New Potentials for Small and Medium Enterprises through PLM

Inter-company collaboration as a building block for holistic Product Lifecycle Management in supply chains

Abstract

Products are increasingly more complex as individual configuration options for the customer raise. Production depth decreases at the same time. The entrepreneurial challenge of the next decade lies in the design of networked, inter-company collaborations between manufacturers, suppliers, and development partners.

It is key to view corporate knowledge as a strategic resource when establishing data interchange with partners using existing systems and resources. PLM provides innovative concepts for the efficient design of inter-company value chains.

Author: Dr.-Ing. Marcus Krastel

Dr.-Ing. Marcus Krastel studied Mechanical Engineering at Darmstadt Technical University from 1991 to 1997. He then received a doctorate in Data Processing in Design. In 2001 he co-founded the company :em engineering methods AG and is involved in consultancy work in the environment of CAD, PDM and STEP

PLM

"PLM (Product Lifecycle Management) is a strategic business approach that applies a consistent set of business solutions in the 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, business systems, and information." (CIMdata 2002)

OEM

An OEM "Original Equipment Manufacturer" is a (manufacturing) enterprise that uses product components of one or many other enterprises in order to produce its own product. This Product is sold under the brand name of the OEM. In the Context of this Paper, the abbreviation OEM is used for Automobile OEM.

values entered change.

Tier 1, 2, 3 Suppliers

From the perspective of an OEM, his Supply Chain is divided in verious layers. The supplier working directly with the OEM is called Tier 1 supplier. The suppliers of the latter are Tier 2 suppliers etc.

With PLM you can

1. increase the speed of information exchange, means that project deadlines can be kept and time-to-market for products is reduced
2. enable suppliers to bundle and reuse the knowledge from different customer teams, thus protecting development know-how
3. make it possible to manage the complexity of today's products and processes by means of inter-company cooperation
4. enable access to current data of the OEM (also using supplier portals) to accelerate information exchange
5. increase the quality in the entire supply chain (Tier 2, Tier 3, etc.) by reducing manual processes and removing redundancies in data interchange
6. increase competitiveness and enhances opportunities for follow-on contracts, as the cooperation among partners works smoothly

This description helps suppliers to build inter-company collaboration better and more efficiently, to effectively reduce the time from concept to series production phase-in, as well as to develop more competitive and more innovative products for a continuously changing market.

Content

In order to categorize collaboration relationships, an introduction to the classification of suppliers will be provided first of all. It will then be described how the deployment of PLM methods can optimize the data interchange process between the OEM and suppliers. The influence of the used CAD modeling methods on the data interchange is described, and the description is concluded with a presentation of the various interchange scenarios, the concrete benefits of PLM deployment, and the path towards implementation in practice.

Classification of Suppliers

The implementation of PLM strategies and concepts for the design of inter-company collaborations depends to a significant degree on the role of the supplier in the development process. According to the cooperation method with the OEM, suppliers can be divided into different classes which have an influence on the integration into business processes of the OEM. ➲ Fig. 1 shows an overview of collaboration models and integration depths in an inter-company collaboration (extended enterprise).

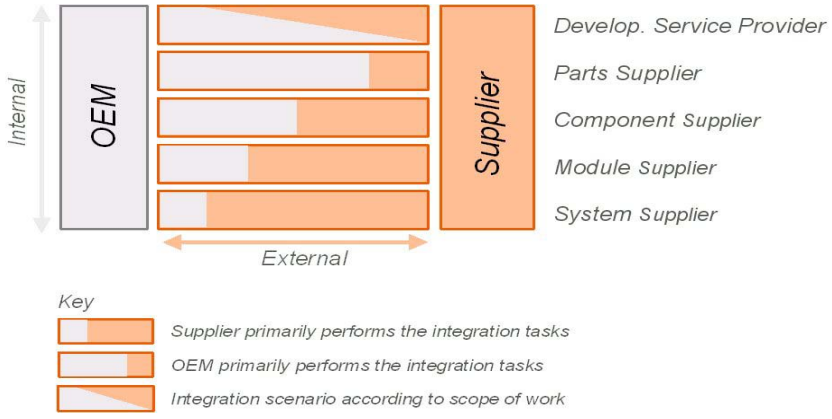

Fig. 1: Integration Depth and Collaboration Models, Source VDA, IBM PLM ↑

Extended Enterprise

An extended enterprise is evolving when external co-operation partners, development partners, contractors, customers etc. are embedded in the business and development processes of an OEM. Often, the extended enterprises are comprising many supply chain layers (Tier-1, Tier-2, Tier-x).

Development Service Provider

The development service provider delivers engineering design data based on the specifications of the OEM. The specification can involve the geometric, functional or production-related design of the product. The development provider is strongly integrated in the development and change processes, as well as in systems of the OEM. The integration can be designed to such a degree that the supplier has direct access to the PDM system of the OEM. New, so-called web-enabled PDM systems use Internet components to enable secure access to the database.

PDM

The term PDM stands for Product Data Management. It describes product-related information management throughout the product life cycle and also includes the planning, steering and control (organization) of the processes required for generating and fully managing these data, documents and resources.

"EDM/PDM can be described as the systematic planning, management and control of all the engineering data required to adequately document a product from its inception, development, test and manufacture, through to its ultimate demise." (McIntosh, 1995)

"The principle of product data management is to link the CAx information islands and to develop the product with completely computer-aided processes through which a virtual product model is created step-by-step [...]." (Schöttner, 1999)

Part Supplier

The part supplier receives approved product data from the OEM and delivers physical parts. They are loosely integrated in the development and change process of the OEM and are supplied with product data by the OEM. As a rule, unidirectional data interchange is sufficient. The part supplier has to transfer the product structure (bill of materials); this can be implemented either using standards for product structure data interchange (e.g. STEP) or PDM system modules for bill of materials interchange such as SMARTEAM® BOM, *(see also ➲ Fig 11).*

Web-enabled

Through web-enabled PDM systems, users can do database inquiries over the internet. The program kernel cantains additional modules in the web-clients for this end. Most often, web-enabled PDM systems´ web clients provide a subset of the standard PDM clients. They are either separate JAVA applications or provide product data information in an internet browser based on HTML/XML.

