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Web-Centric Product Data Management

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Abstract

Communicating and sharing information through Internet technologies have become common practice in most enterprises. Communication and web-centric applications are also influencing the design process. Driven by the need to compete in a global economy, companies are using Internet technologies to concurrently collaborate on design problems. Global collaborative engineering helps to decrease time-to-market while also decreasing production costs. Computer-aided design developers have recognized the potential of the Internet for collaborative engineering and have implemented applications for the sharing and communicating of design data. This paper reviews web-centric product-data management (PDM) applications available from four leading computer-aided design companies: Dassault Systemes, Parametric Technology Corporation, Structural Dynamics Research Corporation, and Unigraphics. Commonly available web-centric PDM functions and the potential impact that web-centric PDM will have on design industries are discussed.

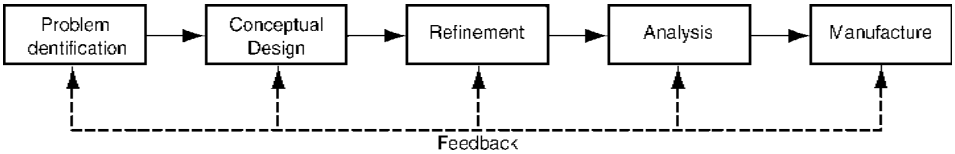
Introduction

The advancement of computer-aided design (CAD) and its expanding utilization of the Internet have led to an increase in the growth of web-based design collaboration. This technological growth has spurred the development of product-data management (PDM) systems that facilitate design collaboration across the global enterprise. CAD developers are examining ways to increase the rate at which information is exchanged among users through web-centric technologies. Leading CAD development companies such as Parametric Technology Corporation (PTC), Dassault Systemes, Structural Dynamics Research Corporation (SDRC), and Unigraphics are placing a significant amount of resources toward the development of web-centric data exchange applications. When fully integrated, these applications facilitate the design process through the sharing of design data. This paper explores and details functions available within most enterprise wide web-centric product data management applications and how these functions help to benefit enterprise design processes.

PDM applications allow companies to construct and disseminate large and complicated models that would traditionally require significant computer resources (e.g. memory, storage capacity, bandwidth, etc.) with the models displayed through the older Virtual Reality Modeling Language (VRML) format. VRML is still used today but less frequently due to the loss of accuracy and the size of files that would accumulate over the design process. The introduction of PDM tools have expanded the access to data and provided a way to easily view models and the corresponding data associated with a design.

The design process for most new products is a complex entity. To take all the various tasks, inputs, specifications, and desires and put them into a project requires detailed organization and management. Before the advent of PDM systems, parties to a design were limited in how they processed data and how they could concurrently disseminate data throughout the design process. This contributed to a linear design process (see Figure 1). This traditional linear approach to design usually consists of sequential steps such as problem identification, concept development, refinement, analysis, and production. Information flow within the process and external to the process is difficult and usually nonexistent. This lack of communication flow normally results in increased cost during manufacturing. To overcome this problem, progressive engineering and manufacturing companies utilize principles of concurrent engineering to facilitate the design process. According to Prasad (1996), within a concurrent engineering philosophy, “everyone contributing to the final product, from conceptual design to marketing teams, is required to participate in the project from its very inception” (p. 2). Concurrent engineering principles utilizing PDM systems provide tools for nonlinear design processes that allow for simultaneous input from many different sources, including customers. With PDM, members of design teams can markup, measure, and perform mass property calculations on CAD models. PDM systems even allow for the sharing of non-CAD data.

Figure 1.



Traditional intra-company PDM implementations fall into five categories: (a) change management, (b) document management, (c) collaboration management, (d) parts management, and (e) product builds from engineering data (Collier, 1996). How each application deals with these aspects varies, but the underlying principles for each application are basically the same (see Figure 2). Change management is targeted toward manufacturing users of PDM by providing provisions for changes after a design has been released to production. Unfortunately for most designs, many changes occur after the final design is released, especially production related changes. Change management tools help to break down barriers that arise between engineering and production. The second category, document management, provides a means for tracking vital design information. This is an invaluable tool for the storing of data within concurrent engineering teams. It keeps record of non-CAD specific material (e.g. Word, Excel, Project, etc.) and CAD specific data, including bill-of-materials. The sharing of data between members of a design team can be a demanding task and is accomplished through intuitive collaboration tools. In a classical sense, collaboration capabilities are the heart of a modern web-centric PDM application. Used in conjunction with document management tools, a PDM's collaboration capabilities allow for the timely distribution of design information. The fourth category, parts management, works to keep track of parts libraries and to promote standard components. This is the category most often associated with product data management and consists of tools for CAD data management and revision (e.g. check-in, check-out, copy, etc.). Finally, product builds from engineering data, from a manufacturing viewpoint, reduces the amount of wasted effort that goes into a project because of extensive product configuration (i.e. design for manufacturing issues). Its implementation goal is to shift the responsibility for defining final product configuration from the manufacturer to the designer.

