Nissan Motor Corporation

"Product Lifecycle Management Case Study"

April 2008

A CIMdata Case Study

Nissan Motor Corporation

"Product Lifecycle Management Case Study"

April 2008

Produced by
CIMdata, Inc.

http://www.CIMdata.com
CIMdata, Inc.
3909 Research Park Drive, Ann Arbor, Michigan 48108
Tel: +1 (734) 668–9922 Fax: +1 (734) 668–1957

Nissan Motor Corporation

"Product Lifecycle Management Case Study"

Today's automotive industry is global, both in terms of customers spread across multiple regions (from mature and emerging markets) and manufacturers and suppliers scattered around the world. The issue from an original equipment manufacturer's perspective is how to respond to and best satisfy complicated demands while at the same time delivering attractive vehicles at higher quality levels, at the right time, and at a reasonable price. Nissan appears to have an appropriate answer to achieving these goals through product and process innovation enabled by a sound PLM approach and solution. In the end, Nissan has realized it with "Shift the Proving Ground" to deliver attractive models with their concept—"Trusted Driving Pleasure."

1. Introduction

Regardless of your interest in the design and manufacturing processes related to the vehicle you will purchase or are currently driving, the latest model you own most likely has been produced by digital technology operating within a comprehensive Product Lifecycle Management (PLM) environment. This is certainly the case when one considers the latest vehicles from the Nissan Motor Corporation (Nissan), such as the Infiniti G37 Coupe (Skyline Coupe in Japan) the top of their brand (shown in Figure 1). Nissan, founded in 1933 and headquartered in Tokyo, Japan, has extensively deployed and utilized a fully digital PLM-enabled environment to design both the vehicle and the processes used to manufacture it. Nissan has coupled their "development environment of the future" initiative to new strategic business concepts to increase their success in the global automotive market. The Infiniti G37 Coupe is the fourth vehicle program in which Nissan has utilized this new digital environment to bring a new model to market. Nissan's plans call for the utilization of this new development environment on all vehicle programs by 2010.

Figure 1—The Latest Model from Nissan: The Infiniti G37 Coupe
(Skyline Coupe in Japan, Courtesy of Nissan)

The world of vehicle design and manufacture is evolving along with the Information Technology (IT) application software used to support the process throughout all phases of the vehicle program's lifecycle; from customer requirements and conceptual design, to detail and production design and manufacturing, to sales support and maintenance services. The vehicle development technologies that support the design of both the vehicle and its production processes are now distributed throughout the organization on every engineer's workstation. Gone are the days when hundreds of physical prototypes had to be produced by hand just to satisfy the requirements of one specific market. There is no doubt that today's vehicle development environment is much more complex than that of the past. Today's modern vehicle development environments provide a wealth of well-defined product and process information to all those in the organization that require it, enabling them to more effectively perform their tasks in the development of a vehicle that must satisfy the requirements of multiple markets.

Today's automotive market is global. No longer can Nissan or any other automotive manufacturer design and deliver a vehicle to only one market in a cost-effective manner. No longer can Nissan afford to develop a new vehicle in one market and hope that it will satisfy the requirements of others. As a result, these development programs need to be global and multi-cultural in nature. This complexity is made more severe by the fact that today's vehicle is filled with an ever-

increasing number of complex electromechanical systems that include a significant amount of embedded software. As if this isn't enough, the typical automotive manufacturer finds itself under an ever-increasing regulatory weight where each country where the product is to be sold and serviced continues to add requirements for safety, environmental concerns, etc.

Even under these circumstances, today's global automotive original equipment manufacturers (OEMs) have become more competitive when one considers the standard measures of Quality, Cost, and Time (QCT). As a result, they are increasingly challenged to differentiate themselves and to respond to market demand in mature markets like North America and Japan, some growing markets in Europe, and very active and evolving markets in developing counties like India and China. This means that each and every OEM needs to establish its own strategic-oriented business solution to sustain and grow the company in this highly competitive global market. Nissan is no exception to this rule. They are being challenged to innovate the company, and as a result are focusing on improving their Product Definition Model, which in Nissan's terms includes the process of creation, dissemination and use, and management of the product definition, through the extensive deployment of PLM enabling solutions.

Nissan's approach to marketing and selling cars is evolving from a classical model that dates back to the 1970's. This legacy model focused on providing a vehicle of equal quality and performance at a lower price point than its competitors. This approach was very successful in gaining a market position in new markets such as North America and Europe. Nissan built on their earlier success by consistently seeding the markets they entered, especially North America, with their signature technological improvements and by focusing on superior customer service programs. Nissan's classical approach has evolved and expanded to include a focus on safety and environmental issues, as well as an enhanced focus on their historic position as a leader in delivering high-performance vehicles. Their current marketing campaigns, "Driving Pleasure" and "Shifting to the Future," are at the core of Nissan's values and business philosophies.

Much of the information technology that is currently used to digitally create, design, and manufacture Nissan's vehicles has been utilized in the aerospace industry for some time. Its availability to the automotive industry, in many ways, means that a new era of product and process definition is now in place enabled by today's PLM solutions, which include a host of enabling technologies such as CAD, CAM, CAE, PDM, Digital Manufacturing, and visualization.

CIMdata defines Product Lifecycle Management (PLM) as a strategic business approach that applies a consistent set of business solutions in support of the collaborative creation, management, dissemination, and use of product definition information across the extended enterprise from concept to end of life—integrating people, processes, and information. PLM forms the product information backbone for a company and its extended enterprise. It is composed of multiple elements including: foundation technologies and standards (e.g., XML, visualization, collaboration, and enterprise application integration), information authoring tools (e.g., MCAD, ECAD, and technical publishing), core functions (e.g., data vaults, document and content management, workflow and program management), and functional applications (e.g., configuration management), and business solutions built on the other elements. Nissan's PLM concept is illustrated in Figure 2.

