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The Future of Automotive Design & Development: 3D for All

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ABSTRACT

For over 20 years, automotive manufacturers have been harnessing the power of 3D to help create, optimize and produce great vehicles. Product Lifecycle Management (PLM) capabilities such as concurrent development, seamless integration, simultaneous engineering, single source database, and real-time visibility have long been capable within the automotive development process. However, the reality is that these tools have existed for a select few within a corporation, and have never been pervasive to every person involved in a product's development process.

Today, there are certain market drivers requiring more from PLM technology. This includes the fact that companies must drive innovation to survive in today's increasingly competitive and global auto industry. The next generation of 3D PLM tools, referred to as PLM 2.0 can bring real-time, global collaboration to life with features such as a single PLM platform for Intellectual Property (IP) management (one database and one server), and the open Server-Oriented Architecture (SOA) development platform. With only a web connection, product authoring and collaboration are enabled for real time, concurrent work, across multiple remote locations all in a 3D lifelike environment.

This presentation will point out how by expanding 3D PLM beyond engineering and manufacturing to include everyone who has a role in the life of a vehicle from business users to end consumers, vehicles will be developed in a shorter time frame, and better-suited to the public desires, with improvements made along the whole product development process.

INTRODUCTION

With the intense competition in today's global market place in addition to recent economic events, the auto industry is under extreme duress to improve the efficiency and effectiveness of the way it designs and builds vehicles. Whereas North America, Western Europe and Japan accounted for nearly 90 percent of global production earlier in the decade, these are mature markets that have clearly experienced over-capacity.[1] China is now the worlds' third largest producer of cars[2], bypassing the United States. Despite the current economic crisis, growth opportunities for vehicle production in emerging markets such as Latin America, India, Russia, and China is still expected to grow.

All of this makes the competition for the North American vehicle buyer even more fierce. Although this market has a large number of automotive styles to choose from, many seem to be similar in looks, function and performance. Successes of cars like the Chrysler PT Cruiser and Chevrolet HHR will continue to fragment the market, yet provide OEMs the ability to differentiate themselves in order to gain customer loyalty and market share. With tightened credit markets, buyers will be much more select in their new vehicle purchase decisions. The bottom line is that vehicle manufacturers must deliver what the consumer wants, when and where they want it, at a price point they are willing to pay.
Global product development strategies are implemented by every major vehicle manufacturer with the Tier suppliers following suit. Work can be performed around the clock to, supposedly, reduce product development time. However, globalization comes with its own set of challenges for manufacturers, including differing compliance requirements, materials availability and cultural issues that affect vehicle styling and features.

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Expanding the number of partners involved, especially when they speak a different language, brings increased risk of miscommunication. Meeting the needs of vastly different consumer markets requires the design and production of additional vehicle styles while ensuring product quality and regulatory compliance. Additionally, design and production facilities are spread across the globe, requiring a central system of consistent and current information. Everyone must be working from the same page.

These global product development strategies have been greatly enabled by the deployment of modern computer-aided design, manufacturing, testing and simulation technologies, helping OEMS gain both financial and operational efficiencies. By employing integrated CAD/CAM/CAE tools across the entire product lifecycle, companies can better automate, manage and collaborate. This leads to increased innovation in creative product design as well as efficiencies in manufacturing considerations.

As globalization of the automotive industry continues, global centers of excellence are developing, making the standardization and sharing of disparate, yet related information even more critical. In order to innovate efficiently, companies must maximize the use of their intellectual assets that are spread across the world to share the knowledge base and intellectual properties, spurring frequent, global, ad-hoc collaboration, leading to innovation.

While collaborative innovation is a critical factor in maintaining competitiveness, it must be achieved within an environment where overall product related costs must be reduced across development, production, and service in order to sustain a company's operational excellence.

Achieving and sustaining business success requires the ability to increase the pace of innovation and new product development. To do so, companies must open communication channels, standardize processes and offer technologies that foster a continuous improvement environment. The challenge is to have everyone -- from planners, designers, and analysts to manufacturers, service personnel, and importantly, the consumer, to be able to see and participate effectively in the complete product lifecycle.