Product Structure

The product structure is a model of a product, describing all the relations between assemblies and individual parts of a product defined on the basis of certain perspectives (e.g. production, assembly, function, planning, cost calculation).

The product structure, which generally arises in manufacturing companies during product development, is also represented as a list, called a parts list. The parts list is one of the most important sources of information within manufacturing companies. Different types of parts lists, such as quantity over parts lists, module parts lists and structure parts lists, as well as design parts lists, production parts lists or assembly parts lists can be generated clearly with the product structure information.

Component Supplier

In a similar way to the development provider, data based on the specifications of the OEM is delivered. The component supplier delivers additional physical parts to the OEM. Integration in the processes of the OEM depends on the range of parts covered by the supplier.

Module Supplier

The module supplier delivers the digital data and the complete physical module for which they are responsible. The module supplier processes a clearly defined scope, receiving only the environment and interface information from the OEM. This is why, as a rule, a lower degree of integration in the development and change processes of the OEM is sufficient for the module supplier.

System Supplier

The system supplier delivers unchangeable data for DMU or functional systems (e.g. electrical systems) based on the detailed functional specification of the OEM. In addition, they deliver the real parts of the system which are usually spatially distributed over the entire vehicle. This is why the system supplier has a high degree of integration in the development and change processes of the OEM.

Data Interchange with STEP

STEP (Standard for the exchange of product model data) is the working title for the international series of standards ISO 10303 (Industrial automation systems and integration - Product data representation and exchange). Within this series of standards, information models for the interchange of product data for different areas of application (Automobile Manufacturing AP214, Shipbuilding AP226, Electrical Engineering AP212 etc.) are defined in so-called application protocols.

The application protocol AP214 provides information models for data interchange in automobile manufacturing. An essential basis in the development of AP214 were the requirements of the German automobile industry for the interchange of organizational and geometric product data. In order to ensure compatible implementation of the standard, delineated areas of information have been defined, and these are grouped into so-called Conformance Classes (CC). The conformance classes of AP214 for the interchange of product data used in the industry today are shown in ➲ Table 1.

Class	Designation	Description
CC 1	Component design with 3D shape representation	Single parts with 3D geometry (wire, face or volume models)
CC 2	Assembly design with 3D shape representation	Assemblies with 3D geometry, description of the geometry of several single parts that belong to an assembly, including the assembly / model structure.
CC 6	Product data management without shape representation	Product data management without geometry. Description of the product structure and administrative product data with the possibility to reference external data (geometry data etc.).
CC 8	Configuration controlled design without shape representation	Extension of the product structure to include configuration and variant management. Configurable product structure without geometry. Definition of configuration rules.

Table 1: CCs of AP214 Relevant to AP 214 Data Interchange ↑

Whereas the conformance classes CC 1 and CC 2 are used for the interchange of geometry information, the conformance classes CC 6 and CC 8 are of decisive significance for the interchange of PDM data between the systems of the OEM and suppliers.

In the course of the STEP-based interchange of product data, the STEP PDM schema is frequently referenced. The PDM scheme came about as a result of a joint study group within the framework of the development of STEP standards between the German ProSTEP GmbH, the American PDES, Inc. and the Japanese STEP organization JSTEP, dealing with the topic of "AP interoperability". The aim of the study group was to coordinate the application protocols AP 203 "Configuration-controlled design", AP 212 "Electrotechnical design and installation" and AP 214 relevant to the production industry in the area of organizational product data.

The scope of the PDM scheme can be compared to the scope of AP214 CC6, and this is why both expressions are often used as synonyms. The PDM scheme itself is not part of ISO 10303.

Configuraton rules

In former times manufacturers created a complete product description for each valid product configuration, made up of bills-of-materials, technical drawings, datasheets etc. in order to be able to react to customer requests quickly. Nowadays, PDM Systems contain the variation rules instead of the complete documentation. These rules - also called variant logic - determine how the elements of a product structure (e.g. parts, asseblies or aggregates) can be combined and forbid the usage of non-allowed combinations of product structure elements. The rules can easily be deposed in so-called "decision tables". The decision tables represent so-called "if-then" relations which have impact on the choice of product structure elements.

STEP PDM schema

STEP (Standard for the exchange of product model data) is the working title of the international series of standards, ISO 10303 (Industrial automation systems and integration – Product data representation and exchange). This series of standards defines information models for different areas of application (car manufacturing AP214, shipbuilding AP226, electrical engineering AP212 etc.) in so-called application protocols. The different STEP application protocols offer extensive visualization of PDM functions for each of the different areas of application. It supports concepts for defining versions, changing, classifying and configuring products. The STEP PDM scheme arose from harmonization via different application protocols and thus represents the interface for the PDM-relevant information with the ISO 10303 series of standards.

management, on revisions, on managing product structures and on configuration management.

PLM optimizes the data interchange process

In future, the collaboration along the supply chain between OEM and Tier 1, Tier 2, Tier x suppliers will develop from the hierarchical supplier pyramid (see ➲ Fig. 2, on the left) towards work and knowledge interchange in networked structures (see ➲ Fig. 2, right). The closer, networked cooperation offers new potentials for reducing product time-to-market on the one hand, but on the other hand requires the deployment of new, innovative methods within the framework of a holistic, inter-company Product Lifecycle Management.

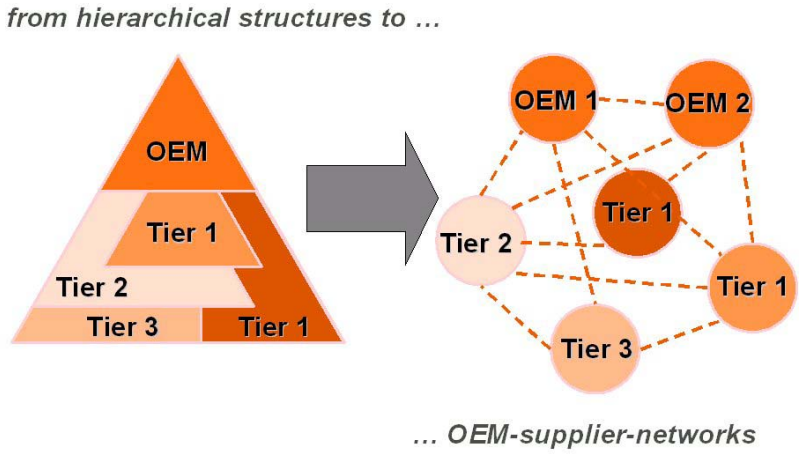

Fig. 2: Change in the Collaboration ↑

Independent of the type of supplier, data interchange processes generally run in accordance with the procedure shown in ➲ Fig. 3 .