Today's globally competitive automotive industry demands PLM—a business strategy that seeks to enable innovation of an enterprise's product and product definition related

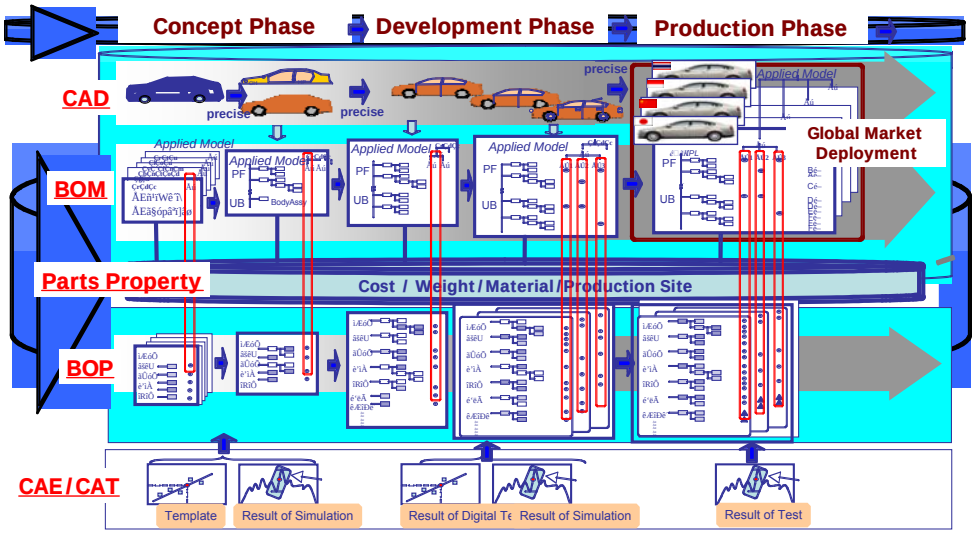

Figure 2—Nissan's PLM Concept: "Empowerment by PLM"
(Courtesy of Nissan)

processes, making sure that the enterprise's people, processes, and technologies are continuously improved in a closed-loop fashion. The importance of PLM is heightened due to the fact that today's OEMs need to continue to shorten time-to-market while at the same time designing more complex globally-applicable vehicles and associated manufacturing capabilities.

2. Issues: Challenges at Nissan

At the 2007 general meeting of shareholders, Mr. Carlos Ghosn, Nissan's CEO, described Nissan's current and future state, and specific strategies to be executed to achieve the goals. Mr. Ghosn's main message included building Nissan's brand image by delivering internally and externally attractive designs, driving pleasure (see Figure 3), and a high level of customer service. He also reinforced Nissan's intent to stay competitive with regard to quality, prices, and availability. Mr. Ghosn also mentioned the company's continued focus on people investment throughout their global operations and motivating their people to work more efficiently and cross-functionally. Finally, Mr. Ghosn stressed Nissan's need to continue to lead through innovation with a focus on R&D spending on new technologies, safety features, and meeting society's environmental expectations.

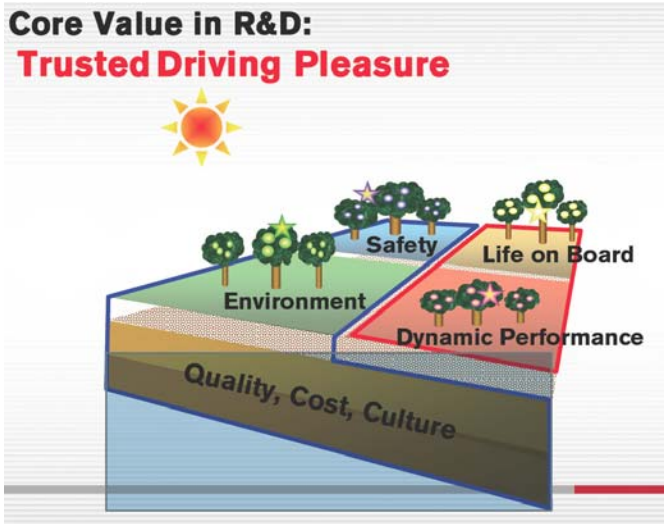

Figure 3—Nissan's Core Value: Trusted Driving Pleasure
(Courtesy of Nissan)

Mr. Ghosn's message was a result of Nissan's continued and long-term effort to revive and modernize itself—an effort that began in the late 1990's when finances were so fragile that the company could not afford to maintain its reputation for technological innovation, the traditional core of its brand identity. In the autumn of 1999, Mr. Ghosn, the new CEO of Nissan who had come from Renault S.A., made a commitment to Nissan's renewal. The initial program, "Nissan Revival Plan" (NRP) as it was called, defined a set of messages that included specific timeframes for corporate improvement. Over the years, the program was extended and renamed "Nissan 180." This program focused on profitable growth based on the completion of the NRP. This program in turn was transformed into the "Nissan Value-Up Plan" program, which focused on sustaining growth by improving value throughout all phases of the product lifecycle. Nissan's revitalization programs are well known in the industry and have been instrumental in Nissan's financial success.

Under the NRP program, Nissan formed a number of Cross Functional Teams (CFTs). Each team was comprised of a number of individuals throughout the organization, each with a different background. The purpose of these teams was to improve and solve, through cross-functional communication and teamwork, a set of long-time business issues that had plagued the organization. These issues included the lack of profit orientation, lack of customer orientation, lack of cross-functional and cross-border work practices, lack of sense of urgency, and lack of shared vision and common long-term plan. In all, Nissan formed the following nine CFTs: Business Development, Purchasing, Manufacturing & Logistics, R&D, Sales & Marketing, G&A, Finance Cost, Product Phasing Cost, and Organization. Each of these teams was instructed to challenge the current status of the organization and the manner in which it works, and to develop plans for improvement.

