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A Review on Valuable Trends of Product Data Management (PDM) Occupied in New Product Development (NPD)

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Abstract. Presently the prime task of manufacturing engineers is to make products within a short span by maintaining the best quality at minimum cost. Recent market trends confirm the continuation of New Product Development (NPD) as a change agent for many more years to come with a focus on high product variety and shorter product life cycles. The effective introduction of new products is critical to the performance of manufacturing industries in more industrial sectors. It is a measure of an industry's strength in innovation and competitiveness in NPD. Manufacturing industries are forced to accept that the focus on NPD is on increasing product variety and shorter product life cycle. For many manufacturing industries mass customization with "voice of customer", agility and leanness are some of the vital prerequisites to survive in the current global competitive environment. NPD is no longer an isolated process; it requires close integration between all active members within the supply chain such as customers, suppliers, manufacturers, etc. and must be viewed as an integrated business process. The proper use of advanced IT has enhanced NPD in manufacturing enterprises. It facilitates shorter product lead-times and increases responsiveness to changes in the market along with improved product quality, as well as maintaining low product cost.

Introduction

Product Data Management (PDM) is a software system that manages the product data and the product development process involved in a particular process [1].The data tracked usually involves the technical specifications of the product, specifications for manufacturing and development, and the types of materials that will be required to produce goods. The use of PDM allows a company to track the various costs associated with the creation and launch of a product.PDM serves as a central knowledge repository for process and product history, and promotes integration and data exchange among all business users who interact with the products including project managers, engineers, sales people, buyers, and quality assurance teams. Many of commercially available PDM systems offer basic functionality such as data vault, documents management, parts classification, product structure &configuration management, workflow management and project management in NPD.

New Product Development Process

A new product development process is the sequence of the steps or activities that an enterprise employees to conceive, design and commercialize a product [2]. The inevitable trend towards customized products, higher quality and faster delivery to the customers has put NPD on the agenda for delivering increased product quality, improved responsiveness to customers and lower unit cost. The pressing need is to capture customer requirements effectively and to translate them into a design specification, while utilizing existing design modules wherever possible. They can be rapidly

turned into a quality and cost effective product delivered within the agreed due date. NPD is the means by which new or modified products are developed from the identification of initial customer needs, through the realization of these needs into products that are launched in the market [3]. Over the last 40 years, there have been dramatic changes to NPD in an attempt to reduce both product cost and development time while remaining competitive. In 1960s new products were designed and re-designed by individual engineers, manually, without use of any structured design process. Many manufacturers had started employing such procedures to reduce product failure, higher cost and insufficient development time. Barclay reported that while in 1990 only 40% of the industries he surveyed had any form of product development procedure implemented; this figure had reached well over 90% in 2000. In fact, there is a British Standard dedicated to managing design activities within NPD called "British Standard 7000: Guide to Managing Product Design". Table 1 shows an overall summarized view of the trends of NPD in the last 30 years, drawn from the literature.

New Product Development Process Trend

Table 1

Process/ Period	2010s	2000s	1990s
Mft. Environment	Global	National	Regional
Competitive Challenge	Product Lead Time, Product Quality, Variety &Cost, Flexibility, Customer Satisfaction	Quality	Cost, Quantity
Manufacturing Objectives	Creating a learning organization to make continuous innovation to work smarter	Flexibility & Integration	Technology adopt for Automation
Working Style	Virtual Team	Project Team	Departmentalized
Design Methodology	Concurrent Engineering	Re-inventing	Re-inventing
Production Systems	Engineer / Make to Order	Make to Stock	Make to Stock
Mft. Organization	World-Wide	Centralized	Centralized
Automation	Integrated	Interfaced	Separate

NPD - Major Role

NPD is an interdisciplinary activity requiring contribution from nearly all the functions of a company, mainly design, manufacturing, marketing and finance [2]. Voice of customer is important in any future design methods and manufacturing strategies that strive towards responsive manufacturing, just like the craft based production, especially with today's increased practice of the mass customization. In the past, manufacturers designed complex sub-assemblies and the final assembled products. New product development is a well-studied process, is the lifeblood of numerous firms, and represents the best hope for future growth. Over the years, it has been refined with attention paid to the consumer [4, 5] the development process the nature of the product [6, 7] the channel the nature of the marketing venue and the source of the product concept [8, 9]. Despite the evidence of attempts at continuous improvement, the need for change still exists. Today's trend, however, does not provide an environment for NPD to be managed by individual persons and requires traditional rigid mass production techniques to be replaced with flexible manufacturing techniques. The need for integrating customer needs into product requirements and increased supplier involvement has added complexity to today's NPD. To manage such complexity, closer integration is necessary among all functions in all industries within the supply chain. This is not nearly on a regional scale but also on a global scale.

