Master Thesis Project

Evaluation of CATIA Team PDM

Toomas Hommik
June 19, 2003

Academic advisor & examiner:	Vladimir Vlassov Department of Microelectronics and Information Technology, Royal Institute of Technology Sweden
Industrial advisor:	Magnus Elfman Electrolux Sweden

ABSTRACT

Data management plays an important roll in product development. Big archives are time consuming and difficult to deal with. To be able to work efficiently documents such as designs, specifications and drawings need to be organized. As a way to satisfy this need the PDM (Product Data Management) technology has emerged.

A PDM-system is a powerful tool for file and revision management, but a successful implementation requires careful consideration. There is a big difference between local and global perspective. The advantages gained with one extensive PDM platform need to be weighted against a more complex implementation.

This report takes a closer look at a PDM-system called CATIA Team PDM. It explains the program in detail and also includes some advice for a possible implementation at Electrolux Home Products. Focus is on how the program works and is used in a product development environment together with the CAD application CATIA.

It can be concluded that CATIA Team PDM offers flexible and user-friendly management of product related information, much thanks to good functionality and a very close integration to CATIA.

TABLE OF CONTENTS

1 Introduction

This thesis has been performed as the final part of the Master of Science Electrical Engineering program, specialization Computer Systems at the Royal Institute of Technology. The research was performed at Electrolux Home Products in Stockholm.

1.1 Why this thesis?

Electrolux has for several years been using CATIA V4 as a CAD tool for product development. The next generation of CATIA (V5) will replace the current system. The way this next generation store data is different from prior versions. This has created a need for Electrolux to find a strategy on how to handle all the new data. One solution is to use a commercial PDM-system called SmarTeam. The intention of this thesis is to evaluate a sub-set of this system, called CATIA Team PDM, designed to work with CATIA.

1.2 Objectives

The objectives of the research can be divided into three parts:

1. Improve the knowledge of the program CATIA Team PDM and product data management in general.
2. Investigate how CATIA Team PDM fulfills the needs of Electrolux
3. Guidelines for what to consider when implementing CATIA Team PDM.

1.3 Scope

The scope of this thesis is limited to functions and functionality that is of interest concerning the integration between SmarTeam and CATIA, CATIA Team PDM. It should not be seen as a complete evaluation of SmarTeam and all its features.

1.4 Research Method

The research was performed at Electrolux in Stockholm where the author participated in meetings and discussions regarding CATIA Team PDM.

A literature survey was done to gain general knowledge about PDM.

Information about CATIA Team PDM was obtained from courses, program documentation and visits to other companies using the program. The conclusions are based on this information and experiences from a simulated working environment.

Furthermore there has been a continuous dialogue with Electrolux staff that in some way would be affected by CATIA Team PDM. The dialogues have been in the form of general discussions regarding the possibilities/problems with the program and have not been structured or documented. A lot of good advice and suggestions came from Electrolux in Orangeburg, USA that at the time of the research was setting up a SmarTeam environment.

To ease the evaluation certain elements that deserves extra attention have been pointed out:

- What is required for an implementation of CATIA Team PDM?
- Which are the fundamental requirements on the system?
- The integration CATIA – SmarTeam, is it possible to customize?
- General description of PDM-systems.
- The user interface, how is it designed?
- Safety of files?
- User permissions?
- Tools for system administration?
- How are different CATIA file types managed?
- How are files stored and retrieved?
- Can data be distributed/replicated?
- How are revisions managed?

1.5 About the thesis

This report does not require any previous knowledge of PDM or SmarTeam. General knowledge of CAD and product development will make it easier to understand the functionality and structure of SmarTeam.

The research was performed on a Win2k PC with the following software:

- CATIA V5, release 9, service pack 4, MD2 and TD1 license
- SmarTeam V4.004, service pack 5.5
- Oracle 8.17

Below is a comment to the report:

SmarTeam is developed by a subsidiary company to Dassault Systems, which is the company behind CATIA. As from release 10 of CATIA V5 Dassault Systems decided that SmarTeam and CATIA are to have synchronized releases. When release 10 of SmarTeam was announced the name for the integration CATIA – SmarTeam was also changed from CATIA Team PDM to SmarTeam Integration. This report was written before this new release and therefore makes use of the old name CATIA Team PDM.

1.6 Outline of the thesis

Section one gives an introduction to the objectives, scope and research method of the thesis.

Section two provides a general introduction to product data management, its advantages and limitations.

Section three lists and motivates requirements/needs that can be seen as fundamental for a PDM-system.

Section four describes the program CATIA Team PDM and gives a detailed description of its structure and functionality. All listed requirements from the previous chapter are covered.

Section five covers what need to be done and taken into consideration if CATIA Team PDM is implemented.

Section six gives an introduction to some alternative PDM solutions.

Section seven concludes the research and formulates future topics.

2 Product Data Management

This section is meant to provide a short introduction to Product Data Management (PDM) and also point out some of the advantages gained when a PDM-system is implemented.

2.1 What is Product Data Management?

Efficient product development is important if companies want to stay competitive. Documents such as designs, specifications and drawings need to be organized. Finding the right document and revision can otherwise turn into a major task. As a way for organizations to improve their product development environment the PDM technology has emerged.

CIMdata defines PDM in the following way [1]:

"Product data management is a tool that helps engineers and others manage both data and product development process. PDM systems keep track of the masses of data and information required to design, manufacture and then support and maintains products."

The amount of information that describes a product is in general extensive. Focus is often centered on the geometric CAD-data. That is however only a portion of all the information surrounding a product. Several departments such as Manufacturing, Finance and Sales/Marketing are in some way involved and they all have their own documents and information regarding the product. A PDM system is the link between the different departments, see Figure 2.1 [2], and has to be able to manage all information surrounding a product.
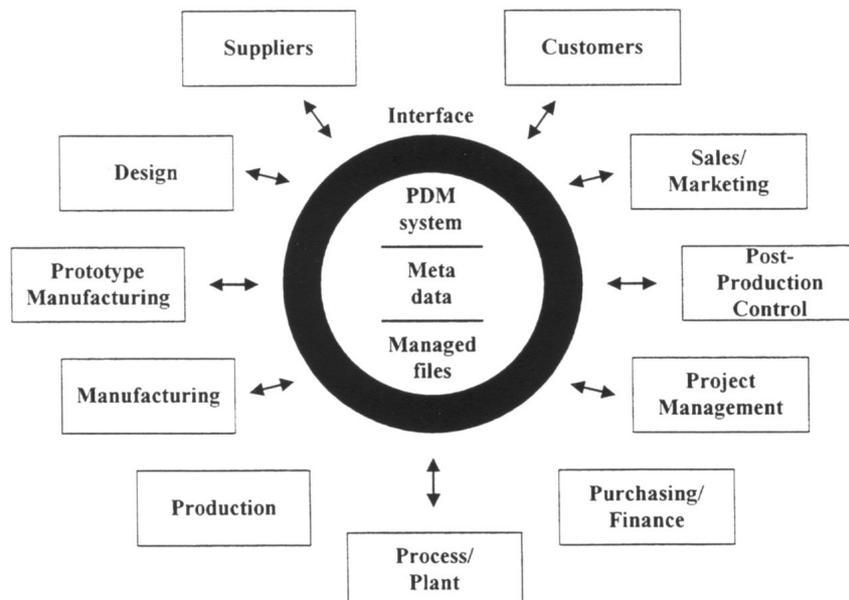

Figure 2.1 *Logical view of a PDM-system*

It is not unusual that companies to some extent already have computer-based document management procedures. The advantage with a PDM-system is that one system can handle all documents. There is no risk that different departments end up with document management solutions that don't work together.

Lately the term PLM (Product Lifecycle Management) has replace PDM. The term PLM is used to describe a business approach for the creation, management and use of product-associated intellectual capital and information throughout the product lifecycle [3]. In other words PLM is a broader definition of PDM.

SmarTeam is a PDM-system with ambition to grow in functionality and enter the market for more extensive (PLM) data management solutions. That level has not been reached yet but SmarTeam already offers more functionality then required of a PDM-system.

2.2 Why PDM?

Product Data Management solutions relate all, not just part, of the information relevant to a product. It does this from a product point of view. This approach to product data enhances a company's ability to perform tasks related to using this information [4].

The major advantages associated with PDM are:

- Shorter time to market
- Better quality on products
- Better communication between departments

It is important to remember that a PDM-system is a tool used to improve an existing working environment. PDM by itself will not provide better products.

3 Program Requirements[1]

Electrolux manufactures and develops a vide variety of products on locations spread out around the world. Many of the sites are specialized in different areas and have their own method of working. Their requirements on a PDM-system can therefore be expected to vary. However the overall need is the same for everyone, a tool that helps engineers manage CAD data. Improved file and revision management is what is needed the most.

Below are more requirements listed. They can be seen as fundamental for a PDM-system mainly to be used to manage CAD data.