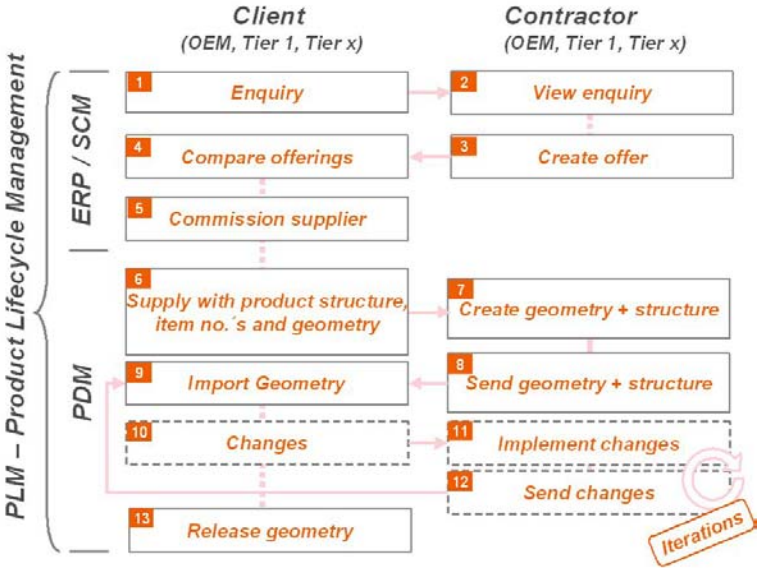

Fig. 3: Data Interchange Process ↑

In the preliminary phase of order placement, there is communication between the OEM and supplier, supported by ERP and SCM systems. When the supplier is commissioned, engineering starts together with the deployment of PDM systems for the administration of product data to ensure tracking and documen-tation of the product development.

> For us, the advantage of 3D modeling lies in the fact that we can assemble the complete vehicle and, in doing so, can check the integrity of all assemblies even as they are being created. We can see very easily where parts and subassemblies exert their mutual influences.
> Rick Cronk, Company Founder, Vepro Ltd.

The requirements for PDM systems for the support of manufacturer-supplier co-operation are varied and will be described in detail in the following chapters.

Data interchange supported by PLM enables smooth communication between partners and accelerates product development speed. Requirements on the part of the supplier such as Multi-CAD capability, support of bi-directional data interchange, support of the workflow or access across the Internet to the database of the OEM are available in todays PDM solutions and can be used productively.

Depending on the collaboration models with the OEM (see section "Classification of Suppliers"), the suppliers must define their strategy for setting up the PLM system environment. In engineering, the solutions for CAx data interchange and for PDM data interchange have to be taken into account. The Tier 1 suppliers face the challenge of supporting the different systems of the OEM as well as those of their own suppliers (Tier 2, Tier 3, etc.). For effective collaboration with OEMs and other suppliers, there are in principle three possible data interchange solutions with different degrees of suitability for different types of collaboration, see ➲ Fig. 4.

ERP

The term ERP stands for Enterprise Resource Planning and has replaced the term PPC (Production Planning and Control) in many manufacturing companies. ERP systems are chiefly used in these companies to support the logistics processes of procurement, production and sales, although they are also used in areas such as Finance, Controlling or Human Resources

SCM

SCM stands for Supply Chain Management and refers to active commercial operations and optimization of the logistics processes of the supplier through to the customer. Within the context of the total logistics process, SCM is understood to encompass the likes of sales management, materials management, warehousing or procurement.

Multi-CAD

For A PDM-System, multi-CAD means it can manage the data of various CAD-System providers. Such a PDM-System allows suppliers with heterogenous CAD-system environments to implement a common data management in order to create internal synergies.

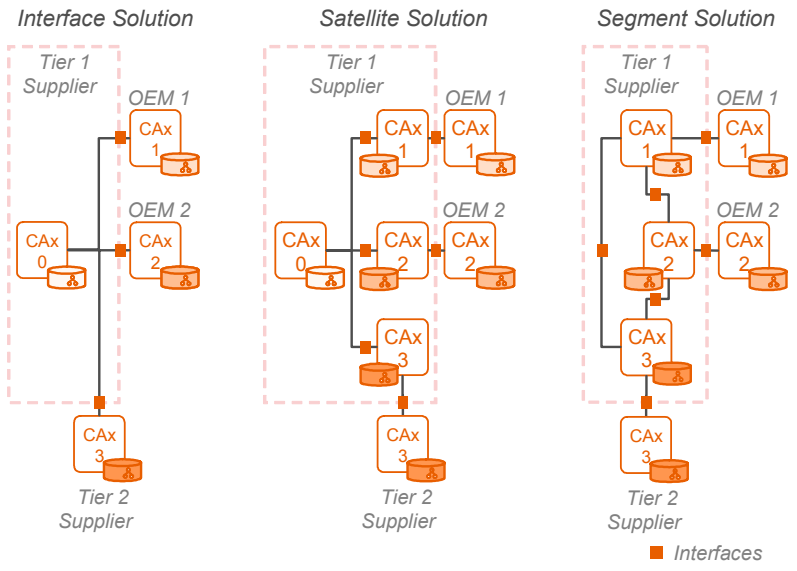

Fig. 4: PDM System Environment for Data Interchange between OEM and Suppliers ↑

1. Interface Solution

With the interface solution, Tier 1 suppliers work in their own PDM and CAx systems. They must use interfaces to ensure that the CAx and PDM data can be processed in the target system of the OEM/Tier 2. Both interfaces to standards (STEP, IGES, VDAFS) and proprietary interfaces can be deployed here.

The interface solution is ideal for suppliers that have lower integration depth in the processes of the OEM, e.g. module suppliers. An interface solution based on standards is only possible if the OEM accepts standardized data formats and does not require access to the original data in the source system. However, if access to original data is required, the suppliers must ensure the availability of direct interfaces or use the satellite solution.