Collaborative Product Commerce

Collaborative Product Commerce (CPC) is an emerging design philosophy that enables companies to be more responsive to the needs of everyone in the design process. According to the Aberdeen Group (1999), it is "a class of software and services that uses Internet technologies to permit individuals … to collaboratively develop, build, and manage products throughout their entire life cycle" (p. 3). It ties together all business, supply, and design functions for the facilitation of design information throughout the life of a product (see Figure 3). It represents the next generation of web-centric PDM applications that will control the flow of design relevant communications throughout the global enterprise. Applications included under the umbrella of CPC include CAD/CAM, computer-aided engineering, manufacturing resource planning, enterprise resource planning, visualization, and component sourcing (i.e. subcontracting components).

Figure 2.

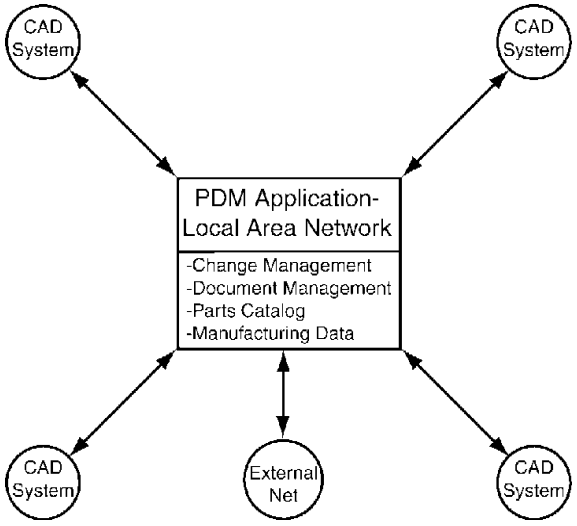
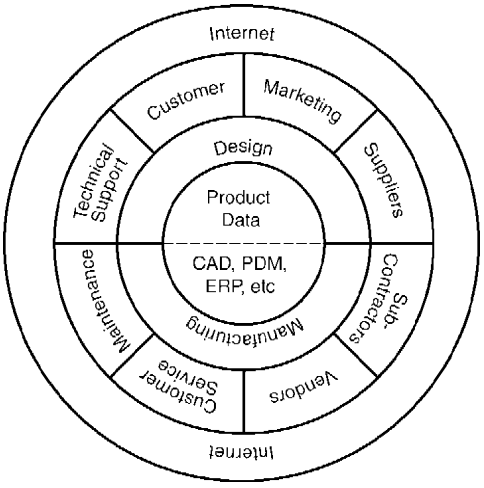


Figure 3.



CPC provides four major benefits for product design (Aberdeen, 1999). First, the collaboration tools available with CPC applications allow multiple enterprise players (e.g. engineers, manufacturers, vendors, subcontractors, and suppliers) and customers to participate in product design throughout the various stages of the design process, including initial design ideation. Second, customers can interface directly with the system to provide input to the design. In doing so, they can communicate specific and customized design specifications. Third, CPC applications can tie together dispersed and disparate computer systems and applications. Finally, CPC can speed up the time to market of a product. In a global economy, the best product to reach the market first is usually the winner. In its truest sense, CPC speeds up the design process by facilitating communication flow.

Focus of Paper

The purpose of this paper is to analyze high-end modeling applications use of integrated PDM and CPC processes and how these applications help to benefit a global design process. Early PDM applications aimed to keep things simple by concentrating on document management and revision control. Modern web-centric PDM applications are moving toward targeting product development directly while emphasizing concurrent development and improved coordination from concept to customer (Collier, 1996). Web-centric PDM offerings from four leading high-end CAD developers: Dassault Systemes, Parametric Technology Corporation (PTC), Structural Dynamics Research Corporation (SDRC), and Unigraphics are discussed. These companies are known for their integrated computer-aided design and engineering solutions; each has its own offerings of web-centric PDM and CPC applications.

