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Product Data Management: An Implementation Case Study at the Motorola Plantation Facility

German Gonzales, Motorola, Inc.

Background

Motorola, Inc. is one of the world's leading manufacturers of electronic equipment, systems and components. In addition to many awards and titles, the company received the Malcolm Baldrige National Quality Award in 1988. It is a major employer worldwide with 139,000 employees. Its net sales in 1997 were $30 billion.

The company is divided into units or "sectors", each of which is financially autonomous. These sectors are Automotive Energy and Components Group, Cellular Networks and Space Sector, Cellular Subscriber Sector, Land Mobile Products Sector, Motorola Computer Group, Messaging Information and Media Sector and Semiconductor Products Sector. German Gonzales works in the Land Mobile Products Sector (LMPS), which manufactures analog and digital two-way radios, mobile and portable radio systems, etc. This sector has three manufacturing and three design sites in the Americas, two manufacturing and four design sites in Europe and the Middle East and one manufacturing and three design sites in Asia.

Motorola has always had one fundamental overall company objective, which is total customer satisfaction. In order to achieve this objective, the corporation has undertaken several key initiatives such as a Six-Sigma quality approach, total cycle time reduction, empowerment for all in a participative workplace, etc. This objective also required the company to continuously revitalize the business, which led to the implementation of the Product Data Management (PDM).

PDM is defined as a system used within an enterprise to organize, access, and control data related to its products. It is a system that coordinates data located throughout the enterprise, enables quick access to that data, and helps transform the data into knowledge.

The LMPS division proposed the PDM system as a means of reducing cycle time, which is one of the company objectives toward customer satisfaction. Without this new system, information has to flow manually through activity units such as design, manufacturing, and vendors. The existence of multiple sites complicates or delays this manual process.

The implementation of the PDM system involved six project phases. The first phase consisted of determining LMPS's strategies. The strategies that were agreed upon in this phase were to design and build products anywhere given ten design sites and six manufacturing sites, to promote functional design re-use and to promote concurrent design engineering. The essence of these strategies was that everyone involved in the manufacturing part of the business should be able to have access to product data electronically.

The second phase involved the definition of the project architecture in terms of the use of software applications such as MCAD, ECAD, preparation of technical documents, supplier relationships, etc. This step required things such as a PC board design, mechanical and electrical software designs for the system, a rapid prototype lab, print room, archive system, ERP/MRP system, and compatibility with suppliers and customers, all networked around an automated release and change control system and a data storage system.

Phase three involved project funding. In order to prove that PDM was worth implementing, Gonzales and his colleagues had to develop some hard financial metrics and benefits in business terms such as required investments and ROI, internal and external assessments of intangible benefits such as cycle time reductions and increased quality, and present these to management. Some of their cycle time and quality goals were to reduce design release time to one-seventh, retrieve time of archived files to one ninety-sixth, increase the bill of material (BOM) accuracy by twenty-six times and create a common design-manufacturing BOM. In addition to these goals, an important issue was human resources. The implementation of the new PDM system required significant consulting expense and a lot of skilled people, which led to the increase in the number of people involved in the project.

Phase four, which dealt with infrastructure, involved some major activities such as determining user requirements, analyzing existing network capability, upgrading the network as necessary, monitoring performance and making the required adjustments. After their analysis of user requirements and of the existing network capability, they discovered that the actual delay in transferring a 10 MB file from an experimental site FE-3 to site A-2 was 0.93 hours. Although this was much better than the three to five day delay experienced with the manual system, it was still unacceptable for a concurrent engineering environment. So they upgraded the network as they presumed necessary and were able to reduce the delay down to 0.38 hours, which was still far away from their goal of 2 minutes. This finding made them consider some further opportunities such as the utilization of a compression algorithm or purchasing additional bandwidth. It also made them realize that perhaps their goal was unrealistic.

Phase five involved determining common user processes. The LMPS unit set up teams with representatives from all organizations to find common process applications and solutions for the implementation of PDM. These teams included a core development team, a maintenance team and a site administration team. The common software development process defined by the core team involved five steps; determine requirements, design, code, test, and implement. The team also came up with common MCAD (Mechanical Computer Aided Design) and ECAD (Electrical CAD) solutions as part of the system architecture described in phase two.