2.1 Shifting the Proving Ground: The Need for Innovative Products and Processes

The CFT responsible for challenging the way R&D operated spent much of its time studying and discussing how new and innovative engineering processes could meet Nissan's changing business model—a model that sought to improve profitability and competitive position as well as introduce more global products supported by a globally-operating organization and supply base. This CFT needed to find and establish a best practice-based methodology that would consistently deliver the right model to the right customer at right time and at the right profit level. One specific area of attention for this R&D-focused CFT was the body (herein, "body" refers to the Body-in-White (BIW) and other associated parts and components except for the chassis and powertrain; Nissan often refers to this as Upper Body design, "Uwaya" in Japanese). For Nissan to

improve in this critical vehicle design area, the CFT needed to embed QCT best practices, including BIW manufacturing process design into the overall body design processes. Ultimately, the CFT felt that this required capturing and managing product and process engineering know-how in an enterprise database so that these intellectual assets (i.e., corporate knowledge) could be re-used across vehicle programs. The implementation of such an environment has resulted in Nissan's ability to deliver vehicles in shorter development cycles while at the same time keeping and increasing their quality, lowering cost levels, and providing more attractive models to the global automotive market.

It is interesting to note that over the last 30 years, Nissan has seen a 20% increase in the amount of development work required to design a new vehicle platform. According to Nissan, this increase is a direct result of the increase in vehicle complexity due to increased safety and environmental demands, and the mechatronics content of the vehicle. Nissan points out that this 20% increase would have been much higher were it not for the reduction in workforce they have been able to accomplish due to a significant increase in product and process knowledge and part re-use. Overall, this increased complexity has placed additional pressure on the organization to implement new innovative engineering processes and/or systems to optimize its workforce further to address these additional complexities.

One of the major initiatives that the R&D CFT seriously considered was the deployment of additional information technology (IT) in support of Nissan's development process. By doing so, the CFT hoped to gain efficiency during the preparation of product definition information resulting in a dramatic reduction of development time. In addition, the CFT hoped that this new and innovative IT supported process would facilitate the digitization of their product lifecycle processes since it would be enabled with fully-developed 3D product models—models that would be leveraged throughout the lifecycle and the extended enterprise to support the definition of dies, fixtures, and complete manufacturing processes, and would be used to ensure the availability of quality product information to everyone who needs it.

The R&D CFT also sought to extend the initial enablement of product development processes, especially the body design processes, with additional focus on simulation and validation techniques. The implementation of these new techniques and supporting technologies have already proven to accelerate product development and increase product quality from styling freeze (i.e., all product definition information is ready so that production engineering and physical prototypes can be prepared by the various working groups involved, including the supplier community) to Start of Production (SOP) by decreasing the number of physical prototypes and increasing the speed at which manufacturing process optimization has taken place. To realize this goal, Nissan has had to move from three physical prototypes to one while at the same time putting into place technologies that supported their shift from physical testing to digital testing as the proving ground.

As part of the NRP, the R&D CFT and other product development supporting CFTs and their implemented improvements have resulted in a higher level of process confidence and a reduction of the development cycle (i.e., from styling freeze to SOP) of more than ten months (from 21 months to 10.5 months). Nissan reports that in the Spring of 2001, they evolved the NRP into the Value-Up Innovation of Product, Process and Program (V-3P) that was designed to focus on design and delivery of more attractive vehicle models to the global automotive market.

3. Deployment

Nissan's V-3P has proven to be a significant step forward for Nissan. This program, which included a sizeable budget for purchasing and implementation of PLM-enabling technologies (e.g., CAD/CAM/CAE/CAT and PDM, and the necessary hardware), is the responsibility of Mr. Keigo Fukushi, General Manager and V-3P Program Director. Beyond the technology element of the program, it also included funding and resources for people, including a new production engineering team, and application development. Mr. Fukushi works within the Process Information Management Department. This department is part of Nissan's R&D Engineering Management Division based in Atsugi, Kanagawa, Japan. The commitment made by the organization with regard to V-3P has been significant. The program's initial goal, as defined at its launch in the Spring of 2001, was to define, implement, and utilize the new V-3P process to design and deliver a completely new global vehicle platform by the September 2004 Paris Auto Show. This new vehicle, known as the "Tone" concept model, was sold as the "Note" in Japan initially and supported by the marketing phrase "SHIFT_compact flexibility," which Nissan believed captured its V-3P vision and intent.

3.1 Defining theV-3P Program and its Goals

Nissan simply and clearly defines V-3P as follows:

- The activity of dramatically improving QCT metrics by creating and capturing Nissan's Know-How about "KURUMA-ZUKURI" (i.e., vehicle design and manufacture best practices) into an enterprise accessible database
- Consistently executing the development process from Styling Freeze to SOP in 10.5 months utilizing one physical prototype prior to formal production

To achieve the V-3P vision, Nissan quickly realized that it needed to define and make an extensive set of changes to its vehicle development process and their fundamental approach to standardization of various aspects of design.

3.2 Standardization

For many years, standardization has been a common buzzword throughout the automotive and other industries. In many ways, the standardization of parts and components is a common expectation in the automotive industry (i.e., defining and utilizing common parts, components, and systems across multiple vehicle platforms) and is something that is well supported by today's PLM solutions. For most companies, this has meant standardization around single parts or simple assemblies in order to reduce internal costs or costs associated with purchasing. For some, this has meant using existing designs and morphing them into new parts and assemblies. Unfortunately, these typical techniques tend to not deliver QCT benefits after SOP. Because of this, Nissan decided that their V-3P process needed to be more advanced and proactive, delivering benefits throughout the product lifecycle. They felt that an incremental improvement was not sufficient.

