

Vehicle and Systems Development

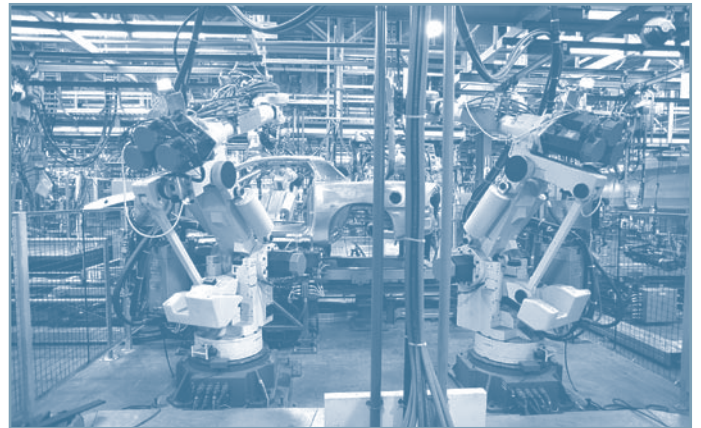
The key role of Product Development in meeting the challenges of the automotive industry in the 21st century

The Automotive industry in Turmoil and the Critical Role of Product Development for the Future.

The automotive industry has changed beyond recognition in the last 10 years. Detroit, once the dominant global force in automotive, is a pale shadow of its former self. Toyota has overtaken GM as the world's largest automotive manufacturer. Traditional markets are saturated. Sales growth is primarily in the BRIC countries, and manufacturing is systematically relocating to low-cost economies. And the product once known simply as the "auto" has changed almost beyond recognition. An explosion of new models, packed with high-technology—engine management, ABS, 'infotainment' and other systems, are all being networked to form a highly complex system.

And the rapid pace of change continues unabated. Automotive innovation is now being driven primarily by electronics and software, with that trend also destined to continue. On top of that, environmental issues will result in other fundamental changes. On the one hand, traditional methods will see fuel consumption and emissions continually reduced through improvements in aerodynamics, weight-reduction and engine optimization. On the other hand, Hybrids are already having a growing impact in the market. Electro-vehicles, fuel-cells and alternative fuels will bring further radical changes. Should these measures fail to bring the necessary relief to the global climate, the future of individual transportation itself is in question, with an increased focus on mass transportation virtually inevitable.

But the automotive industry has always been faced with change: the introduction of mass production by Ford in the early 1900's, the oil crises of the 1970's, and the rise of the Japanese automotive industry in the 1970's and 1980's. Towards the end of the 20th century, cost and quality were the dominant challenges. Not surprisingly, for an industry whose costs are determined primarily by labor and materials for manufacturing, there was a heavy focus on automating and optimizing the manufacturing process. Toyota led the way with the Toyota Production System—rigorous adherence to process, continuous improvement and an uncompromising focus on quality being the hallmarks. Others have followed, with Ford adopting the Toyota Production System in 2000. The next major challenge and revolution falls on the shoulders of product development.



Automotive companies have been heavily focusing on automating and optimizing the manufacturing process. The next major challenge falls on the shoulders of product development.

Product Development: The Next Challenge for Automotive Companies

Many of the challenges facing the automotive industry have a huge impact on product development. The list is long, but some of the key factors are:

- Explosion in the number of new models being developed
- Increasing proportion of electronics and software in the vehicle
- Need to optimize fuel consumption (e.g., minimize weight, aerodynamics, etc.)
- Increasing global regulations regarding fuel consumption, emissions, recycling, safety, security, etc.
- Increasing need for competitive differentiation through design, styling and features
- Increasing importance of suppliers as the drivers behind innovations
- Increasingly complex network of design partners and suppliers

Should product development fail to cope with these increasing demands, the consequences are dramatic: vehicles will either cease to be competitive in design, quality or cost, or they'll be delivered late. Image and market share will be lost, and may never be recovered. There are many well documented cases where this has happened.