Results

In terms of the architectural status, the LMPS unit completed a PC board design, mechanical design through common MCAD solution, electrical design through common ECAD solution, the archive system and the automated release and change control system.

Also added into the system are Production Print Engineering Change Notices, prototype design releases, and supporting documents such as quotes, scanned documents. Currently two other sites are also using the same PDM system and another European site is scheduled to be on-board in Fall 1998. Six out of eleven major sites are projected to be up and running by the end of fiscal 1998.

Since the beginning of the implementation, LMPS unit has reduced cycle time from 14 days to 3 days. In addition, average immediate on-line access to an archived file has been reduced ninety-six times from one day to five minutes.

Engineering Information Systems: Sourcing Common Products for Global Markets

Brian E. Cozzens, AMP Incorporated

Background

AMP Inc., headquartered in Harrisburg, PA, is the world leader in developing and manufacturing electronic and electrical interconnection devices. The company employs over 45,000 people in 50 countries around the world. It was founded in 1941 and its sales for 1997 were $5.75 billion.

The company set globalization as a goal and has been undergoing some major changes since 1990 in order to reach it. Traditionally, its business was made up of country-centric operations with independent business philosophies and hierarchical, traditional management styles. In the last several years, it has been constantly trying to convert itself into a corporation with a global industry/global competency focus with an ability to source AMP products from anywhere in the world. It has also been uniting its separate business philosophies to create a one-company look to its customers.

Implementation

The basic framework the company used for change involved the conversion of AMP's global objectives into core business strategies, which led to the formation of policies derived from the engineering objectives. The third step focused on determining standards and procedures that would help them achieve these objectives. Obviously as a last step, some tools and systems were necessary to successfully go through this conversion.

Cozzens and colleagues approached the issue from an engineering perspective and determined some key engineering policies, which included integrity in design, global-based designs, simpler processes for engineering change notifications and approvals within the company and customer notification of product and process changes. In order to implement these policies, they had to focus on some fundamental issues. First of all, they had to organize chunks of information stored in the company's systems and make them usable.

For a better understanding of the issue, it is necessary to examine AMP's Global Engineering Information System. The system contains an Engineering Information Center (EIC), an Engineering Document Center (EDC) and an Engineering Change Express (ECX). The ECX was started as an attempt to implement the concept of global engineering change management in 1993 as an on-line system. Over the years it evolved into the engineering change process and currently has 4,500 users in all engineering organizations of the company. It is basically used for processing of requests for change, product change notifications (PCNs) and approvals. On average, 230 PCNs are processed in the system.

In AMP's engineering drawings distribution system in 1992, that is, before the implementation of ECX, engineers prepared over seven thousand new or revised drawings each month and mailed them to the Microfilm Department. From there, 135,000 copies were distributed around the world. Document distribution was not very different. The company issued 150 new or revised specifications and standards each month. The Corporate Standards Department, then, was responsible for handling these documents and distributing about 330,000 sheets each month around the world via mail. The standards and specifications had over 550 unique recipients and since it took at least one hour to file 100 specification cards, many cards were never filed and users had to place requests for cards when they needed them. There were also ambiguities as to whether the filed copies were the most current revisions. As a summary, the old system was not very user friendly in that the card-handling equipment was aging, it required a "push" system that created a significant amount of waste and it was error-prone and labor intensive.

Following this analysis, AMP set goals for its new EDC. One goal was that anyone who needed to use the latest revision must be able to determine it within an hour from anywhere around the world. Secondly, the delivery lead-time of any document was to remain within 24 hours. Lastly, elimination of microfilm aperture cards was necessary. The company also determined some key design points such as converting the system from "push" to " pull" and "scan on-demand" for the existing 2,016,000 aperture cards.

