PTC Windchill® and a Service Oriented Architecture

Strategies for Optimizing New Product Development

Manufacturers are under intense pressure to bring new products to market faster, at lower cost, and with higher quality and more reliability than ever. Many of today's industry leaders are achieving these objectives by leveraging advanced PLM (Product Lifecycle Management) applications which allow in-house design and manufacturing engineers to collaborate in real-time with external business partners. In addition, PLM also provides seamless integration between all essential software applications that support product development.

This paper discusses how PTC has leveraged Service Oriented Architecture (SOA) strategies and tools to provide the critical link between PTC's Windchill PLM software solutions and external applications to create operational efficiencies not possible in a stand-alone systems environment.

Executive Summary

The ability of industrial firms to bring new products to market quickly is critical to preserving product market share and profit margins. Businesses must be able to achieve aggressive product launch targets within decreasing time and budget constraints, while maintaining very high levels of product quality and performance. To operate within these constraints, businesses have turned to advanced information technology tools to improve engineering productivity and to reduce the lag time between the engineering design activities and the corresponding activities with suppliers and other areas of the business.

Historically, the tools that comprised the product development environment have been deployed as stand-alone applications that were not integrated with the ERP and manufacturing systems that consumed the engineering design data. Responsibility for integrating the engineering environment with ERP and MES became the responsibility of the in-house IT organization. These integrations tended to be point-to-point integrations that solved specific problems. While this approach addressed basic integration requirements, the point-to-point integrations were costly to maintain and slowed the deployment of new IT systems necessary to satisfy business requirements.

Today's reality is that, to remain competitive in the global marketplace, businesses must adopt new technologies and new business strategies if they want to bring products to market faster and provide greater product value at the same – or lower – cost to the customer. To do this, some product manufacturers are pushing greater responsibility for the product design and development down to the suppliers, while moving product engineering and manufacturing to low-cost countries. As businesses grow and move into international markets, they must adapt products to the local marketplace. How? By modifying the product to meet government regulations and by increasing the amount of locally supplied product content to meet cost targets and local content requirements.

To meet these challenges, PTC has created an integration solution based on Service Oriented Architecture (SOA) standards. This flexible integration strategy allows businesses to adopt a more agile "design anywhere, build anywhere" product development strategy. This whitepaper explains how PTC's Windchill Product Lifecycle Management software leverages SOA technologies to support process and data integration, and how these technologies make it possible for companies to bring new products to market faster and at lower cost.

Product Development Business Challenges

When the U.S. Air Force announced it would reopen the procurement for the $40 billion Air Force tanker contract, it opened the door in January, 2007 for Northrop Grumman and EADS, a partner in Europe's Airbus consortium, to bid on the tanker contract. Although Congressional representatives argued that the Northrop/EADS bid was from a "foreign" competitor, in fact, 52 percent of the components for the "Airbus" tanker would be made in the United States, and final assembly would be performed in Mobile, Alabama.

For its part, Boeing estimated that at least 15% of the parts on the KC-767 tanker would be supplied by overseas suppliers. While the decision is being contested by Boeing, the Air Force awarded the contract to Northrop/EADS/Airbus based on its better price, its greater fuel carrying capability, and the fact that the aircraft would be assembled in Alabama and the majority of the components made in the United States.

This story highlights the extent to which globalization is changing the way industrial firms design and build products. In order to compete for business anywhere in the world, Original Equipment Manufacturers (OEMs) and suppliers are quickly adopting a "design anywhere, build anywhere" approach to product development. While this approach offers many benefits for all participants in the design process, at the same time it greatly increases the complexity involved in managing the product development process.

From the perspective of the OEM, the benefits of collaboration across the collaborative development lifecycle are impressive:

- The OEM can move much of the cost and risk of new product development over to suppliers.
- The OEM can better leverage the unique skills and knowledge suppliers possess in designing and building their own products, and incorporate that knowledge into the final product to reduce manufacturing costs and gain competitive advantage.
- The OEM can accelerate product development cycle time by subdividing the work across a larger population of suppliers, while performing more development in parallel.
- The OEM can move work to engineering centers in low-cost countries to reduce development costs, and engage more engineers to undertake more development projects with the available resources.

