Siemens PLM Software

Global engineering for the automotive industry

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white paper

The automotive industry has always been competitive. It's this competition that drives automobile manufacturers and their suppliers to continuously adapt in the marketplace. In the 1980s, adapt meant expansion. Fueled by foreign investment, OEMs grew their organizations by diversifying their manufacturing footprints. Having a broad manufacturing footprint enabled organizations to build products in close proximity to the markets they were to serve. The 1990s brought consolidation. Mergers and acquisitions allowed OEMs and Tier 1 suppliers to quickly gain global market share as well as broaden their product portfolio.

These strategies from the past will not suffice in the hyper-competitive environment we are in today and for the foreseeable future. Certainly expanding manufacturing to a new market and strategic acquisitions or partnerships will continue, but they are no longer providing the competitive edge they once did. Success today will only be achieved through new operational models, designed to take advantage of a global footprint. Business processes designed, not just to support globalization, but to leverage it and thrive.

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Executive summary

Manufacturers today have global footprints that to some degree include both product development and product manufacturing. That footprint is designed to pursue markets that are dispersed around the globe. These same manufacturers leverage a supply chain for specific expertise – those suppliers being local to the region or regional operations of equally global organizations. Where these three dynamics overlap is at the product. An automobile manufacturer, together with its supply chain in response to specific customer requirements, introduces a product to capitalize on that specific market.

This has produced two distinct product development styles. The first is the global grid or homeroom. It's characterized by a matrix of engineering expertise classified by primary and secondary vehicle development responsibility. Primary vehicle development includes execution and decisions surrounding vehicle structure, chassis, engine box, build process, powertrain protection, safety, electronics, seating dynamics and sourcing decisions thereof. Secondary vehicle development includes execution and decisions surrounding final exterior and interior design, homologation/regulatory issues, late integration components (tubing, glass, wheels/tires, interior/exterior colors, etc.), plant logistics concerns and final vehicle contenting.

The second distinct product development style is a more centralized model with all primary development done in a single location to ensure a tighter degree of process commonality. Each of these approaches has its own unique benefits and challenges. There is no right or wrong way, and there are no absolutes. In the homeroom methodology certain aspects of the business, such as purchasing, still may be centralized. And in the centralized model there may be such specific expertise at a local level that it becomes a center of excellence.

Globalization is also linking national economies and cultures in new ways requiring engineers to develop a global perspective. The international competition for talent is and will be intense. Global work teams are becoming commonplace as engineers are being assigned to projects with international components.

To be successful in this global environment, engineering teams must work effectively with personal, social, business and cultural differences across its membership. Each member must become competent in the international business environment and hone their multicultural awareness. An engineer in today's global workforce must be able to complement his or her technical skill with many other critical skills, including:

- *Being able to analyze other cultures' needs, and design products and services to fit those needs*
- *Understanding the business environment of the countries where your products and services are made, bought or sold*
- *Awareness of customs, laws and ways of thinking*
- *Being self-confident yet humble, listening and learning from people whose value systems differ from yours*
- *Understanding local negotiating strategies*
- *Balancing efficient and effective global business travel with family responsibilities*
- *Being able to unite individuals' diverse skills and interests into a common purpose*

In addition to effective interpersonal skills, companies need a development environment that is built specifically to engineer automotive products globally.

Three requirements are essential for success:

- *The ability to validate designs virtually*
- *The ability to access information when and where you need it*
- *Let individuals work the way they want*

"Managers really need to rethink their approaches to R&D globalization and move beyond a primary emphasis on cutting costs or extending global R&D platforms. Instead, they should tap into local engineering and marketing talent, give them the responsibility to identify local trends, and then develop products and services that meet local demand. Otherwise, these companies will be overtaken by increasingly sophisticated local players in these markets."

Mads Lauritzen
McKinsey & Company Automotive & Assembly Extranet
http://autoassembly.mckinsey.com

[1] *The CPG Innovation Agenda*, December 2005.

Introduction

With their eyes on the exploding markets of Russia, China and India, the world's automakers are searching for ways to quickly produce vehicles that capture the hearts and imaginations of the regions driving consumers. Anyone who has observed the automobile industry over the years has seen dramatic improvements in the development cycle time for new models – down from four years in the early 1990s to about 18 months on average today. Yet automakers know that earning a position in the greenfield markets of the Far East will require more than just a nimble response.