The ultimate goal for Nissan's standardization directive, in V-3P terms, was to create a complete product and process definition; one that described the entire vehicle, including the production process definition and other information that covered all of the product and process issues within the scope of developing and delivering a car to the market. From the beginning, V-3P's goal was to establish Nissan's "know-how" database related to the design and production processes; namely establishing "MONO-ZUKURI" (i.e., equal meaning to KURUMA-ZUKURI, but a more general industry term) know-how as the standard supported by solid and proven processes that are enabled by technology that support history-based 3D CAD architecture instead of the old paper-based system. Overall, Nissan is able to use templates that enhance the database's content and context for further model development within the context of validated best practices. Nissan believes that 40% of those processes may be standardized elements and therefore should be automated, and that the remaining 60% are more likely to be vehicle model-specific processes that include 30% of an engineer's decision process in design. Nissan names it "Know-How CAD" and templates were also used to incorporate design process best practices for re-use and improvement as required in support of QCT initiatives across the entire product lifecycle. Nissan named this standardization directive "Digitalized Knowledge."

3.3 Process Changes

Historically, Nissan's engineering process (used to define product definition information up to SOP) was comprised of two major phases. The first phase was partially concurrent in nature, with Styling, Design, Production, and Production Preparation tasks executing simultaneously to define the product definition information and to provide it to production engineering as a styling freeze. The second phase focused on prototyping production to develop additional rich product information including production process definitions, and actual vehicle test and validation data taken from the three physical prototypes constructed prior to SOP. With Nissan's deployment of 3D modeling technologies in the late 1990's, Nissan's engineering process gained a certain level of efficiency and cut the time it took to get to SOP to approximately 20 months—comparable to other Japanese OEMs and shorter than most European and US-based OEMs who were taking approximately 35 months at that time. For Nissan, this improvement was not good enough.

To achieve the desired efficiency gains, Nissan had to find and implement a more advanced approach. The approach Nissan took sought to incorporate richer and more mature context into the product definition information by the end of Styling Freeze. Nissan accomplished this by involving more partners in the development process earlier, and by focusing on the use of only one physical prototype prior to SOP. In many ways, this forced Nissan to greatly enhance the maturity of their vehicles' virtual product and process definition, including the validation of this information prior to SOP. Without doing this, Nissan would not be able to successfully assembly the vehicle at SOP. At the core of this approach is what Nissan described as "Digital Collaboration." This collaborative approach simultaneously involves participants from various development organizations, including Styling, Design, Production, and Production Preparation, in a tight partnership. This process, which is now called "Digital Lot," is a very innovative process—one that could not have been achieved without shifting Nissan's culture and how its people work, dramatically changing multiple processes, and aggressively

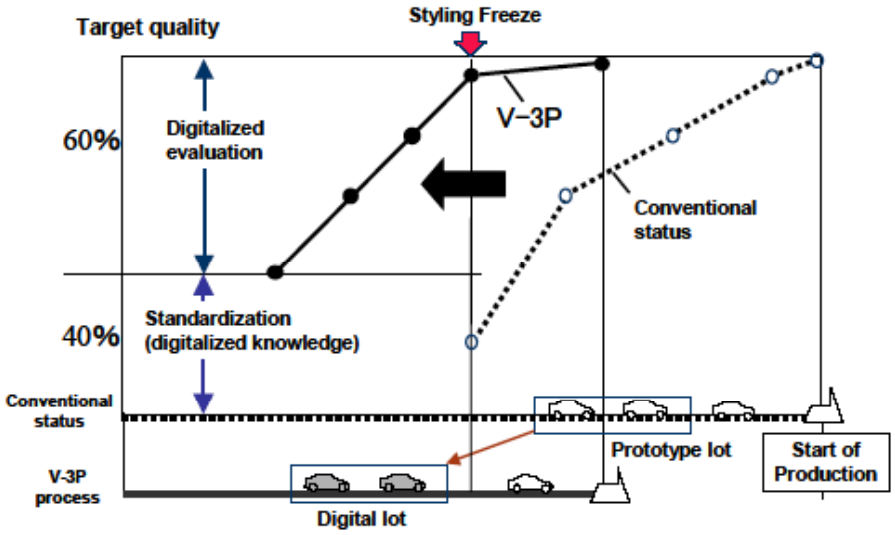

Figure 4—Accelerating Production Engineering Studies
(Courtesy of Nissan)

using IT in support of collaborative engineering and the deployment of simulation and validation technology for what Nissan describes as "Digital Evaluation." Figure 4 summarizes Nissan's improvements gained through standardization and digital evaluation.

3.4 Process Innovation and Standardization: A Historical Prospective

To understand how Nissan was able to shift to a digital environment as defined by the V-3P program, it is important to review the path and various product data-related improvement activities that Nissan has taken over the years. Nissan recognized that the utilization of 3D models and the proper management of product information are essential to enable an effective digital environment for defining the virtual product design and production processes, as well as linking the virtual product with the physical product. Much of this was due to Nissan's experiences in switching from their corporate homegrown CAD system, based on 3D proprietary wire-frame technology, to a commercially-available 3D solids based CAD system (i.e., I-deas from SDRC, now supported by Siemens PLM Software) in the mid-1990's.

Nissan's recognition that they needed to standardize on a commercially-available 3D CAD package was also due to their understanding that they needed to support their global enterprise, including the integration of its suppliers. From the beginning, Nissan expended a significant effort on incorporating their design process into I-deas and utilizing the 3D model as part of a fairly comprehensive Digital Mockup and Design Review (DMDR) process. Nissan's efforts shortened the development cycle to approximately 20 months and allowed them to successfully create production molds without physical prototyping, in a process Nissan calls "One Shot Formal Mold." In the area of supplier integration, Nissan applied European OEM-styled modular responsibilities, where suppliers deliver integrated and completely assembled modules. The adoption of this approach has provided Nissan with significantly more flexibility for the introduction of new models.

