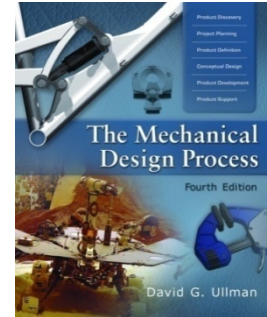


# Achieving a single truth at Eclipse

A Case Study for *The Mechanical Design Process*#



## Introduction

Eclipse, Inc., one of the world's leading manufacturers of industrial burners used for heat treating, drying, curing, and industrial process heating had a problem. While they had plants on three continents and while their business was strong, they had at least three versions of the truth. If a part was needed for a product, a product that could be manufactured in the U.S., Asia or Europe, there were multiple CAD models for the part. And, not every model in each of the areas accurately reflected the "official" drawing of the part in the system. Even worse, if a change was made to fix a problem or meet a customer's need, it was unlikely that the change would make it to all the part representations.

In 2006, Eclipse launched a project to get this problem under control using a data management system. This process has taken four years and is still a work in progress. This case study explores their journey, the benefits achieved, and evolving world of product data management. By studying Eclipse, it becomes clear why companies that make products sharing common parts, or companies that have multiple manufacturing facilities, need a Product Data Management (PDM) or a Product Lifecycle Management (PLM) system.

Further, the case study will show how Bills of Materials (BOMs) and Engineering Change Orders (ECOs) are an integral part of these systems and how they are managed through them.

- **The Problem:** Eclipse had multiple, disconnected locations creating 3-D models of the same parts. These different models did not necessarily exactly reflect the actual part.
- **The Method:** They instituted a commercial Product Data Management System mixed with some home-grown systems to resolve the problem.
- **Advantages/Disadvantages:** A clear advantage of a data management system is one drawing for each part and the ability to keep it that way. Further, there is the ability to tie engineering part documentation into BOM, ECO, and business systems. This all leads to better product quality, decreased order-fulfillment time, and decreased waste. The only downside is the need for corporate commitment and time to implement the system.



Figure 1 Eclipse burner

## Eclipse: The Problem and the Commitment to Resolve It

Eclipse, Inc. is a worldwide manufacturer of products and systems for industrial heating and drying applications. They produce a wide variety of gas and oil burners, heat exchangers, complete combustion systems, and accessories for combustion systems. Eclipse has five engineering locations and four manufacturing sites with many products common between these sites. The problem was that, by the late 1990's, parts for many of these machines had been redrawn at different plants and with different CAD systems leading to "three variations of the truth" (a quote from Eclipse product engineer Scott Stroup).

Eclipse has nearly 50 different families of products. It is primarily a "configuration to order" company with 60% of its products customized from standard parts to meet the needs of the customer. The other 40% of their business is "engineered systems"; standard parts need to be re-engineered to meet the customers' needs. To build these products, there are over 40,000 parts defined with many of the products using common parts. Using common parts is an efficient way of getting the most usefulness out of each of them and keeping inventory to a minimum. But, it also means that a single part may have to mate and work with a variety of other parts. Thus, any change in one part may not only affect one product, but many products. By structuring their products in this way, Eclipse can more easily customize products to meet the needs of the customer. This is sometimes called "variant design."

Using variants is not unique to Eclipse. For example, when ordering a new computer from a company such as Dell, you can specify one of three graphics cards, two different battery configurations, three communication options and two levels of memory. Any combination of these is a variant that is specifically tuned to your needs. Also, Volvo Trucks (and their subsidiaries, Mack Trucks in the U.S. and Renault Trucks in France) has eight wholly-owned assembly plants and nine factories owned by local interests. About 95% of the company's production capacity is located in Sweden, Belgium, Brazil and the U.S.A. Volvo Trucks

estimates that of the 50,000 parts it has in its inventory, it annually supplies over 5,000 variants or different truck models specifically assembled to meet the needs of the customer.

In 2006, Eclipse decided to develop sharable documentation for key products that were sold and maintained on a global basis. The goal of this was so that a part made in any of Eclipse's plants would fit in a

Year	Rockford	Europe
Pre 1995	Paper drawings of parts	
1996	SimCAD	AutoCAD ( 2-D, top level assemblies)
2000	Effort to get every-one on AutoCAD	
2003		Autodesk Inventor (Solid Models)
2004	Begin conversion to Inventor	
2005		Fully on Inventor
2007	75% 2D, 25% Solid models	
2009	Most standard parts and assemblies on Inventor	
2006-2009	Integrate Autodesk Vault	

product made in another plant. So far, this process has taken four years and, although key products now have a single “truth”, the process is still not complete. To understand the difficulty of such a transition, its history needs to be explored.