From a supplier perspective, the benefits are also significant:

- Suppliers have more control over the product specifications, and can work with the OEM to use existing components, reduce the number of late-cycle design changes, and maintain better control over the allocation of available resources.
- Suppliers can reduce costs by leveraging offshore design centers and contract-engineering firms to reduce development costs.
- Suppliers can better utilize existing resources by leveraging product development tools and integration technology, enabling an engineer to collaborate with the OEM's engineers and other business partners, and to design and test products virtually, from a single engineering workbench environment.
- Suppliers can leverage the collaboration processes to create a deeper business relationship with their customers and become more tightly integrated into the OEM's product development process.

To achieve these benefits, both OEMs and suppliers must be able to align their business processes, and integrate the tools and data used to support product development, production planning and manufacturing. Since the business partners involved are likely to be using different tools and processes to support the product development process, the integration environment must be able to compensate for differences in the operation of the product development tools and make it possible for suppliers to collaborate with OEMs without having to modify their existing tools and processes. The resulting integration environment should continue to support design and manufacturing business processes, even if the business partners upgrade or enhance the functionality in their IT tools environment.

Excellence in New Product Development Execution Drives Business Performance

A characteristic of industry leaders is their ability to bring innovative new products to market faster and at lower cost. Firms that have consistently achieved a dominant market share in any industry are more effective at managing the product development process, and more effective at collaborating with business partners to apply new technology to create more innovative new products than their competitors.

The Toyota Prius and the Boeing 787 are examples of products that have created highly profitable new market niches and changed the competitive balance in their respective industries. In each case, these companies have leveraged design technologies and collaboration with business partners to incorporate breakthrough technology into their products, and then developed new design and manufacturing processes and tools to bring these products to market ahead of the competition.

Boeing closely collaborated with its partners in designing its 787 Dreamliner

The Boeing 787 Dreamliner is an example of a product that redefined the ground rules for competition in its industry. After losing market share to Airbus through the 1990's, and after launching a string of marginally successful products with the 767 and 777 wide-body aircraft, Boeing shifted gears and began focusing on developing a completely new aircraft that would be far more fuel efficient, and less costly to maintain and operate, than the current generation of aircraft.

After consulting with its airline and business partners, Boeing developed the requirements for an aircraft that would incorporate an unprecedented level of composites into the structure of the aircraft. Whereas the 777 used 50% aluminum and 15% composites, the 787 would use 15% aluminum, 50% composites, and 12% titanium. By substantially reducing the weight of the aircraft through extensive use of composites, by improving aerodynamics of the wing structure, and by using advanced engine control technology, Boeing is now committed to delivering a commercial aircraft that will be 20% more fuel efficient than any other aircraft currently in service, while requiring less maintenance.

To deliver an aircraft that satisfied these requirements, Boeing worked with its suppliers to create new technologies to design and build the aircraft. Boeing facilitated design collaboration across its business partner community to solve the complex problems of integrating design with manufacturing. This included new manufacturing technologies that were needed to fabricate and cure very large assemblies made from carbon fiber composites. By the time the first aircraft was rolled out of production, the Boeing 787 had become the fastest selling aircraft in history with over 600 firm customer orders.

The Toyota Prius is another example of how collaboration with business partners using advanced technology can create a new market niche. The Prius has created a new marketplace for hybrid, fuel-efficient vehicles. In order to develop the Prius, Toyota had to collaborate with business partners to: build a new, lightweight electric battery technology that could last at least seven years before replacement; design a new engine technology that could minimize fuel consumption and could shut down during periods when a normal internal combustion engine would be idling; and design a new hybrid, continuously variable speed transmission that could blend power from both the gasoline engine and the electric engine. With Prius's impressive fuel-efficiency ratings of 48 MPG/city and 45 MPG/highway – at a time when U.S. gasoline prices were approaching $4 per gallon – Toyota has captured a 79% market share for hybrid vehicles in the U.S., with more than a million vehicles sold worldwide.

The common denominators across each of these innovative new product introductions have been:

- The ability of the OEM to identify new technologies that give their products a competitive advantage.
- The ability to collaborate with key suppliers to adapt and incorporate new technology that creates a new market segment.
- The capacity to collaborate with partners to identify and overcome first, design challenges, and then manufacturing challenges, so that the product can be launched in the marketplace before competitors are able to develop similar product offerings.

The Emerging Business Model for New Product Development

As the Toyota and Boeing case studies illustrate, the ability to get new products to market faster, at lower cost, is very much dependent on the ability of a manufacturer to leverage the skills and knowledge of its business partners during the new product development process.