3.1 Interface

Installing a complicated and time-consuming PDM-system will most likely not be appreciated. There is a great risk that no one will ever use it unless it is absolutely necessary.

For a program to be user-friendly it needs to have an intuitive interface. Users should have a good overview over documents and how they are related to each other. Likewise should the meaning of icons, pop-ups and terms be easy to grasp. It is also good to have a working environment that already is familiar for most users, for example a typical Windows application.

3.2 Integration

The level of integration depends on how well the PDM-system can be modified to work in close relation with CATIA. A good integration generally leads to less workload for users.

It is to prefer if users can perform most of their work from within CATIA. To avoid unnecessary time spent entering the same information twice it should be possible to map data between the two programs.

3.3 File Management

The purpose of a PDM-system is to control and facilitate file management. Files should be managed in such a way that users never have to worry about the location or name of the actual file. Instead all files are represented by their properties.

The total amount of data should be reduced, since multiple copies of the same file will no longer occur.

To implement concurrent engineering users have to share data with each other. This can lead to problems if access to files can't be restricted. It is important that users are not allowed to update the same file simultaneously, or the result will probably be loss of data.

---

[1] Ideas from [5]

3.4 Revision management

Every time a document is modified the PDM-system should update its revision number. If the document is part of an assembly the changes should affect the assembly as well. Old revisions are good to keep for backtracking, but too many will quickly fill up the vault.

The revision field should be updated differently depending on document stage. Approved and released documents are not assigned revisions in the same manner as preliminary documents.

3.5 Assembly management

Working with assemblies should not be more complicated then working with single parts. It is up to the PDM-system and not the user to keep the assembly structure intact during Save/Load operations.

To allow concurrent engineering users must be able to work on different parts of the assembly independently of each other. It is good if users in some way are notified when someone else have made changes to the assembly they are currently working on.

3.6 Drawings

Since engineers every now and then want to see other people's drawings there is a big advantage if the drawings are created from a standard template. Not only will it be easier to interpret the contents but also to incorporate the data into the own system.

A PDM-system that can map data between drawing and part will speed up the creation of drawings. Extra caution should be taken on how important properties such as drawing number are filled in.

3.7 User Maintenance

To maintain a high safety level in the system it should be possible to control and set user permissions. There should be rules for what different types of users are allowed to do and what documents they have access to.

To remove/hide a function means that the function is no longer available, or grayed out, from the menu. By removing/hiding functions rules can be set for which users that have the right to execute certain functions. This is useful in order not to shock users with too many functions in the beginning and also to prevent them from performing operations they are not allowed to do.

3.8 Variants

It is not unusual to have several variants of a product. It would be very nice if the PDM-system could propagate changes made to one variant to all the others.

3.9 Viewer

It is not enough to be able to browse document properties. Users also want to look at documents without having to use an external application. Most of the time they are only interested in a quick look so the document doesn't need to be displayed in detail. A simplified image will also improve performance since CAD files can be large and therefore slow to load.

To get a better image the viewer should support features like rotation and zoom for 3D models.

3.10 Search Tool

As time passes the amount of documents will without doubt increase. If users are to find what they are looking for the PDM-system needs to be equipped with a powerful search tool. It should be possible to perform searched based on document type and properties. A user shouldn't have any problem finding the documents he or she is currently working on.

3.11 Export/Import of data

To be able to import/export data to/from the PDM-system is important if for example data is to be sent to a subcontractor. If an assembly is imported/exported the structure must stay intact.

When a PDM-system is installed the company will most likely have large amount of already existing data. If it is going to be of any use it needs to be incorporated into the PDM-system.

4 CATIA Team PDM

CATIA Team PDM is a subset of a PDM-system called SmarTeam, developed by SmarTeam Corporation Ltd. With SmarTeam it is possible to manage all kinds of product related information on workgroup or company wide level. SmarTeam offers data management for a number of programs and has built-in integration to some of them. CATIA Team PDM is the name for the integration SmarTeam - CATIA.

This thesis describes CATIA Team PDM and to some extent SmarTeam as well, since they share the same core. For the sake of simplicity CATIA Team PDM will be called TeamPDM.

4.1 SmarTeam

SmarTeam started as a small PDM-system with focus on management of CAD data from Windows-based CAD applications. Today SmarTeam has grown to become a more general system with functionality to manage more types of product data.

Compared with its competitors SmarTeam can be classified as a medium-sized PDM-system.

A product data management solution from SmarTeam has a generalized architecture and capabilities that can fit the broad needs of companies and user. It consists of a PDM core in combination with additional modules and a database. Every module has varying functionality and is added, if needed, to the PDM core. This way a SmarTeam installation can be customized to fulfill different requirements.

There are several add-on modules available. Some of the most interesting ones to use together with TeamPDM are:

SmartFlow, enables users to manage project workflow, track project status and automatically route work from one stage to the next.

SmartBOM, controls the creation and change of Bill of Materials throughout the product lifecycle and across the value chain.

SmartWeb, a web-based solution that allows access to SmarTeam database and file management from a standard Internet browser. No SmarTeam software needs to be installed.

Smart Multi-Site, connects multiple sites together into a distributed environment and thereby enables different sites to share data with each other.

SmartGateway, allows for exchange of data between SmarTeam and other enterprise applications.

4.2 What is CATIA Team PDM?

The integration SmarTeam – CATIA is obtained through a package of products called CATIA Team PDM. Purchasing CATIA Team PDM is the only way to have SmarTeam integrated in CATIA. The package includes:

- SmarTeam (without any add-on module)
- Oracle 8i Enterprise (run-time only)
- SmarTeam Vault Server
- CATIA integration

As can be seen, CATIA Team PDM is a configuration of SmarTeam designed to work with CATIA.

4.3 Interface

TeamPDM organizes data in a tree structure to allow users quick and easy access to documents. Descriptive information about a selected document is displayed on a so-called Profile Card, placed on the right hand side of the document tree. It consists of several pages showing key data about the document such as attributes, links, notes, revisions etc.
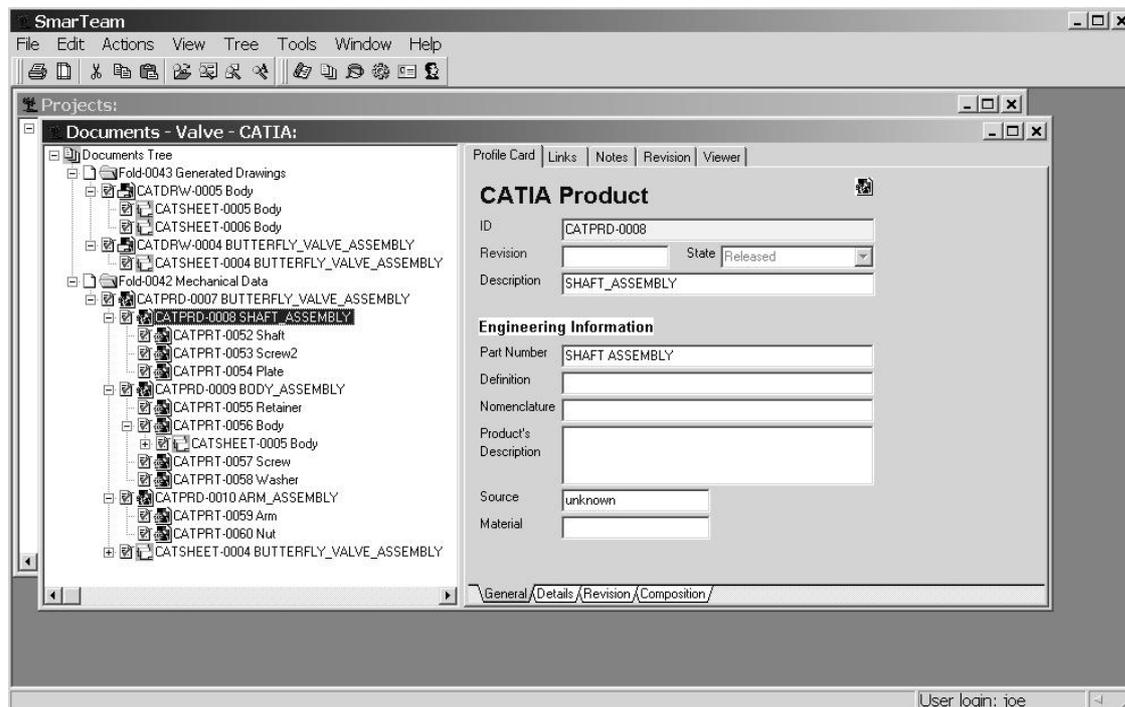

Figure 4.1 *TeamPDM user interface*

An embedded viewer makes it possible to view the contents of documents without having to invoke the external application. The icons in the tree show what type of document it is and its Life Cycle state.