As shown in the Table above, in the 1990's, Eclipse-Rockford (Eclipse's main U.S. plant) began to move from paper drawings to CAD. These were 2-D and initially on a system that no longer exists. Their facility in Holland, the facility needing the closest integration with the U.S. plant, began to convert to AutoCAD in 1996. There were over 40,000 part drawing files in Holland alone. In 2000, the U.S. office began to convert their drawings to AutoCAD, but still in 2-D. The U.S. and Dutch effort were, for the most part, independent and so a single part might have a different U.S. and European reality. In 2003, the Dutch began to use Autodesk Inventor, a solid modeling capability, and had completely converted to this system by 2005. In 2004, the U.S. began to convert to Inventor. These conversions further clouded the truth as:

1. Not all 2-D drawings were correct and these errors become evident when making a solid model of a part and including it in an assembly. Correcting these errors added new inconsistencies.
2. The people who modeled these parts simply needed a 3-D model to complete their assembly. They were not responsible for maintaining the official design standards. They did not need, nor did they make, a specific effort to insure that their models fully represented the piece part drawing.
3. The groups of people creating these “multiple versions of the truth” were simply creating models to fulfill their immediate need to process an order. The Product Engineering Group did not have the resources nor did they have the charter to convert all existing standard component parts into 3D models.

By 2005, things were beginning to come apart with uncontrolled part drawings. There were often three different models for the same part: a 2-D drawing in the U.S.; a solid model in the U.S. that was not validated relative to the older 2-D drawing; and a solid model in Europe. It was not that Eclipse is sloppy company. On the contrary, Eclipse is a company that has strict processes and standards. It is just that this is a hard problem to resolve. And, Eclipse was operating separate, stand-alone systems.

Eclipse had another common problem. In most CAD systems, the drawings are not directly tied to the Bill of Materials (BOM). Thus, when a new order was initiated, sometimes people would miss listing all the parts needed to make the product on the BOM. This error sometimes was not caught until assembly - an expensive error.

These problems led Eclipse to invest in a PDM system. PDM is helping them to not only get the part and assembly drawings under control, but to streamline their product variants and their BOM system. With an integrated system of a solid models tied to a parts library, as the product is designed the BOM can be automatically generated.

## The Data Management Process

Companies that grow multi-nationally, that grow by acquisition and mergers, or that make “variant products”, all face the same problems as Eclipse. And, like Eclipse, all have turned to systems that integrate the control of data files, detailed information about parts, and business systems.

This emphasis managing product information goes by many names. The two most common are PDM and PLM. Product Data Management (PDM) evolved in the 1980's to emphasize the controlling and sharing of the product data. Some began to use the term Product Life-Cycle Management (PLM) in about 2001 as a blanket term for computer systems that support the definition or authoring of product information from cradle to grave. Regardless of the name, the goal is to manage product information in forms and languages understandable by each constituency in the product life cycle—namely, the words and representations that the engineers understand are not the same as what manufacturing or service people understand. The only way to get the inherent problems under control is to move to a PDM system which is not a trivial undertaking.

On a larger scale, in the early 1990's, The Boeing Company launched an effort similar to Eclipse's. Boeing's problem partially stemmed from the fact that a wing rib on a 737, for example, might have as many as 10 different part numbers – one for each customer (e.g. United, Lufthansa, and Southwest). This created a nightmare whenever there was a product change, and it was inefficient when ordering parts. Beginning in early 1994, Boeing initiated a process improvement activity called Define and Control Airplane Configuration /Manufacturing (known as DCAC). This project was aimed at eliminating the ills of legacy practices from the 1950's – a wing rib with ten part numbers – and led to a single source of product data for each airplane and a simplified materials management method for tracking and ordering parts, scheduling production, and managing inventory for each business stream.

This project took thousands of people over a six year period. Implementation challenges such as organizational change management, new process/system introduction, data migration/conversion, and training took commitment from the top of the organization. The first efforts began with a single parts plant in 1996 followed by additional sites with more complex parts and finally, the airplane program assembly and installation in July 2000.

The ability to manage customer-specific options and leverage reusable module configurations and part definitions, led to more streamlined processes resulting from the implementation of best practices of “business object management” as opposed to processes related to coarse-grain document management practices.

Additionally, Boeing reported a reduction in part shortages following improvements in BOM accuracy and reductions in data errors, enhanced traceability and accountability processes, and reduced cycle time and quality improvements from global sharing of product information.