Fig.1 Major Role of New Product Development

PDM Systems within the New Product Development Process

In a survey carried out between Electronic Data Systems and The Design Council within India, Nichols showed that the industries in India were responding to provide better, cheaper, and faster to market products through the adoption of a concurrent engineering approach [10]. Concurrent engineering (CE) is an enabling technology that helps lower development and operational costs through parallel working within the product development process to reduce lead time, improve product quality, and reduce costs. CE is made possible through the early involvement of all parties, including key suppliers and customers by integrating people and systems across functional boundaries and performing as many activities as possible concurrently. This helps in managing the moving targets inherent in the design and production of complex products [11]. In the past, many business processes were performed in a sequential manner that resulted in long product lead-times and costly products. The main contributing factors were high percentage of scrap and rework, inefficient use of both technology and skills available, and this resulted in a lower profit margin. "Over the wall" was a common practice where there was no interactive activity or sharing of information between different departments. The essence of CE is an integrated and collaborative process with a complete understanding of the product and process information that can be shared by all members of the product development team. Consequently, CE deals with highly heterogeneous environments. Within such an environment, bi-directional information flows are necessary to allow consideration of both downstream and upstream inputs for optimum decision-making. Using conventional paper-based data management and stand-alone computers could lead to impaired communication, data loss, and redundant development. CE requires a reliable communication infrastructure, particularly within industries that deal with complex products such as IT, aerospace, electronics and computer industries. PDM systems have been identified as an enabler for implementing CE [12].

Successful implementation of PDM systems reduces "over the wall" scenario within the product development process by facilitating effective communication channel through controlled workflow and increased sharing of accurate and up-to-date product data. Automation has been successfully introduced within the product development process in the past digitization of data within several departments of an organization. To benefit from the automation of individual departments, automated processes within an enterprise need to be integrated through the establishment of an integrated product database that contains a total, comprehensive, and unambiguous product model. Literature has shown the importance of having an integrated communication and information infrastructure to enable individuals and teams to rapidly interact within both the enterprise and its supply chain. Computer Integrated Manufacturing (CIM) is a strategy that aims to optimize the operations of an enterprise throughout the entire product development process. CIM streamlines the flow of the full product related information between divisions and allows these data to flow seamlessly through the business with a particular focus on the design and the manufacturing processes. It links islands of automation into a distributed processing system through various methodologies, tools and techniques, which help to manage all business activities in an integrated way.

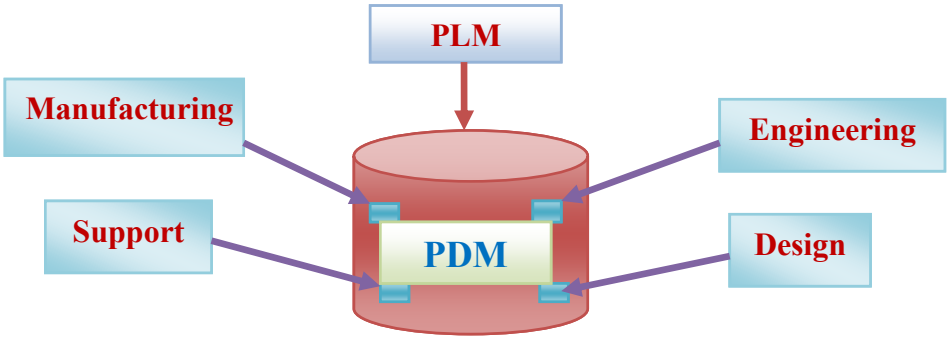

Fig.2 PDM Manages Product Life Cycle

The literature shows that a PDM system has been identified as a solution or an enabler to achieve an integrated information infrastructure to improve the flow and quality of information throughout the enterprise, as required within a CIM environment. This is particularly important for manufacturing enterprises involved in the design and manufacture of complex products where PDM systems help managing the voluminous data and control the flows of product information within the entire product life cycle in an effective and efficient manner [13] is shown in Figure 2.

The current trends in manufacturing outlined below have contributed to the need for PDM systems within the NPD

i. With the increasing use of today's sophisticated CAD systems in the design process, enterprises now have two major types of archive: paper-based and digital/electronic based. With most enterprises holding 60% to 70% of their archives in paper or microfilm, costly paperwork has been an unavoidable plague [14, 19]. The situation is worsened with traditional manual storage systems no longer able to cope with the massive volume of documents generated and the demand for data retrieval. Today, managing paper-based and electronic product data, as well as the transition from paper-based product data to digital media is a major issue for many industries.

ii. The complexity of a computer system supporting the manufacturing environment can be directly related to the volume of product data processed to support decision-making. To achieve this, integration between different computer systems to enable extensive use of the product data, which exists in different sections of an enterprise, is essential. This is particularly important because widespread use of commercially available computer applications in different business areas has resulted in unmanageable proliferation of computer systems and the industrial explosion of product data.

iii. All application systems have their own specific data management functionality. This leads to the rise of different product data structures, formats, and definitions that represent a different description of a part. Multiple data representation relating to the same underlying product data is of great importance to accommodate the various needs of the users. For example, when a product evolves through the development process, different views of that one product will be required without consuming much time and costly manipulation of incoming data. Such representation can be made possible through a multiple data representation capability.