Product Development is being asked to deal with these challenges largely within frameworks established in the previous 20 years. Development budgets and headcounts remain largely unchanged. And with some notable exceptions (digital simulation, for example), the methods and tools being used are also unchanged.

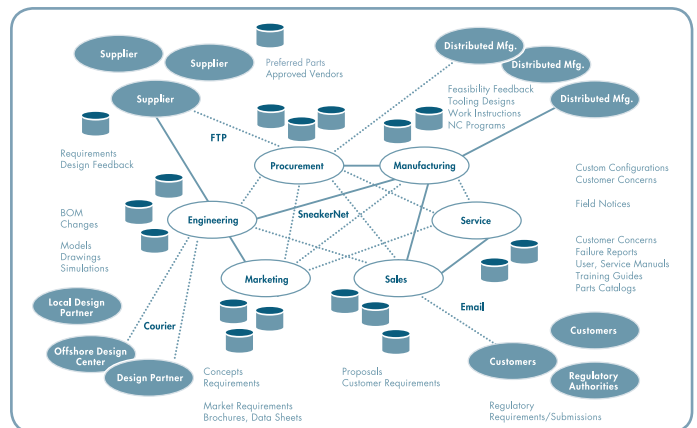
While the majority of automotive companies and their suppliers have always invested heavily in automotive technology, the management of the highly complex product development process itself has largely been ignored. The recent PTC-sponsored study, "Managing Complexity in Automotive Engineering", conducted by the Institute of Machine Tools of RWTH Aachen University and focused on senior executives from leading German Automotive OEMs and Tier One suppliers, highlighted many issues, and identified three key areas to be improved if the complexity of modern vehicle development is to be controlled successfully:

- Ability to manage the rapidly increasing product architecture complexity
- Ability to manage functional complexity, with a special emphasis on the complex interrelationships between mechanical, electronic and software engineering
- Ability to manage process complexity in an environment in which a steadily growing portion of innovation is contributed by suppliers

The Mosaic of Vehicle Development Today

The product development organizations, methods and tools of today can often be traced back to their origins in the 1980's (or earlier). At that time, vehicles were very different from those of today. The electrical system consisted primarily of the ignition system and lights. "Electronics" were limited to an interchangeable radio that was slotted into the dashboard, with connections only to an antenna, the power supply and usually two speakers. There was a limited number of vehicle models, each having just a small set of options. Development times were 54 Months or more (compared with the 12 months that leading OEMs are targeting today).

The development ecosystem was also much simpler. Suppliers were providers of components rather than of systems, and were mostly co-located in the same country or region as the OEM. On the IT side, CAD, CAM and CAE were emerging technologies. The mainframe-based BOM systems were customized developments to manage the almost exclusively mechanical vehicle components.



The product development organizations, methods and tools in today's automotive industry can often be traced back to their origins in the 1980's (or earlier). The result is a mosaic of organizational units and corresponding processes and IT tools.

In essence, these structures have remained unchanged to the present day. As the new disciplines of electronics and software have emerged and grown in importance, additional organizational and IT structures have been added, each with their own processes and toolsets. In parallel, IT techniques, such as simulation (crash, aero-dynamics, noise and vibration, etc.) have developed to partially replace the building and testing of prototypes. But the core structures are unchanged.

The result is a mosaic of organizational units (interior, exterior, powertrain, chassis, electrics and electronics (e/e), software, development, simulation, product development IT, etc.) and a corresponding mosaic of processes and IT tools. Inevitably, the many pieces of this mosaic are linked via interfaces, with data held redundantly. This opens the door to inefficiencies, time-lags and inconsistencies.

As with all complex systems that have evolved haphazardly over time, a point is reached where throughput can no longer be increased proportionately. This is the situation we find in many automotive development organizations today – and, at a time when the challenges and demands on product development are increasing dramatically.