As part of their strategy for accomplishing this, the major automakers have adopted a platform approach in which about 40 percent of vehicle content remains the same across multiple vehicle variants. Toyota's Camry platform, for example, forms the basis for a four-door sedan, a two-door coupe, a cross-over SUV, a minivan and others for a total of 7 different vehicle variants. Other vehicle manufacturers form alliances in which they share vehicle platforms with one another.

A global platform strategy lets automakers react to changing demand more quickly since development can focus on the remaining 60 percent of the vehicle tailored to the target market.

Another difference in how platforms operate can be seen in the configuration of the platform development footprint. Some companies create a global grid of "centers of excellence" or homerooms while others take a more centralized approach. The management of each vehicle platform in the grid methodology is "owned" by a specific homeroom, typically located in the region of the world that has the most expertise in that type of vehicle. In addition to platform ownership, each homeroom also serves as the center of excellence for a primary development function, such as powertrain, electronics or vehicle safety. With a centralized approach most platforms and primary vehicle development functions come from the corporate headquarters with the remaining vehicle content coming from the different regions where the cars are manufactured and sold.

In the past, auto companies tried to design a single car for the multiple markets around the world. These "world car" efforts almost always failed due the generic nature of the resulting designs. By trying to design and build a single vehicle for multiple markets, automakers failed to capture buyers in any of them.

Today, the concept of a vehicle platform is somewhat more complex, incorporating a variety of systems shared between vehicles but with styling that disguises the parentage. In fact, not even the floor-pan is common across a platform, as significant alterations are usually required to suit the individual models. The subframes, powertrain, suspension, steering, braking, safety and electrical systems are often common, as is the HVAC (heating, ventilation and air conditioning), but detail variations can be considerable. In terms of the resultant vehicles, the manufacturers can instill vastly different characteristics. Using a single source of product and process knowledge to manage this complexity enables engineering teams dispersed around the world to retain their domain focus and user preferences, while working in each other's context to jointly meet overall development goals.

▶ Validate designs – virtually

Physical mockups of a vehicle take time and mistakes are common. Digital mockup is intended to ultimately eliminate the need for physical "bucks" used for the purpose of validating fit, form and function of components and subsystems. Digital mockup has made things easier, but it still does not allow for analysis and validation in real time. Furthermore, much of the impact of analysis – the validation – of a proposed change still needs to be done manually by an engineer. In other words, the impact of proposed changes – whether new design, alternate approaches or cross-product re-use – has to be examined in terms of all the parts of an existing design and all currently considered variations.

- Traditional digital mockup is essentially a collection of 3D models which are positioned in 3D space to represent the form of the product to be developed. This process has come a long way over the years, but it still has many limitations. While it does provide for full visualization of the product in three dimensions, it is typically built at the single vehicle level. This means that a subsystem provider would need to launch multiple mockup sessions to validate for the platform. And that's assuming that a mockup structure has been built for each vehicle. Usually, the time required to build and maintain each "virtual buck" is prohibitive and just the most complex variants are maintained. It certainly provides for collaborative engineering as all users can see other users' work as it evolves, which will improve error detection by locating clashes/interferences earlier in the process. The problem is that those detections are based on static models. Clashes need to be evaluated dynamically, while simulating the function of the vehicle or the vehicle manufacturing process.

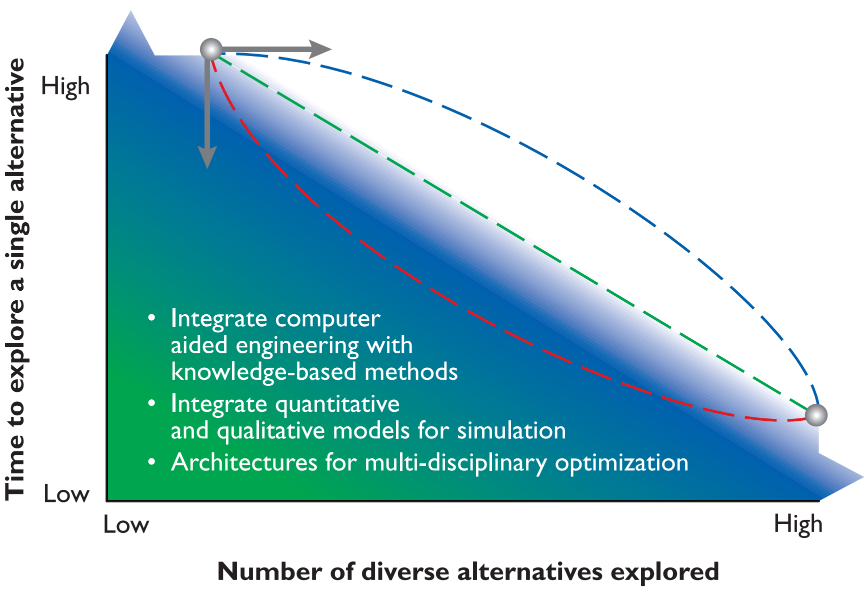

Figure 1: How time available affects innovation. Source: DARPA RaDEO Project.