2. Satellite Solution

With the satellite solution, the Tier 1 supplier has at least one workstation of the CAx and/or PDM system of the OEMs/Tier 2 (satellite). The interface problem then arises for suppliers who have to interchange data between their CAx / PDM system and the satellite systems of the OEMs/Tier 2.

The satellite solution can be used at suppliers that have close development partnerships with OEMs/Tier 2 and therefore require data in proprietary formats. For suppliers, the satellite solution means significant additional overhead with regard to administration and training for satellite systems. The satellite solution can be deployed in all the supplier classes described in the section "Classification of Suppliers".

3. Segment Solution

With the segment solution, the suppliers forego separate CAx and/or PDM systems. They work completely with the CAx / PDM systems of the OEMs/Tier 2. They form segments each of which represents an independent system environment for each OEM/Tier 2. In order to exploit internal synergies, it is required that interfaces are available between the systems.

EAI

EAI describes the function in modern PDM systems to integrate data from existing application systems. The data can be distributed via various departments, company divisions or locations. The EAI concept doesn't entail copying data, it keeps the data in the application systems and makes them accessible via a logic link.

The segment solution becomes interesting for suppliers that have established development partnerships with OEMs/Tier 2 who require a high degree of integration in their processes. The segment solution can only be used properly if a corresponding development scope is to be processed jointly. The challenge for suppliers is to exploit internal synergies by means of the different development teams in the segments. Today's PDM systems include Multi-CAD and EAI capabilities that provide the possibility to use a database at the supplier with functional integration in the CAx systems of different manufacturers.

In addition to the system environment at suppliers, the data interchange strategy is determined to a significant degree by the data interchange process. ➲ Fig. 5 shows the allocation of suppliers to classes depending on the scope and alignment of data interchange. Depending on allocation to one of the fields numbered 1-4, different data interchange strategies can be selected.

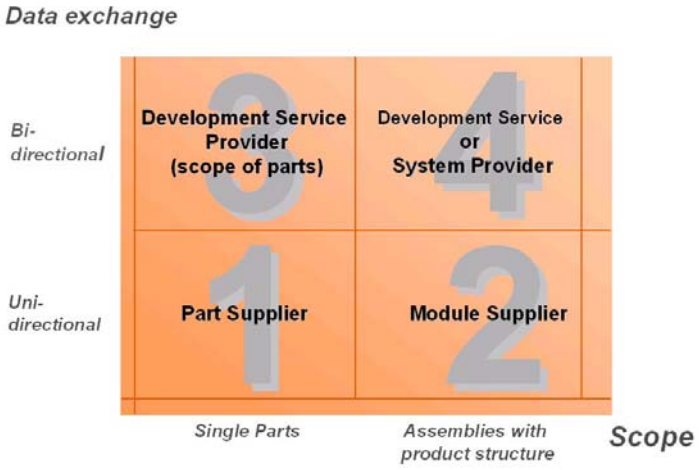

Fig. 5: Types of the Data Interchange

Field 1:

The supplier (part supplier) receives individual geometry models from the client. There is no interchange of product structures. As a rule, this process is used for small development scopes with, for example, part suppliers. A flat structure is sent on data interchange. As the data is not returned to the OEM, it is irrelevant that the information on product structure is lost in this data interchange process.

Field 2:

The supplier receives product structure information from the OEM. This process becomes necessary in the case of more complex assemblies and it is required, for example, for supplying environment geometries. As a rule, the supplier requires no item numbers for the environment geometry. The product structure is not returned to the OEM.

Field 3:

The supplier sends smaller amounts of parts back to the OEM. As a rule, the parts are designed in their installation positions. This procedure is to be used exclusively for small, manageable scopes, as the OEM receives no information at all on the original structure. It is usually sufficient to update the data manually in the product structure of the PDM system at the OEM.

Field 4:

In this process, the supplier sends assemblies, including the product structure, to the OEM. This process is always necessary if there is close integration between the OEM and the supplier. The product structure is identical at the OEM and supplier. The use of data interchange formats for structure data interchange enables automated processing of the data. This process is required for development providers or system providers.

The type of data interchange has the greatest influence on the technical design of the processes and interfaces.

Data Interchange Manager – Catalyst for Data Interchange

Usually data interchange with partners takes place by means of a special tool – the Data Interchange Manager (see ➲ Fig. 6).

The Data Interchange Manager ensures adherence to the data interchange standard ENGDAT, proper dispatch, correct addressing, secure data interchange (in conjunction with networks such as ENX) and complete logging of data interchange operations.

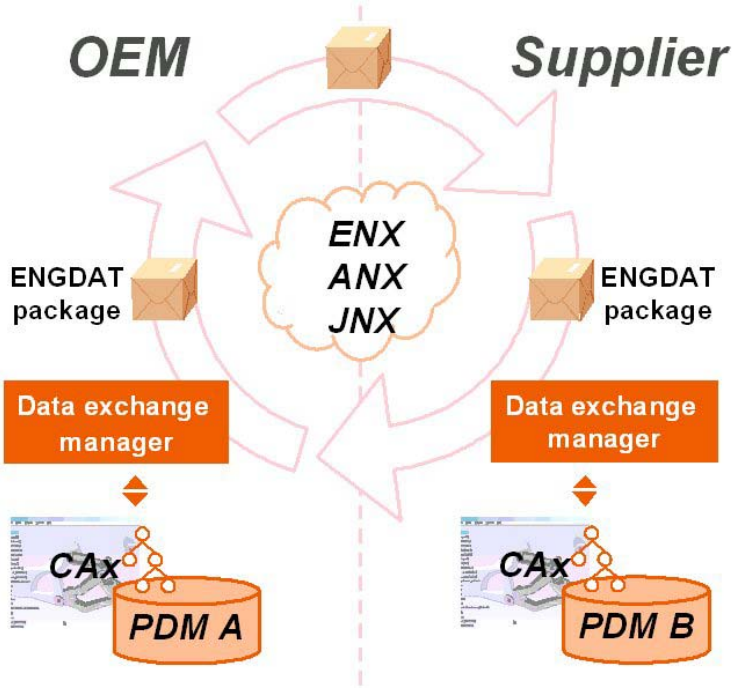

Fig. 6: Data Interchange Process ↑

EDI, ENGDAT and ENGPART

Data-exchange between Manufactures and Suppliers increasingly takes place in public networks like ENX,. The German Automotive Association (VDA) has published a reference for the data exchange in EDI (Electronic Data Interchange) environments known as directive #4951 about "Remote Transmission of CAD/CAM data – ENG-DAT / ENGPART".