Technology Support for the Vehicle Development Process

The Critical Role of System Architecture

In order to successfully manage the increasing complexity in the vehicle development process, both OEMs and systems suppliers need solutions that are able to represent the complete vehicle or system (and the required sub-sets), including all of its associated data regardless of origin, and to map and control all key processes.

Given the mosaic—we could also say fragmented—nature of product development IT infrastructure today, and the related challenges of data redundancy and inconsistency with resulting negative impact on development efficiency and product cost and quality, it is not surprising that the industry is searching for improvement.

In this search, a number of competing directions can be identified:

- Extension of ERP solutions in the manufacturing area back into the product development arena. These attempts are largely failing, as the static and highly controlled ERP approach is not applicable to the highly creative, dynamic and flexible product development process.
- Improved integration of the IT systems, using framework techniques such as SOA, or standard based approaches such as proSTEP. However, these fail to eliminate the fundamental issue of multiple, redundant and inconsistent data pools.
- The aggregation of multiple systems into consolidated “product development systems.”

In fact, these approaches are not mutually exclusive, and in today’s automotive industry, product development is characterized by a mix and match of solutions, technologies and interfaces.

A “New Breed” of Automotive Product Development System

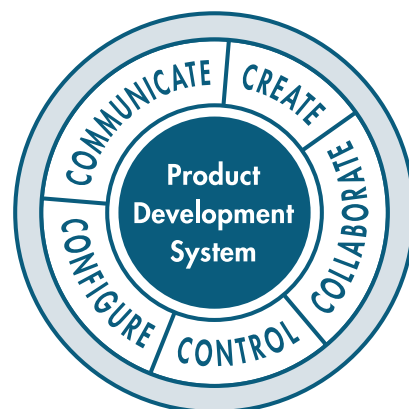
PTC believes that a new breed of standard “Automotive Product Development System” is called for, with a broader footprint than existing solutions, and linked to other enterprise applications such as ERP, using SOA or other open architecture approaches.

Given the complex nature of today’s vehicle ranges, variants and configurations, the requirements for a new, integral breed of Automotive Product Development System are extremely demanding. A system capable of handling today’s levels of complexity has to be able to accommodate a number of sophisticated methods of product structuring, adopted and refined by automakers and tier one suppliers over time, including:

- Super Product Structures: Ability to handle extremely complex product structures, including all associated data, regardless of their origin (Multi-vendor MCAD, ECAD, Software, ERP, etc.).
- Product Configuration: Ability to identify the exact set of assemblies, components and related information for a specific instance of a product, such as a specific car to be simulated, prototyped or manufactured.

- Modularity: By carefully architecting the vehicle into modules, interdependencies can be minimized and managed through a clearly defined set of interfaces. Modules can be utilized in multiple vehicles or systems, thus maximizing reuse and quality while reducing cost, and are subject to their own lifecycle (module management).
- Layered Product Structure: Ability to manage product structures with several levels of abstraction: from the complete range of variants of a given vehicle range (upper layer) down to modules, parts and components used in the different vehicle variants and versions (lower layer), linked via a configuration layer, representing multiple options for individual assemblies and components.
- Zone Management: Ability to divide a vehicle into a number of zones, such as front-end, rear-end, interior, powertrain, etc., with zone responsibility allocated to a specific development team.
- Design in Context: Provide visibility of neighboring parts or assemblies to enable first-time-right design for any new components.
- Stage Gate Development: Stage gate development processes force synchronization of product development information at predetermined points in the overall development process, and provide transparency to the progress of the overall development process.
- Views: As the product progresses through development, different functions require different views of the product. Typical views may be: ‘as-proposed’, ‘as-specified’, ‘as-designed’, ‘as-manufactured’, ‘as-planned’, ‘as-maintained,’ and ‘as-operated’.

In addition, automotive vehicle development requires multiple different stakeholders and organizations, such as engineering, manufacturing, cost and weight targeting, etc., to view and handle data in their respective form and format.



