected competitor, the availability of a new technology, or a change in overall product portfolio and business strategy.

Product companies must instill an enterprisewide design collaboration activity that encompasses all activities and interactions that occur continuously throughout the product's useful life and cover all product life-cycle phases: concept, design, source, build, install, service, end of life, and disposal.

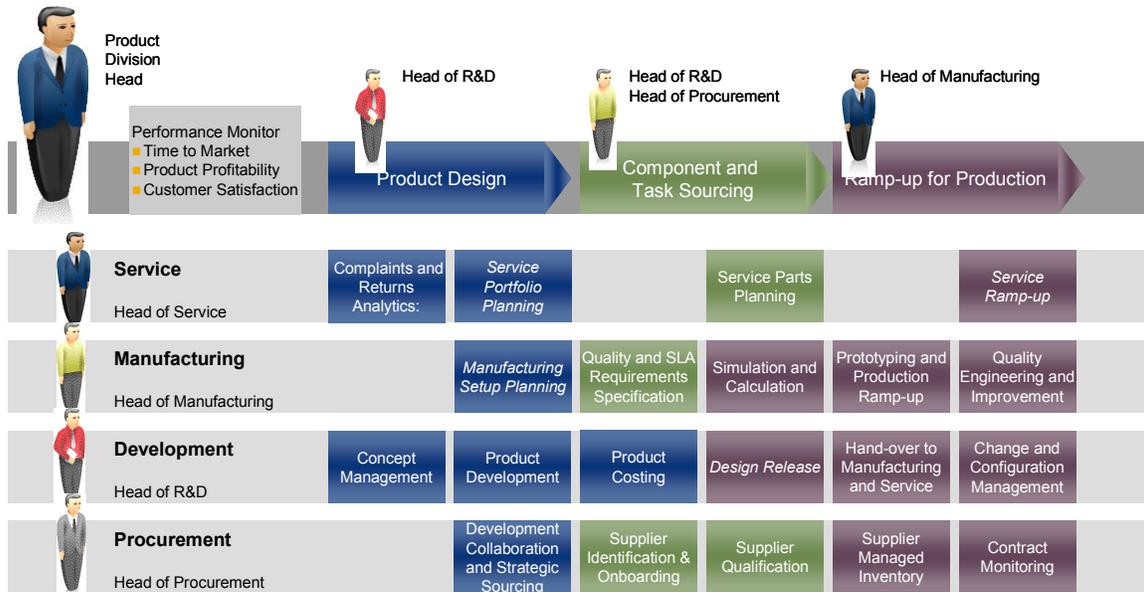
The integrated product development framework for making product development decisions focuses on two fundamentals:

- Maintaining a complete, consistent, and up-to-date view of all product representations, ensuring that all aspects of a product are defined, tested, and validated
- Involving all stakeholders, simultaneously, in the product development process from the early design phases and maintaining a high level of involvement throughout

The fundamental strength of integrated product development is that it incorporates all inputs into the design optimization process that includes suppliers, logistics, and environmental concerns, creating a truly integrated development environment, as depicted in Figure 1. These decisions are made not only based on technical specifications but also based on estimated product costing, manufacturability, testability, serviceability, and environmental aspects and in close collaboration with design and manufacturing partners. Stakeholders can validate that their unique needs are met, and, as importantly, any member of the product team can assess the impact on all upstream and downstream activities and strive for global product optimization.

FIGURE 1

Integrated Product Development



Source: SAP, 2008

Integrated product development is a fundamental capability that product companies need to develop to bring together communities of practice that represent multiple product facets to work toward a common goal. The following sections provide some examples.

Service and Serviceability

As product proliferation increases and erodes brand differentiation, forward-looking product companies and brand owners are moving to adopt a broader view of their products as an opportunity to grow a profitable services business. They view products primarily as services platforms and often sell or rent products with the prime purpose of generating revenue from services, parts, and consumables.

Effective and lean service operation is greatly dependent on products that are easy to service and maintain and the overall efficiency of the service operation. Product manufacturers must consider service operations and the impact of design decisions on serviceability early in the design phase and reach the correct balance between initial costs and downstream costs.

In an integrated product design environment, all relevant participants have access to information and can assess up-front design and manufacturing costs, including the cost of design for service, such as reliability improvement, special features to allow access for testing and repair, safety features, and diagnostic software and test tools, and suggest design changes before the design is frozen. The cost of extra design features and possibly manufacturing costs can be weighed against the benefits they provide: faster repair and higher customer satisfaction. The integrated product team can also look at the spare parts inventory requirements and forecast repair costs to ensure that they are not prohibitive.