The significance of web-centric PDM applications is their ability to manage the digital enterprises of the future. The understanding of these abilities is important for designers, engineers, and managers. According to Toole and Lemke (2000), "the product creation process facilitates innovation by encouraging designers and engineers to leverage the digital information available throughout the enterprise to create new, high quality products demanded by new and existing markets". A true digital enterprise is an environment where all resources will be linked together throughout the lifecycle of a product or a family of products. A digital enterprise encompasses more than just the sharing of CAD data. It is the real time sharing of any documentation, data, or information associated with a product, including information from vendors and subcontractors. It is also the interfacing of customers into the enterprise for the promotion of timely design criteria. These web-centric PDM abilities create new design process models and incorporate modern design philosophies. As stated by Toole and Lemke, "the product creation process facilitates innovation by encouraging designers and engineers to leverage the digital information available throughout the enterprise to create new, high quality products demanded by new and existing markets".

Methodology

A comparison of different web-centric PDM applications will reveal similarities between each application. The PDM applications studied for this paper included PTC's Windchill, Dassault's ENOVIA, SDRC's Metaphase, and Unigraphics iMAN. The following section of this report is a description and discussion of the tools, techniques, and resources that are generally shared by each of these four applications. It should be noted that each application is composed of many smaller modules that may or may not be implemented by all users. It should also be noted that the four companies covered in this project are developers and providers of high-end, enterprise wide engineering tools. Other PDM applications are available that are tailored toward more limited applications.

Functions of Web-Centric PDM Applications

A variety of companies have developed applications for web-centric collaboration of design problems. This section focuses on the exploration of web-centric PDM solutions from four established developers of high-end CAD products: Dassault, PTC, SDRC, and Unigraphics. While all identified solutions have many tools in common (e.g. Internet capability, revision control, CAD interface, etc.), the author identified six functions that distinguish web-centric PDM applications from standard intra-company PDM applications: (a) the ability to handle multiple CAD formats, (b) the ability to manage disparate data sources, (c) the integration of ERP solutions, (d) life cycle design capabilities, (e) Internet and PDM integration, and (f) customer integration.

Multiple CAD Formats:

A true global enterprise requires the sharing of information from many different vendors, suppliers, and enterprises. Even with smaller, more geographically constrained companies, it is difficult to maintain one standard CAD application. Changing economies necessitates diverse requirements, which in turn dictate collaboration with many different companies. The growth of CAD application developers also plays a role. The CAD industry changes at a rapid pace. Who's to predict which CAD package will dominate five to ten years down the road? Due to the utilization of different CAD applications within one organization, PDM systems are required to manage multiple CAD formats to include standard industry formats such as IGES and STEP. As an example, PTC's CAD application Pro/ENGINEER is in direct competition with Dassault's CATIA product. Despite this, through PTC's ProductView module, a CATIA file can be viewed and manipulated. Other 3D and 2D formats supported by ProductView include AutoCAD, Microsoft, I-DEAS, Solidworks, and 3D Studio Max. ENOVIA also has a similar capability. Through its ENOVIA Portal foundation and its ENOVIA 3D COM product, web browser plug-ins allow for the sharing of Pro/ENGINEER, Unigraphics, I-DEAS, and CATIA models.

Multiple Disparate Data Sources:

CAD models are not the only electronic information that goes into the design of a product. Information such as word-processed documents, database files, engineering data, and project management data can be seamlessly integrated into the design process. SDRC's Metaphase application provides its MetaDocumentManager (MetaDM) for the organization and management of documents from authoring tools such as Word, Excel, and Word Perfect. Like most web-centric PDM applications, web interfaced engines are provided for locating and managing documents. A key benefit to this functionality is users do not have to learn the primary PDM application; it typically works behind the scene.

Enterprise Resource Planning Integration:

In a global market, design input comes from a variety of sources. Typical players in the design process include product designers, engineers, and manufactures. Other individuals such as customers, suppliers, sub-contractors, and vendors also have important criteria to input into a product's design. "Companies who embrace the diversity of their suppliers, partners, and customers must link processes and systems together more dynamically, to create a complete source of product knowledge that crosses organizational boundaries" (PTC, 1999a, p. 2). Modern production and inventory control methodologies focus on enterprise resource planning (ERP) applications to link nontraditional sources such as vendors and sub-contractors. Web-centric PDM applications are typically integrated and linked with ERP applications. This allows designers to receive data, including CAD models, from outside sources such as vendors. The sharing of this information speeds up the design cycle, allowing a faster time to market for a product.

Lifecycle Design Management:

The management of a product throughout its lifecycle utilizing web-centric applications is an expanding design methodology. Traditional linear design processes end when design information reaches production. PDM applications within this environment are typically concerned with document and product management, not product design. Modern philosophies such as concurrent engineering place an emphasis on the timely receipt of design criteria from many different sources to include manufacturing, vendors, and customers. There are limitations to concurrent design approaches. According to Collier (1996), "concurrent development processes contain no built-in guarantees that the information used in a given step is accurate, or that the information generated by a given step will be available to the appropriate users doing concurrent work". Life cycle management tools available within PDM applications can help overcome these problems through their extensive use of data and information sharing. This extends sources of design information from engineering and design departments to everyone with an interest to include terminal end-users, maintenance technicians, and environmental experts.