TeamPDM provides functionality for users to interact with and manipulate documents in the tree structure. The functions are accessed either from the menu bar or the right click menu. Users can for example:

- Add or delete documents from the tree.
- Change information about documents, i.e. the Profile Card is modified. There are however certain restrictions, attributes such as ID and revision may not be changed.
- Use drag and drop to create links to other documents.
- Search for documents using the Search tool.
- Perform Life Cycle operations to change the state of documents.

Menus and buttons looks the same whether you work from within SmarTeam or any integrated application.

4.4 Data model

TeamPDM is a PDM tool and it is used to manage product data. The question is, what is product data? Most organization will probably have different answers to that. For some it is every document connected to a product while others might think of it as engineering documents only. In either way there is a need to somehow specify what type of documents TeamPDM should manage and for that purpose TeamPDM uses a data model.

The data model is a structure that consists of classes and the relationship between those classes. The basic concepts are recognized from object-oriented programming [6]:

- **Object:** An object can be a physical object, a computer file, a person, or anything else. It is described by a set of properties called attributes. For example, an object of type person can have a *Height* attribute.

  An object has attribute, behavior and identity; the structure and behavior of similar objects are defined in their common class.

- **Class:** A class is a type of object. For instance, you are an object of a Class defined as *Person*. An Object is said to be an instance of a Class. You, in fact, are an instance of a *Person*.

  A Class is set of objects that share common structure and common attributes. Every engineering entity is an object that can be classified.

- **Inheritance:** A Class can have Subclasses. A Subclass inherits the attributes of its parent Class, as well as other information called methods

In the data model all product data is categorized into classes. The relationships between the classes form a tree structure. Figure 4.2 shows what a typical class structure can look like.

For every class it is possible to define a profile card with a set of attributes.

Classes are linked to each other with a parent-child relationship (also called tree link or hierarchical link). The child being the subclass inherits attributes of the parent class in addition to its own set of attributes. Thus, as you descend from the highest class in the data structure down to lower sub-classes, the information is more specific.

The top most class is called super class, in this case Projects, Documents etc. A class without any children is known as a leaf class. Leaf classes represents objects.
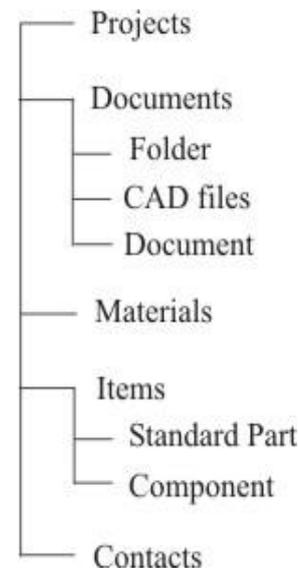
```
— Projects
— Documents
    — Folder
    — CAD files
    — Document
— Materials
— Items
    — Standard Part
    — Component
— Contacts
```

Figure 4.2 *Class structure*

The difference between classes and objects is not something the average user has to worry about. In TeamPDM all data is represented as objects. Working with product data in TeamPDM consequently means working with objects. To prevent users from getting confused by all the new terminology objects are simply referred to as documents. This is also true for this thesis.

Depending on object type (class) the attributes will vary. What is considered relevant information for Office documents may not be of interest when dealing with CAD drawings. Attributes are displayed on a profile card found on the right hand side of the object tree in the TeamPDM browser.

Objects can have a file attached to them, for example Office objects may have a word or excel document attached, but it is not necessary. For some objects like folders it is not even possible. Files are attached with a reference to its location.

There are two types of links between objects, tree links and general (associative) links. Tree links makes it possible to create an object composed of other objects i.e. an assembly. This can only be done with objects having the right class composition, in other word they are from the same branch in the tree. General links are used to create links between any two objects, regardless of type. Useful because it makes it easier to browse information related to an object. Links can also have attributes, for example quantity.

4.5 Data Vaults

In TeamPDM electronic vaults control and maintain security over documents. The vaults hold product related data or pointers to the actual data. However the vaults only store files. Information about various attributes, usually called metadata, is kept in a special database.

The reason to use vaults is to provide a secure environment for files. Only persons with permission are allowed to access and modify files. To prevent problems that arise from concurrent use only one user at a time can access a file.

In the default configuration the vault is divided in three sections. Each one reflecting different phases in the document lifecycle.

- Files under development are placed in the checked in vault. All files in this vault are available to users with permission. They can be checked out, modified and then checked in again. Files are moved in and out of the vault with the Check In and Check Out operation.
- Files that have been approved are placed in the released vault. This vault often has more restrictions, meaning fewer persons have access to files. Modification of a released file is only possible when making a new release. Files are moved in and out of the vault with the Release and New Release operation.
- Files that no longer are used in production are placed in the obsolete vault. They can only be moved here if they are not linked to an active object. Files are placed in this vault with the Obsolete operation.

When performing Life Cycle operations files are moved partially by the client and partially by the vault server as shown in Figure 4.3. Clients move files back and forth from/to the client's working directory and a temp directory while the vault server moves files back and forth from/to the temp directory and the vault. Files can also be copied out of the vault for viewing. They are then placed not in the work directory but in a view directory and are in read only mode.
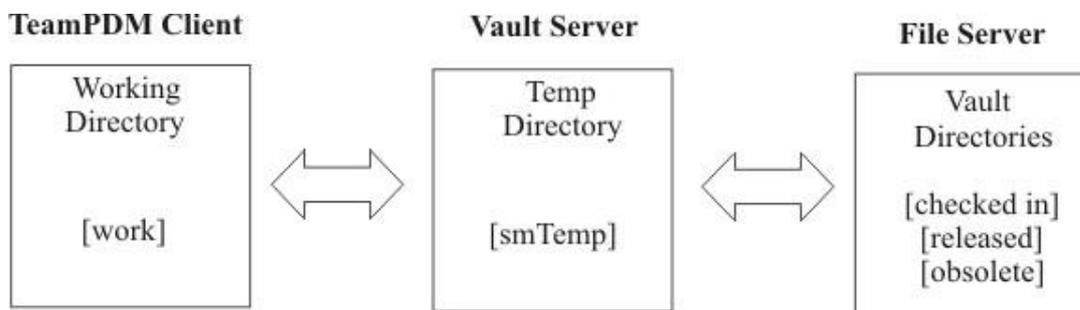
Figure 4.3 *File exchange between Client and Server*

The temp directory, the vault directories and even the work directory can be placed on the same computer depending on setup. The actual location or name of a file is not really of any importance for users. When users want to get hold of a file they search for its descriptive object in the database, they are not supposed to use Windows File Explorer to access the vault or any other folder and try to retrieve it that way.

Files copied out of the vault for viewing remains in the view directory after they have been closed. If they are considered as confidential material use the Local Files Explorer tool from the TeamPDM menu to access the view directory and remove them manually.

4.6 CATIA Integration

SmarTeam has concentrated on developing own direct CAD-integrations. Several other more general PDM-systems have integration to a closely integrated PDM-tool. The advantage with a direct CAD-integration is that no other software is required and the integration looks similar to the rest of the system. On the other hand can it be hard to keep up with the integrated PDM-tools, which often are developed together with the CAD system. This has however not been a problem for the integration CATIA – SmarTeam. The overall impression of the CATIA integration is very good.

When the CATIA integration is installed an extra dropdown menu is added to the menu bar in CATIA, see Figure 4.4. It allows users to perform TeamPDM operations from within CATIA.

The new menu contains all the basic TeamPDM functions an engineer needs and thereby reduces the time spent working from the ordinary SmarTeam/TeamPDM window.

CATIA documents are stored in the TeamPDM database only when a save operation from the TeamPDM menu is performed. Save and Load operations from Edit menu should never be used since they only store and retrieve data to/from the local computer.

The New From command enables users to create a new CATIA object from a template.
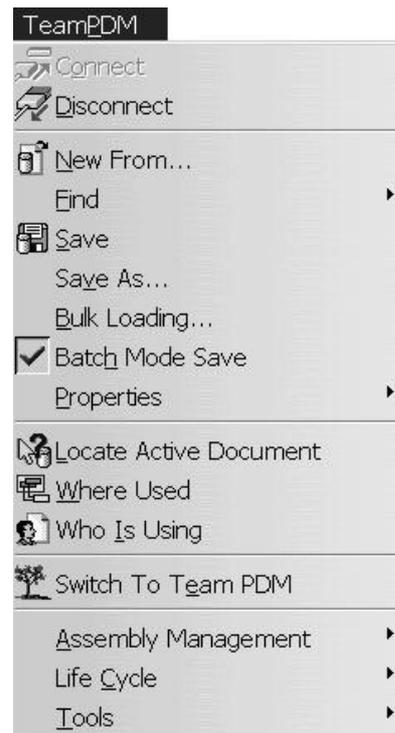
Figure 4.4 *TeamPDM dropdown menu*

Properties are automatically mapped between CATIA and TeamPDM. The mapping is defined with the Integration Tools Setup utility. It specifies which CATIA property is mapped to which TeamPDM attribute and also whether the mapping is bi-directional or not.