PTC believes that a new breed of standard “Automotive Product Development System” is called for with a broader footprint than existing solutions and tightly linked to enterprise applications.

The PTC Automotive Product Development System

In an integral environment known as the PTC Product Development System, PTC is able to provide the automotive industry with the first state-of-the-art product development system covering the comprehensive range of requirements of all different stakeholders in the automotive engineering process.

Based on the modern PLM platform called Windchill®, PTC's Automotive Product Development System provides a proven, integral architecture, where all capabilities and all forms of product information are linked through a single source of product data, ranging from all major MCAD and ECAD applications used in a typical product development process, through to information shared with other enterprise applications, such as ERP, CRM, and SCM.

PTC's Product Development System manages interdependencies across all forms of product information, so that everyone on the team can easily understand how their input impacts the overall product. The PTC Product Development System integrates product information from multiple sources and disciplines, enabling total vehicle and system confidence, from the first design iterations to start of production (SOP). This holistic, systems approach to product development enables a front-loaded development process, with synchronized processes for simultaneous execution and rigorous standardization for strategic flexibility.

Through its holistic concept, the PTC Product Development System enables the efficient management of the development process, product structures and documents, options and variants, and configurations, across the extended enterprise. By providing all stakeholders with individualized views of content, digital products can be complete, compelling, and stable—all before the expensive physical process of manufacturing ever begins.

Key Capabilities and Benefits:

- Work with a 'single point of truth' for all product information throughout the development process, including CAD data from Pro/ENGINEER®, CATIA® and other systems
- Manage the many options and variants typical for cars, trucks and heavy equipment
- Manage mechanical, electronic and software components in a single structure, thus reducing inconsistencies
- Control change management across all information and applications
- Increase product quality by ensuring that virtual and physical prototypes are built with the correct product configuration
- Reduce the number of physical prototypes required
- Support multi-site, multi-company, global collaboration in all its forms

PTC's Product Development System for the Automotive Industry:

Targeted on Six Key Initiatives:

Based on extensive research and project experience from working with major automotive OEMs and tier-one suppliers around the globe, PTC identified six key initiatives that can be efficiently addressed through the Product Development System. All these initiatives benefit from the PTC Product Development System's holistic, systems approach to product development, enabling a front-loaded development process through global collaboration and process and project management for simultaneous execution.

1. Vehicle and System Development Management

Isolated systems and processes today make it difficult to obtain a complete and transparent view of the entire vehicle being developed, its components and modules. Through its integral Product Development System, PTC provides one single source of truth for vehicle information, enabling the efficient management of product structures, options and variants, zones, and configurations. With its open systems architecture, the PTC Product Development System is capable of integrating information from various sources and disciplines, enabling total vehicle confidence, from the first design iterations to SOP.

2. Automotive System Design and Mechatronics

As automotive product development continues undergoing massive changes, with Electronics and Software engineering playing a more significant role in vehicle development, individual development disciplines often collaborate insufficiently, resulting in required changes being discovered late in the development process, causing unforeseen cost and quality problems. The PTC Product Development System offers the widest support of integrations to different ECAD and software configuration management tools, including IBM® Rational® ClearCase®. It also enables automated design checks to identify potential problems across disciplines, and provides collaboration tools to solve problems early in the process.

3. Design, Supplier and Manufacturing Collaboration

Due to major shifts in the value chain, with tier-one suppliers taking over the role of technology drivers in many areas, vehicle development requires close collaboration with design partners, suppliers, and global manufacturing sites. To protect intellectual property, collaboration needs to take place in a secure environment. In addition, companies must ensure that up-to-date product information is being used. With its role- and task-based access, PTC provides a collaboration portal solution, enabling secure and efficient collaboration both within the extended enterprise and across the supply chain.