MAIN SECTION

THE ROLE OF PRODUCT LIFECYCLE MANAGEMENT (PLM) -- Product Lifecycle Management (PLM) is defined as a strategic business approach that applies a consistent set of business solutions support the collaborative creation, management, dissemination and use of product definition information. It also supports the extended enterprise (customers, design and supply partners) and spans the concept of end of life for a product, integrating people, processes, business systems and information.[2] The goal is to capture every aspect of the automotive development cycle in a way that can automatically convey, not only how design modifications affect manufacturing planning but also, how changes in materials cost and labor, differing environmental regulations, etc., can affect the delivery, maintenance and cost of a vehicle.

Whereas early implementations of PLM were typically customized programs of functionally-focused applications to address specific issues (primarily CAD file management), most current PLM includes management of all product-related information from design to manufacturing deployment to maintenance to compliance requirements. PLM solutions link information from many different authoring tools and other systems to the developing product configuration. However, even with this level of sophistication, both PLM and PDM (Product Data Management) solutions are typically document-focused solutions delivering a CAD part, a Word file or Excel spreadsheet… something that is textually-based. (Fig.#1) This can be a potential problem in a global workspace.

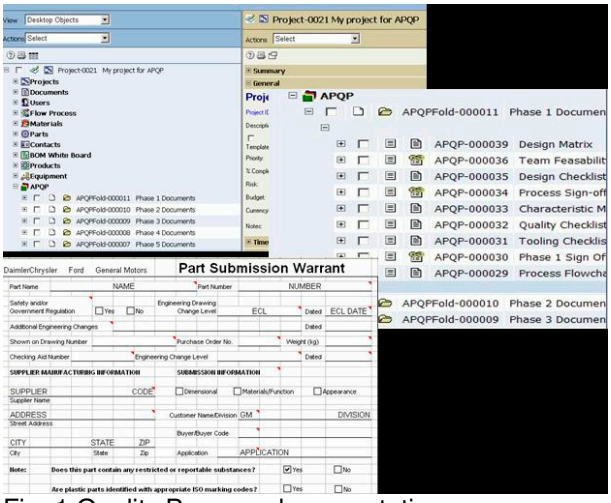

Fig. 1 Quality Process documentation

Also, the idea of a single source database from which all other data throughout the lifecycle process is based, has been elusive. There has always been an issue of moving this data from one application into another application. Although a successful strategy, there is a time factor involved as well as a potential loss of data richness, depending upon the various applications.

As the progress in adopting 3D PLM technologies has expanded throughout the automotive industry and into the supply base, it has become increasingly important that this product, process and resource information be made easily accessible to a wider audience of users -- both externally to vendors and internally to purchasing agents, executives, field service technicians, or manufacturing personnel. This demand has put pressure on PLM solution suppliers to develop solutions that allow non-engineers to also be part of the collaborative product development process. Additionally, to involve this extended audience in the product development process would require a simpler, more intuitive user interface.

A first step in this process was the development of lightweight XML-based CAD files that enabled users to share accurate 3D data quickly and easily, via email that then allowed the opening programs in typical Microsoft applications such as Word or Excel. This was, and still is, an excellent communication tool to involve purchasing and executives in the process, but it is not a real-time collaborative tool.

Dassault Systèmes then leveraged that technology to develop 3D Live, which not only had a new, simpler intuitive interface, but was the first solution to allow companies to conceptualize, develop and deliver products in a shared environment over the Web, communicating with partners in real-time.

Studies have found that implementation of an integrated PLM solution can significantly improve a company's performance to affect these types of savings:

- Data searching reduced by 20-60%
- BOM accuracy improved by 40%
- Entering and rekeying of data reduced by 75%
- Cost of launch delay positively impacted by 30%
- Product development time easily decreased by 60-70%.

