Chapter 5 – Integration of the PLM system with other applications

This chapter considers the role of PLM systems in relation to other systems used in the company. Furthermore, the most essential ways to integrate applications with each other are discussed.

Different ways to integrate PLM systems

The PLM system plays a central part in the IT infrastructure of an industrial enterprise. When the first PLM system is brought into use in a company, it does not usually replace any specific old system but brings new surplus value to the infrastructure. This value is increased by the new properties and possibilities brought by PLM, which allows many old manual processes to be converted into electronic processes.

Systems which have specialized in product data management contain many functions and features specially designed to manage items and documents. These are rare for example in ERP and CAD systems. On the other hand, PLM systems do not include many ERP system properties. Thus, PLM and ERP are not mutually exclusive. The systems supplement each other. However, the exact role of each system must always be decided on a case-by-case basis.

In a PLM project, it is necessary to decide what kind of information will be updated in each system. The central question to be examined is the ownership of the information in various life-cycle phases.

A reasonable objective is that information should always be updated in one place. Other systems can read information directly from the PLM databases, and if necessary, the required information can be replicated on the databases of other systems.

However, it is essential that the original source of all information and the business process responsible for it is known within the company. The operation must be designed so that information will be updated only on one system.

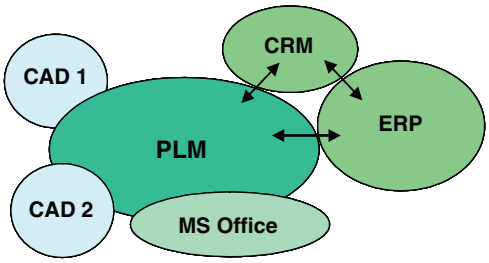

Figure 20. Integrating PLM with other systems.

System integration and related problems are often the most difficult and most laborious parts of a project. When designing the relationship between PLM and other systems, the following different systems – among other things – must be taken into consideration (figure 20):

1. Enterprise resource planning (ERP) systems
2. Document management systems
3. Mechanical or electronic CAD systems
4. Other design applications, image editors
5. Applications for cost accounting and bookkeeping
6. Customer relationship management (CRM) or other sales applications
7. Reporting systems
8. e-Mail programs
9. Office applications
10. Viewers
11. Internet browsers

It is not necessary to integrate the PLM system with all other systems in the company. However, it is worth considering the utilization of document management functionalities in many fields. Naturally, integration with currently used applications must also be considered.

The level of integration can vary considerably. Information can be moved between PLM and other applications in several different ways, from the manual transfer and copying of files to sophisticated database or middleware integration between systems.

An application has two opportunities to acquire the information it needs: information transfer and information sharing. These two methods diverge from each other in the way information is copied. Information transfer involves copying the information prior to moving it. Shared information involves the use of one

common database. Many different applications have access to a single database, if necessary at the same time.

The three commonest ways to integrate systems are:

- Transfer file integration
- Database integration
- Middleware integration

In practice, it is often easier to transfer information than to share it, because sharing information requires an exact knowledge of the basic mechanisms of the software in use and sometimes involves application specific tailoring. However, the problem with information transfer is that it is often extremely difficult to ensure the harmony of information after copying and transferring files. Later changes in moved information are not necessarily updated in the original database. One could say that the transfer of information is suitable for communication between separate companies and organizations. The sharing of information is a good solution inside a company, where applications can be more tightly integrated.

Transfer file

Information is usually moved as a so-called transfer file (figure 21), which is created either manually or automatically in the application from which the information is exported. The generated transfer file is read, manually or automatically, by the application into which the information is imported.

As always in integrating applications, common terms and concepts must be clarified carefully. Issues related to the classification and structure of information is especially important. There must be exact agreements on:

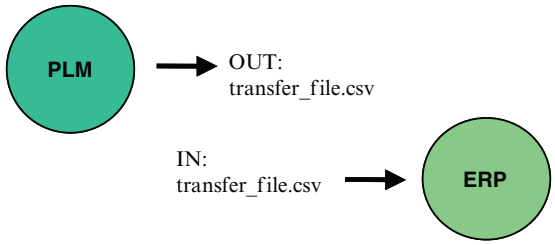

Figure 21. Transfer file.

- What information is moved?
- How is the information moved?
- In which file format is the information moved?