Nissan has spent a significant amount of time and effort to ensure that product definition information is prepared appropriately and accurately within a streamlined and digitalized manner. Their ability to do this is a key element in innovating their vehicle development process under the V-3P program. Nissan calls this ability "Data-Show" and it represents an initiative in the activity of product data definition management. "Show" here is the Japanese pronunciation for the Kanji character pictured in Figure 5. "Show" holds a significant meaning for Nissan; it can be translated as "Core," "Important Role," or "Pivotal," and it may express an extended meaning of "Balancing" or "Impact" by adding one or more small Japanese characters. As fundamental as "Data-Show" is for Nissan, their dedication to ensuring that accurate product information is given to the next step in the vehicle development process is also important. Without being able to do so, Nissan would not be able to create accurate designs for simulation and validation of the digital product and manufacturing processes—keys to an efficient

Figure 5—Symbolized, Japanese Character "Show" Represents Preparing in Practice Accurate Product Information at Nissan

and productive PLM environment. It is interesting to note that Nissan owns and tracks a proprietary metric that measures the maturity of product definition information (i.e., its accuracy) for new parts. Nissan reports that they have seen steady improvement with regard to this metric (they have reported that they achieved 95% in 2004).

3.5 New Process Examples

This section lists a few specific examples to provide a better understanding of the types of processes that Nissan has implemented.

- **Standardized Design**—Nissan examined existing paper-based design processes, and extended them with the inclusion of additional production engineering process content and supplier community collaboration, and then defined and established a new procedure called "digital flow." This procedure leverages an integrated database environment that contains standard structures, i.e., templates containing history-based 3D solid CAD data modeled in I-deas. Design engineers working within this environment can create geometry while following the appropriate quality standards and taking advantage expertise and know-how via the environment's web interface (see Figure 6).

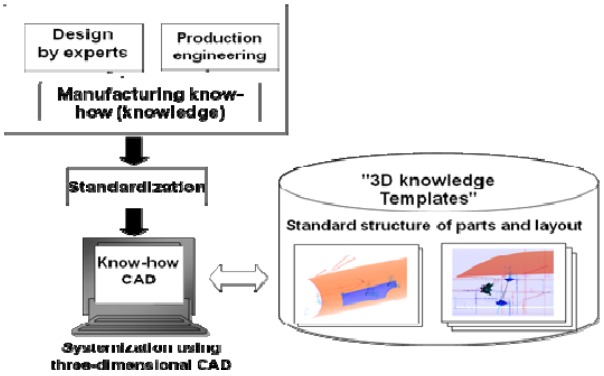

Figure 6—Knowledge Database with Template Approach
(Courtesy of Nissan)

- **Performance Analysis**—In this area, Nissan has spent a significant amount of effort expanding the availability and use of simulation and validation technologies in support of virtual testing. As a result, Nissan has deployed several software applications, mainly from global vendors, in support of conventional Structure Analysis, Crash Analysis, Flow Analysis, Engine Performance Analysis, Mechanical Analysis, Electromagnetic Analysis, Optimization, Modeling, and Animation. With the implementation of the V-3P program, Nissan placed a specific emphasis on enabling virtual crashing testing and other virtual testing that would support their desire to utilize only one physical prototype. Nissan reports that the implementation of these technologies has allowed (so far) accurate and predicable digital evaluation of approximately 45% of a vehicle's items. Nissan reports that they have successfully applied these digital evaluation technologies on the 2003 Note program and in that vehicle program they were able to accurately evaluate 95% of its thousands of items. According to Nissan, this was the highest rate ever accurately digitally prototyped and it has validated that they could reduce the number of physical prototypes used during development with predictable and accurate analysis processes.
- **Production and Plant Engineering**—As described above, production engineering is now supported in the early design phase with Know-How CAD, which provides the ability to reuse intellectual assets, which are now stored in a database. This is a major improvement over the old conventional process where information was gathered based on physical prototyping. Nissan established two phases to validate production processes (e.g., Press, Welding, Body, Resin, Powertrain, and Assembly) with the implementation of the V-3P program. To accomplish this, Nissan has implemented a number of software applications in support of Product Process Simulation, Die Product Simulation, Analysis Simulation, and Digital Testing. With the support of these applications and the new processes they support, Nissan has been able to more quickly transform the designs in the physical plant. Besides being able to reach the SOP quicker, Nissan reports that the resulting product lines and their interaction with suppliers have been of a much higher quality. With this success, Nissan established new production support facility as a part of V-3P program. This new facility, which was established in April 2007, is called the Global Production Engineering Center (GPEC) and is located in Zama of Kanagawa, Japan. Its purpose is to focus on production process optimization through the use of production trials and analysis to achieve the best quality at SOP at the same level on a global basis.
- **Visualizing Product and Process Information**—In support of this, Nissan has deployed what it calls Computer Graphics (CG) to support the process of styling evaluation. CG's purpose is to allow virtual evaluation of a

vehicle's styling on one large-scale screen. It has been expanded into the production area to allow inexperienced workers to visualize and better understand assembly techniques that have been defined by skilled experts, and it is now part of Nissan's e-learning system.

3.6 IT Solution View

In order to realize V-3P's vision, where product and process innovation is at the core, Nissan needed to implement the appropriate information technology (IT) as an enabler. As described previously, Nissan replaced its proprietary CAD software with a globally-available, commercial CAD tool and moved to a 3D design paradigm. Nissan strongly feels that their decision to purchase commercially-available software and to utilize the industry-proven best practices that have been embedded in them has allowed the company to create and maintain 3D designs that are of a high quality, without incurring continuous in-house software development expenses. From the beginning of the V-3P initiative, Nissan has focused on building their specific vehicle development processes on the purchased software and continuously improving them so that they can economically sustain the business and enable a competitive edge. For Nissan, this has been a fundamental philosophy for the implementation and use of enabling technologies.