Design for Sustainability

Compliance continues to be critical to all manufacturers in all industry sectors. In view of the criticality and pervasive impact of existing and emerging regulations, compliance cannot be an afterthought; companies must take into account regulations during the design, manufacturing, shipment, servicing, and phasing out of their products. Forward-looking manufacturers recognize that compliance requires more than a good-will statement of best intentions; sustainability must be designed into the product and be an integral part of its entire life cycle. It requires an integrated set of controls along the entire product life cycle in design, supply, manufacturing, service, and end of life.

For example, a designer will incorporate sustainability consideration into the product design to reduce potential environmental damage during equipment service (e.g., collection and disposal of lubricants and refrigerants) and assess the impact of compliance on repair time and costs.

Design for sustainability stresses the need to evaluate alternative designs for sustainability alternatives. For example, designers can assess the direct and indirect costs, hazardous waste, and emissions resulting from the use of photodegradable materials against the long-term environmental benefits of these materials.

Design for sustainability is yet another example of how the integrated product development approach achieves the highest possible level of performance. It allows all relevant participants to assess the impact of product-related decisions such as material selection or maintenance practice on any and all regulations, and, because they are involved early in the process, they can identify compliance infringements and suggest design changes before the noncompliant design is frozen.

Integrated Warranty, Repair, and Quality Management

Integrated product design is targeting not only downstream activities such as design for manufacturing, sustainability, or service. This approach is just as powerful when looking at upstream processes.

Despite the importance of initial product quality and the best efforts made by product companies to reduce product defects, the harsh reality is that almost all manufacturers face the need to repair or replace failed products from time to time.

Organizations amass valuable quality-related information when taking customer complaints over the phone, fulfilling warranty claims, or providing service for a fee. This information details types and frequency of failures, misinterpreted product functionality, customer requests, and so forth. Yet, culling this wealth and turning it into actionable knowledge is a challenge. The challenge is not in performing analytics and producing fancy reports; it is in providing this information to multiple knowledge workers for in-context analysis and then providing this insight to all who can use it for improved decision making.

Sequential decision-making processes and fragmented IT environments stand in the way of exploiting information for effective failure root-cause analysis and rapid response. This challenge is amplified severalfold when information is generated by a third party or when a third party needs to be involved in the analysis or the implementation of a solution. But in an integrated product development environment, all information is shared and is acted upon cohesively, accelerating the speed and fidelity of design-related decisions.

Design for Supply Chain

All product companies recognize that supply chain planning is critical to the success of a product. Ensuring that components and raw materials are available when needed and at acceptable cost to fulfill demand but not bloat inventories is a constant challenge. Mature organizations already employ some level of integrated product design and involve supply chain planners as early in the design process as they can.

Yet, there are opportunities for even higher levels of optimization when the integrated development process incorporates additional product life-cycle activities and the design teams and communities of practice that represent them.

For example, the integrated product development process can explore the impact that product modularity has on the complex relationships between supply chain planning and field service planning. From a product repair standpoint, high-level assemblies allow faster repair and, consequently, higher availability and better customer satisfaction. On the other hand, higher-level modules are likely to be more expensive and sometimes larger and more expensive to store and ship, so the supply chain planner would advocate for smaller, simpler, and less costly field replaceable units. Service planners now need to ensure that the diagnostics, test, and repair tools can support the level of repair granularity recommended by the supply chain team.

It is very apparent that this type of dialogue that must take place to accomplish highly optimized supply chain and service operation cannot be realized in any other way than within an integrated team whose participants collaborate in a single unified development process.

CHANGE IS CONSTANT

The notion of an integrated product development environment that appears to promote constant changes may seem to be in conflict with previous discussions that underscore the high cost of changes and seek to avoid them. In fact, integrated product development allows a manufacturing organization to effectively identify those areas that can be reliably designed to completion and others that should be kept flexible. Integrated product development assumes that in some areas constant change is unavoidable and in some instances it is actually required to remain competitive. Therefore, this strategy encourages:

- Reuse of previous knowledge to minimize the need for (late) changes
- Small and manageable incremental changes
- A modularized approach to minimize the impact of change on other subsystems
- Ability to globally optimize decisions and avoid noncritical and hasty changes

INTEGRATED PRODUCT DEVELOPMENT: SUPERIOR DECISION-MAKING STRATEGY

Manufacturers in today's globally connected economy face costly development cycles, delays to market, increased customer demands, and stiff competition. Technical complexities and elaborate and geographically distributed supply chains in many industries place an additional burden on manufacturers that struggle to reach market in time with the right high-quality products.