In practice, these definitions are listed in a special definition document, which defines the applications needed to handle the transfer file.

In practice, the transfer file can be, for example, a *.txt or *.csv-type text file in which the fields to be moved are distinguished from each other using a separator character, such as ";" or "|". Using the definitions from table 1, the example might create the following line in a transfer file:

465259; ; PLATE; S=20; pieces; P004310; A;

A more general technology for transferring information is XML (Extensible Markup Language). When the contents of the transfer file are in XML format, the transfer file can also include information about the structure of the content. XML technology is described in more detail in chapter appendix 1.

Table 1. Definition of the transfer file.

Field number	Field name in sending application	Field name in receiving application	Maximum field length in receiving application	Maximum field length in sending application	Field length in transfer file	Obligatory field in transfer file
1	Item code	Product code	30 characters	18	18	yes
2	Empty	Empty	-	-	-	no
3	Description 1	Name	50 Characters	38	38	yes
4	Description 2	Techinal information	50 Characters	50	50	yes
5	Unit	Measure: m/kg/pieces	8 Characters	3	3	yes
6	Drawing number	Drawing code	30 Characters	18	18	yes
7	Drawing revision	Drawing revision	8 Characters	3	3	yes

Database integration

Database integration usually involves the use of a common database. Certain information is shared between two or more applications. The information is located in only one application's database, to which other applications have access where applicable. However, retrieved information can also be copied regularly from one database to another. In other words, the information can be replicated to another database. This is still a case of transferring information, but the method used is database integration instead of a transfer file.

Database integration is often carried out through a so-called API (Application Programming Interface). Many application programs include a specially defined software interface, the API. The services that the application in question offers to external applications are defined in the API. In practice, the API serves as an interface for "discussion" between applications. For example, a PLM application could include an API service that transmits detailed definitions of data for a certain product. An ERP application could receive the information through the API interface and use the information for inventory management. In this case, the ERP application would in practice, start certain functions of the PLM predefined in the API. The functions would then start the actual information retrieval in the PLM.

A PLM application could offer, for example, the following API functions as services to other applications:

- Retrieval of information, for example searching for documents or items with a certain code
- Free text-form search of information using AND/OR/NOT functions
- Retrieving the structure of a certain item
- Adding information to the database
- Editing information in the database

When comparing direct database integration and transfer file integration, attention can be paid for example to the following points:

Advantages of transfer file integration

- Easy to implement
- Inexpensive solution
- Easy to make changes

Disadvantages of transfer file integration

- Slow, does not operate in real time
- Information has to be replicated over several databases

- Timing/launching of the transfer file often involves manual work
- Management of several transfer files can be difficult

Advantages of database integration

- Speed
- Ability to use common databases for several applications
- Information in one place
- Automatic

Disadvantages of database integration

- Implementation can be quite heavy
- Making changes is more difficult
- Expensive

System roles

When integrating information systems with each other, it is necessary to think profoundly about the roles of the systems in the first place. Not all companies have considered their systems at all from the viewpoint of the whole infrastructure. In the course of time, situations and needs may have changed. For example, there may be systems in use that could already have been replaced with some other system used in the company. The properties of new systems have perhaps not been used to the maximum possible extent.

Take the example of a company that has acquired a new ERP application. It is possible that they have left the old ERP application in use just to manage spare part items – even though the new system would have been equally able to manage the spare part items. The focus of the project might simply have been elsewhere, and there has not been sufficient pressure to change the prevailing situation. Long term infrastructure planning is often complicated also by the fact that project targets must always be achieved within very tight schedules. There may also have been a lack of skilled people. The company's few experts cannot always participate in every development project. From an overall viewpoint, the result is not always perfect.

However, in IT projects it is extremely important to think about the entirety of business processes. The definition of different systems and their roles has to be prepared accordingly.

ERP

The relation of PLM and ERP (Enterprise Resource Planning) systems can be roughly described as illustrated in figure 22. Traditionally, PLM systems have been used in the product development process, just as ERP systems have been

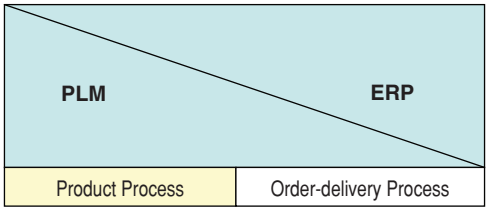

Figure 22. Support of PLM and ERP in the business processes.

used in the production process. PLM is the system for product data producers; ERP in turn is a system for product data consumers. The PLM system manages product items and item structures, but seldom the stock levels for warehouse items. This information is controlled with the help of ERP systems but the basic information on items may be read into ERP from the PLM system.