The development of such a system included steps such as the setup of server hardware and software; data collection systems utilizing paper scanners, A/C scanners and electronic data capturing methods from CAD; and UNIX workstations and MS Windows to be used in the REDC (retrieval of data from EDC). The company designed an EDC server that was configured to pace the flow of incoming drawings and documents and easy to use by operations personnel. The REDC client PCs operate under UNIX and MS Windows equipped with view, search and print capabilities. In addition to electronically captured CAD inputs and scanner inputs, the system is capable of responding to the customers' data requests. Customers can retrieve data from AMPFAX (AMP's fax system) or through the Internet by using electronic catalogs. For that purpose, AMP has a search tool called PDX, which is basically a search tool under a Netscape browser. This tool combines particular product information with an archive that contains drawings related to that product. Customers can also input feedback and other data into the system.

Results

The number of unique documents stored on the EDC has gone up from 350,000 in 1996 to over 600,000. The number of on-line information requests has gone up from 20,000 to over 130,000 within the same period. More importantly, the average time it takes to retrieve information from the system is currently near two seconds, whereas in 1996 it was around 20 seconds. This is in part due to the utilization of a very small TIFF type file for scanned data.This system has helped the company to approach its goal of having integrity in global design, which also helps it to get closer to a "one global company" look to its customers.

"Involve the People, Improve the Product, Impress the World"

Harold Zuschlag, Motor Coach Industries

Background

Motor Coach Industries (MCI) is a multinational company that produces tour coaches, city buses, and medium to heavy trucks. The company was once part of Dial-Greyhound Corporation, but was sold and merged with a Mexican Company. Its sales are approaching $1 billion. MCI currently has a 55% share of the tour coach market, which represents a little slippage from prior years. The tour coach business is the most profitable market segment. The Renaissance Coach provided an opportunity for MCI to win back this market share.

MCI used to concentrate primarily on reliability. A tour coach costs between $330,000 and $400,000, can accommodate 56-60 passengers, has 17,000 serviceable components (modules), and weighs 56,000 pounds. Each coach is expected to last for twenty years and be driven for six million miles. MCI's warranty covers one million miles and five years. MCI's competitors had European styling and many amenities. Customers expect amenities, such as TVs.

MCI was traditionally a function-based company. It saw the development of a new tour coach as an opportunity to undertake a radical change in its relationship with customers, suppliers, data management, tooling and facilities, etc..

Implementation

The product development team performed a strategic analysis which involved an assessment of customers, legislative and regulatory matters, and information management. The team had to decide early who the customer was. Traditionally, the customer was viewed as the coach operator. The team decided that the coach rider was the neglected customer. If the coach operator satisfies its riders, then it will make money. This required a commitment to gather product data from many sources. The team also decided that it would compete in the higher priced tour end of the market, not commuter buses, and on export to developed countries.

The team relied on data collected by engineers, hourly personnel and management. These people visited current customers, former customers and competitors' customers. They spoke with a cross-section of customers from different parts of the country as well as to mechanics and others who worked with buses. A variety of techniques was used for analysis and trade-offs. All of the generated data was stored electronically and used through to detailed design. Five hundred thousand dollars was invested in engineering.

The large team evolved into six sub-teams that were organized around major systems of the bus, e.g., powertrain, electrical systems, axles. All six sub-teams were located in one large room with no internal walls. The walls for the entire room were covered with information regarding targets, operating costs, dates, etc. The prototype bus was located in the center of the room for easy access by everyone. A total of 100 people were selected for team membership.

The project had $30 million to spend and three years to complete the project. Common product information was shared between teams. Drawings could be marked up and stored in real-time. The initial goal was to develop a common design-manufacturing data-base. The product data management challenge proved too ambitious. Instead there were separate engineering and production data bases. Also, a third temporary bill of materials data-base was developed. The interface between product/process engineering and materials requirements planning was handled by developing close relationships within and between teams. PDM is more than an engineering tool. Interpersonal relationships are critical too. Everyone had access to all drawings and could comment on them. Only the team with responsibility for a system had authority to change drawings for that system. All key stakeholders had to sign off before final release of the product to the company for manufacture.

Results

The project was completed in 39 months, which was about on schedule. Program achievements included 83% fewer build hours, approximately one-third less factory space used, half the parts count, less than half the assembly stations, and fewer suppliers. The project produced a successful new product which was produced in a new factory. The new material control system was developed also.