Results like these would make any CEO take notice. However, it is a known fact that disparate IT systems increase the cost of business application ownership. This fact has led many OEMs to go to a single CAD or ERP system, yet with PLM solution process there are many, many niche players.

For a successful PLM strategy implementation, it is necessary for these solutions to accommodate a wide range of applications -- not only those developed by the PLM solution partners, but from the existing applications within the enterprise such as ERP or Financial solutions. In addition, thousands of legacy applications are in widespread use, which has been a key reason for corporations to not implement and streamline solutions across the corporation -- the integration has just been too difficult.

CURRENT LEVELS OF COLLABORATION -- Various types of collaborative processes and tools have long existed within the automotive industry, from simultaneous engineering to concurrent development, single source database, seamless integration, and real-time visibility. These are all enabled by a product/process and resource data hub, where all the knowledge about the product is produced and maintained including the Engineering BOM, Manufacturing BOM, manufacturing process, product routings, tooling requirements, sourcing information, etc. These various engineering data are all interconnected, so that the impact of a change in one data type is visible in the other data processes. This allows the change to be easily examined and propagated, leveraging relational design and manufacturing capability.

All data sources are integrated but, true collaboration has had to be structured and scheduled – such as in a webex or video conference, which works well when you want efficiency, control and accuracy.

Also, the data involved in the product development process is limited to a select few within the corporation. As mentioned earlier, delivery formats are typically text-based, resulting in potential language issues in a global environment. The idea of flexible, unstructured or 'ad hoc' collaboration has not been possible, and the idea of making data available throughout the enterprise would be very difficult given the limitations of bandwidth available to email large files of information.

Additionally, the idea of real-time data has not truly been deliverable. In past platforms, every time a file is worked upon, an engineering change order must be recorded. Files are checked out to be worked on, changes made and then files checked back into the PDM. The system then checks all files that have been changed and updates accordingly. But, while the design engineer is working on File A, the manufacturing engineer has no way to know that File A is being changed. So, he is still going forward with his tooling based upon the last configuration.

PLM 2.0: UNIFIED LIVE COLLABORATION -- We have all become comfortable with the idea of Web 2.0, where users can do much more than just retrieve information from the Internet. They can run software applications entirely through a browser and own the data on a Web 2.0 site, exercising control over that data. These sites may have an "Architecture of participation" that encourages users to add value to the application as they use it. User-developed content and online applications provide a significant leap in interactivity and power beyond the initial wave of Web content.

The same concept is being applied to PLM, with the idea of PLM 2.0 or as Dassault Systèmes refers to it, "PLM online for all." With the implementation of Dassault Systèmes V6 platform, PLM 2.0 becomes a reality. V6 is an enterprise-level platform that provides a single environment in which product-related information created in both DS and non-DS applications can be consolidated and collaboratively used by participants from all business functions and areas of the extended enterprise that are involved in the product lifecycle.

What truly makes this platform different from previous generations, is that in this environment, people can work concurrently in real time via a simple Web connection relying upon a single server.

The V6 (SOA) enables global deployment while centralizing the meta data in a single master site repository and distributing the file within the different remote locations. This centralized dataset is accessible to all users, regardless of location. The different distant sites use a local file server to load large representation files, eliminating time consuming network transmissions.

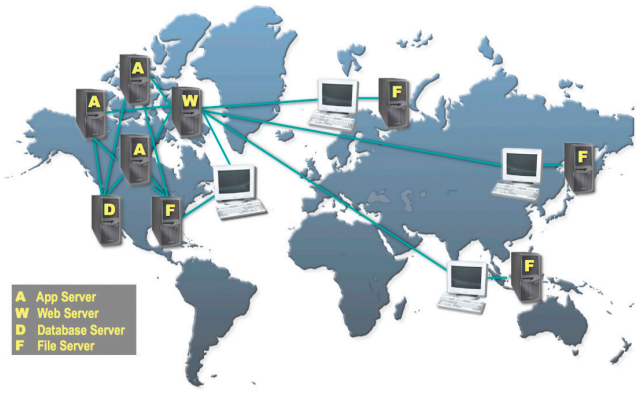

Fig. 2 Centralized Database Architecture w/distributed file stores

Heavy CAD files are replicated, but, the logic on how they are composed is held in one single file, which is cached at the local file servers. This is achieved through optimized performance features including low memory consumption, optimized packet transport, and a smart caching mechanism.