In addition to tools that create product definition information, Nissan's V-3P program has recognized the importance of product data management technologies. Nissan considers these technologies as another critical and core-enabling component of the V-3P program. As described previously, Nissan's "Data-Show" ability demands that product definition information is accurate and that it covers all aspects of a vehicle's definition, including its production processes. This is no simple process since the collaborative environment needs to support multiple organizations on a concurrent basis, and provide access to the right product definition information, in the desired format, to the right person, at right the time, in a quick manner. This is further complicated due to the diversity of the information managed, which includes 3D geometry, raw materials, weight, various specifications, FEM and other analyses, prototype test instruction, reports, process sheets, tooling, assembly instructions, regulation, etc. that all have multiple relationships. On top of this complexity, the volume of data to be managed is significant. For Nissan, this environment demanded the implementation and use of a PDM solution to manage this complexity—a solution that could manage, disseminate, and provide controlled access in a collaborative fashion to its product definition information. To support this need, Nissan implemented Teamcenter Engineering as part of the V-3P program (IT systems map illustrated in Figure 7).

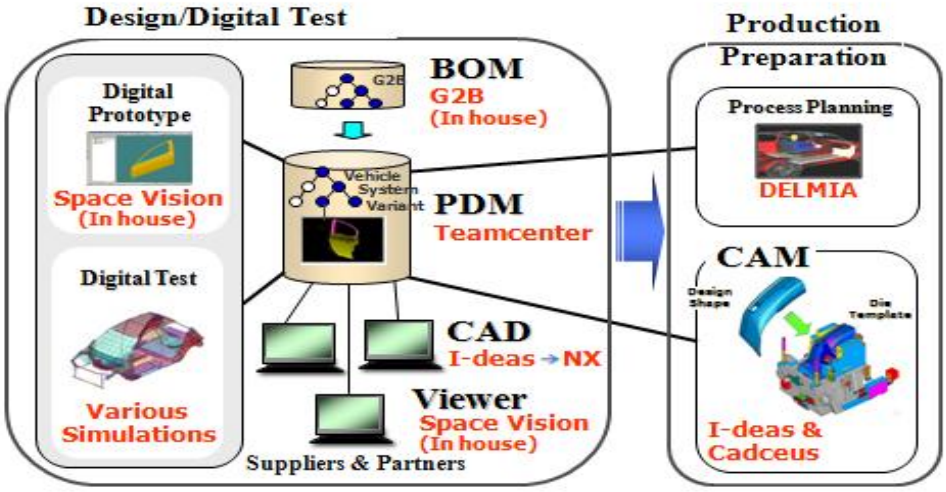

Figure 7—Nissan IT Systems Map
(Courtesy of Nissan)

4. Initial Results

After years of executing the V-3P program, Nissan proved that it could design and deliver a new vehicle (i.e., the Note) to the market in a shorter period of time and at the high quality level required. As described earlier, the Note project proved that Nissan could reduce the time it takes to reach SOP from styling freeze (from 21 months to 10.5 months). This reduction was a result of process innovation that incorporated the production engineering process into an earlier design stage, along with the standardization of corporate know-how related to re-use. Additionally, Nissan was able to reduce the number of physical or production prototypes it constructed prior to SOP by utilizing various simulation and validation techniques that proved to be accurate and repeatable. Shortening the development cycle continues to be one of Nissan's key targets and a clear

measurement of the V-3P activity. However, there are a couple of other key areas of focus though the V-3P program that may be even more important for Nissan's future success.

4.1 Delivering Industry-Leading Quality

To validate and clarify the results of its process innovation, Nissan has been compiling statistics on two important aspects (i.e., metrics) of the V-3P and its effect on the vehicle development process. Nissan uses these metrics to better understand and recognize V-3P's contribution to its business. These two metrics are:

- **Reducing Frequency of Design Changes**—This metric measures the number of design changes prior to SOP. According to Nissan's internal figures, before the V-3P implementation they achieved an approximate 25% reduction of design changes with the deployment of 3D CAD modeling based on solids as compared to the conventional design methodology previously deployed. With the additional deployment of V-3P and its associated process innovation and enabling technologies, Nissan reports that they measured a 75% reduction in design changes during the execution of the Note vehicle program. A follow-up vehicle program (i.e., the Wingroad for family use and AD van for business use), which was based on same platform as the Note (internal B-platform), reported an approximate 90% reduction as compared with programs that were not supported by V-3P program-defined processes and technologies. This clearly demonstrated substantial improvements. In the G36 sedan (Skyline in Japan) and G37 Coupe (Skyline Coupe in Japan) vehicle program, which represents the incorporation of a significant amount of new vehicle technology (e.g., advanced safety design and the incorporation of green technologies that protect the occupants in an accident), the reduction measured 60%—a slightly lower rate than the Note and related vehicles that are mainly comprised of matured technologies and processes. This should be of little surprise, since the G36/37 program utilized a significant amount of first-time use technologies that required extensive testing, and the definition and trial of a number of new manufacturing processes.
- **Increasing Market Quality**—In many ways this is a more significant metric than the reduction in design changes; it measures the number of errors found during a specific period after the initial release of a new vehicle to the market. Nissan's internal figures that compare previous models that were designed using their conventional vehicle development methodology show an approximately 80% reduction in the number of errors found in vehicles developed (e.g., Note, Wingroad, and G36 sedan) using the V-3P deployed process and enabling technologies. Nissan is happy to see that their work to ensure that both the product and process definition are accurately defined prior to SOP has resulted in a lower error rate once the vehicle has been released to the market. Nissan feels that this is a direct result of leveraging the digital design into the validation of the production process itself.