Web-Centric PDM Tools:

Web-centric PDM applications help to expand product design throughout the entire enterprise. It is easy to get lost in their many capabilities, but at their heart there exists a powerful PDM application. As stated earlier in this paper, traditional PDM implementations have tools that allow for change management, document management, collaboration, and parts management. Web-centric PDM applications have these tools, but they are enhanced to expand the design enterprise. One of these enhancements is the utilization of a web interface. This allows individuals, such as customers, with standard Internet connections, to access relevant design information. "Webcentric applications are more flexible and scalable, are easier to manage and integrate, and have a higher user acceptance rate" (PTC, 1999b, p. 3). According to Stevens (1997), Internet technology "helps boost the richness of information in design documentations, facilitates data communications within and between companies, enhances workflow and cooperation in extended design teams, and opens useful design information to interested parties outside the design community."(p. 52). PTC's approach to web-centric PDM is the integration of its Pro/INTRALINK product with its Windchill application. Intralink is a traditional collaborative PDM application. Combined with Windchill, traditional PDM tools can be extended across the lifecycle of a product.

Customer Integration:

A natural result of a global enterprise is increased competition. Increased competition gives rise to increased customer demands for shorter product time-to-market and for customizable designs. The need for shorter time-to-market and the need for customization often conflict. Companies that can provide a product that a customer wants and provide it in a shorter timeframe will, more than likely, win the competition. Through collaborative processes and technologies, such as enterprise wide PDM applications, customers can provide input during the design cycle, lessening the likelihood of later design changes. Most web-centric PDM applications provide avenues for customers to view designs through a web browser during the design cycle. PTC's ProductView application has a client application that can be downloaded using standard Internet capabilities. What a customer can view with the client application is controlled through ProductView's server application. Another developing web-based PDM technology is the ability of a customer to customize a part through a web page, similarly to how many companies sale products online, such as modern computer vendors. The difference lies in its affect on the product database. Once customized, the system generates a bill of material for the product and a 3D visual representation. (Unigraphics, 2000).

Impact on Industry

Electronic-business (E-Business) continues to grow in functionality and popularity. To the traditional users of the Internet, E-Business is a way to

purchase, market, and communicate. Collaborative engineering tools such as web-centric PDM applications are in reality E-Business tools. These tools are impacting industry in four significant ways: (a) increased global collaboration, (b) faster time-to-market, (c) higher quality, and (d) customizable products.

Developers of engineering design tools have recognized the need to integrate modern communication technologies to facilitate the growth of global markets. An overview of the history of computer-aided design and of the Internet will reveal increasing utilization of web applications within CAD systems (Burchard, 2000; Smith, 1999). The integration of web and CAD applications combined with PDM systems present the tools necessary to facilitate global collaboration. Traditional linear design processes required face-to-face information sharing. At best, engineering drawings could be shipped through the mail to customers and vendors. Now, with the advent of web-centric design applications, designers and customers can collaborate in real time. Companies that once were restricted by geographic boundaries can now expand. Similarly, vendors and subcontractors which once had to collocate to guarantee smooth business exchange can now bid for business from an expanding array of global enterprises.

To compete in a global market, companies have to produce high quality products in a timely manner. Often, faster time to market results in initial poor quality. Traditionally, quality is engineered into a product during design. Older design techniques that do not facilitate communication between engineering and manufacturing require an extensive amount of rework and redesign during production planning. Engineering philosophies such as concurrent engineering help to decrease production costs through increased communication and collaboration, but they tend to also increase design time, especially for geographically dispersed companies. Web-centric design applications help to facilitate collaborative engineering philosophies and techniques through the integration of Internet tools. These applications have the capability to synchronize the lifecycle design of a product. This increased design input helps to increase quality. In addition, it also facilitates faster time-to-market for products, especially customized products.

Summary

Due to the emergence of Internet capabilities, the communication and sharing of engineering designs are in a state of change. Information technologies have increased the demand for collaboration between global enterprises. The display of designs through 2D drawings is giving way to electronic display of 3D models. Designs can now be shared in real time with clients from any point on the globe. Engineering design tool of the future will be web-centric and will allow for timely input of design intent. At the center of these design technologies will be PDM applications that are capable of not just CAD data management, but the management of all data associated with a product. While these technologies are currently in their growth and development stages, it is important for designers to be aware of their capabilities.

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