In this new business model for product development, the product manufacturer (or OEM) drives the product development process forward by analyzing customer needs and by capturing the key product features that will drive the customer's buying decision. The OEM then translates these requirements into a set of functional specifications for the product, then a set of detailed technical requirements, and lastly, a plan for designing and manufacturing the product. The OEM then collaborates with its key business partners to create product designs and to develop manufacturing technologies that can deliver a product that satisfies these requirements within the cost, time and resource constraints imposed by the marketplace. The OEM itself acts as the systems integrator bringing together the skills and technologies needed to create a product that satisfies the needs of the customer.

PLM's Critical Role in New Product Development

In such a collaborative environment, working with the exact same set of product information is both critical and complex. With PTC's Windchill PLM software, everyone works with the same, single source of product-related information. As a production-proven PLM system, Windchill is essential for companies who need to collaborate with suppliers, or for suppliers who must react to demands from OEMs to take on responsibility for the design of key components in a complex product. Windchill manages all product content and business processes throughout the product lifecycle. Controlling everything from MCAD and ECAD data to software, calculations, illustrations and technical publications, Windchill enables all users – across the global enterprise and supply chain – to work with a single representation of the entire product, or 'one single source of the truth'.

As the single source of product-related information, Windchill has the control and configuration capabilities needed for users to collaborate across the extended enterprise. Windchill also enables users to optimize key product development processes and help them achieve specific business initiatives.

All of this engineering design data created during the product development lifecycle is eventually consumed by other IT applications within the extended enterprise. For example, the ERP systems use the technical specifications for the parts that drive the production planning, sourcing, procurement processes, and supply chain management processes with the suppliers. Although industrial customers need a high level of integration between the systems that support product design, production planning, manufacturing and sales, most IT organizations generally use one of the following options to support applications integration within the enterprise:

- Manual data entry, with information entered separately in each system
- Flat file transfer using translators and import/export routines
- Custom developed, point-to-point integration software.

While these simple point-to-point integration strategies are acceptable when the transaction volume is reasonable and the applications are static, it becomes vastly more difficult when the IT applications must support an increasingly complex business environment. Eventually, the complexity of the integration environment reaches a point where most of the available IT resources are consumed maintaining the custom point-to-point integrations, leaving few resources and little budget available to deploy new applications in response to changes in the business conditions.

The IT industry's answer to this challenge has been the development of tools and standards to support an integration strategy called Service Oriented Architecture (SOA). The underlying concept behind SOA is to treat the applications functions that support a business process as a self-contained "service". If a consistent set of interface strategies and methods is used to manage the integrations between each of the "services," then a specialized software program – the "middleware" – can be used to manage the complex problems of data transport and delivery, data security, error detection and recovery, and process choreography.

This approach makes the application integration environment much more reliable and robust because much of the complexity that would need to be handled in the custom applications programs – i.e., those supporting the point-to-point integrations, are handled by the middleware program. Thus, when an application program needs to be upgraded or replaced, the only components in the integration environment that need to change are possibly the data maps and the adapter that provides the interface between the middleware environment and the application program. As well, any process orchestrations, which manage the way external applications exchange data and trigger business processes in the new business application, would also need to be updated.

Since most interface development work is performed via GUI development tools, the change process is easier to manage and is much less likely to introduce subtle errors that are difficult to detect as compared to the level of effort required to develop and test custom point-to-point integration software.

PTC has long recognized the value of open industry standards as a strategy for cross-enterprise systems integration and thus designed its Windchill application to support integration with external applications using SOA as the integration architecture.

The Role of SOA in Supporting the Product Development Lifecycle

PTC has always embraced Open Standards, such as Service Oriented Architecture (SOA), as its strategy for supporting integration between the product development environment and IT applications that support the core business processes of enterprise resource planning, manufacturing, and sales, both within the enterprise and with external business partners.