4.2 Higher ROI than Expected

When ROI is considered, Nissan reports that they have received better results than they had originally expected. According to Mr. Fukushi, Nissan estimates that a significant ROI on a direct revenue basis has resulted by applying this newly-developed innovation process. Mr. Ghosn has commented that he recognizes that this new innovative approach was the right way for Nissan to become a more innovative company and is a result of the commitment made by the R&D CFT. Additionally, Mr. Ghosn commented that the project illustrated a good practice where people work together to create and deliver the right product to the market with the support of well-defined technologies and processes, and based on their intellectual assets and corporate knowledge.

In addition to the above-mentioned ROI metrics, this transformation will undoubtedly provide much larger benefits as Nissan delivers well-defined and new attractive models to the market that display Nissan's competitive advantage and their "Driving Pleasure" strategy. Finally, it should be noted that Nissan has already decided to implement V-3P process improvements and enabling technologies to support all new vehicle programs. Nissan expects the implementation to be completed by 2010.

5. Current and Future Plans

Nissan's current and future plans for its PLM initiative can be divided into the following three main areas:

- Enhance products and processes by continuous incorporation of feedback

- Support additional business initiatives and lifecycle phases
- Expand V-3P fully to the supplier community

5.1 Enhance Products and Processes by Continuous Incorporation of Feedback

Nissan will continue to enhance and mature the intellectual assets related to its products and processes in support of the V-3P methodology by continuously incorporating feedback (i.e., lessons learned) in a closed loop manner into new vehicle development (see Figure 8). In general, this is expected to result in the ability to respond in a timelier and accurate manner to changes in market demand with the on-time delivery of Nissan's brand strategy and will improve Nissan's intellectual property with confidence.

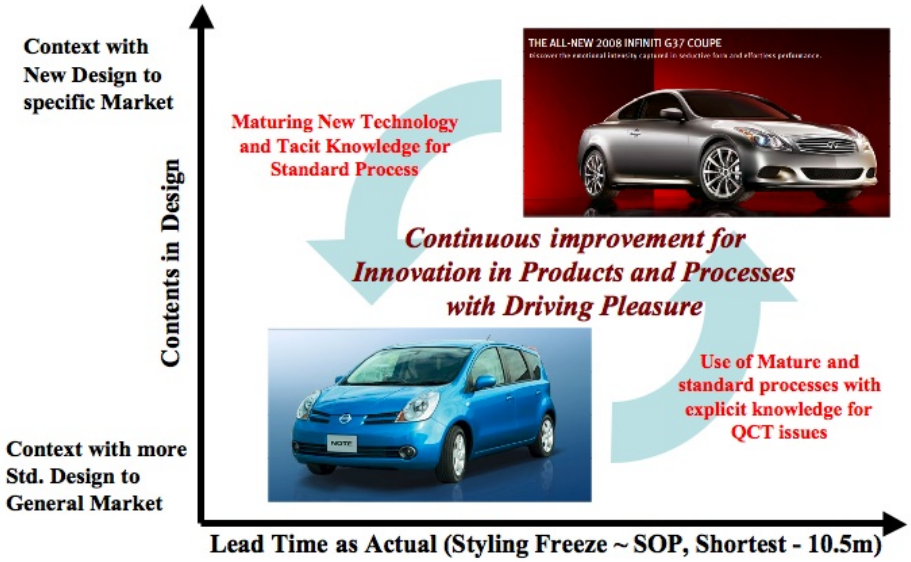

Figure 8—V-3P Extends Product and Process Knowledge

5.2 Support Additional Business Initiatives and Lifecycle Phases

Nissan plans to extend the now-proven V-3P approach and its enabling technologies to additional lifecycle phases, such as the "Idea Phase" that focuses on early vehicle concept development. Furthermore, they plan to focus on areas related to cost management. Nissan is quick to clarify that this does not only mean the implementation of a "quick to execute" process that supports cost management, but that they will need to define and implement an innovative process in support of cost management throughout the vehicle development process.

5.3 Expand V-3P Fully to the Supplier Community

To date, the implementation of the V-3P process at Nissan has supported four vehicle programs. This support has proven to be beneficial, but not without its own difficulties; especially those associated with the incorporation of the supplier community within the V-3P program and their ability to deliver assembled modules and components that met the shorten development cycle time. To accelerate the delivery of both product information and physical components to Nissan's integrated process, suppliers will need to improve their product and processes to a level comparable to V-3P. To facilitate this, Nissan is open to disclosing the V-3P methodology to their supplier base as a partner who wishes to share their newfound benefits to the market.

Currently, Nissan plans to migrate its corporate CAD system to NX in late 2008, building on an advanced pilot program that has already been started. Nissan expects to complete this roll-out in both the body and powertrain areas by the end of 2010. With this announcement, Nissan made it known that they will use Teamcenter as their CAD data management solution for NX. They also announced that they will provide availability of lightweight JT-formatted design data for viewing purposes, and that they will use and make available other tools such as Data Quality Check with NX to the suppler community.

6. Conclusion

CIMdata believes that Nissan's V-3P program has proved to be a very successful PLM implementation based on a solid foundation and business strategy, and as result we believe that many companies can learn from what Nissan has accomplished.

Today's global market is filled with companies that have made, or are in the process of undertaking significant efforts to use and/or implement PLM, and as a result, expect to receive sizeable benefits. As described at the

beginning of this study, PLM is a strategic business approach and not just a set of technologies, regardless the size of the implementation or investment. To be successful in a manner similar to that at Nissan, a company must define and follow a very clear vision; starting from the company's executive office. In turn, this vision must be supported and shared with the rest of the enterprise continuously (e.g., on a monthly basis the V-3P steering committee meets and shares visible progress). The company also needs to understand the defined goals and communicate and support them with the appropriate level of motivation so that PLM is properly pursued at a program and project level.