One thing to keep in mind is that document properties changed in TeamPDM are not automatically updated in CATIA if the document is active, the operation Load From Database must be used to update all changes.

4.7 File Management

The idea of using a PDM-system is to gain control over documents through their entire Life Cycle. All documents of interest are maintained regardless of type and the present state of every document is always known. Users can then in an easy manner find out revision state, modification date or any other information related to a document.

TeamPDM has five different document states. Documents move from one state to the other through the Life Cycle operations: Check In, Check Out, Release, New Release and Obsolete.

Figure 4.5 *The Lifecyle flow of documents in TeamPDM*

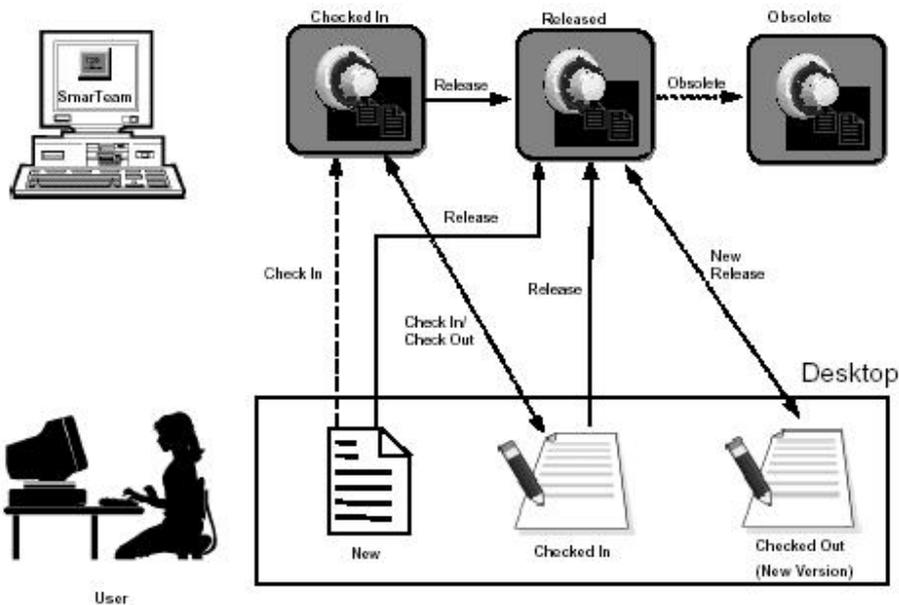For example a user creates a document and with the Check In operation places it in the vault. Another user can now Check Out the document and continue to work on it. While the document is checked out it is not accessible for modification by anyone except the current user. When finished working the user can Check In the document again or if no more changes need to be done Release it. Either way it will be available to other users once again. Each Check In/Check Out creates a new revision of the document. Old revisions are kept in the vault to allow for backtracking.

If someone wishes to modify a released document it can be done with the New Release operation. This creates a new version of the document and the user can handle it as an ordinary checked out document. The old version is still in the vault but marked to show that it is no longer the latest version. Old versions can be made obsolete.

4.8 Revision Management

Revision control is carried out automatically. It is important to understand the meaning of revision. In TeamPDM major revision numbers, also called version, are given to documents when they are released. Minor revision numbers are set every time documents are Checked In/Checked Out.

The form and behavior of the revision field can be customized. The default is a character followed by a number, see Figure 4.6. When a document is modified for the first time it is given the revision a.0. For every following Check In/Check Out the last number will be

increased a.1, a.2 etc. When documents are released the revision is set to be the current letter only, in this case a. A new release operation results in an increase of the letter in alphabetic order. Check In and Check Out operations will as before only affect the number b.1, b.2 etc. If enabled by the system administrator it is possible to create parallel branches of a revision. Each branch is assigned a revision state of three characters. If revision a.1 is branched the two new branches will be a.1.1 and a.1.2. Two users can now work with each file simultaneously.
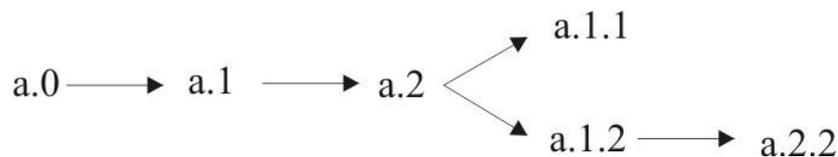
Figure 4.6 *Example of revision assignment*

4.9 Assembly Management

One of the best features in TeamPDM is the ability to work with assemblies. Assembly structures are always preserved, that is links (tree links) to all children are created automatically. It is also possible to add, delete or replace components.
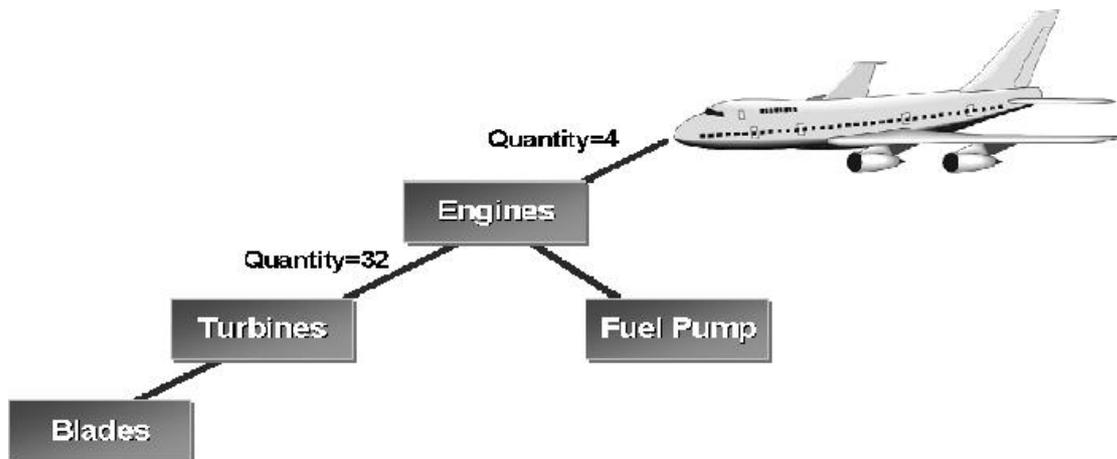
Figure 4.7 *Example of assembly structure*

An assembly structure can look like Figure 4.7 [7]. It is a structure that consists of parts and sub-assemblies. However an assembly can only be made of certain objects. For example an engine sub-assembly drawn in CATIA can contain children that are CATIA parts or products but not office documents.

Life Cycle operations performed on assemblies can be propagated to all their children. When an assembly is checked out there is an option to either Check Out, Copy or not include the children. If they are checked out they will become available for modifications as usual. Children that are copied are in read-only mode and may not be modified. That does not affect

the fact that they still can be moved around freely in the main assembly. Retrieving copies also allows for concurrent work. Someone is perhaps responsible for the main assembly while other work on its sub-parts.

Note that users are not notified when changes have been made to a part. That means that you have to be extra careful when working with assemblies. For example there might exist a newer revision of the sub-part you are currently using in your assembly or that someone else is relying on your assembly staying intact. There are options available to decide whether parts should be switched automatically to latest revision or not on Check In and Check Out. It is also good to use the commands Relatives Being Modified and Show Parents, found in the Actions menu, to see how others are affected.

4.10 Drawings

Drawings based on a part or product is linked, with a general link, to its part or product. They share a so-called dependency. This allows you to manage the part/product together with the drawing as revisions are created. Dependencies are defined in the smasscls.ini file and shown with color code in the object tree.

[CATIA Sheet]
ass1=CATIA Part
ass2=CATIA Product

The three lines above are taken from the smasscls.ini file. They define a CATIA Sheet to be dependant on a part or a product. The part and the product on the other hand have a reverse dependency to the CATIA sheet. When a sheet is checked out a copy of the part or the product is automatically taken out of the vault as well.

To avoid confusion always check the drawing in and out of the vault together with the part or product. Changes made to a part/product are then with certainty updated on the drawing. It is also good to keep their revision number synchronized.

Figure 4.8 *Example of specification field on a drawing*

The best way to work with drawings is through the use of templates. It makes it possible to have properties mapped directly to fields on the drawing. To make it even easier it is a good idea to add a script that retrieves the properties from the part/product. Creating a drawing is then transformed to a simple task were different views are set up and the rest is filled in automatically.

Drawings on more then one part/product should never be created, instead make another sheet.

4.11 User Maintenance

Assigning user rights for objects is important in a distributed environment. Objects represent information and must not be accessed by unauthorized users.

