

PDM Technology and Its Application Overview on Mechanical Product

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Abstract: PDM is an important core technology of smart factory. This paper summarizes the characteristics, functions and components of PDM technology. The advantages of PDM are included in detail. Additionally, a comprehensive solution are given based on PDM technology.

Keywords: PDM, Technology characteristic, Product manufacturing.

1. Overview of PDM Technology

In the 1960s and 1970s, companies began to use computer technology in product development and production. From design calculations, electronic reports to the application of new technologies such as CAD/CAPP/CAM/MRP, a new trend has emerged in enterprises [1]. In the past, the drawings, processes, production plans, and material management used in product design, process design, and production management were all paper documents. However, once processed by computers, these paper documents have become data in various formats in the computer. Hence, the concept of product digitization is proposed. Digital product data management are called product data management (PDM, Product Data Management).

With the development of information technology and management concepts, the connotation and extension of PDM are also constantly developing, and recently it has developed into product life cycle data management PLM (Product Life Management). It has become the key to solving information integration in enterprise informatization, and has now developed into one of the key supporting technologies for smart manufacturing and smart factories.

As a technology that emerged at the end of the 20th century, PDM is positioned for manufacturing enterprises, with products as the core of management, and data, processes and resources as the three major elements of information management. Based on software technology, it implements integrated management technology that integrates product-related data, processes, and resources. The two main lines of PDM for information management are static product structure and dynamic product development process^[2,3]. All information organization and resource management revolve around products. The core idea of PDM is the ordering of design data, optimization of the design process and sharing of resources.

The development of PDM technology can be divided into the following three stages: PDM system with CAD tools, production of professional PDM system and standardization stage of PDM.

(1) PDM system with CAD tools Early PDM products were born in the early 1980s. At that time, CAD had been widely used in enterprises. While engineers were enjoying the benefits of CAD, they also had to waste a lot of time on finding the information required for design. New methods for

storing and acquiring electronic data are becoming more and more urgent^[4]. In response to this demand, various CAD manufacturers launched the first generation of PDM products in conjunction with their own CAD software. The main goal of these products is to solve the storage and management problems of large amounts of electronic data and provide the function of maintaining an "electronic drawing warehouse". The first generation of PDM products only alleviated the "information island" problem to a certain extent, and there are still common problems such as weak system functions, low integration capabilities and low openness.

(2) Professional PDM systems have continuously expanded the functions of early PDM products, and finally professional PDM products have emerged, such as SDRC's Metaphase and UGS's iMAN, which are representatives of the second generation of PDM products. Compared with the first-generation PDM products, many new functions have appeared in the second-generation PDM products, such as the ability to manage various forms of product data during the product life cycle, the management of product structure and configuration, and the management of electronic data. Release and change control, and parts classification management and query based on group technology^[5]. At the same time, the integration capabilities and openness of the software have also been greatly improved. A few excellent PDM products can truly realize enterprise-level information integration and process integration. While the second generation PDM products have made great progress in technology, they have also achieved great success in business. PDM began to become an industry, and many companies specialized in developing, selling and implementing PDM emerged.

(3) Standardization stage of PDM In February 1997, the OMG organization announced its draft standard for PDM Enabler. As the first international standard in the PDM field, this draft was developed with the participation of many leading manufacturers in the PDM field, such as IBM, SDRC, PTC, etc. The announcement of PDMEabler marks a new step in standardization of PDM technology^[6]. PDMEabler is based on CORBA technology and proposes a standard for PDM system functions, PDM logical models and interoperability between multiple PDM systems. The formulation of this standard laid the foundation for the development of a new generation of standardized PDM products. Background of PDM New Technology In the late

1990s, some new trends emerged in the development of PDM technology. Driven by corporate needs and technological development, a new generation of PDM products was produced. New enterprise needs are the traction that generates a new generation of PDM systems. For a long time, people have mainly used this method to analyze the functions of an enterprise: first, define the functional boundaries of the enterprise, and determine which functions are the functions of the enterprise itself and which are not functions of the enterprise. Then, a "top-down" layer-by-layer decomposition method is used to decompose the functions of the enterprise from coarse to fine to form a functional decomposition tree of the enterprise. With the rapid development of modern science and technology, it is increasingly difficult for any enterprise to establish a large and comprehensive system. Any enterprise must often join forces with other enterprises, and even many functional departments from different enterprises are temporarily organized together to form a so-called "Virtual enterprises" jointly complete a certain social production task. These new social production methods require people to change their thinking and methods of analyzing corporate functions. If the second-generation PDM products cooperate with the "top-down" enterprise information analysis method, the third-generation PDM products should support new enterprise information analysis methods centered on the ideas of "standard enterprise functions" and "dynamic enterprise". The development of new technologies is the driving force behind the production of a new generation of PDM products. The Internet has achieved tremendous development. The Internet has penetrated into and affected every aspect of life. The concept of "e-commerce" has also been deeply rooted in the hearts of the people, and a network era is ushering in. The widespread popularity of the Internet has brought huge impact to traditional business management methods of enterprises. How to face the challenges of the Internet age has become a problem that enterprises must face in the process of informatization.