To make matters worse, business and market realities often limit organizations' ability to achieve complete, accurate, and timely product knowledge, forcing them to make hasty business and design decisions based on partial information and continuously improve these decisions during downstream processes, often at very high costs.

Manufacturing Insights believes that an effective product development environment that creates a complete, accurate, and up-to-date context for decision making is key to product development excellence and overall process agility.

We emphasize process agility and fidelity in decision making. Sooner or later, competition, disruptive technologies, design and manufacturing problems, and a host of unexpected events may require a quick response to identify the cause and the appropriate response as well as subsequent actions that the extended product development chain should take. The most effective way a product company can achieve this agility is by a coordinated effort of all product development functions, aggressively synthesizing the knowledge, experience, and best practices of the enterprise toward a highly optimized product.

HOW TO A BECOME A BEST-IN-CLASS PRODUCT DEVELOPMENT ORGANIZATION

Effective and efficient product development has become substantially more complex, and failures are more commonplace due to the rapid pace of changes in technology, markets, and global supply bases. Successful product companies excel not only in technology and product innovation but also in their ability to continually innovate and improve the critical product development process itself.

Manufacturing Insights has identified several key capabilities of best-in-class product development organizations where an integrated product development approach optimizes decision making to achieve product leadership.

Product Development Is an Integrated Cross-Functional Process

Best-in-class product development organizations recognize that product development is an integrated cross-functional process that requires tremendous collaboration and coordination among product specifications, organizational functions, and disciplines.

They also recognize that the long tradition of many product companies and human nature have erected functional silos that make cross-disciplinary development challenging and are instilling a culture of

collaboration. However, these companies make extensive use of IT tools to provide a comprehensive unified view of product information that is accessible to knowledge workers across traditional boundaries to accelerate and improve the capacity and fidelity of decision making.

Harmonizing Life-Cycle Activities to Achieve Optimal Product Design

Realizing that a unified holistic view of product development process brings needs and strategies of different functional organizations and knowledge workers, mature product development organizations stress the need to harmonize requirements and specifications that may appear at odds and accomplish an optimal product design by analyzing and scoring the impact of design decisions on all upstream and downstream activities throughout the product life cycle.

Adopters of "design for X" practices exploit analytic tools to traverse multiple product views and information repositories to gauge the impact of design decisions and, later in the life cycle, design changes on performance, manufacturability, and serviceability and ensure that cost and compliance goals are met. Moreover, they conduct what-if evaluation scenarios to identify the design that would provide the best long-term solution that meets the needs of all stakeholders.

Innovation in Moderation

Innovation and innovation management in product development are always prominent topics that garner much attention. Mature product companies allow enough creativity and freedom to innovate outside the well-traveled product road map. At the same time, these companies ensure that they engage in smart innovation — that they transition innovation to concepts that eventually become products only as needed. While encouraging innovation, they also demand reuse of intellectual property and tangible components and products, and, when possible, they employ partners and suppliers to provide alternative technologies, products, or services.

To support "lean innovation," mature firms provide all stakeholders visibility to product information, including design, test, manufacturing, and field performance data. Product designers accelerate time to market, improve initial quality, and reduce costs by leveraging past experience and existing intellectual property or even reusing existing designs and products.

The key to effective use of this information, which often resides in multiple repositories, is the ability to search for information across disparate databases, including those that are outside the enterprise and potentially owned and managed by suppliers and partners.

Forward-looking organizations are pushing the envelope in implementing search and retrieval paradigms that are not strictly text based and can identify desired functionality or design intent, improving reuse efficiency manifolds.

Align Product Development Priorities with Business Strategy

New product development must be done in concert with the company's existing product portfolio and align with the long-term product business strategy. Best-in-class companies develop products in a structured framework that applies an integrated view to manage the product portfolio composition, the refresh rate of current product lines, and the introduction of new products. With the aid of portfolio management and analytical tools, the comprehensive integrated view helps determine optimal design, go-to-market strategies, and sales operation against the potential cannibalization of other products.

Product business strategy is not limited to tangible products. Innovative product companies develop products that serve as services platforms, generating services revenues in addition to, and sometimes instead of, direct product revenues. This lucrative strategy necessitates that an integrated product team be created to build the product capabilities that can deliver the necessary service offering and be able to support a profitable service level.

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