User rights are specified with the User Maintenance tool. Authorization can be given to either individual users or to an entire group.
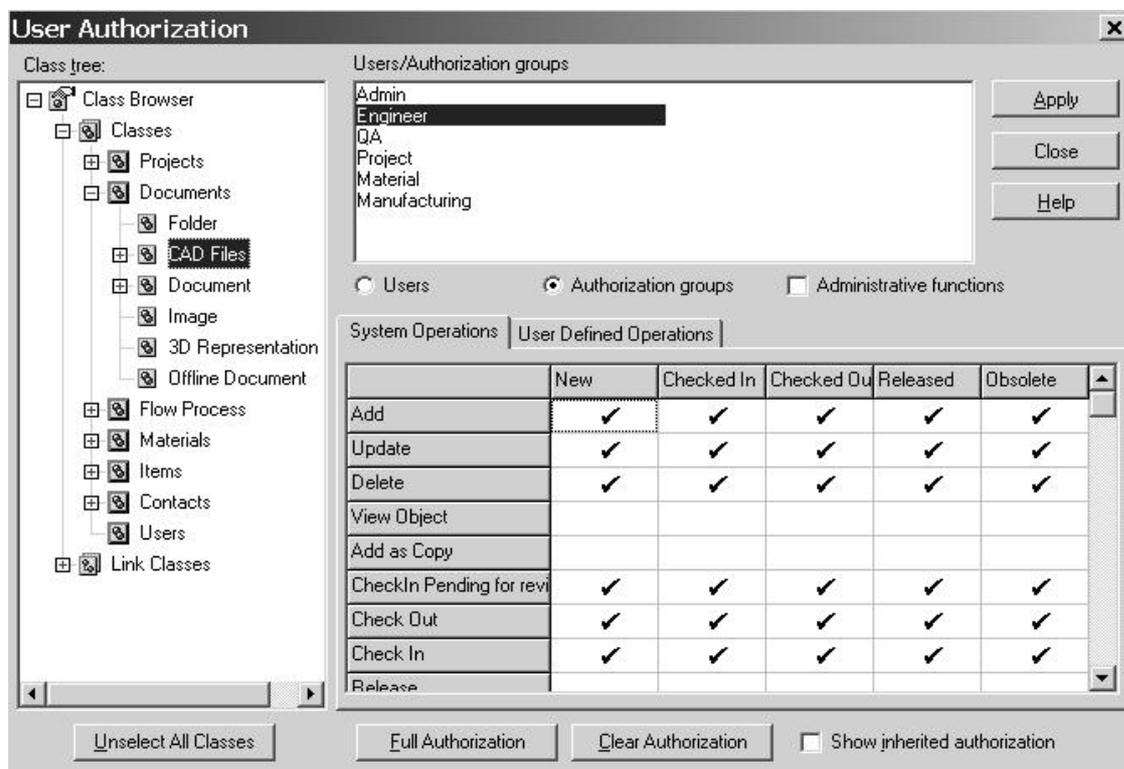

Figure 4.9 *User Maintenance tool*

The user permissions are assigned on class basis. A check mark indicates whether a user may or may not perform a certain function on objects belonging to the selected class, see Figure 4.9. In other words there is no way to restrict access to specific documents. If there is a need to protect documents or store confidentially information access to an entire class have to be restricted, for example all CATIA drawings or all project folders.

To further restrict users permissions the Menu Editor, described in the next chapter, can be used to remove functions from menus and toolbars.

4.12 Variants

There is currently no support for variant handling in TeamPDM. Changes in geometry on one variant are not propagated to the other variants.

There is an alternative approach to solve the problem with variant management. If every variant share a common sub-assembly changes inside that sub-assembly will affect all variants. However to update and see the changes a new release must be made for every variant. Also moving the sub-assembly in one variant does not change its position in the others.

4.13 Viewer

A viewer makes it possible to look at documents without having to invoke the external application. It shows a less detailed representation of files in either 2D or 3D. Depending on viewer users can rotate, zoom and add comments (redlines) to the image.

TeamPDM comes with several viewers. Which one to use depends on document type. To view CATIA files use the viewer from 3dCOM, shown in Figure 4.10. It allows rotation and zoom for 3D models but not redlining. CATIA Drawings and Office files are best shown with the SmarTeam Viewer, which have more features then 3dCOM but unfortunately can't display CATIA files in 3D.
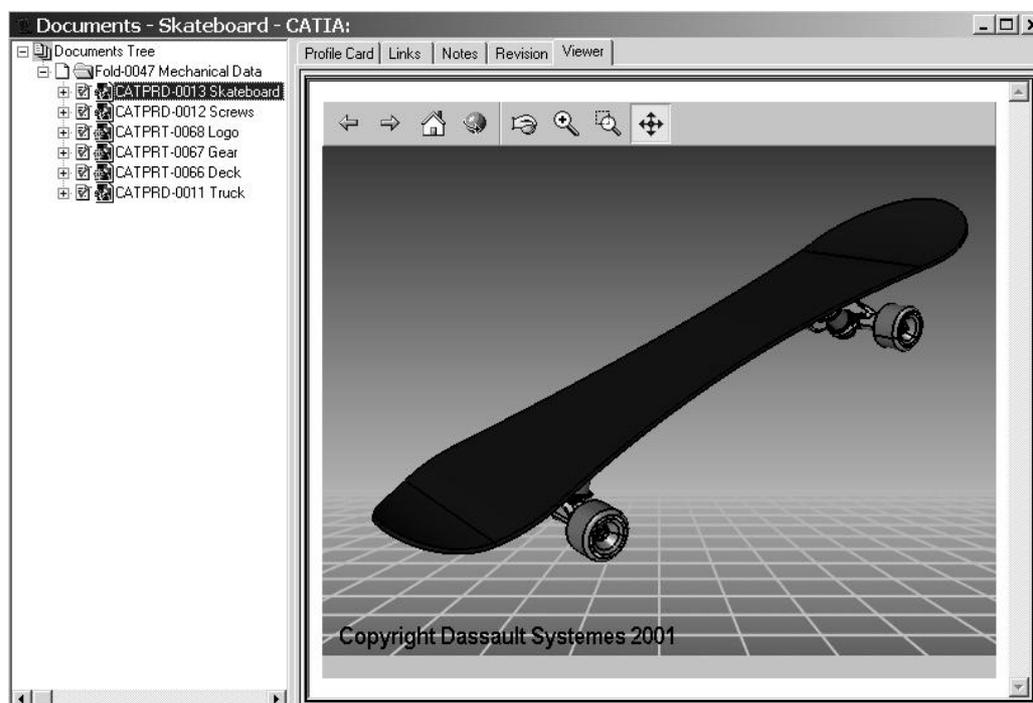

Figure 4.10 *CATIA product shown with the 3dCOM viewer*

4.14 Search Tool

TeamPDM has a powerful search function for locating and retrieving objects. Users can either create new searches or run previously defined searches to locate all types of objects. The results of a search are listed in a Search Results window from where user operations can be performed as usual, i.e. the objects can be viewed, edited, deleted etc.

In TeamPDM you distinguish between two kinds of searches.

- **Search by Attribute,** this option enables users to search for objects from a selected class. Search criteria are defined by entering search information in the attribute fields.

- **Search by Example,** this option enables users to create advanced searches across multiple classes. Search criteria are defined by entering search information for attributes belonging to the selected classes and the links between them. Creating a Search by Example is difficult and should be done by advanced users only.

When a new search has been successfully created, for example all CATIA drawings, it can be made either public or private. A public search is available for all users to run while a private one is only available for the user who defined it. Public searches can be modified and saved as private.

It is allowed to use operators and characters to specify search properties. They are well known for anyone who searched information on Internet.

4.15 Export/Import of data

The Import Utility imports values and adds them to specified attributes. The values can be imported from the following sources:

- **Database (Table):** Values are loaded from an external database.
- **Text File:** Values are loaded from a specific column of a text file.
- **Mask:** Values are generated using a mask. The values generated are based on the mask formula.
- **Fixed Value:** Fixed values are assigned to the selected attribute.
- **Default Value:** Default values are assigned to the selected attribute.

For Electrolux the most interesting usage of the Import Utility would be to import old CATIA V4 data to the TeamPDM environment. This is however not particularly useful at the moment. Objects and attributes can be created for the old CAD data but there is no way to modify or view it. Instead it is better to migrate the old data to CATIA V5 standard and then save it to TeamPDM.

The Export utility allows for export of values from the TeamPDM environment in order to transfer them to another database. The values to be exported are selected by defining a search.

To send data to people not using TeamPDM it is recommended to use SmartBom. It sends the data in the form of an executable file attached to an e-mail. The data contains the complete product structure with all necessary CAD models and a tool to modify them.

5 Implementation

Because it can be tailored and customized, TeamPDM requires that someone set up the data management scheme. If the program is installed for the first time it may take a lot of time. The time-consuming part of the task is to figure out how documents should be managed in the organization. Realizing the ideas is not difficult.