This directive describes the content, structure and format of a machine readeable set of CAD-exchange files ("ENGDAT"-Engineering Data Message) as well as a machine readable partner profile description ("ENGPART" – Engineering Partner Data).

When exchanging ENGDAT data, at least 2 files are transmitted: the CAD files and the ENDAT description file which contains information about the sender, recipient, format, coding etc. The benefit from ENGDAT lies in the logical collection of all w.r.t. one transfer process, because of which it is called "ENGDAT package".

After selection of the scope of the data interchange in the PDM system, the data to be sent is transferred to the data interchange tool. The data interchange tool has the task of packing the data into an ENGDAT package and sending it to the selected recipients by means of EDI.

At the recipient, the data interchange system processes the information package, interprets the content and distributes the data, i.e. the metadata is imported into the PDM system and the useful data is stored on the file system or 'checked in' to the PDM system.

Within the framework of the data interchange, network technologies with guaranteed band-widths, such as ENX, ANX or JNX, are used for the transfer.

ENX - Network Technology in the Automobile Industry

Automobile manufacturers and suppliers entered into a partnership in June 2000 with the aim of introducing consistent inter-location and inter-company process chains on the basis of high-availability, secured communication channels with guaranteed band-widths: ENX was born.

The description ENX stands for *European Automotive Network eXchange*.(www.enxo.com), and the following companies, among others, are involved: Audi, BMW, Bosch, DaimlerChrysler, Fiat, Ford, MAN, Michelin, Opel, Porsche,

Renault, Siemens, Volvo, and VW.

All those involved are provided by so-called certified ENX service providers with a uniform network architecture that enables them to set up user-group-defined Virtual Private Networks (VPNs). The VPNs permit communication between the interchange partners that is shielded from outside.

ENX implements concepts for

- Registration (only companies with the corresponding access rights gain access to the network)
- Authenticity and encryption (data encryption is run with certificates)
- Tunneling (data interchange only on the basis of bilaterally agreed connections) and
- The complete separation of the ENX networks from the Internet.

ENX thus guarantees high performance, the highest availability and highest possible security of the communication channels.

The utilization of ENX is not restricted to pure asynchronous interchange of engineering design or business data. Synchronous activities such as distributed, networked cooperation in the context of CAD or Digital Mock Up (DMU) are also taken into account in the application scenario.

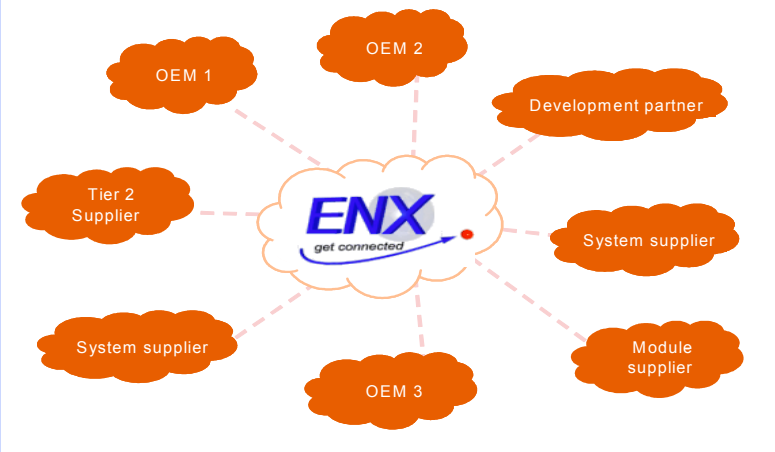

Fig. 7: ENX Network

Influence of Modeling Methods on the Selection of PDM Systems

PLM data interchange supports CAD modeling method

Each member of the team has access to all other parts, which means that each person can model the part they are responsible for and, in doing so, ensure that they do not influence others negatively.
It is absolutely essential that everyone in the team can see what all the others are doing, and in the context of the overall vehicle.
Rick Cronk, Company Founder, Vepro Ltd.

Parametric, associative CAD systems provide a wide variety of possibilities for modeling and generating relationships between models for efficient engineering design. The CAD system CATIA® V5, for example, enables the user to flexibly define inter-part and even inter-model relationships. As far as data interchange is concerned, this new CAD system functionality generates the requirement that the relationship structure remains intact even after data interchange and the supplier can open and edit the models.

New PLM methods enable retention of the relationship structures and allow the data interchange partners to work in a manner that is fully parametric-associative. For example, the PDM system ENOVIAvpm™ with its Mobile Mode enables bidirectional interchange of product

structures and CATIA® V5 assemblies between OEM and supplier.

Parametric-Associative CAD Modeling (Relational Design)

In the case of parametric-associative CAD modeling, a complex network of relationships can be set up in the 3D-CAD model. This is why a so-called VPDM system is needed to handle the relationships. This has a high degree of integration in the CAD system in order to be able to manage these internal relationships.

➲ **Error! Reference source not found.** shows the essential distinction in relationships - with CATIA® V5 as an example - between instances of a product structure, e.g. for setting up the assembly structure and relationships that are defined as references between parts.

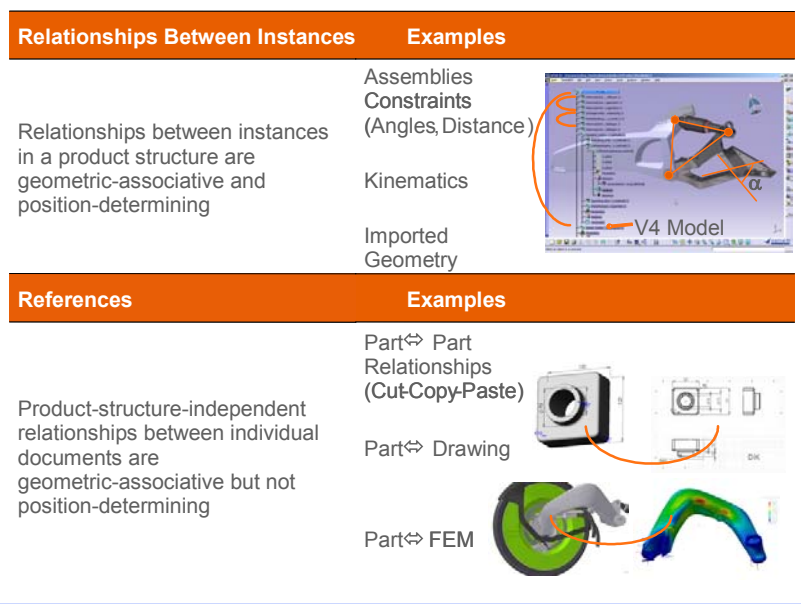

Fig. 8: Relationships in CATIA® V5

Today's VPDM systems are able to manage the networks of relationships and interchange with identical systems. Standards, e.g. STEP, are unsuitable for interchange of the relationships, as at the moment the corresponding functions are not taken into account in the standardized information models.