The next generation of digital mockup needs to sponsor the virtual analysis and validation of the vehicle as a platform – including each and every buildable vehicle combination within that platform. These buildable combinations need to be validated by the multiple domains and disciplines involved in the development process. Furthermore, those domains need to perform those validations in the context of the behaviors for which they are responsible. Critical decisions and tradeoffs will be made, fully supported by visual communication. And quick, valid decisions during the development process shorten the time it takes to bring a new product to market. The next generation of digital mockup must also support the ability to visualize the effects of changes in software (SW) and electronics; today, these are nearly invisible to the virtual build process.

A typical vehicle has well over 10,000 components. Vehicle design done at the platform level has as its goal to reduce the number of unique components per vehicle but at the same time greatly increases the complexity and size of the platform itself. Effective platform strategies require that digital mockup be performed at the platform level. Engineers responsible for common subsystems and processes must enter the mockup environment in the context of that platform. This creates a huge challenge to performance. What is required is a paradigm shift – combining a traditional platform level product hierarchy with an intelligent and always-on options and variant engine and up-to-date spatial analysis results. This system capability enables the engineer to configure all of the data specific and relevant to their decision making process in real time... every time. This always-on and up-to-date context then becomes the setting for validation studies and decision making analysis. Simulation results can be viewed within the context of the components' or subsystems' multiple usages. That means that a CFD analysis for airflow under the hood can quickly be viewed in the context of both multiple powertrain options as well as multiple grill and fascia applications. Thermal analysis done to generate the keep-out zone for an exhaust system can quickly be viewed in the context of the multiple vehicles with all of their options to see if a single component on any build violates it.

The goal in the end is to combine both geometric and analytic information into a single, always-on and always-current visual environment. This environment has visibility at the platform level to the multiple domains involved in the vehicle design and manufacturing processes. This new environment will allow each member of the platform team to make rapid and confident decisions producing higher quality, more innovative products, for less cost in a shorter time.

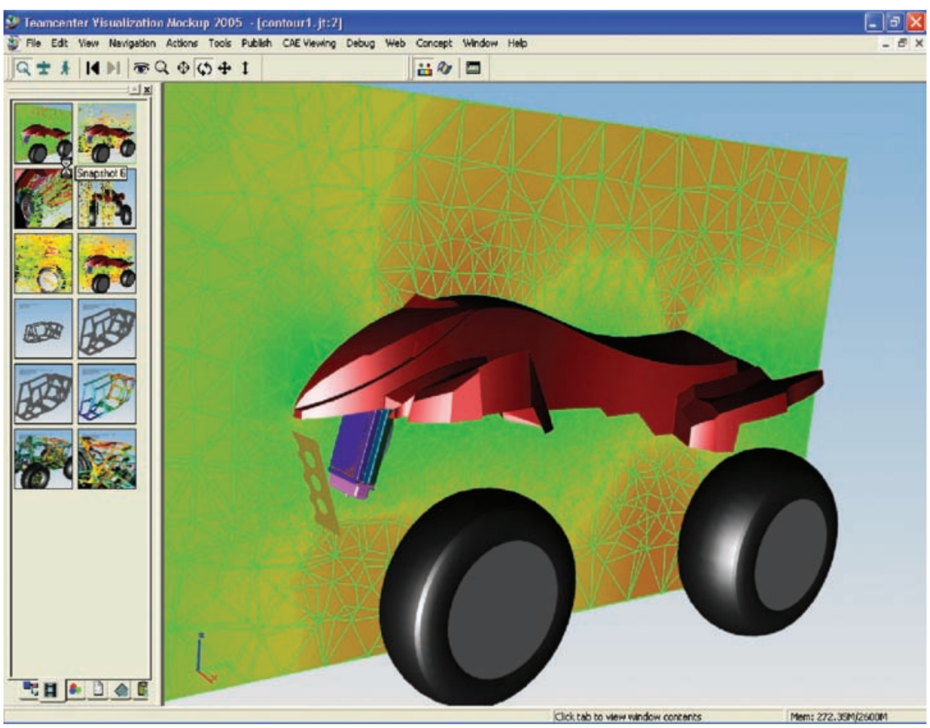

Figure 2: Interactively simulate behaviors, in real time, from multiple domains and validated in the context of the platform.