The Importance of Technology to NPD

The industrialized world has seen a shift from labour and capital-intensive industries to knowledge and technology-based economies. According to Bsharah [15] as competition increases in markets throughout the world, technology has emerged as a significant business factor and a primary commodity.

Manufacturing Systems to Support Manufacturing Strategies

Table2

Period	Computerized Manufacturing Systems
2000s	"Intelligent" Manufacturing System; Flexible and Agile Automated Systems; Continuous Benchmarking Systems; Community Involvement; Continuous Infrastructure Improvement; Paperless Systems; Ergonomics and Safety System.
1990s	Computer Integrated Manufacturing (CIM); Decentralisation; Simplification; Total Quality Management (TQM); Activity-Based Costing
1980s	Manufacturing Resource Planning (MRPII); Optimised Production Technology (OPT); Statistical Quality Control; Computer Aided Design and Manufacturing (CAD/CAM); Simulation; Pull Systems
1970s	Material Requirements Planning (MRP), Master Production Scheduling, Computer Numerical Control (CNC); Push Systems

For example, in a study of the technology adoption practice of 20 major Asian manufacturers in 1997, it was identified that quality control was more easily achieved with technology rather than with manual quality control processes. Orr et al. [16] quoted that Sony Precision Engineering found that their workers were able to identify only 90% - 95% of quality defects, whereas the advanced manufacturing technology employed was able to identify nearly 100%. From the manufacturing perspective, Ostwald and Munoz [17] provided examples of the use of computer technology as shown in Table 2 to support modem manufacturing strategies.

The Need for Efficient and Effective Management of Product and Process Data

Manufacturing enterprises are generating massive quantities of data especially from the design to production process with the increasing use of sophisticated computer technologies in NPD [18]. This data can be largely grouped into two groups: product data and process data. Process data provides information about the processes that create a product, such as engineering change, project approval and authorization, product configuration, workflow, and information exchange. Product data can be divided into technical and non-technical information. Non-technical information includes the direct and indirect product costing, marketing information, sales orders, purchase orders, correspondence, product warranty, etc. Technical information includes the following: Design specifications such as bills of material and design geometry, CAD files such as engineering drawings and assembly diagrams, CAE files such as engineering analysis results, CAM files such as NC programs and others like product instructions manual and manufacturing plans. All these data are used, created, processed, consulted, and multiplied, stored, etc. at different functional areas within an enterprise throughout the product life cycle as shown in Figure 3.

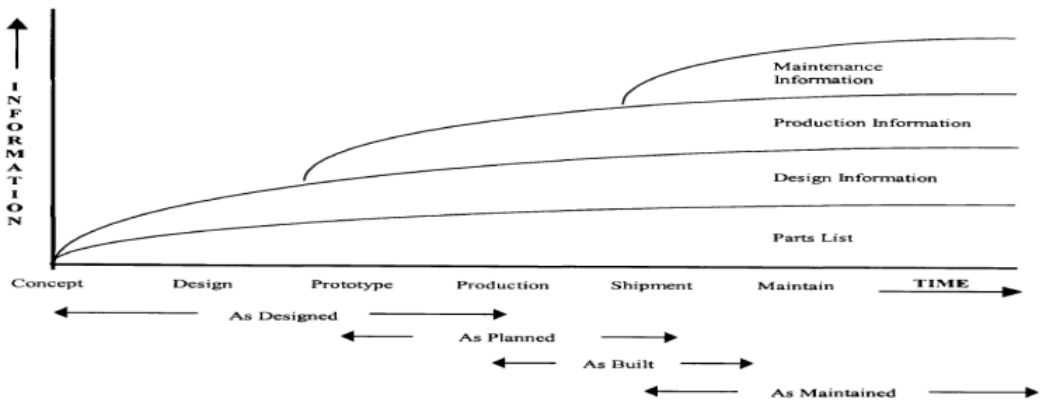

Fig. 3 Information throughout the Product Life Cycle

Conclusion

Latest market trends prove the continuation of NPD as a change agent for many more years to come with the focus on high product variety and shorter product life cycles. The valuable introduction of new products is critical to the performance of manufacturing industries in most industrial sectors. It is a measure of an industry's strength in innovation and competitiveness in NPD. From this study in most of the manufacturing industries, mass customization with "voice of customer", agility and leanness are some of the vital prerequisites to survive in the current global competitive environment. The proper use of advanced IT has enhanced NPD in manufacturing enterprises. Additionally the improved technologies include CAD/CAM are expected to allow faster response to the customer's requirements at a lower cost. It facilitates shorter product lead-times and hence increases the responsiveness to changes in the market along with better product quality in low product cost. Efficient PDM enables fast access and adds value to the existing corporate resources by converting raw product data into information and then into knowledge to facilitate innovation and enhance collaboration.

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