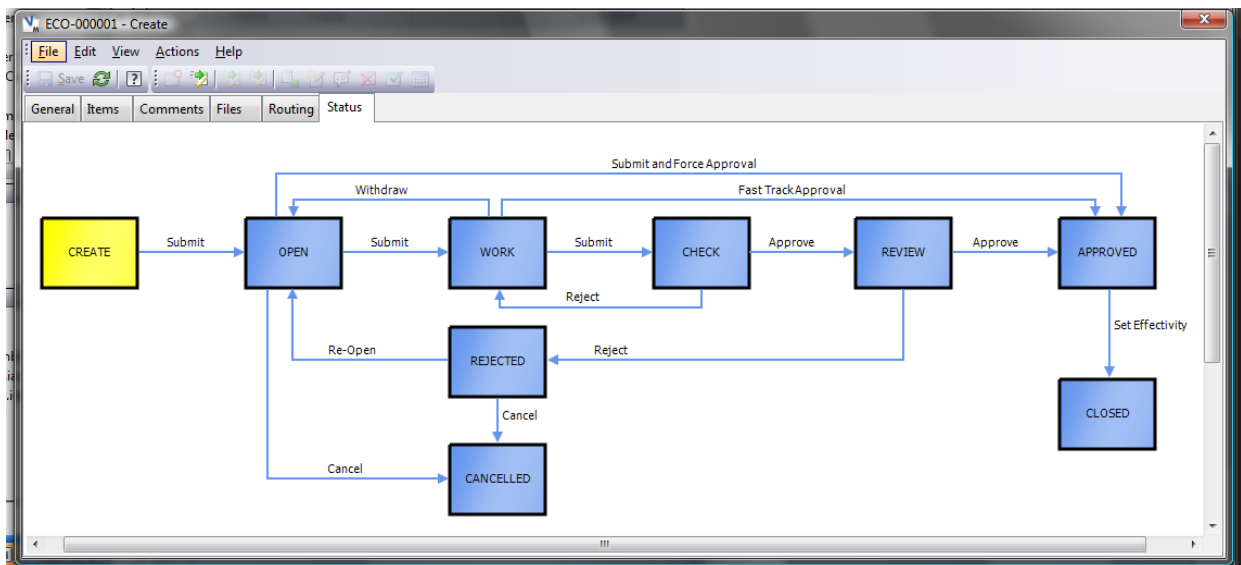
To understand the path taken by Eclipse and, on a much larger scale, Boeing, it is important to understand the levels<sup>1</sup> of product information.

- **Level 1 Data Management: Drawing Files**

All parts are represented in CAD files. These can be 2-D, 3-D or solid models. There is no relationship between drawings other than through assembly relationships in the CAD system. If there are multiple facilities, there might be separate drawings that are not coordinated. Eclipse was doing better than this even in 2000 as they had a home grown drawing management system, which put them at Level 2.

- **Level 2 Data Management: File Control**

File control includes managing check-in and check-out, and file history management. This is the most basic level of product data management. It ensures that data is not over written, that only one person makes a change at a time, and that there is a history of changes to each file. This is where Eclipse was in 2005 with a system that did not integrate with the CAD systems. Engineers had to check drawings in and out of a separate system. According to Mr. Stroup of Eclipse, this was not difficult. They now use Autodesk's Vault system for this level of support.



**Figure 2 The process built into Autodesk's Vault system**

- **Level 3 Data Management: Part Management**

Here the focus moves from data files to the parts represented in files and how changes to parts occur. The concern here is for part revisions and releases along with life-cycle states and part properties. Figure 2 shows the life-cycle states of a part or a change in a part as it moves through the

<sup>1</sup> Levels 2-5 mimic the functions provided by the Autodesk suite of products: Level 2 = Autodesk Vault, Level 3 = Autodesk Vault Work Group, Level 4 = Autodesk Vault Collaboration and Level 5 = Autodesk Vault Professional (see Product Stream). Other vendor's product levels are similar.  
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process from its creation, through work, checking, review and finally, to approval. A Level 3 system manages this process aiding in assigning revision numbers to this release process.

The process shown in Figure 2 is built into Autodesk's system. This process begins to overlap processes managed by ERP systems (Enterprise Resource Planning - an integrated computer-based system used to manage financial resources, materials, and human resources). In fact, Eclipse uses their ERP system for processes such as these. As PDM and PLM mature, they are moving toward functions traditionally supplied by ERP systems and ERP is moving into traditional PDM territory.