VPDM

Virtual Product Development Management (VPDM) solutions offer a holistic approach for managing products, processes and resources (PPR). They also support the integration of PPR data into inhomogeneous CAD environments. A typical example of a VPDM solution is ENOVIAVPM® in integration with CATIA V4 and/or V5. VPDM extends and optimizes the use of digital mock-up (DMU) applications through three-dimensional analysis, simulations and calculations. In addition, it enables VPDM systems to visualize the design intent, i.e. the knowledge of the engineer. Through the integrated management of PPR data, such as specifications, rules, parameters or simulation results, the engineer can optimize the product early on with the support of VPDM, even before the product behavior, production processes or costs have been optimized.

PLM Solutions for Data Interchange

The concepts of a holistic PLM contain different scenarios of the information exchange between the OEM and suppliers. The following section will present solution approaches and experience from system integrators that contribute to efficient data interchange in manufacturer – supplier networks.

Merging Different Structures

Different modeling methods, adaptations of the PDM system and business processes lead to the creation of different forms of product structure at the OEM and supplier. The task of PDM-supported data interchange is to merge and map the structures. ➲ Fig. 9 shows various possibilities for representation of the product structure with the same final geometric result. In Case A, product structures between parts are set up in the PDM system and shared utilization of geometry models (e.g. for mirror parts) is possible. Case B shows the structure of a PDM system that sets up the product structures between geometry models and maintains additional references to parts, e.g. for the bill of materials. The mapping of the product structure in Cases C and D corresponds to Cases A and B, but the difference is that the PDM system is unable to map the multiple use of a geometry model. For this reason, the models have to be replicated and stored redundantly.

In order to enable data interchange between the partners even with different PDM systems, mapping rules between the individual methods have to be defined.

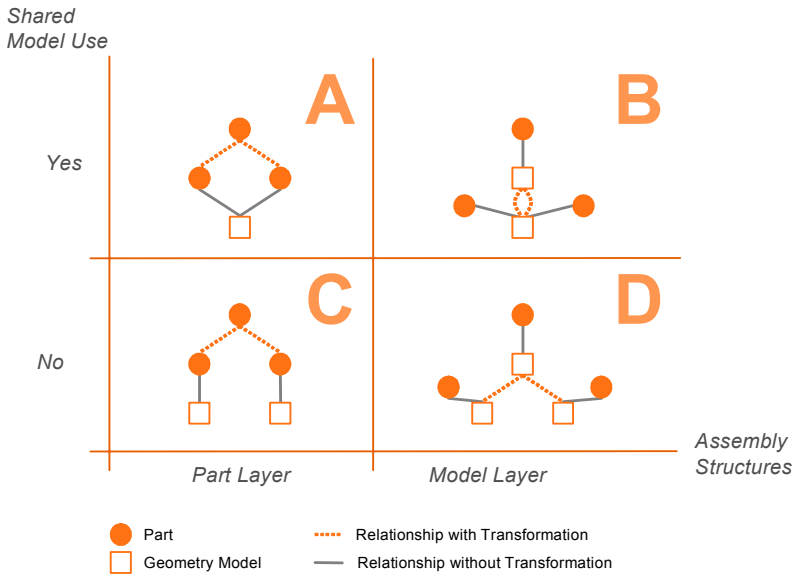

Fig. 9: Structuring Options (Source: DaimlerChrysler)

The broad experience of system integrators from consulting projects involving data interchange provide preconceived and proven solutions to successfully implement and operate data interchange. Experienced integration partners can access a large number of proven methods and procedures; there are templates and mapping rules available that can easily be adapted to the individual business onditions, thus enabling efficient interchange between the areas A, B, C and D shown in ➲ Fig. 9.

Templates

Used in conjunction with PLM, database templates are used for quick introduction and productive use of a PDM system. The templates are defined on a branch-specific basis and may be adapted to suit the company's specific framework conditions, where necessary. Predefined templates enable SMEs to support their own processes quickly with manageable investments.

Managing Parallel Item Numbers

Suppliers use internal item numbers in their own PDM systems. These item numbers do not match the numbers of the OEMs and the suppliers face the challenge to internally maintain and manage ranges of item numbers from different OEMs.

When exchanging data, the item numbers have to be mapped. This can take place either during the import on the OEM side or when exporting on the supplier side.

Ideally, the PDM system of the supplier enables parallel storage of different item numbers. ➲ Fig. 10 shows the possibilities of the PDM system SMARTEAM

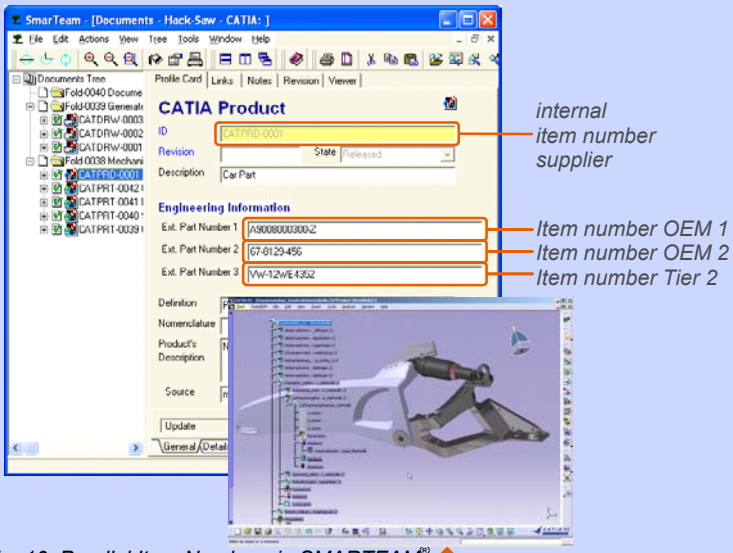

Fig. 10: Parallel Item Numbers in SMARTEAM®

The PDM system SMARTEAM® has a data model that can be flexibly expanded and modified. The data model is object-oriented and consists of classes and subclasses. The inheritance of attributes between the classes is supported. For implementation of the data model and user interface, an assistant that enables rapid modification of classes, attributes, relationships and input masks is deployed.