From the beginning, Nissan had a clear goal in mind—to quickly and efficiently deliver an attractive car to the market that met or exceeded market demands in a shorter amount of time than previously required. Once this goal was set, Nissan's R&D group within the CFT construct defined a new methodology to design and manufacture vehicles in an innovative manner. The vehicle development processes now in place at Nissan have resulted in measurable benefits and are validated through the development and delivery of four new vehicles to the market. In addition, Nissan has enabled a rich 3D solid model-based design environment that includes leveraging the product's 3D models for the definition of dies and other manufacturing specific definition information (including the definition of the manufacturing process) and the use of extensive simulation for validating the entire body and its associated components. Facilitated by the implementation of V-3P, Nissan has shown its ability to define and deliver quicker than ever, more accurate and complete vehicle and manufacturing process designs, as well as complete product information that can be used by the next action or process throughout the organization and reused as corporate knowledge.

Nissan has implemented their new product lifecycle management environment by integrating industry-proven best practices with a set of technologies, including commercially-available software (e.g., 3D CAD tools and PDM software from Siemens PLM Software). These elements are at the core of Nissan's ability to utilize best practices in support of the design and manufacture of vehicles, and to enable an environment and associated processes that differentiate Nissan and provide a competitive advantage. Focus now should be centered on refining and fine-tuning the processes now in place, and maximizing the use of the technologies they are using.

It is worth noting that Nissan expended effort on not only process and technology enablement, but also on people issues that are always associated with the implementation of new work practices. This reinforces CIMdata's PLM triangle (see Figure 9) that describes the three most important elements of any organizational change initiative, namely People, Process, and Technology—changes require continuous improvement of all elements in a closed loop manner. Without doing so, companies that implement PLM generally never reach the level of benefits possible.

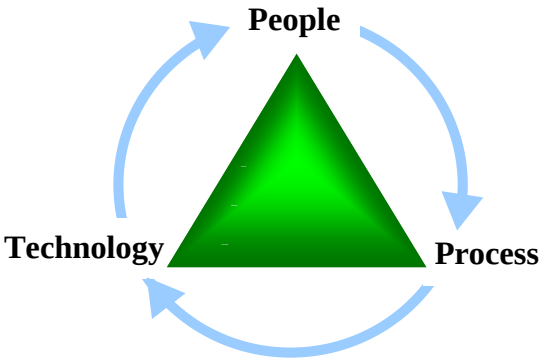

Figure 9—Three Essential Elements for Successful Innovation with PLM

The environment that Nissan has implemented can be simply defined as a collaborative PLM environment as illustrated in Figure 10. This might appear to be a very simple description, but it is a very innovative environment as proven by the benefits already realized by Nissan. At the

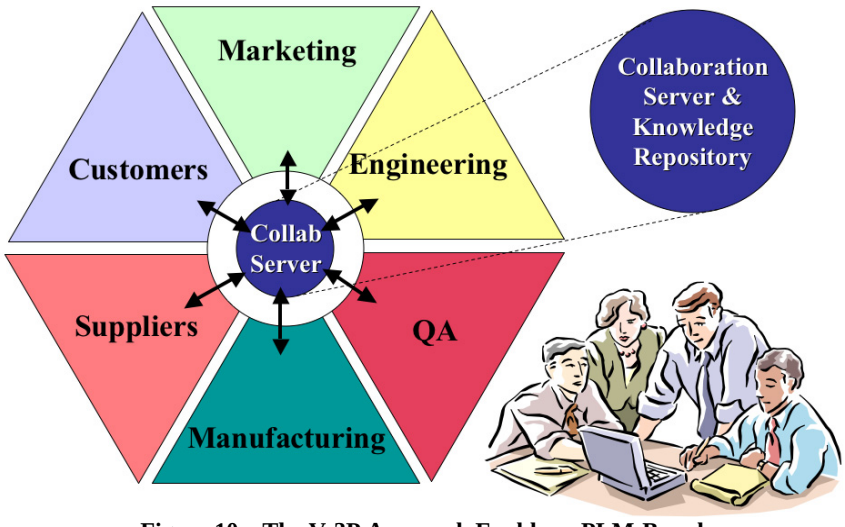

Figure 10—The V-3P Approach Enables a PLM-Based Collaborative Working Model

center or hub of this simple figure is PDM; a key enabler that plays an important role in support of very complex product definition information and processes used by multiple groups for defining and delivering the right information, to the right people, at the right time.

Finally, it should noted that Nissan has very clearly demonstrated to the market that the vehicles designed and produced digitally in their V-3P PLM environment are of a higher quality than vehicles it has built previously. Nissan has demonstrated a solid approach to implementing both process and technology improvements and has achieved its planned objectives. Nissan's decision to migrate its entire vehicle development environment to the V-3P approach by 2010 demonstrates the value that they believe is provided by PLM.

About CIMdata

CIMdata, an independent worldwide firm, provides strategic consulting to maximize an enterprise's ability to design and deliver innovative products and services through the application of Product Lifecycle Management (PLM) solutions. CIMdata offers world-class knowledge, expertise, and best-practice methods on PLM solutions. These solutions incorporate both business processes and a wide-ranging set of PLM enabling technologies.

In addition to consulting, CIMdata conducts research, provides PLM-focused subscription services, and produces several commercial publications. The company also provides industry education through international conferences in the US, Europe, and Japan that focus on PLM. CIMdata serves clients worldwide from locations in North America, Europe, and Asia Pacific. To learn more about CIMdata's services, visit our website at www.CIMdata.com or contact CIMdata at: 3909 Research Park Drive, Ann Arbor, MI 48108, USA. Tel: +1 (734) 668-9922. Fax: +1 (734) 668-1957. In Europe: Siriusdreef 17-27, 2132 WT Hoofddorp, The Netherlands. Tel: +31 (0)23 568-9385. Fax: +31 (0)23 568-9111.

CIMdata, Inc. • 3909 Research Park Drive • Ann Arbor, MI 48108 USA
Tel: +1 (734) 668-9922 • Fax: +1 (734) 668-1957 • http://www.CIMdata.com