Main benefits of this approach include:

- A single platform approach reduces costs by eliminating the complexity and replication required with a distributed system
- The HTTP connection provides stable performance and access globally to always current data
- Memory consumption is stable, enabling companies of all sizes to take advantage V6
- Response times are quicker enabling enhanced collaboration

Graphical Interface -- Another difference is that rather than searching through documents or text to find the part you need to work on, you can navigate the product structure in 3D. With this 3D interface, based upon the 3DLive application, a graphical turntable visual allows for product information navigation. (fig.#3) Users simply click on the 3D vehicle and it opens up into various modules, which then break down into various components and so on, allowing users to drill down to the exact area that needs modification. (fig.#4) This capability goes beyond design into the engineering BOM, manufacturing BOM, and attributions like weight, cost, and supplier involvement. This furnishes companies with a powerful data warehouse indexing and search capability to amass IP across all business process domains into a single meta-model. Users across the extended enterprise can easily and quickly find product IP-based on key words and file content regardless of how it was originally created. Indexing readies the information for ultra-fast on-demand response.

Fig # 3

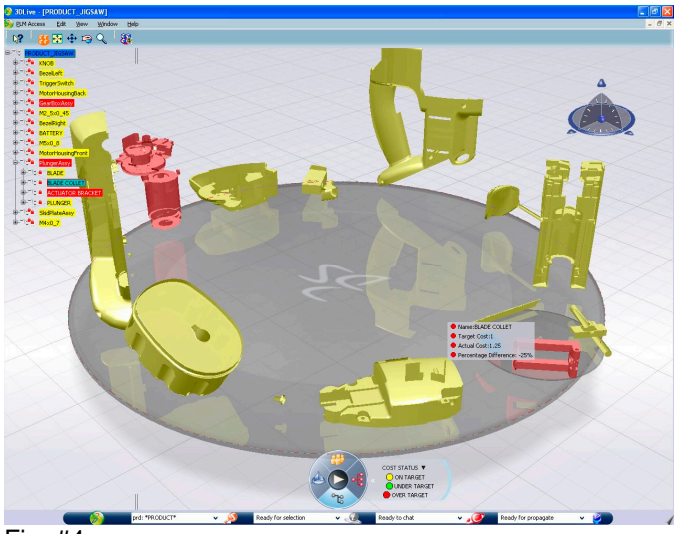

Fig. #4

In this application, the object-oriented architecture allows users to simply check out only the features that are necessary for their part of the project such as only a particular spot weld attribute. Information is sent out in smaller bits, eliminating the need to continually transfer large files, thus speeding the process. There is no longer the need to always 'check back in' and update the document -- everyone involved in the process is always connected to the same central source of truth. In PLM 1.0, there is a design-in-context capability to ensure that interfacing parts that share common design elements match up perfectly. However, it typically requires the implementation of digital mockup. With PLM 2.0, designers are always working in context. For example, one engineer can work on a trunk lid opening, while another is working on the hood opening that are part of the same stamping. Working in context is the norm.

This approach provides "in-context" visibility and access to information that allows for data viewing, data analysis, searching, collaborative sessions, chats, and buddy lists, as well as context-sensitive searching for experts and for

assistance. In previous systems, many digital manufacturing and CAE activities were not in sync with the product development cycle, but lagged behind, awaiting current product definition data. V6 offers increased functionality across product design, manufacturing planning and performance simulation through a single integrated environment. Changes to any of these areas is relayed to the central repository and propagated across the user universe. This helps to eliminate costly design and manufacturing errors.