To ease implementation TeamPDM supplies a number of business templates for various types of usage. There are also wizards that help users adapt these templates to their organization and business processes.

5.1 Working Environment

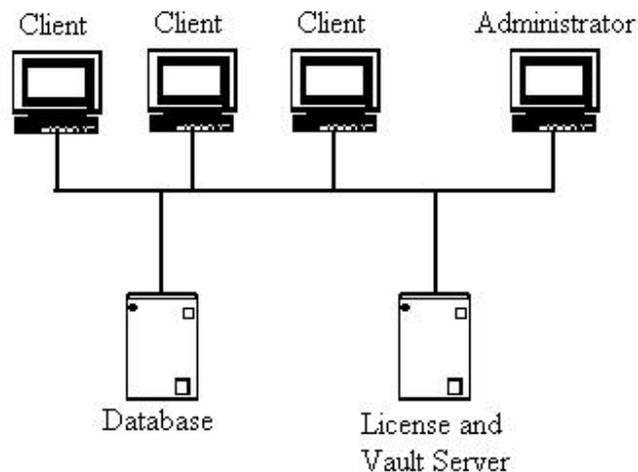The standard, and recommended, TeamPDM working environment is seen in Figure 5.1.

Figure 5.1 *TeamPDM working environment*

The vaults have to be placed on a server with NTFS partition. Oracle recommends that the database be installed on a Windows 2000 machine. Clients can run on windows 98/NT/2000. TeamPDM may also be used on UNIX machines but only through the web interface.

For small sites the database, license manager and vault can with advantage be placed on the same server. An ordinary desktop computer is in that case enough. Just make sure it has plenty of hard drive space to store all data.

Sometimes engineers working on different sites want to share product development data between each other. There exist a number of ways to do this. One solution is to have everyone access a single central database and file vault. The problem with this approach is that it is troublesome to move large amount of data over wide-area networks. High-capacity long-distance connections are costly and networks with little bandwidth suffer from long transfer times.

Another approach is to store all metadata in one central database and have multiple file vaults, one in each location. When a file request is made, the system first collects its descriptive data from the database and after that retrieves the file from the closest file vault. This approach also may be slow, especially if many requests are made to the database.

The best way to serve multiple locations is to replicate both metadata and files. Users then have access to all data locally. Such replication is possible in TeamPDM if the Smart Multi-Site module is added and Oracle 8i is used. Smart Multi-Site allows asynchronous replication on a schedule set up by an administrator. During the replication process only data changes are transmitted and the exchanged data is both encrypted and compressed. The vaults at each location will end up containing the same files. In addition a flag on each file tells what location owns it. Users are permitted to work with files owned by their site only. Ownership of files can be moved from one site to another.

Compared with other SmarTeam modules Multi-Site is an expensive investment. More hardware and software will increase expenses and also local support is required to keep the system operating. As an alternative to data replication there are some other ways to share data. With SmartWeb users can view and add notes to files using a Web browser, without having SmarTeam installed on their computers. This is a good way to share data with people who are not interested in making engineering changes. Another product is SmartBom, which allows users to electronically mail packets containing bills of materials and related documents. The packet also includes a tool that makes it possible for users to view and edit files without having SmarTeam installed.

If none of the alternatives above seems like a good solution to share data there is always the option to make your own solution. One way to do it that is popular among TeamPDM users is to convert drawings into PDF documents that are accessible through a Web interface. How it is done is explained in the next section.

5.2 Distribution of PDF Documents

In most cases the need to exchange data is limited. Engineers want to look at drawings from other sites but they have no interest in the actual 3D model. Furthermore it is not likely to happen particularly often. Installing Multi-Site or even SmartWeb is then not the ideal solution, since only a small part of the functionality offered would be used. Instead it is better to find an own solution and implement it in TeamPDM. Electrolux currently has a system that distributes drawings as PDF documents through Lotus Notes. This approach has proven to be very useful and appreciated but will not work for CATIA V5 files. With some programming it is possible to configure TeamPDM to make use of a similar solution.

The idea is to be able to view drawings on computers that do not necessarily have TeamPDM or CATIA installed. Converting the drawings to PDF documents means that only Acrobat Reader is required. A PDF document does not contain as much information as the original CATIA file but there are other advantages. Acrobat Reader does not require any license and since PDF is a common file format it is often used when people with different CAD systems want to exchange construction data.

When a drawing has been approved and is released a PDF copy of it will automatically be created. Unlike the original the PDF copy it is not placed in the released vault and not registered in the TeamPDM database. Instead it is stored in a folder not managed by TeamPDM together with previously made PDF copies. In the same manner the copy will be removed from the folder if the original is made obsolete. The reason to have a separate folder is that when someone wants to look at the PDF files he or she is not forced to go through TeamPDM. The folder will probably end up containing lots of files so to make it easier to browse files a web interface with search function is preferable.

The ability to generate PDF files is added to TeamPDM with scripts. They are executed upon release and obsolete operations. Changes in TeamPDM will therefore update the PDF folder but this is not true for the other way round. Manipulating PDF files, which only are copies, has no affect on CATIA files stored in the vault. Extra care should also be taken when the PDF file is created. In order to be able to distinguish them from each other they should be given names that correspond to part number and description.

5.3 Installation Procedure

Setting up a workstation with CATIA and CATIA Team PDM is time consuming and involves the steps listed below. It is assumed that the workstation already has network connection to existing database and vault server.

- Step 1: Uninstall any previous installation of CATIA and CATIA Team PDM
- Step 2: Install SmarTeam 4.004
- Step 3: Install latest service pack
- Step 4: Install hot fixes
- Step 5: Install Oracle or other database client
- Step 6: Install CATIA integration
- Step 7: Configure database connection, if necessary configure smTeam32.ini
- Step 8: Install CATIA
- Step 9: Install CATIA service pack

A workstation designed for CATIA V5 meets all hardware requirements for TeamPDM.

5.4 Data Model Design

When you design your data model there is a lot to think about. What type of documents are we dealing with? What properties should be associated with these documents? How is the release procedure handled? The list of questions grows very long and it is not easy to find all answers at once. Luckily TeamPDM comes with some data model templates that can be modified to fit most organizations. Building a data model from scratch is a very extensive task.

If the plan is to install TeamPDM on sites not connected to each other the best thing to do is to try and design a basic data model that applies to them all. Every site can then modified it to meet their specific requirements. For example they can add their own sub-page with details to the profile card. This approach will shorten installation time and facilitate administration and support. It also makes things easier if different sites some time in the future decide to share data with each other.

A typical TeamPDM installation usually follows a certain pattern. To start with it is always good to spend time investigating how documents are managed currently. Perhaps some kind of PDM-system is already in use. Since many people from different departments are involved talk with them and find out their work routines. Hopefully this will create a feeling for what is needed. The next step is to use the knowledge to design a data model and make a pilot installation. Many overlooked things have a tendency to show up after a while. Just make modification to the data model as they are discovered and when everything works satisfying make the final installation. Unfortunately quite often lack of time, resources and knowledge makes it difficult to realize this kind of installations.

To get started as quickly and painlessly as possible with the design task it is best to start from one of the provided templates. For TeamPDM users the most appropriate is the CATIA demo database template. It has a structure that defines classes and attributes for all CATIA file types. In fact it probably contains more information then ever is going to be needed. The first thing one should do is to remove some of the many attributes before thinking of adding new ones. Too many letters and numbers on every profile card will end up confusing users rather then the opposite. Besides it is not likely that anyone want to spend time filling in all the blank spaces.

Most attention should be focused on description and part number. These two properties are what users are going to look at when they search for parts and products. A good idea is to make it compulsory to fill in the description field while the part number field is filled in automatically. To make sure that the description is not meaningless for everyone except the originator the field can be in the form of a lookup table.

Other useful tips for designing a data model is to [8]:

- Minimize the number of classes to get easier user navigation and better startup and overall performance
- Place majority of attributes on super classes to get better startup and overall performance
- Use lookup tables to get guaranteed standard field contents
- Limit use of Reference to Class to improved performance
- Define File Management to improved performance
- Minimize use of "Add to Top Level" to improved performance
- Keep file and directory names short to improved performance

5.5 Database Configuration

Designing a data model is only one step on the way to get the database up and running. Many other things have to be configured, for example the CATIA integration, user permissions, life cycle options and the layout for profile cards and menus. Configuration and settings for users is consequently stored together with the database. This is very useful since it means that once a database has been successfully set up it can be copied and used as a default database for other installations. Of course some settings need to be changed but most of the time it is possible to keep them as they are.

Database copies are made with a tool called SmartDbExplorer. It copies the entire database from one platform to another. At the moment InterBase, Oracle and Microsoft SQL are supported. InterBase is always installed together with TeamPDM, but is not a good alternative for managing large amount of data or more then five users. The advantage is that all information kept in an InterBase database is stored in one file, which is welcome when someone wants to have a copy of the database.