In SMARTEAM®, all the data can be structured as project-oriented, i.e. all defined objects are allocated to an object of the 'project' class. The class structure for any objects is displayed in structure trees. Project-oriented structuring enables the suppliers to have OEM-specific data storage on the one hand and to utilize internal synergies with the joint SMARTEAM® database on the other.

The flexible definition of the data model means that several item numbers can be managed in parallel and visualized on the user interface, see ➲ Fig. 10. During data interchange with the OEM, the corresponding item number is selected and sent.

Bill of Materials Take-Away

The interchange of product structures or bills of material is a central part of product data interchange. New, innovative PDM system developments with separate modules enable bidirectional interchange of product structures. As an example, the functions of the SMARTEAM® BOM module of the PDM system SMARTEAM® will be described here.

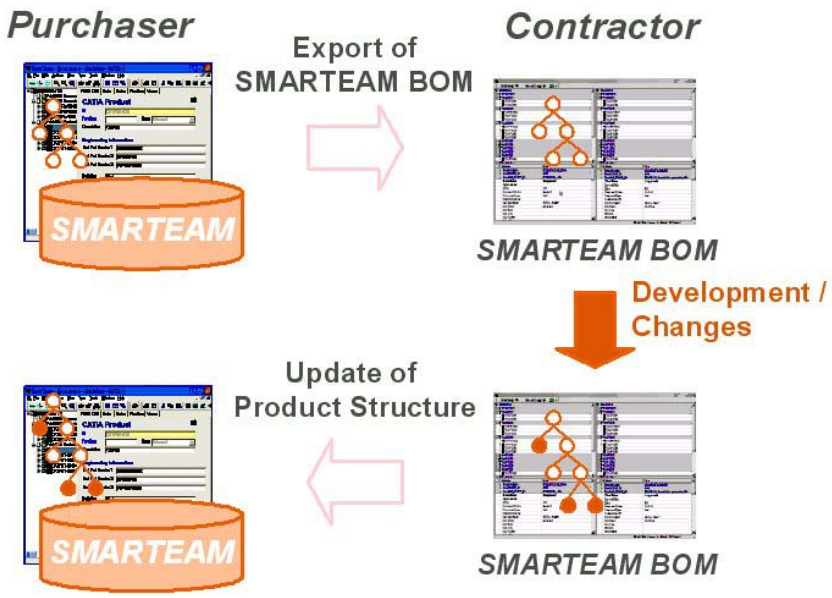

Fig. 11: SMARTEAM® BOM - Interactive Bill of Material Interchange ↑

➲ Fig 11 shows the concept for bill of material interchange using SMARTEAM® BOM, which is used to create bills of material directly from the product structure stored in SMARTEAM®. Inaccuracies and errors caused by manual input or transfer of data are drastically reduced. In order to involve suppliers at the earliest possible stage in the development process, bill of material packages can be taken from the central bill of material, compressed, encrypted and assigned to external partners.

Those bill of material packages are self-extracting and can be opened, checked and edited by suppliers even owithout having own PDM system installed. Product developers and suppliers thus form a joint, virtual team that collaborates closely from the outset.

At the same time, bills of material are also an important bridge between PDM and ERP systems. SMARTEAM® BOM uses the XML-based format iXF™ for the interchange of bill of material data. This means that, among others, rapid and reliable mapping of bill of material information in ERP and MRP systems is ensured.

Data Interchange Scenarios

The system-related design of data interchange between the OEM and supplier can in principle take the form of two fundamentally different strategies:

1. File-based data interchange on the basis of proprietary formats
2. File-based data interchange on the basis of neutral formats or
3. Multi-site PDM system integration

➲ Fig. 12 shows the possible data interchange procedures depending on the infrastructure available at the supplier.

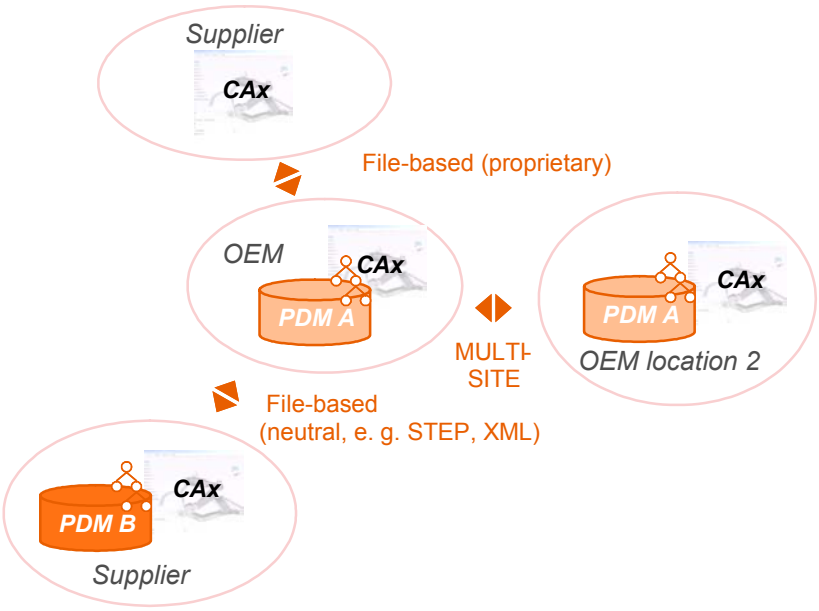

Fig. 12: PLM Data Interchange Scenarios

For each possible system configuration at the supplier (same PDM system as the OEM, different PDM system, no PDM system), PLM solutions provide system-related implementation approaches that can lead from file-based data interchange through neutral formats all the way to multi-site PDM environments. The scalability of each of the solutions ensures the optimized data interchange using existing resources and systems.