The emphasis with V6 is on providing "an online environment for virtual experience in 3D from anywhere," creating a user experience that makes it easy for anybody to participate in the product lifecycle – designers, supply chain or end customers.

Since V6 is built on SOA, it allows the integration of engineering practices with enterprise business processes on a single platform that spans the entire product lifecycle from program management to compliance management to sourcing. This includes the management of all product-related information such as requirements, recipes and BOMs during the work in process, synchronizing this information from concept through planning to production. In addition, as it provides interoperability with virtually any other enterprise application, users can access and leverage diverse data sources to be used in the context of PLM.

The old adage that a picture is worth a thousand words is emphasized through this application. The V6 graphical 3D approach is intended to simplify the user experience and more consistently guide users into their own functional domain space, such as mechanical design, simulation and analysis, digital manufacturing, etc. DS' new user interface can be run as a "lightweight," online Web application, and is usable by individuals no matter where they are working from. This increases collaboration in real time with people also communication via chat windows or other means such as Lotus notes.

Single Source/Single Language -- A key aspect of V6 is that it extends to intellectual property (IP) authoring online, making full PLM solutions accessible from anywhere. For example, a designer with CATIA on their laptop can log-in from home and directly edit a model which resides in the central office database. This work can also be done concurrently with other members on the team.

This online collaboration and IP authoring and modeling is facilitated in V6 via an architecture in which all IP is maintained within a single, integral database designed so that associates can work with the same IP simultaneously, regardless of their physical location.

All applications within this system are interconnected and designed to function together as a united whole. This seamless ability to access current data will facilitate and encourage frequent, ad-hoc collaboration among individuals, regardless of their physical location, and to empower collaborative, online communities, which has the capability to significantly reduce engineering change orders and product launch time. Key benefits of this approach include:

- Global collaborative innovation, expanding PLM to include business users and consumers, bringing together requirements and the functional, logical, and physical definitions of the product
- A single PLM platform for managing intellectual property (IP) with modeling applications that span all engineering disciplines and business processes
- Collaborative online creation in real time using Web technology
- Ready-to-use PLM business processes that consolidate engineering and enterprise best practices
- Lower cost of ownership with a single database, an open service-oriented architecture (SOA), and ease of installation.
- Lifelike experience with 3D products looking and behaving as in real life, plus an intuitive interface to find, communicate, collaborate, and experience products in 3D
- Universal language of 3D

Everyone is accessing real-time 3D data, understandable to the viewer no matter what language he speaks. In the United Kingdom, they may call a car hood a bonnet; in Germany, it's an auto haube. However, via a 3D rendering, everyone knows which part they are working on.

For example, the designer of an axle is situated in Detroit, and he has a product review with a quality engineer in Paris. Both of these engineers can be looking at the same 3D CAD model at the same time, and can be communicating via an open instant messaging window. With a conventional PDM system, the quality engineer would review the file and then check it back into the PDM with the requested changes. The design engineer would then access that file, make the changes, post it back to the PDM system and so on and so forth until the two parties are in agreement. Now, the entire process is worked out via one online collaborative session with engineers both working on the same live data delivered via the Web, resulting in one engineering change order as the issue is resolved. Based upon early findings of customer implementations, the V6 platform is achieving up to an 80% reduction in engineering changes.

Sharing Knowledge -- A primary feature of V6 is its "federation" capabilities, which allows user to harness collective intelligence from diverse communities. What this means is that data can be collected from a wide range of different data sources into a single consolidated/ comprehensive view, thus supporting third-party applications.

This approach also allows for the incorporation of data from legacy systems and the wide range of product-related applications that already exist across the customer's enterprise to expand the view and use of information from within the V6 environment. This data is then classified and standardized within a company's PLM plan so, for example, similar parts are grouped together. This consolidated data view is then displayed in a consistent form via the common user interface. The objective is to enable companies to collect all product-related information and knowledge (intellectual property) across both DS and non-DS applications to expand collaboration among diverse and distributed groups.