4. Powertrain Development

Modern engines, and in fact the entire vehicle powertrain, must be highly optimised in order to meet stringent environmental, fuel consumption, cost and weight requirements. PTC's solutions - including Pro/E, Mechanica and Mathcad - are ideally suited to rapidly calculating, making and verifying the changes needed to optimise powertrain components and systems. In addition Windchill manages the entire Powertrain development process, from requirements to prototyping and release-to-manufacturing, ensuring efficient and transparent execution at all stages of the process. The result: clean and efficient propulsion systems developed on-time and in budget.

5. Quality Management

Rising customer expectations and warranty costs require automotive manufacturers to take quality as seriously as ever. PTC's solutions support the rapid and efficient implementation of quality initiatives such as 6Sigma, APQP and CMMI (or CMII). By rigorously managing quality related information and documents, as well as processes and workflows, quality processes are institutionalised in the product development process. Standardised processes form the basis for continual improvement and a learning organisation, resulting in higher quality products with satisfied customers and reduced warranty costs.

6. Publishing for Owners' and Service Manuals

Increased product complexity, regulatory compliance, and customer demand for personalized information are forcing auto manufacturers to rethink how they author, manage, publish and deliver their product information. With the dynamic publishing capabilities of PTC's Arbortext® software, PTC's Product Development System is the industry's first and only integral solution that enables companies to collaboratively author, manage, publish and dynamically deliver personalized publications from a single-content source.



Through its holistic concept, the PTC Product Development System enables the efficient management of the development process, product structures and documents, options and variants, and configurations, across the extended enterprise.

Optimizing Product Development Processes:

The PTC Value Roadmap

To be effective, technology solutions must be more than a disconnected bundle of features and functions; they must be designed and tested to work together to optimize key business processes in a way that addresses specific user's requirements while maintaining data integrity for all constituents. PTC's Product Development System supports the typical landscape of processes relevant for automotive manufacturers and leading suppliers, enabling the simultaneous execution in an integrated, associative environment. This process-based framework also helps guide a phased deployment strategy, so companies can extract value sooner by addressing the highest priority processes first.

Key Processes of the PTC Automotive Product Development System include:

Systems Design

For a successful vehicle system design process, it is important that functional and physical architecture design tools are integral with those tools used not only to create detailed product designs, but also to execute the project plan. The PTC Product Development System supports the creation and management of both functional architecture and physical architecture, and the interfaces necessary for successful system design. With strong process management capabilities, companies can consolidate existing knowledge from all members of the extended enterprise to create a global standard as a base of a global system design process.

Change Management

In today’s competitive global business environment, in which products and development processes are becoming more complex and increasingly collaborative, a well-defined and orderly process for controlling the changes to product configurations, from conception to retirement, is assuming a key role. PTC’s Product Development System provides automated, best-practice change processes that enable all product development stakeholders to instantly access all necessary data. Comprehensive configuration management capabilities allow the impact of proposed changes on product lines to be easily communicated and evaluated, as well as safely implemented.

Design Outsourcing

As manufacturers are transforming their product development models from local cross-functional operations to highly collaborative global operations, the collaboration and process management capabilities of the PTC Product Development System optimize the design outsourcing process by providing project templates and management of project plans, deliverables and actions, to ensure the proper process control. In addition, the PTC Product Development System provides integrations with all major MCAD and ECAD formats, enabling an environment ideal for working with many partners. Visualization and markup capabilities, combined with workflow-driven process automation, deliver a perfect collaboration environment.

Concept Design

With the PTC Product Development System, all product information surrounding concepts is managed in a single, structured, cross-discipline product data repository that offers timely and role-based access to a geographically dispersed product development team. Suppliers and downstream processes can be integrated securely and seamlessly into this collaborative environment to ensure concept designs meet requirements.

Detailed Design/Design in Context

Today’s detailed design process is characterized by highly sophisticated designs and an ever-increasing demand for data sharing. Since many companies operate in a distributed environment—involving partners and design teams operating across timzones and language barriers—it means fast, secure information access is essential. PTC’s integral Product Development System ensures that everyone is working on the correct version of the data while tracking team decisions and having real-time visibility into the team’s progress.