File-based data interchange on the basis of proprietary formats

In the case of file-based data interchange on the basis of proprietary formats, the product structure information is saved in a system-specific format. This file can then be transferred to the supplier, who

must have the corresponding target systems, to process the packages. Here, the suppliers can have their own PDM systems or receive the data without a PDM system using only the CAx application.

The advantages of data interchange with proprietary formats compared to standardized formats lie in the mapping of internal referencing options of the CAx systems, see also the section entitled 'Parametric-Associative CAD Modeling'.

For suppliers, this form of data interchange means that they can receive and process the parametric-associative models from the OEM without losing the references in the models. When transferred back to the OEM, the references are updated accordingly and can be entered more quickly in the PDM system of the OEM.

File-based data interchange on the basis of neutral formats

In the case of neutral formats in data interchange, STEP plays an important role as an established standard, as does XML as the new Web-based technology. The methodical procedure is identical for both formats and is explained in Fig. 13 ➲

XML

XML stands for Extensible Markup Language, a standard developed by the World Wide Web Consortium (W3C) and published in 1998. XML has beed developed as HTML (Hypertext Markup Language) - the language used in the World Wide Web nowadays - wa insufficient to semantically structure information. Although it has been developped as alternative to HTML, the focus on structural aspects made XML the future universal language for the exchange and management of data in the intra- and internet. XML allows to easily create applications which can effectively structure documents and process information.

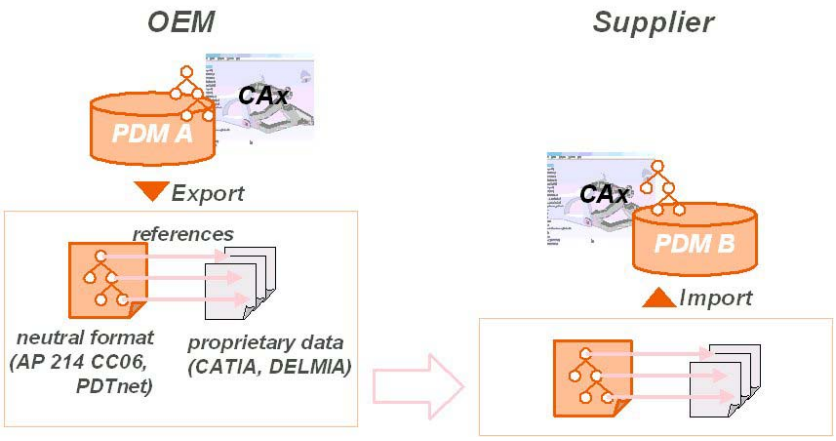

Fig. 13: STEP based interchange

For the interchange of assembly structures, the Data Interchange Manager sends a package consisting of a neutral file (STEP or XML) and the original files to be used. The neutral file contains the metadata (item number, version, author, creation date, etc.) and the assembly information (product structure and transformation) of the product. In addition, the neutral file contains references to the actual CAD data, e.g. CATIA® model files in the native format.

When suppliers receive this package, they are able to read the structures of the OEM and work with these structures. With the corresponding interfaces, they can import the metadata into their own PDM system and process them. The disadvantage of standardized data interchange is that the internal references and relationships within the CAD models are not mapped in the standard and can therefore not be interchanged.

Today, data interchange using the standard STEP is already being used productively at many OEMs with suppliers. In order to be able to use the STEP interface to interchange data, the supplier / development partner must be able to read and write files that conform

with STEP-AP214 CC06. This can take place in two ways:

- By means of a PDM system (with STEP interface), insofar as the interchange partners keep their assemblies and metadata in a PDM system.
- By means of a CAD system (e.g. CATIA® with STEP interface) if the interchange partner does not use a PDM system.

The project PDTnet provided a separate XML schema based on the semantics of STEP within the framework of XML technology. This schema has been approved as PDTnet XML schema by the project consortium and is to be used productively in data interchange in future.

'Multi-site' Data Interchange

In the case of multi-site data interchange, there is direct communication between the PDM systems of the interchange partners. Deployment of multi-site data interchange requires that both interchange partners have the same PDM installation. For this reason, it is mainly used between different locations of a company to interchange structures between the cooperation partners synchronously or asynchronously. Synchronous alignment has the advantage that the structures between the databases are permanently aligned, but it requires a correspondingly powerful network environment (e.g. ENX). If high volumes are sent by data interchange and the currency of the data has to be ensured at all times, the deployment of a multi-site can be recommended.

Conclusion

The integration depth influences the necessary investment in the area of data interchange to a significant degree. The stronger the integration depth, the more overhead is involved for conception and implementation of the collaboration on the one hand, but the benefit for the company as a result of more efficient data interchange is enhanced on the other. The decision in favor of a solution depends on the general conditions in the specific interchange project and can be supported by the experience that partners already have.

Implementation in Practice

Efficient data interchange is an essential component of today's engineering and it will become increasingly important in the coming years. The data interchange agreement of the OEMs is part of every project agreement. On the one hand, the supplier is forced to implement the requirements of the OEMs to receive the project order; on the other hand, the immediate benefit for the supplier lies in the opportunity to significantly accelerate the development speed through efficient communication with the OEM and with other suppliers.

Amortization of the investment in efficient design of data interchange is already possible after deployment in a few projects.

Experience has also shown that it is beneficial to start with oversee-able project scopes which can be accepted and suppoerted by all involved employees on the one hand, and which guarantee fast return rates.

The described dynamics of future collaboration models mandate the system environments to be easily adaptable at the same time. This means that – amongst others – the implemented solutions are open,

based on standards and that they deliver intuitive tools to minimize system integration and administration efforts.

Your Path to Successful Collaboration …

With the aid of system integrators and their proven experience from numerous data interchange projects, collaborations you can rapidly and securely start with an initial collaboration project.

> "We are now able to run a continuous 'error check' and I as head designer am better able to use common sense to estimate what individuals are working on and to prevent fleeting errors from occurring."
>
> Rick Cronk, Company Founder, Vepro Ltd.

The rapid and low-cost establishment of intelligent and automated data interchange processes between OEM and suppliers helps to reduce data interchange times and significantly shorten product development times.