File sharing and open communication also require increased security standards. From the first development of a new program, the components and features that will be accessible to other people is configured into the system. There are lock-out aspects that allow only those involved in a particular area to have access to that area.

Successful companies will be the ones that can efficiently share and repurpose data in ways that lead to improved operations, new products and greater revenue. Cross-leveraging information can produce new ideas across disparate domains within a firm. Studies show that there exists a strong correlation between a company's ability to find new uses for information and its ability to innovate.

Incorporate the Consumer -- One of the most valuable and interesting aspects of this platform is the ability to involve customers in the product development process. As stated earlier, today's vehicle buyer is faced with a multitude of choices. Vehicle makers struggle to leverage every niche demand of the consumer in hopes of maximizing profits against expanded products offerings that complicate manufacturing and the supply chain. In a quest to 'innovate', OEMs continuously collect and analyze data, but by the time a product comes to market, it may no longer be relevant. As an example, according to a recent Consumers Reports survey, 79% of consumers are interested in buying a more fuel-efficient vehicle, such as a hybrid or diesel. A year prior to this study, that number stood at a mere 47%. Being able to react quickly to consumer desires is paramount to remaining successful and viable in today's market. Plus, with the next generation of car-buyers raised on Nintendo and Wii, instant gratification will become a standard.

With this PLM 2.0, "3D Online for All" platform, vehicle buyers can see and participate in the product development cycle. Every person can understand the language of 3D pictures. Consumers will be able to experience the product online virtually, yet with all the constraints of the real (physical) world. This is a new paradigm from traditional PLM tools where environments were typically limited within the world of the OEM's supplier chain.

The value of enabling a company's consumers to see a vehicle as it is being conceived, experience its operation in a virtual world, and then provide direct feedback that can significantly improve its market attractiveness and performance is immeasurable in an economy that demands faster and more effective responses to market opportunities. This approach will help to more effectively capture and define real end-user requirements, improving the success rate of the product development process.

Closing the consumer desire loop -- Imagine that there is a consumer in Los Angeles who has just provided feedback on a vehicle maker website by choosing his preferred interior environment. A market analyst in Detroit analyzes this consumer feedback and provides the design studio with the U.S. consumers' interior design expectations. The designer, who is located in London, takes this consumer request into account, and restyles the top of the console and posts it back on the website.

Next, a program manager in Detroit investigates the impact of integrating a new parking assistant on an existing car being manufactured in Brazil. The systems engineer for this vehicle, who is stationed in India, develops a new system that includes a camera and new sensor on the rear bumper, which is immediately accessible to the other parties. A simulation expert in Germany then performs an interior NVH optimization, vibration, safety, thermal trade-off while a process planner at the manufacturing plant in Brazil checks the impact of this new park assistant on the existing assembly line, causing him to request new tooling from the supplier. The maintenance manager in Brazil updates the technical documentation for maintenance and end of life request.

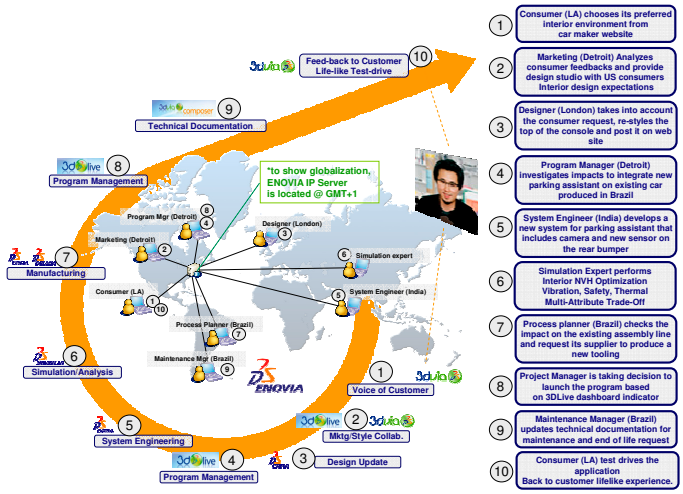

Fig. #5 Global Collaborative Product Development

The consumer in Los Angeles performs a virtual test drive on the application and provides his feedback, and the information continues to be shared. Not only does this allow the vehicle maker to be much more in-tune with the customer, but the seamless sharing of information reduces the product development cycle.