- **Level 4 Data Management: Distributed Part Management**  
Important to Eclipse is that a data management system support the entire enterprise. This function is often called Enterprise Configuration Management, ECM, and is concerned with maintaining completeness, consistency, traceability, and accountability of the product structure across all organizations in the enterprise. This is essentially Level 3 functionality with the addition of an IT structure. For companies like Eclipse, with facilities on three continents, a Level 4 system replicates data in multiple sites to increase speed, yet the users see no difference and information consistency is maintained.
- **Level 5 Data Management: Business Object Management**  
Level 5 is a large jump to full integration of the PDM and ERP functions. Here the focus is on business objects such as BOMs and ECOs. Where Figure 2 shows a part centric process, a business is interested in selling a product that is defined by a BOM or managing a change as defined by an ECO. To accomplish this, the part data must interface seamlessly to other business activities and systems such as Customer Relationship Management (CRM), Supply Chain Management (SCM), and Enterprise Resource Planning (ERP). This way, anyone in the organization can see the information they need in a language with which they are comfortable. This brings harmonization and synchronization to the way that companies carry out everyday business. This level is what is generally meant when the term "PLM" is used. The focus change makes Level 5 challenging as the lower levels are engineering-centric whereas, at Level 5, information is now part of many organizations and so there is no single owner.

Eclipse has a Configurator as part of its ERP system. For a standard product (60% of sales), the sales people log the capabilities of the product and the Configurator automatically produces the BOM from the product specifications. Volvo functions in the same manner. For engineered (non-standard) products, the Eclipse engineer begins with an existing product, reengineers it in Inventor, updates the BOM to match the changes, and creates a new BOM as part of the ERP system. Eclipse has its ERP system tightly integrated with Autodesk Vault through an SQL database making this integration work for them.

The five levels are measures of data management maturity and a shift from file-centric, to part-centric, to business object-centric systems. For a company such as Eclipse to mature through these levels, there were a series of questions that needed answering:

- **Question 1: Why do we want a Product Data Management System?**

For Eclipse the reasons were:

- the desire to manage information in a multinational environment and maintain a single truth
- the need to support variant products where a single part may be used in many different products
- the ability to fulfill orders for standard products in a manner that was integrated with their ERP system

- **Question 2: How do we get data into the system?**

Eclipse had to migrate over 40,000 parts into the data management system. Fortunately, their older, home-grown system was fairly robust so, for most files, they could automatically convert using a custom script. They elected to do the migration themselves although there are third party organizations that can do this for a price.

- **Question 3: How are we going to control the transitions?**

Transitions are organization wide so there must be commitment from the top levels. They must allocate sufficient resources to make the transition happen. In Boeing's case, it required thousands of people over a six year period.

- **Question 4: What is the truth?**

Eclipse had as many as three versions of the truth. For each part, there needed to be a method to ensure that there was a single specification. Thus, there had to be a mechanism for resolving the inconsistencies.

- **Question 5: What is our library of parts?**

Eclipse decided that it had a basic library of 40,000 parts. A library can range from just the common parts, like fasteners, to a majority of the parts made for standard products as was the case with Eclipse.

- **Question 6: What are the life-cycles I need to support?**

Figure 3 shows a basic life-cycle, yet there may be many other processes that need support. These may include new product development, change management, product decommissioning, etc.

- **Question 7: What are the languages we need to support?**

Eclipse has facilities in the U.S., Holland and Spain. Engineers and sales people in Holland speak English, but this is not as common in Spain.

Additionally, Eclipse makes sales in South America. Eclipse decided to support both English and Spanish.

- **Question 8: What is the expected life of the system?**

Eclipse has invested much time and effort into their PDM system. However, they are at the mercy of the vendor in that future changes may force them to redo some of the effort. All organizations face this challenge and thus most opt for larger, stable PDM suppliers.

## Summary

This case study has described how Eclipse resolved the problem of “three versions of the truth” by using a Product Data Management system. This system enabled them to not only control their CAD files, but to support multiple variants, multiple languages, integrate with their ERP system, and support BOM and ECO needs.

## Author

This case study was written by David G. Ullman, Emeritus Professor of Mechanical Design from Oregon State University and author of [\*The Mechanical Engineering Process\*](#), 4<sup>th</sup> edition, McGraw Hill. He has been a designer of transportation and medical systems and holds five patents. More details on David can be found at [www.davidullman.com](http://www.davidullman.com). David was assisted by Scott Stroup of Eclipse Inc. Rockford, Illinois, Todd Nicol, Mikel Martin and Brian Schanen of Autodesk and Wayne Embry of Siemens PLM.

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