The templates are made to be ready-to-use from start, that is configuration and options are set to give a fully functional product management solution.
Since the database is empty in the beginning there is plenty of time for modifications.

A few words ought to be said about the database used by Electrolux installations in USA. It is more or less similar to the CATIA demo database template, except that adjustments have been made to make it fit in an Electrolux environment.

- New classes and attributes have been specified for part, product and drawing. The set of attributes are similar to the one found on previously made CAD data. The idea is that sometime in the future old construction data is to be transferred to the TeamPDM database.
- The integration to CATIA has been improved in the sentence that more properties are mapped.
- New parts are given an experimental number and first when they are approved and released do they receive a permanent part number, which is retrieved from another database.
- Drawings are synchronized with parts when a button on its profile card is pressed. As a result the drawing properties are filled in automatically and correspond with the ones that belong to the part.

The complete data structure and layout for Profile Card can be found in Appendix A and Appendix B.

5.6 Learning Material

To quickly get started with TeamPDM it is best to stick to a limited amount of learning material. An ordinary user will in the beginning only need to know how to Create, Check In/Out and Search for documents. These things can be taught fairly easy. The main thing is that users acquaint themselves with the TeamPDM menu.

Most of the learning material from USA can be reused. It covers the basic tasks in a good way. What is needed is to make it fit more general. The idea is to use the material to hold a one-day course and after that have staff remain on site a short while to act as support.

The TeamPDM help guide included in CATIA contains useful exercises. They give users an opportunity to practice on everyday work tasks. New functions are introduced step-by-step to make it less confusing.

5.7 Scripts

An event is an operation, or function, which takes place in TeamPDM. By adding a script that is triggered before, after or instead of a default operation TeamPDM can be modified to perform user-defined operations. For example you can specify that before a drawing is released a PDF copy of it will be generated. TeamPDM has pre-made scripts that can be used to create a BOM structure in Excel and highlight active objects in CATIA.

A TeamPDM script, or macro, is written in Visual Basic Script. A relative simple script editor is available from the Script Maintenance utility. The SmarTeam documentation includes a detailed API guide.

The ability to add functionality with scripts becomes very useful after that TeamPDM has been used for sometime. Small scripts can quite easily be written to make adjustments and improvements to the system.

5.8 Licenses

Like many other software TeamPDM can only be used if a valid license exists. When a TeamPDM client is started it will grab a license from the license manager, in this case a TD1 license. If any add-on module is installed additional licenses are required. The problem is that it is not always obvious which licenses are actually needed for different configurations of TeamPDM. One reason is that all licenses are sold separate or in packages together with other licenses. Sometimes you need to buy a whole package and sometimes you don't. Another reason is that the add-ons tend to change name from time to time, which makes everything more confusing.

The license distribution is controlled by a mechanism called LUM (License Use Management). It can serve concurrent licenses across the entire network. In other words everyone share the same licenses.

When a CATIA session is started it will grab and hold on to a TD1 license to allow interaction with the TeamPDM database and vault. To use CATIA without TeamPDM deselect the TD1 license in the options menu and restart CATIA.

5.9 Administration Tools

It is difficult for a program to be user-friendly and at the same time flexible and customizable. TeamPDM solves the problem by offering a whole set of utilities for administration and configuration of the system. There is no need to spend time studying configuration files. Advanced adjustments to the system are performed with a few simple clicks and drag-and-drop maneuvers. The process is similar to how system configurations are made in Windows.

Some of the utilities listed below are only available if the option to install administrative tools was chosen during setup.

5.9.1 SmartWizard

Creation or modification of data models is done with SmartWizard. There are three alternatives.

- Load a provided template and customize it as required to create a new empty database
- Import a template from an existing database and customize it as required to create a new empty database
- Modify an existing database. Note that deleting something from the structure may cause loss of data

The process of creating/modifying a database structure is performed step by step. After a structure has been successfully loaded the user is asked to enter information about classes, class attributes, links, link attributes and finally the layout for profile cards.
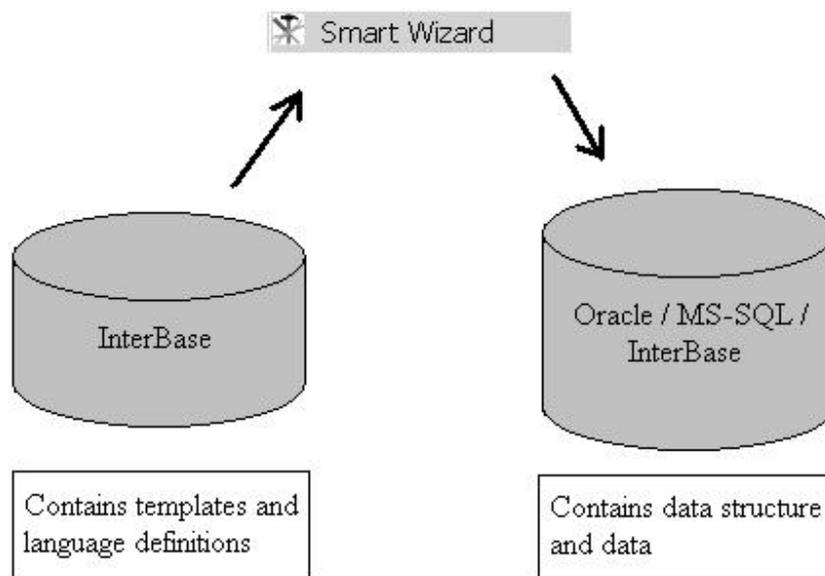

Figure 5.2 *SmartWizard resources*

System and user defined templates are stored together with language definitions in an InterBase source database, see Figure 5.2 [8]. This is the reason that InterBase is always installed with TeamPDM, or else it wouldn't be possible to load the templates.

5.9.2 Form Designer

Use the Form Designer to modify the appearance and contents of profile cards. Add or remove labels, text fields, tabs etc.

The Form Designer also defines the behavior and properties for fields and buttons. You can for example specify from which column in the database the data shown in the field should be retrieved and which script should be triggered when a button is pressed.

A useful tip when designing profile cards is to use the copy, paste function. It saves a lot of time since many of the profile cards will look more or less similar.

5.9.3 Menu Editor

Menus and toolbars are customized with the Menu Editor utility. It provides functionality to add or remove menus, sub-menus, commands and buttons. The modified menu profile is saved in the TeamPDM database and can be used by specific work groups or individual users.

Figure 5.3 *The Menu Editor utility*

The best function is the ability to add user-defined commands, especially since it is possible to define exactly when and where they should be accessible.

An advice in order to prevent future inconveniences is to never change the system menu profile.

5.9.4 Sequence Designer

Use the Sequence Designer to create and modify masks. A mask is a formula by which TeamPDM automatically increments a field in a profile card. The most common usage of a mask is for ID and revision numbers. The value given to a field defined as a mask is based on the formula and the current field value.

The Sequence Designer can be accessed from the From Designer and from the Import utility.

5.9.5 User Maintenance

The User Maintenance utility is used to assign authorization or access permissions for individual or groups of users. Restricted access to data is good for security reasons but also for preventing users from performing operations they shouldn't and don't know the consequences of.

Passwords and additional information about users such as full name and address is stored in the User Maintenance utility.

5.9.6 Multi-Language utility

With the Multi-Language utility the displayed language in TeamPDM can be changed to one of the supported languages or a user defined language.

Since TeamPDM saves user settings two people can use the same client computer but still work with the interface and language they are used to.

5.9.7 Default Values Utility

Use the Default Values utility to define default values for specified attributes in a TeamPDM class. When a new object is added, default values are automatically assigned to the specified attributes.

Typical usage for default values is for example to set the Phase field for documents to be design. Every time a new document is added and the user looks at the Phase field it will then state design.

5.9.8 Script Maintenance

Use the Script Maintenance utility to link scripts to SmarTeam functions. The script is performed before, after or instead of an operation.

If the script is not supposed to be triggered by an event add it in the User Defined tab. It will then be accessible for users when they select Actions and sub-menu User Defined Tools.

The scripts listed in the Script Browser are found in the ...\smarteam\scripts directory.

5.9.9 Vault Maintenance

The Vault Maintenance utility is probably only used once, at first installation. It is used to define and setup the vault directory structure. Users may want to have different vaults for different file types or maybe separate vaults for individual or groups of projects. For example all CATIA files that are checked in are placed in a directory called \\Server\Checked In\CATIA.

If the option create a default vault environment is chosen, vault directories are created under the SmarTeam directory. That is not a particularly good location so don't use this option.

After vault server installation, the vault service automatically runs transparently in the background. The Vault Monitor utility is used to display the current activities of the vault server. It shows information about the number of clients that requested and operation from the vault server and the number of requests that were made.

Use the Vault Tester utility to confirm that vaults were successfully installed.