▶ Access information when and where you need it

In today's global environment, companies need to manage and share information deep within the organization, as well as broadly with all of their diverse and remote locations.

Product development today is a function of multiple domains. The information that is generated in each engineering department is very different. Mechanical design data has certain requirements. Electrical components have their own specific characteristics. Wire harness and manufacturing processes are different as well. A global product development environment needs to provide an intelligent structure to manage this varied data and make it useful to the other domains – not just unintelligent folders of data that hang off of an item in the bill of material. There also needs to be very robust extensions to provide support for all the aspects of product lifecycle management data requirements such as security, configuration, workflow and change management. These two distinct sets of requirements combined are typically referred to as the data model.

The second aspect of a comprehensive global product development environment is its ability to efficiently move the information around the globe to your many diverse team members. File sources are geographically distributed and need to be managed where they are used and securely available to the many partners on the team throughout your extended organization.

Some of the challenges here include the very different network resources that are available around the world. Bandwidth and latency become very important. Compounding the challenge is the larger file sizes of CAD and simulation data. The solutions to these challenges are typically described in terms of architecture.

"Having a single source of information has become very important to BSH because now there is no question as to what is right and what is wrong."

Matthias Bronowski, BSH Project Manager, Teamcenter Next Generation
BSH – Bosch und Siemens Hausergeräte Gmbh

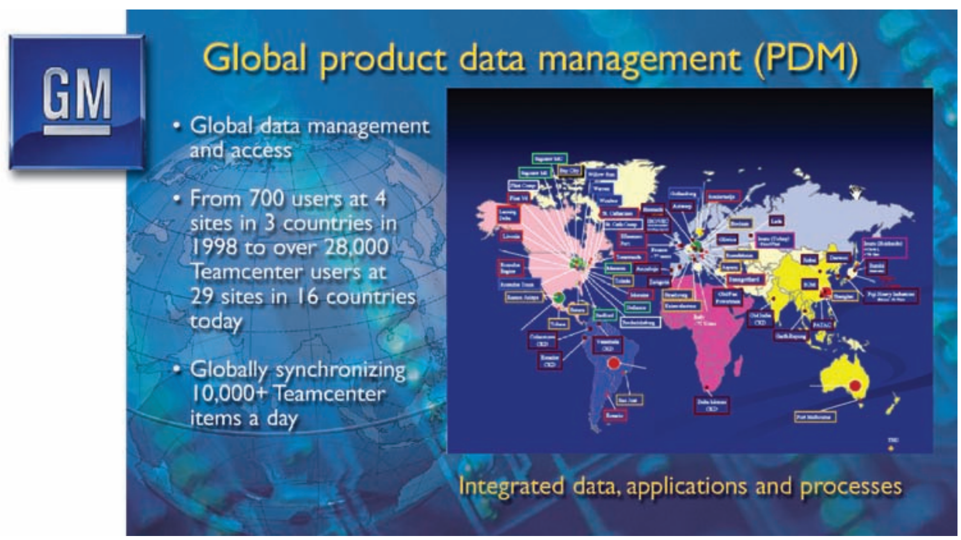

Figure 3: A scalable product development environment leveraged worldwide daily.

Having a highly scalable solution in both data model and architecture also helps to simplify the requirements for deployment, provides a great deal of flexibility in that deployment and simplifies system maintenance. The system will also provide extremely high availability and very good performance for thousands of users simultaneously around the globe.

In addition, automotive companies are achieving greater engineering synchronization by facilitating collaboration across their manufacturing environment. These initiatives enable all parties to conduct their design work in a digital representation of the plant floor. This makes it much easier for everyone to understand how their particular designs affect other designs. Once this initiative is implemented, design teams no longer need to meet in a single location or go to the physical plant to work in context. They can simply collaborate around the digital version from wherever they normally reside. Synchronizing product and manufacturing engineering leverages the strengths of the entire team to arrive at decisions that represent the best course of action.

Let individuals work the way they want

Increasingly, globalization is bringing together design teams with multiple ethnic groups with very different cultures. Today, your design team will more likely consist of team members from France, China, Germany, Brazil and other locations around the world. It is important to recognize that people from different cultures bring unique perspectives, alternate ways of expressing themselves and distinct working styles. They also bring with them a keen understanding of the market your products will enter.