ERP systems have largely developed from earlier MRP (Material Requirements Planning) systems, which were used for calculating material needs for production. Modern ERP systems are often module based; different modules have different user interfaces and different user groups. For example, the following modules can be used:

- Manufacturing module
- Procurement module
- Logistics module
- Financial module
- Maintenance module
- Sales module

Different modules manage different operative functions within their particular fields, covering all kinds of issues needed in the daily control of the business: customer data, purchases, backlog of orders, warehouse items, bill of materials, delivered products, billing, procurement control data, sub-contracting data, and so on. However, much of the necessary basic information, and the updating of that information, may be located in the databases of a PLM system.

In practice, the ERP system must often be integrated with a PLM system. Depending on the databases and the needs of the company, the link can be by transfer file, database or middleware integration.

Workers' assignments define how their daily work is divided between the different systems. Organizations that work largely with purchase transactions, orders, inventories, deliveries and similar operations will probably work more

with ERP systems. These include, for example, production, purchase and maintenance. For those involved in producing product information, such as product development and marketing, the system is more likely to be PLM. However, integration of these systems provides all organizations with access to product data as well as operative business data.

CAD

Many early commercial PLM systems have developed from software intended for the management of CAD drawings. The programs have gradually acquired additional features and modern PLM systems are no longer CAD system additions. Rather, they operate very widely with all kinds of applications, of which CAD is but one. CAD systems can be 2D or, increasingly, 3D design software. There are many specialized CAD applications, for example for mechanical planning, electrical engineering, electronics design, hydraulics planning, pipe planning and shipbuilding. However, the division of labor between CAD and PLM systems is clear: information that has been produced by a CAD system is controlled by a PLM system. The PLM does not contain any features related to the actual modeling and engineering work.

At its simplest, a PLM system can serve as a file vault for documentation produced by a CAD system. There might not be strong integration between CAD and PLM, and the created documentation might be imported manually into the PLM, with the designer moving drawings into the PLM system one by one.

From the designer's point of view, a somewhat easier approach is to have the CAD system connected to PLM so that the created documentation is saved directly into PLM without any intermediate stages. In practice, the engineers are constantly connected to PLM. The PLM user interface can be integrated into the CAD user interface.

Integration is not restricted to drawings; it can cover all other created information including:

- Individual 3D-models
- Structures of models: Assemblies and subassemblies
- Items
- Item structures
- Drawings: workshop drawings, assembly drawings, exploded drawings, etc.

Strong integration allows product data produced with a CAD system to be controlled by the PLM system. In such cases, the PLM user interface is usually

GENERAL TOLERANCE		SCALE	DESCRIPTION		MATERIAL
SFS-EN 22768-1	m	1:2	TIE ROD		
SFS-EN ISO 3920	A	SIZE	CYLINDER		SURFACE FINISHING
SFS-EN 25817	C	A4	INTERMEDIATE MAST		
DRW	JAPPIMI		A altosen Konepaja Company TKK / Konepajatekniikan laboratorio	DARWING NUMBER 2003212	DRW REV 0
DATE	08.05.03				
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APP		0.2 kg			

Figure 23. The information lines of a workshop drawing have been filled in from the PLM system database.

integrated directly into the user interface of the CAD system. The designer need not operate the PLM user interface at all. All information is handled directly through the CAD user interface, which is connected to the PLM databases. For example, when an engineer creates part lists or fills up information in document sheet info fields, all the information can be taken directly from the PLM item database (figure 23). This can happen, for example, when the designer starts a subprogram (in other words a macro) which collects the right lines of information for the part list, matching the model currently on display.

A company might use many different CAD systems, but these can all be integrated with the same PLM system. This makes actual concurrent engineering possible. Several persons, or geographically different organizations, can work with the same CAD assemblage and they can all see the others' engineering data. At the same time, the PLM system ensures that only one person at a time can edit a particular file. The advantages of concurrent engineering are discussed in chapter 10.