PTC's use of Open Industry Standards and SOA offers substantial benefits for customers:

- Any middleware tool that conforms to these standards can integrate Windchill with external applications and access product data within Windchill, on-demand.
- If the customer implements an advanced middleware tool that supports process and data integration, the workflow and configuration capabilities of Windchill can be used to integrate the process flows in Windchill with the process flows in external applications like ERP and manufacturing systems.
- If the middleware tool supports process and data integration across an enterprise service bus, and other enterprise applications are integrated using the ESB and SOA standards, the cost and complexity of managing integrations between applications with high levels of volatility and change can be substantially reduced.
- If the customer has implemented a middleware environment, such as that provided by IBM's WebSphere Process Server, the customer can integrate the IT applications of business partners into an integrated collaboration environment that supports a wide range of business partner collaboration capabilities.

Windchill exposes functionality for purposes of integration through a standards-compliant Web Services framework populated with an extensive library of prebuilt services. In addition, Windchill provides an industry standard JCA connector that allows auto-generation of Enterprise JavaBeans or J2EE Data Access Objects, which seamlessly implement standard Web Services communication protocols to exchange data with Windchill from within any Java-capable application server or middleware tool.

As shown in the figure below, the WebSphere/Windchill solution provides a modular architecture that supports two-way integration between Windchill and external applications. The Web Services interface can encode process requests and transactions initiated within Windchill to trigger events and processes in external applications via Web Services. The Web Services framework supports bidirectional message flows, making it possible to create integration scenarios, where external applications can access data in Windchill and trigger process events in Windchill through the Web Services adapter.

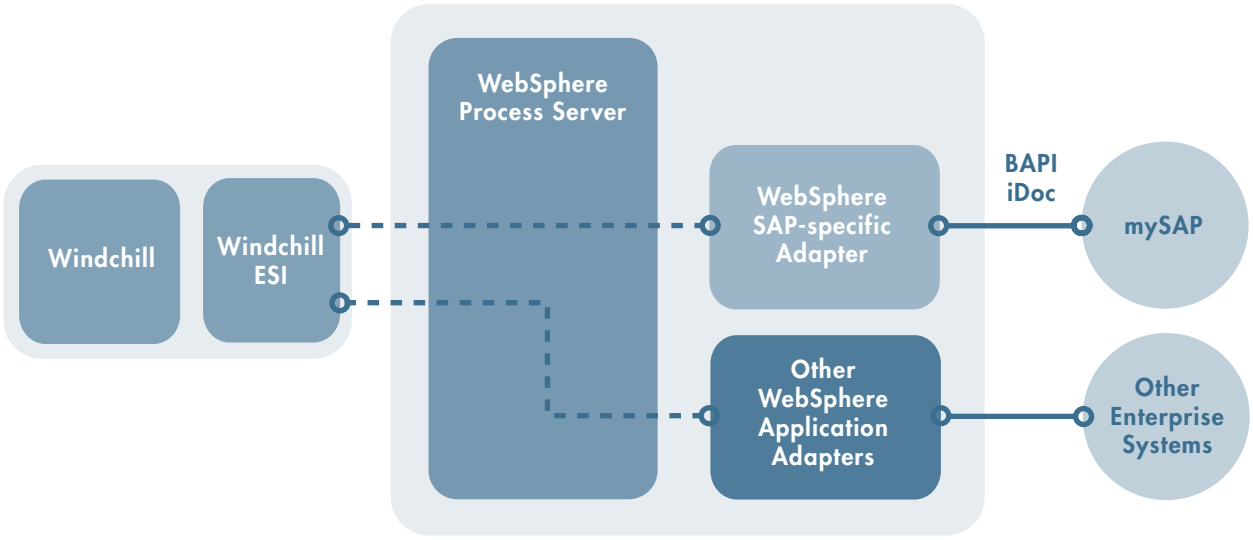
Today, it is far too complex and time-consuming to build point-to-point, custom integration software for every step in the product development lifecycle. It is much easier and faster to deploy a middleware environment to route data between application services. Process triggers can then invoke services in downstream applications, such as ERP and MES, to manage the execution of business processes in the complementary applications. Once an SOA integration environment has been deployed within the enterprise, it is much quicker and far less risky to integrate new applications and enhance the existing integrations to adapt to changes in business requirements.

Understanding the PTC-IBM SOA Integration Architecture

The Boeing and Toyota case studies illustrate the importance of collaboration in bringing new products to market faster and at lower cost. PTC's use of SOA and advanced middleware tools like IBM's WebSphere Process Server tools make it possible for customers to quickly deploy an integration environment based on IBM's WebSphere integration suite and use "best practice" process templates and data mapping templates for common industry application suites like mySAP ERP and Oracle Manufacturing.