2. PDM Technical Characteristics

2.1. Basic functions of PDM technology

(1) Drawing document management

PDM drawing document management provides storage, retrieval and management functions for distributed heterogeneous data. In PDM, data access is completely transparent to users. Users do not need to care about the specific location of electronic data storage or whether they are getting the latest version. These tasks are all completed by the PDM system.

(2) Product structure and configuration management

Product structure and configuration management is one of the core functions of PDM. This function can be used to manage product structure and configuration information and bill of materials (BOM). Users can use the graphical interface provided by PDM to view and edit the product structure.

In the PDM system, components are organized according to their assembly relationships, and users can associate various product definition data with components to ultimately form a complete description of the product structure. Traditional BOM can also be automatically generated using PDM.

(3) Classification and query management (parts management)

Organizing data in a database is an important feature of a

PDM system, but information is useless if it is not easily accessible. Application of classification and query management functions makes it easy to query, access, and browse design information.

(4) Project and workflow management

To manage the product lifecycle in PDM, it is necessary to start from the product project development plan, continuously track the product process, and develop the dynamic definition process of product data, including macro processes (product lifecycle) and various micro processes (such as the approval process of drawings). The management of the product lifecycle includes retaining and tracking all historical records throughout the entire process from conceptual design, product development, production manufacturing to cessation of production, as well as defining the processing steps that must be followed when a product transitions from one state to another.

Managers can construct product design or change processes by combining various basic processing steps of product data. These basic processing steps include assigning tasks, approving, and notifying relevant personnel. The construction of processes is based on the analysis results of various business processes in the enterprise.

(5) System integration

To manage the various data required throughout the entire life cycle, it must have a good interface with the CAD/CAPP/CAM/ERP system that generates the data. It must not only accept the data output by each system, but also be able to input various data from each system. Extract relevant information from data in various formats, and establish a unified database of various materials, drawings, data attributes and product structure of product components to ensure the integrated operation of various systems.

(6) Attribute data and structural data management

Attribute data and structural data are extracted from product drawings, documentation, and process files, and are stored in a database file format. These data are the source data for organizing and retrieving product drawings, documents, and process files. They are also key data needed to share integrated applications such as CAD/CAPP/CAM/ERP, and are the core of the PDM system. It has functions such as data inspection, statistical reports, data browsing and human-computer interaction data input.

2.2. PDM technical composition

2.2.1. PDM architecture

The current mainstream PDM system can be divided into five layers, the underlying service layer, the PDM core service layer, the PDM application component layer, the application tool layer and the implementation concept layer.

(1) Bottom platform layer

It mainly refers to the heterogeneous distributed computer hardware environment, operating system, network and communication protocols, database, middleware and other support environments. The current development of the underlying PDM software platform has two main characteristics: First, the adaptability continues to expand and can support more and more software and hardware environments. PDM manufacturers have been committed to launching PDM systems that adapt to more platforms. In terms of hardware environment, everything from the simplest user terminals and PCs to high-end workstations and servers can run corresponding PDM systems. Second, the underlying platform is developing in a cheap direction. In terms of

operating systems, Unix is still the main service platform used by most PDMs, but PC/Windows is quietly expanding its territory due to low cost, friendly interface, and easy operation. The servers of many large-scale PDMs such as metaphase, IMAN, and PM still run in the Unix environment, but they have successively launched their own computer versions. New aristocrats such as Windchill use PC/Windows as their main platform and later launched a Unix version.

Due to the huge data volume and high performance requirements of enterprise-level PDM systems, the underlying databases are almost without exception concentrated on large databases such as Oracle, SQL Server, and Sybase. In particular, Oracle is the first or only database of choice for many PDM systems. In addition, almost all PDM software supports LAN and WAN standard protocols such as TCP/IP, IIOP, NetBIOS and HTTP.