In order to accommodate these multiple perspectives the product development environment must support a variety of views. Product structure, for example, should support being viewed in the classic arrangement with the left justified indented bill of material fully supported by the large embedded graphic viewing subpanel. Attributes are aligned in a tabular fashion, and you

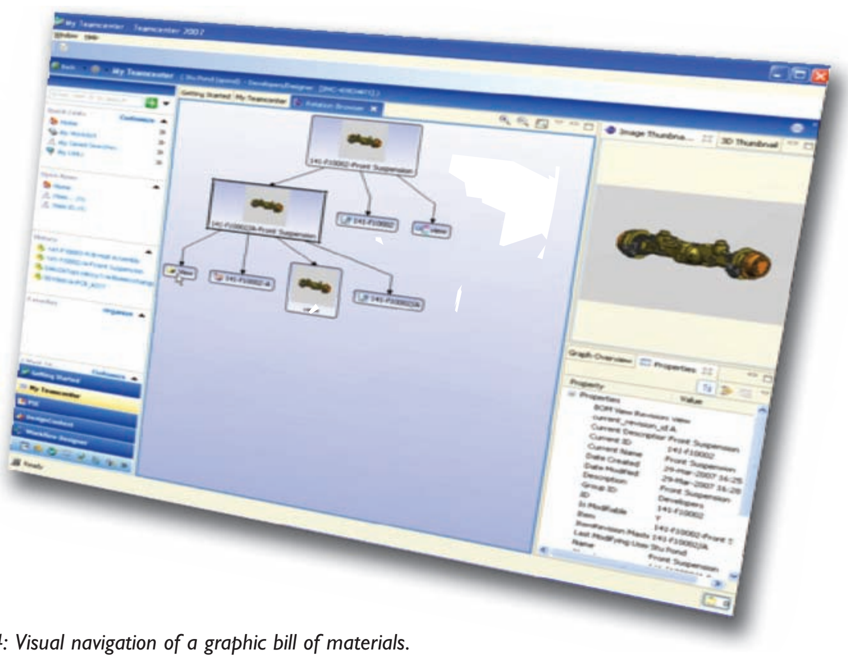

Figure 4: Visual navigation of a graphic bill of materials.

can navigate the structure by expanding the plus sign to the left. Conversely, there is also a completely graphic structure whose hierarchy display is top-down. Each item is supported by its own thumbnail with specific attribute detail being displayed in a subpanel. Product expansion is accomplished through double clicking on the item. The window itself supports panning and zooming. The result is two different arrangements to perform essentially the same tasks but supporting different perspectives and work cultures and, most importantly, driven by the same single set of data representing the product.

Many tasks should support the diversity of views, providing context for users. Change management is also an area that can benefit from this alternative presentation of views. One view could provide the specific subject, details and parts affected for the change itself; another view displays the workflow necessary to complete the change, the status of each step, with deadlines and due dates to ensure the change achieves completion. Not only must the development environment support multiple views and perspectives of the PLM information, it supports multiple options for clients to connect to the PLM environment. Thin clients, rich clients, clients embedded in the applications, network folder access and community clients are all designed to give PLM access to very specific work processes and perspectives. The individual users stay in the authoring tool that they prefer and can transition seamlessly between them when necessary or desired.

Conclusion

Global market dynamics continue to drive investment into production facilities and design centers in emerging markets in order to reduce operating costs. Establishment of global alliances and in some cases established commercial strategic partnerships between North American, European and Japanese automobile manufacturers continues. Automotive suppliers are not immune to this expansion and continue to follow their customers around the world. The competitive global business arena is relentless in its demands that companies reduce costs, speed cycle times and improve efficiency in order to succeed. Executives must have the right information in the right systems and in the hands of the right people so that critical decisions can be made in an aggressive marketplace.

To satisfy those challenges, companies need a working environment that is built specifically to engineer automotive products globally.

Specifically there are three requirements that are essential:

- The ability to validate designs – virtually
- The ability to access information when and where you need it
- Let individuals work the way they want

In order to remain competitive and to ensure that they have the most functional and collaborative product development environment, automotive OEMs and their suppliers need to fully embrace PLM. Companies that implement PLM-based global engineering processes can manage today's complexity and optimize their product development from a strategic global perspective. PLM removes the challenges imposed by a global footprint and turns that scale into a product development asset resulting in:

- An increased number of new product introductions in less time
- Greater level of commonization and re-use while maintaining specific market distinctions
- Greater leverage of production facilities and supply chain
- Improved capital utilization

To learn how automotive companies are meeting the specialized, local market needs while leveraging common systems and platforms through PLM, visit: www.siemens.com/plm/automotive/

Siemens PLM Software

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