Prior to the V6 platform, many of these activities, although collaborative, would have been performed sequentially. Now, with a single database and common server, all of those involved in the process can truly be working simultaneously to deliver what the consumer wants in a much reduced time frame.

SCHULER CASE STUDY: LEVERAGING INTELLECTUAL PROPERTY IN PLM 2.0 – Schuler is the world's leading manufacturing of press systems and metal forming solutions, and is at the forefront of developing transfer and servo presses widely used across the automotive industry. The company has ten forming system sites in Germany, sites in Brazil and China, as well as advanced technology sites in Germany and the U.S.

Schuler's number one business challenge is trying to satisfy the ever-changing requirements of its automotive customers. To maintain its lead in the metal forming industry, it must constantly demonstrate its commitment to innovation, product quality and customer service. This requires reacting quickly to new marketing opportunities and delivering technologically superior products.

Schuler is a long-time user of Dassault Systèmes solutions, experiencing success with both the V4 and V5 platforms. Schuler believed that V6 PLM would enable the company to further leverage worker knowledge and skills, providing its global development teams with the right tools for concurrent engineering. The company wanted a solution that would leverage its intellectual property to enable all stakeholders to work together and run with new ideas.

With V6 PLM, Schuler has benefitted from the single Service Oriented Architecture platform that serves both its multi-discipline engineering groups and its extended enterprise. This collaborative approach delivers flexibility, open standards, scalability and industry-specific solutions. It helps to accelerate product innovation by bridging the company's enterprise business processes and engineering practices.

Schuler can manage all of its product and process IP, from idea to product experience, from this single platform grouping all this information in a single environment. Schuler stakeholders can create and collaborate in real-time from remote locations via a basic web connection. For example, engineering teams can display, manipulate or design parts concurrently in Germany and Brazil.

Online, remote collaboration allows for more flexibility and reactivity. Work can easily be allocated to sites around the world where resources or expertise are available. Schuler also uses outside designers to meet demand, and V6 helps to simplify the process of connecting these small suppliers into the process.

The intuitive user interface brings Schuler's IP to life in 3D for both technical and non-technical staff, noting that "it's easier to work with geometry on the screen than with words that you find in a traditional interface."

With a single platform requiring only one server to install and maintain across all IP modeling and collaborative business process applications, V6 PLM delivers a substantial increase in ROI by lowering the cost for adoption and reducing the time necessary to deploy a full PLM solution.

CONCLUSION

The PLM online for all strategy, enabled by the V6 platform, brings product-related knowledge from ideas to product experiences, to life. It merges the real and virtual in a immersive lifelike experience, interpreted by the universal language of 3D to help vehicle manufacturers:

- Enable collaboration among virtual product teams spread around the world so that they can conduct product development and support 24/7.
- Leverage intellectual assets effectively across the entire product lifecycle.
- Create a virtual, global value chain with no time, distance, or organizational boundaries.
- Continually innovate and improve products, and the processes used to design, produce and service them.
- Ensure that product innovation and development is based upon current customer desire at a reasonable price

The automotive industry may be ahead of all other industries in both conversion to 3D and in the way that it manages IP data. However, today's market is brutally intense given the current financial crisis, the accelerated rate of change, the rising costs of material and labor, environmental regulations, and the intense competition for fickle consumers and marketshare.

To meet these demands, vehicle makers must streamline processes, capture knowledge across their enterprise and make this intellectual capital available to all parties involved in the product development process. Within the organization this means collaborative online sessions that add to creativity while reducing process time and cost. Outside of the organization, it means involving the consumer in the process in order to make sure that manufacturers are delivering the right product at the right time with an acceptable pricing schedule.

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