(2) PDM core service layer

PDM software products generally refer to the core service layer and PDM application component layer. Because the two functions are different, they are discussed separately. In the C/S structure, the core service layer is generally the server side, and the client software belongs to the application components of PDM. In the C/B/S structure, both run on the server side, but there may be differences in software product purchase and installation. Core services are necessary, and application components can be selected. For example, Metaphase's object management framework, Windchill's Windchill Foundation, and IMAN's eServer all belong to their respective core service layers.

The core service layer is actually a set of object models. It mainly completes three functions. One is to connect and manipulate the database downwards, the other is to provide basic services for PDM application components upwards, and the third is to provide application programming interfaces (APIs) for application software to integrate application software. In addition, some PDM software also adds Web processing mechanisms in the core layer.

(3) PDM application component layer

PDM application components are actually functional modules that are composed of a set of programs (interfaces) that call PDM basic services and can complete certain application functions. For example, the workflow management application component is a functional module that completes workflow management, consisting of a workflow definition tool, a workflow execution machine, and a workflow monitoring tool. Each PDM manufacturer is constantly enriching its application components. For example, metaphase provides life cycle manager, change control manager, product structure manager, product configuration manager, component family manager, and is used with CAx/DFx/ERP. /CSM/EC/SCM and other application software integrate metaphase application integration interfaces, visualization tools, collaborative design support tools, digital prototypes and other rich application components.

The unified user interface is also integrated into the application component layer. Almost all PDMs support accessing and manipulating PDM through the Web. Newer PDMs with C/B/S structures such as eMatrix and Windchill all use Web browsers as clients terminal, and metaphase, IMAN, etc. have also launched their own web-based clients.

(4) Application tool layer

Application tools mainly refer to engineering design software such as CAx/DFx, office software such as Word, and

all other application software other than PDM. PDM is integrated with these application software in a variety of ways.

(5) Implementation concept layer

In the final analysis, PDM is not an enterprise's business management model but just a software tool. This software tool can only play its role in an advanced enterprise operation mode. Therefore, the implementation of PDM is almost inseparable from CE (Concurrent Engineering) and CPC (Collaboration). Product commerce), VM (virtual manufacturing), SCM (supply chain management), ISO9000 and other advanced management concepts and quality standards. Only under the guidance of these advanced ideas can the implementation of PDM ensure success and play a greater role. On the other hand, PDM implementation is one of the most effective tools and means for the successful implementation of these advanced concepts. While PDM software manufacturers are promoting their software products, they are also promoting their concepts. For example, PTC advocates CPC, metaphase advocates its 4C concept, etc. PDM software is a kind of software that can be perfectly integrated with the enterprise and reflect its value only through implementation. Therefore, the implementation concept is listed at the top of the PDM architecture.

2.2.2. PDM key supporting technologies

(1) Object-oriented technology

PDM takes products as the research object and manages information about the entire life cycle of the product. Due to its complexity, object-oriented analysis (OOA) and object-oriented design (OOD) must be used in the development of PDM systems.), establish an object-oriented data model so that its complex data structure can be correctly described.

(2) Object-oriented database management system

Based on the above reasons, it is appropriate to use an object-oriented database to manage its data, and an object-oriented database should meet two basic conditions: (I) support the core object-oriented data model, (II) expand/modify the semantics of traditional databases to enable It is consistent with the core object-oriented data model to support all database features in traditional databases. Therefore, it can be said that object-oriented database is the integration of object-oriented system and database system.

(3) Data warehouse technology

Our operations on data can be divided into manipulation processing and analytical processing. The former is mainly for data maintenance and management of data, while the latter mainly provides the basis for managers' decision-making and analysis. It is very convenient for the PDM system to implement the complex diversity of data management using a data warehouse. Data warehouse management of data is subject-oriented, that is, data is classified by subject. Data warehouse technology uses a multi-dimensional database model to store data.

(4) Network technology and remote communication technology

Dynamic alliance enterprises are the product of social development and technological progress, and are considered a new generation of manufacturing models in the 21st century. The key to successfully implementing dynamic alliances is the use of various advanced and mature supporting technologies. PDM is one of the key enabling technologies for establishing a parallel product development environment. The development of parallel PDM systems between enterprises cannot be separated from network technology and remote communication.

technology.