5.9.10 Integration Tools Setup

The Integration Tools Setup utility is recommended for advanced users only. Without a good knowledge about classes and attributes it will probably do more harm then good. The utility provides the ability to define and administer the CATIA integration and other SmarTeam integrations.

The integration specifies terms such as component type and their classes. In other words it specifies how CATIA properties are mapped to TeamPDM attributes. The direction of the mapping can be set to be either on-way or bi-directional.

5.9.11 Database Connection Manager

The Database Connection Manager utility has been developed to maintain a user's database connection list. Typically it is used to define a default database that TeamPDM connects to every time it is launched.

Before a new connection can be entered to the list an alias for the database needs to created using the BDE utility.

6 Other PDM Systems

SmarTeam is not the only PDM-system on the market. Maybe it is one of the best to use in a product development environment together with CATIA but there are other alternatives as well.

6.1 Enovia[2]

ENOVIA is a set of PLM products for the management and distribution of development data and knowledge. Like SmarTeam Enovia is developed by a wholly owned subsidiary of Dassault Systems and its products are marketed, sold and supported by IBM. Some of the Enovia products can with advantage be used together with SmarTeam, for example the Enovia Portal Navigator. It can access the SmarTeam database through a web browser much like SmartWeb but in addition to view objects it is also possible to take measurements.

Enovia is a PDM/PLM solution for big companies. If someone were to compare SmarTeam with Enovia he would probably find out that Enovia offers more but is also a more complex system. Implementing Enovia on workgroup level is not a good solution. Enovia is best used as a system that ties together all the different business applications in an organization. The vision is a complete solution for the entire company, in papers and brochures often known as the extended enterprise solution.

6.2 Matrix10[3]

Matrix10 is a PLM solution from MatrixOne. Some of the key features of the PDM/PLM system are the ability to enable companies to address critical product-related challenges such as managing global development programs, enabling interactive design and manufacturing. Integration to CATIA V4 and CATIA V5 is going to be added to Matrix10 sometimes in the near future. However a legitimate guess is that it will not be as good as TeamPDM.

The Matrix10 platform is designed for large-scale, global deployments and is divided into three areas:

- Collaborative Applications, represents a collaborative foundation for the enterprise and its network of global value chain partners and address the needs of a wide range of roles within an organization.
- Lifecycle Applications, represents a broad set of fully interoperable PLM applications for the specialized roles involved in product planning, product development, product sourcing and manufacturing that can be quickly and easily deployed into a wide range of industries.
- PLM Modeling Studio is dependent upon the Matrix PLM Platform and provides dynamic modeling information services that empower global enterprises to quickly and easily adapt to ever-changing market demands.

---

[2] Info from [9]
[3] Info from [10]

6.3 @MAC

Electrolux has for several years been using CATIA V4 as a CAD tool for product development. File and revision management of CATIA V4 files is handled by an internally developed application called MAC (Model Access Control). This system allows a user to send a file for approval. After approval the files are secured or checked into an archive. In parallel the 2D drawing is converted to a pdf-file and sent to a Lotus Notes database from where it can be retrieved by those who need to view drawings without having access to CATIA. These two systems cannot handle CATIA V5 files. There is currently a project ongoing at Electrolux with the purpose of rewriting the two existing systems so that they can handle CATIA V5 files. The new system is named @MAC.

The project is steadily making progress but there are some issues that have caused problems. MAC was written for UNIX systems and therefore certain things can't be expected to work in a Windows NT environment, for example restricting access to files by changing user permissions. Another problem is that Dassault Systems have not released the entire API for CATIA V5, which is vital for a close integration. Because of that @MAC will not be able to manage assemblies.

7 Conclusions and Future Work

7.1 Conclusion

Product development at Electrolux has never been particularly centralized. With the introduction of the new CATIA V5 system this is about to change. The system requires a new approach on how to handle construction data. This provides an excellent opportunity to implement a common PDM solution.

A PDM-system is a powerful tool for file and revision management, but a successful implementation requires careful consideration. There is a big difference between local and global perspective. The advantages gained with one extensive PDM platform need to be weighted against a more time consuming and complex implementation.

The special circumstances at Electrolux speak for a smaller PDM-system. There is a need to share information but it is limited. Also the lack of knowledge about PDM, often a local problem, makes it difficult to carry out large installations.

CATIA Team PDM is a PDM solution designed to work with CATIA. It offers flexible and user-friendly management of product related information, mainly because of good functionality and a close integration to CATIA.

At the present moment Electrolux International USA is in the progress of installing CATIA Team PDM. Their knowledge and experience is clearly a valuable source of information.

Some of the most distinguishing advantages/disadvantages with CATIA Team PDM are:

+ Flexible, the many configuration possibilities make CATIA Team PDM suitable for installations on sites with varying demands.
+ Very good CATIA integration.
+ Easy to work with assemblies.
+ Good security and control over files.
+ Good Lifecycle Management.
+ Powerful search tool.
+ Intuitive and friendly user interface.
+ Easy to create drawings.
+ Integration to other software can be added.
+ High degree of automation facilitates for users.
+ Good viewing possibilities.

- No solution for variant management.
- Unnecessarily many administration options if only used as a file manager for CATIA files.
- Program is unknown for most staff at Electrolux.
- Confusing with all add-on modules. It is hard to know how to combine them in order to get the right configuration.

7.2 Future Work

7.2.1 Extended Implementation

Does CATIA Team PDM provide enough functionality to cover all requirements? The answer depends on local circumstances. Without too much investigation a legitimate guess is that most sites probably would benefit from additional add-ons, especially the Workflow and the SmartWeb module. A more detailed examination of the add-ons would provide a better understanding of what they can do.

7.2.2 Future Upgrades

CATIA and SmarTeam are under constant development. New program releases and service packs are released every now and then. Something that was considered as a shortcoming may have been corrected or removed. It is important to stay updated with the latest information.

Nomenclature

API	Application Program Interface
Assembly	A part that describes the geometrical relationship between other parts.
CAD	Computer Aided Design.
CAM	Computer Aided Manufacturing.
CATIA	CAD-system developed by Dassault Systems.
CATIA Team PDM	The SmarTeam – CATIA integration.
Class	PDM-term, used to organize different types of information.
Document	All product information at Electrolux regardless of type can be called document.
Object	PDM-term, an entity that represents information in the PDM-system.
Office document	A document generated from an application in the Microsoft Office family of products.
Part	A CATIA generated file ending with .CATpart.
Part-number	A combination of letters and numbers used to identify a part.
PDF	A file-format associated with Adobe Acrobat Reader.
Product	A CATIA generated file ending with .CATproduct.
SmarTeam	PDM-system from SmarTeam Corporation Ltd.
TeamPDM	Short for CATIA Team PDM.

References

[1]   CIMdata; Product Data Management: The Definition, An Introduction to Concepts, Benefits and Terminology, Fourth Edition, 1997.

[2]   Wesikko, Mikael; Product Data Management in Distributed and Large Scale Projects, Master's thesis KTH Inst. DKT, 1998

[3]   CIMdata; Product Lifecycle Management, Empowering the Future of Business, 2002.

[4]   Williams, Christopher S; What is Product Data Management and Why should I Care, http://www.pdmic.com/articles/whatspdm.html

[5]   Dahlström, Henrik; Val av PDM-stöd för Unigraphics-användare, Examensarbete KTH Inst. DKT, 2000

[6]   SmarTeam Administrator's Guide, SmarTeam Corporation Ltd., 2001

[7]   SmarTeam User Course, SmarTeam Corporation Ltd., 2003

[8]   SmarTeam Advanced Administration Course, SmarTeam Corporation Ltd., 2003

[9]   IBM/Dassault Systems; ENOVIApm: Industry proven Product Data Management solutions, http://www-1.ibm.com/solutions/plm/doc/content/bin/pmus.pdf

[10]   MatrixOne Inc; Matrix10, http://www.matrixone.com/pdf/ds_prod_matrix10.pdf, 2003

Appendix A

The data model from Electrolux installations in USA.

```
Classes
  Projects
      Project
      Model
  Documents
      Folder
      Document
      Other CAD Data
          SolidWorks
          Solid Edge
          Mechanical Desktop
          AutoCAD
          Cimatron
          CadKey
          MicroStation Document
          Inventor
          CATIA
              CATIA Analysis
              CATIA Catalog
              CATIA cgr
              CATIA Material
              CATIA Model
              CATIA Process
              CATIA NCGM
              CATIA Raster
              CATIA System
              CATIA Library
              CATIA Process Library
              CATIA Feature Dictionnary
              CATIA CADAM
              CATIA Internal Component
              CATIA Sheet
          ProE
          IDEAS
          Unigraphics
          ASCIS
          Parasolid
          Other
          DELMIA
          Image
          Part
          Drawing
          Product
  Flow Process
  Materials
  Items
  Contacts
  Batch Plot Queue
  Users
```

Appendix B

Profile Card from Electrolux installations in USA.