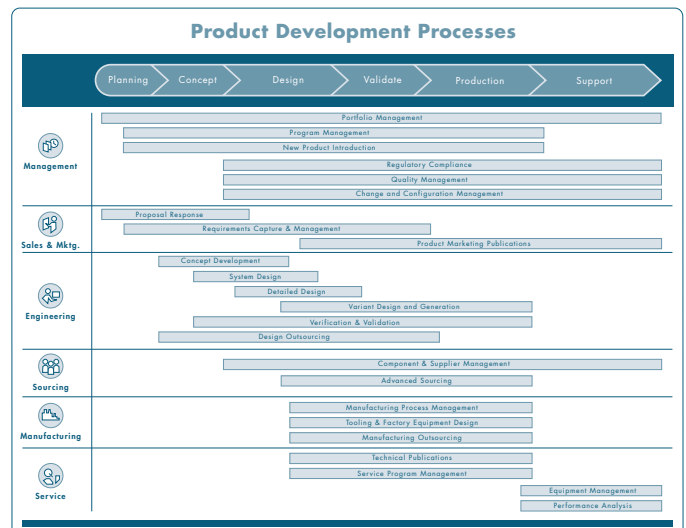
Physical and Digital Validation

Test configurations used in digital and physical testing often differ from the design configuration, and once testing is initiated, the design configuration may well continue to evolve, resulting in a testing configuration that has “fallen behind” the design configuration. PTC’s Product Development System provides integral solutions for synchronizing changes between configurations, and full traceability between test results, test configurations, and design configurations.

Conclusion

The automotive industry will face unprecedented challenges in the coming years, and product development is a key to successfully facing those challenges. In order to do so, a major overhaul of current Product Development processes and IT-infrastructure is necessary.

Based on PTC’s state-of the-art Windchill PLM System, the PTC Automotive Product Development System will make a major contribution to the competitiveness of vehicle development organizations, using the system as the heart of their vehicle development environment.



PTC’s Product Development System provides automated, best-practice processes that enable all product development stakeholders to instantly access all necessary data.

Top Automotive Firms Worldwide Trust PTC to Improve Processes

PTC today serves a significant customer base in the global automotive industry. From working with these customers, we have gained significant insight into best practices, which have provided the basis for the solutions portfolio of the PTC Automotive Product Development System. PTC customers include:

- Arvin Meritor
- Behr
- BMW
- Borg Warner Automotive
- Brembo
- Bridgestone/Firestone
- Continental
- Cooper Standard Automotive
- Daihatsu Motor Co
- Daimler
- Dallara Automobili
- Dana Corporation
- Delphi
- Dong Feng
- Ducati
- Faurecia
- FAW
- Federal Modul
- Ferrari
- Fiat Auto
- Getrag
- GKN Driveline
- Goodyear
- Harley-Davidson
- Harman Becker
- Hino Motors
- Hoerbiger
- Honda Motor Co
- Hyundai
- IVECO
- Kawasaki
- Knorr Bremse
- KTM Sport Motorcycle
- Kwang Yang/Kymco
- Lear Corporation
- Leyland Trucks
- Magna
- Magneti Marelli
- MAN
- Mando
- Maserati
- Michelin
- Mitsubishi
- Paccar
- Penske Racing
- Piaggio
- Pirelli
- Polaris
- Porsche
- Robert Bosch
- Scania
- Schaeffler
- Seat
- Skoda Auto
- Suzuki
- Tata Motors

©2008, Parametric Technology Corporation (PTC). All rights reserved. Information described herein is furnished for informational use only, is subject to change without notice, and should not be construed as a guarantee, commitment, condition or offer by PTC. PTC, the PTC logotype, and all PTC product names and logos are trademarks or registered trademarks of PTC and/or its subsidiaries in the United States and in other countries. All other product or company names are property of their respective owners.