(5) WEB technology

Computer network is the information infrastructure that realizes dynamic alliance, and exchanging information between partners through INTERNET is the key to successful collaborative development. WEB technology is an important enabling technology for PDM, and as WEB technology becomes increasingly mature and rapidly popularized, the combination of WEB/PDM technology has become a new hot spot in product data management technology research. In the field of enterprise collaboration development, the application of WEB technology breaks the constraints caused by enterprise distribution and system heterogeneity. For example, the combination of PDM and INTERNET allows users to use the browsing function of WEB to browse from different regions and platforms. Utilize a unified access form to conveniently access and browse multiple node views of product data from different angles.

The current PDM system mainly focuses on information integration in the field of product design, and has less involvement in integration issues between different areas of the product (design, production, manufacturing) and between different enterprises. In order to realize the product integrated development environment of dynamic alliance based on PDM system, it is necessary to start from the global information integration and process integration between enterprises, the configuration and conversion method of global product structure and local product structure, process model and its triggering rules, data The coordination of the update mechanism, the data locking mechanism and version management within the scope of the dynamic alliance, and the encapsulation technology of the WEB server's method of extracting product information from the DM database will be studied in depth. Usually the B/W/D mechanism (i.e. browser/WEB server/data server mechanism) is used.

(6) DB/API technology

The DB/API interface provided by PDM not only provides an interface with the database, but also allows users to customize and expand, as well as more tightly integrate with other systems. Users can use APIs to better adapt PDM systems to their requirements, including the required functions and usage habits, and can define and manage enterprise level data and workflow based on the characteristics of the enterprise. Through the API, users can also expand the PDM system and add special functions required by the enterprise.

(7) Openness

The PDM system is developmental and can continuously incorporate new technologies. Because its basic technology adopts various latest international standards and mature products, such as network technology (TCP/IP), graphical user interface, and database management (DBMS), it has good openness and adaptability, and users can It is used in a variety of system environments and has a unified user interface and system interface. For example, it supports WWW (world wide web) browsers and uses it to query information in corporate sites through INTERNET.

(8) Group technology

The establishment of the enterprise part family system in the classification retrieval and part family management modules of the PDM system relies on group technology

(GT), establish a parts classification and coding system based on group technology and a parts retrieval control method based on GT.

(9) Integration of PDM with other application systems

When establishing an integrated system, the main role of PDM is to provide a unified support environment for engineering data management and automated management of workflows, and use it as the integration framework of the system. It can only implement functions such as CAD/CAPP/CAM/PDM/MIS. Only through complete integration can their advantages be reflected, operation, management, and production automation can be completely realized, and the economic benefits of the enterprise can be improved.

3. PDM Technology Development Trends

As the pace of modernization continues to accelerate, the production tasks and market competition of aerospace enterprises have become increasingly tense and difficult, and the projects have become more and more complex.

The PDM system enables all participants (such as people involved in creation, communication, and design maintenance) to share and deliver all product-related data. The PDM system provides a virtual collaborative working environment for office workers in different locations and with different functions. The main information in the development and testing process of new products can be created, managed and distributed. In other words, PDM helps operators manage products and development steps, improving management, R&D, and manufacturing efficiency.

Due to the continuous advancement of network technology, database technology and object-oriented technology, PDM technology is used in various fields of manufacturing industries such as machinery, electronics, automobiles, and aerospace. PDM technology can not only improve the work efficiency of office personnel, but also reduce engineering costs, shorten product life cycles, reduce engineering change control time, and reduce changes in the number of projects. At the same time, it can shorten the launch cycle of new products, reduce the cost of new product development and new products, and improve product quality and service quality.

Enterprises can integrate various application systems through PDM to collect, process, count, and summarize data in an all-round way to form the cost decision-making information they need. It can provide timely and complete information for product cost planning, analysis, and control. PDM

It can reduce the complexity of product data in the information system and improve the utilization of information. In addition, it can also solve the problems of missing, untimely and difficult to predict and control cost data, and ultimately achieve the purpose of controlling product costs. PDM is a new technology for managing data produced and developed in today's product development environment. It can effectively promote product research and development, shorten product design time, and improve product competitiveness.

At present, the application of PDM products in my country mainly includes the following aspects: (1) Archiving of enterprise product data. (2) Enterprises use unified coding. (3) Management of enterprise product structure. (4) Process management of the technical department. (5) Processing of enterprise product data. (6) Integration of engineering and production areas. In recent years, with the advancement and

development of big data, cloud computing, storage technology, 5G communication technology, etc., PDM technology is becoming one of the indispensable key technologies for smart manufacturing and smart factory construction.

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