Configurators

Configuration is a method of arrangement. In the terminology of information technology, a configurator is an application that manages the structure of a product and its variations, in other words alternative configurations. When speaking of configurators, one must be exact with the terminology. Different software suppliers and IT consultants can interpret the word "configurator" very differently indeed. The following applications – which differ very clearly from each other in their operation and content – are often mixed up:

- Sales configurator
- Product structure configurator

A sales configurator controls the sales properties of a product and the rules relating to sales properties. The rules define the allowed combinations of sales properties and prevent the choice of forbidden combinations; for example, a car factory may have decided for technical or other reasons that a car equipped with a 70 kW engine is not available with an automatic gearbox. In other words, if the sales item, engine power, has a value of 70 kW, then the sales item, transmission, must not have the value automatic. A sales configurator can also control other kinds of customer information, such as market area or customer-specific price lists for different sales properties.

The sales configurator produces a so-called sales structure (figure 24), in practice a group of features that determine the technical structure of the product. The following properties, for example, could be configured for a car:

In the example, the sales configuration for the selected car on the feature level would be as follows:

- Chassis of the car: a three-door coupe
- Engine: 50 kW
- Gearbox: automatic
- Color: red

A sales configurator can be integrated with PLM software, for example, when the configurator uses sales items that are managed by the PLM. In addition, based on a chosen sales configuration, a physical product structure can be created in the PLM with those items and item variations that fulfill the selected product properties defined in the sales configuration. This requires that the PLM system have product structure configuration features. Not all PLM applications support the configuration of the product structure very well yet.

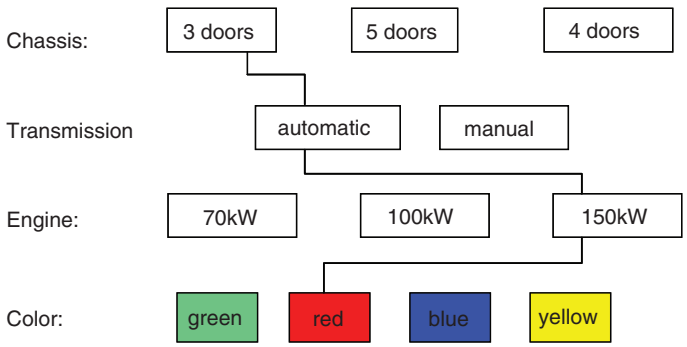

Figure 24. A practical sales structure.

A product structure configurator can be part of a PLM system or it can be an independent application that is integrated with PLM. For the product structure, the configurator is fed the sales configuration as an input value after which it produces a product structure matching the sales configuration in question as an output value. Management of the product structure with a configurator is programmatically challenging because it is possible quickly to accumulate thousands of different variations of the product. If all possible combinations of the four different features in the car example were allowed, the combination of three different chassis, three engines, two transmission and four colors would alone be enough to produce 72 different configurations.

Usually a product contains many sales properties that affect the product structure. The number of different structures can easily rise to thousands or even hundreds of thousands. For a configurator automatically to create a product structure for all these thousands of different variations requires a carefully designed product model that combines sales features with physical item structures. The configuration software must also have a very advanced user interface for the maintenance of the product model.

EAI

EAI (Enterprise Application Integration) is a method that makes efficient and process like data transfer and distribution possible between different applications in a company's data network. The principle of EAI arose from the need to move information more effectively within and between companies. That need has increased because of business processes that go beyond the organizational boundaries of a company.

Over the last few decades, IT systems were built to carry out certain functions or business processes that companies considered independent, such as warehouse management, procurement or product design. When companies began to form networks and expand into several different localities, it was noticed that the islets of the IT infrastructure must be connected in order to meet the challenges of international competition and company expansion. When the business environment develops, the company's IT infrastructure must also develop. Many companies began to develop large-scale integration for transferring information between systems. However, this development led to a huge amount of work due to the large number of specialized systems and to the ineffectiveness of tailored integrations. Integrations have to be built individually in the form of tailored links from system to system. Likewise, the maintenance of these integrations is quite laborious as the linked applications develop continuously, for example in connection with version updates of commercial standard software packages.