The Windchill integration environment, as implemented on an IBM WebSphere Process Server integration framework, provides a very robust SOA integration environment that can be easily configured to control the demands of managing product development across a complex, heterogeneous tools environment. The PTC-IBM SOA Integration Architecture framework provides the following functional capabilities:

- A robust, Web Services-enabled interface to Windchill that allows authorized transactions to invoke Windchill services, and allow Windchill users and processes to initiate transactions in other enterprise systems.
- A highly reliable and scalable middleware solution that can provide mediation, message routing and delivery, recovery and restart, and Business Process Execution Language (BPEL) execution support.



WebSphere/Windchill Integration Architecture

- A suite of "best practice" BPEL process templates for managing the process interactions between applications tools connected to the integration environment.
- A suite of tools for defining, testing and modeling the behavior of dynamically assembled and executed business processes.
- A large portfolio of out-of-the-box application and technology adapters for a wide range of applications and tools, along with adapter development tools for developing custom adapters to handle specialized customer requirements.
- GUI-based mapping and translation tools for converting content data into the native data formats used to invoke application services in target applications.
- Tools to define, capture and report user-defined performance metrics.
- A suite of administrative tools for managing the performance and throughput of the middleware integration environment.

The integration environment is deployed as a self-contained enterprise integration hub. Application suites can be connected to the middleware environment either through a set of JCA 1.5 Web Services adapters (if the application has been enabled for connectivity to an SOA-enabled middleware environment), or through any IBM-supplied application program adapter. For in-house, custom-developed applications, customers can use an adapter development toolkit from IBM to build SOA JCA 1.5 integration adapters.

Together, IBM and PTC provide a broad portfolio of tools that enable customers to define the process choreography and data translation functions required to support the product development lifecycle.

WebSphere Modeler (Modeler) is a graphical user interface tool for defining process workflows by designing the business logic and business that will be integrated by the BPEL processes. The Modeler can be used to define both short- and long-running (offline) business processes for any type of business object. The Modeler includes tools to simulate the operation of the business processes, to test the processes, and to detect any potential bottlenecks in the execution of the business processes.

WebSphere Integration Developer (WID) is a tool for defining both the data mapping across business objects and the WPS resources being used to manage the end-to-end execution of the WPS process integration, event-handling and error-recovery processes.

WebSphere Business Services Fabric (WBSF) tool is used to dynamically assemble and execute BPEL workflows. While the Modeler tool can create BPEL process flows that can contain decision trees, or IF/THEN/ELSE logic, this level of static process definition might not be sufficient. For example, most manufacturing companies use more than one supplier for a specific part, and may use different suppliers for the same part for its manufacturing plants in other geographies.

WBSF can be used to spawn different BPEL process flows that could propagate data to each of the suppliers, and adjust for differences in the toolsets that are used by different suppliers in different geographies. WBSF gives you the flexibility to create business process models that can adapt to changes in the IT tools environment or in the preferred business processes that are used to manage relationships with suppliers, or the way in which other business groups within the business prefer to operate their businesses.

Proven Solutions from PTC and IBM

As the pressures increase to accelerate the introduction of new products into the marketplace, there is a growing need for IT applications that will allow businesses to use its product development resources and business partners more cost effectively. One proven solution is to adopt the advanced technology in PTC's Windchill to improve the effectiveness of the product development processes, as well as deploy the SOA technologies of IBM's WebSphere to provide seamless integration between existing IT applications that support product development, production planning, and manufacturing processes.

Windchill is the only Product Lifecycle Management (PLM) solution that was designed from the ground up to work in an Internet-based, distributed product development environment. The Windchill/WebSphere solution builds upon Windchill's advanced PLM technology by adding industry "best practice" templates that provide data maps, configuration templates and business modeler process flows, which can link the business process triggers and data created in Windchill to the complementary business functions in SAP's mySAP® Enterprise Resource Planning applications suite.

The combination of this advanced product development system and leading SOA technology can significantly reduce the challenge of integrating the product development processes of the enterprise with the product development processes of external suppliers and downstream enterprise applications.

For More Information

To learn more about Windchill or PTC's Product Development System, please visit PTC at **www.ptc.com**

For more information about IBM's WebSphere Process Server product portfolio, please visit IBM at **www.ibm.com/software**

3838-Windchill/SOA-WP-1008