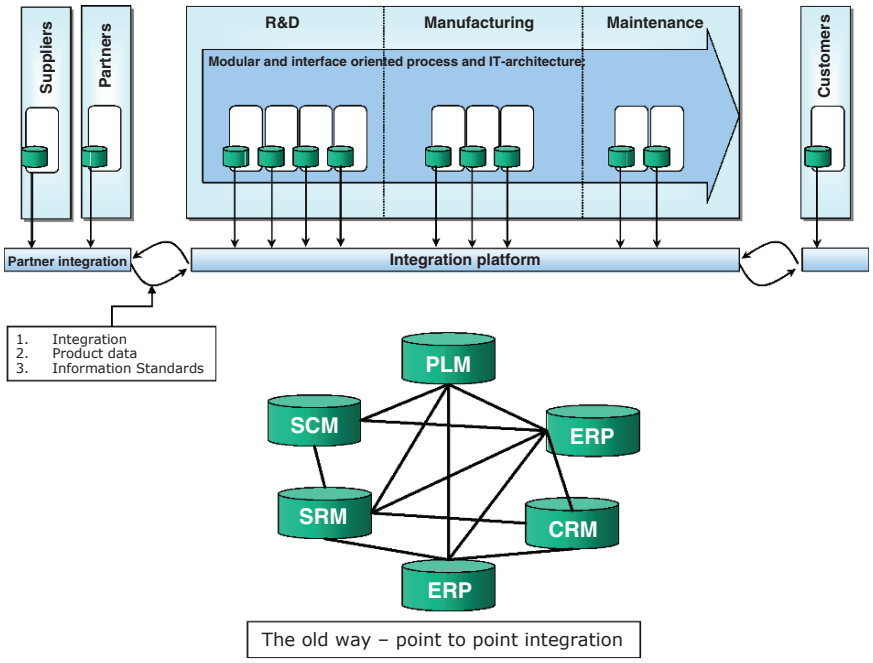

Figure 25. Principle of EAI conceptually, compared to traditional integration concept.

The need arose to build generic integration platforms, in other words a way to integrate different systems with each other with the help of a common generally functioning layer. EAI aims exactly at this. Instead of separately integrating specific systems, the basic principle of EAI is to add to the IT architecture of companies a software layer (middleware) that transmits and moves the required information between different systems (figure 25). The need for integration between the systems decreases significantly! At the same time, it is possible to reduce significantly the amount of work needed for the maintenance of the integration. This is especially noticeable in connection with application version updates.

EAI is multiform and still a little open. The exact nature of the concept can therefore vary in different connections. EAI can be defined, for example, as follows by Marc Byens:

> EAI is a continuous process using the methods of information technology to develop a company's IT infrastructure so that it creates a logical ensemble, which supports the business processes of the company, makes the change of business processes possible, and supports the development of new processes.

EAI is not a product or a tool that can be bought in a shop. It is a continuing process that is used to develop the operation of the company so that IT systems share and move information better. At the practical level, EAI is often implemented using a commercial middleware product. In addition, many producers of middleware software are happy to connect their own technology with the term EAI.

As stated earlier, a PLM system is extremely suitable for developing communication between separate business units or business processes within a company, and between companies. Adapting the principles of product data management improves especially the communication and management of existing company information both internally and externally.

Improved communication brings many other advantages at a strategic and operative level. In practice this is appears in the ability to integrate separate CAD, CAM, PLM, ERP and other operative applications and in the centralization of information management. Furthermore, an integrated IT architecture can benefit from automation of the sales and other e-business applications for electronic trade.

One can say indeed that when investing in the development of PLM, which very often includes plans for integrating many IT systems, one must also consider whether it would be worth utilizing EAI immediately when designing the totality. Furthermore, one should investigate the development trend in the company concerning system integration. For EAI, one can say without dispute that following its principles makes possible the flexible development of business processes to meet the needs of the future and new business areas. In other words, by combining the principles of PLM and EAI it is possible to create a flexible and lasting foundation on which to develop the business to meet future challenges.

Summary

- When integrating IT systems, the central question to be examined is *the ownership of the information*.
- The commonest ways to integrate systems are by transfer files or database integration.
- The role of PLM compared to other systems in a company can vary because of different initial situations and approaches.
- Middleware (EAI) software can be used to reduce the number of integrations and make them easier to manage.