Designing Products to Match Unique Customer Needs with Competitive Solutions

Robert Kundinger, Jr., Sparton Electronics

Background

Sparton Electronics was originally involved in manufacturing products for the U.S. defense industry and was also selling to some NATO member countries. However, the decline of orders from these countries made the company consider commercial markets, which obliged it to assess its strengths. It had to look for ways to bring products into the commercial marketplace faster and at lower costs.

Implementation

The company focused on concepts such as Design for Assembly (DFA), Design for Manufacturability (DFM), brainstorming, Design Failure Modes and Effects Analysis (DFMEA) and Process Failure Modes and Effects Analysis (PFMEA), which were all in line with the company's overall strategy to implement concurrent engineering. These concepts were important in the sense that they formed a methodology by which to reduce product development time and costs, improve reliability, create better designs with fewer changes and meet market timing needs, which all lead to meeting or exceeding competition and keeping the business profitable. Other companies have used these concepts successfully. For example, John Deere shortened its release time from seven or eight years to three years; Chrysler shortened its release time and reduced its number of operations; and Mazda saved an average of $18 million in prototypes, reduced lead-time by six months, and reduced engineering hours by 40%.

The difference between concurrent engineering and the old system was that under the old system, engineering would finish the design of the product and pass it on to manufacturing. Manufacturing then would go back to engineering if it had problems, which usually resulted in the design going back and forth between engineering and manufacturing and passing through several changes. However, concurrent engineering, which is defined as the execution of the manufacturing and procurement elements of a program in parallel with the product design, enabled early implementation of changes, which significantly reduced costs.

DFA is defined as guidelines for design for automated assembly refined to a set of rules that are used by a design team in order to improve ease of assembly of a product through simplification and standardization. It focuses on minimizing part count, which basically means making products from fewer number of parts and in turn reducing production costs, designing for top down processing and making use of gravity in manufacturing, simplifying processes wherever possible, minimizing precision, simplifying assembly, and, most importantly, understanding and watching hidden cost drivers such as engineering change notices, documentation, material handling, inspection, rework, etc.

DFM, on the other hand, is the application of knowledge of processes, cycle times, technology, machinery, etc. to the design of the product. It assures compatibility of the design to the facility in which it will be built. Sparton's circuit board design can be given as a DFM example. During the design phase of the project, the design team took into account placing and spacing of components, which would facilitate the assembly of the board. For example, the team considered the height of the components that would be assembled onto the board to prevent the parts from being knocked off as the board moved through the assembly line. This was a result of having manufacturing people on the design team.

As to the concurrent engineering team process, the company required daily interaction of some or all of the team members to assure that information on the product was disseminated. The members used phone, e-mail and video conferencing as means of contact. Formal team meetings were held on a periodic basis to bring the team together and discuss progress since the last meeting. However, allowing team members some time to do their part of the work on their own was also crucial to the success of the team approach. The teams were formed at the beginning of the concept phase and included members from design engineering, manufacturing, procurement and suppliers, quality assurance, and customers, who were the most crucial members. All members were empowered and technically competent and had good interpersonal and leadership skills. It was not uncommon to see an electrical engineer working with people from purchasing.

The team organized its meetings such that in the beginning of the concept phase it had a kickoff meeting where members selected a facilitator who would be responsible for reviewing action items, mediating and recording meeting information, establishing ground rules, and reviewing the progress of the project. During the product development phase, the members held daily to weekly meetings to review the design work status, keep track of costs, and discuss inputs from all members. They also had brainstorming sessions where they allotted a certain amount of time for a problem and at the end of the allocated period, they made sure they had a solution to the problem or at least had a direction in which to go. The members shared data regarding CAD systems, component information, documentation management and BOM, cost and pricing and manufacturability analysis.

Another part of the company's approach was Failure Mode and Effects Analysis (DFMEA/PFMEA), which is basically a technique used to identify potential product failure modes early in the design period and address corrective action before production kickoff. The analysis was primarily a list on a document of possible failures that the manufacturing people might come across during production and the assignment of risk priority to each of these failures.

Results

All of the techniques outlined above were used to develop and manufacture a traffic sensor. This was a device used to acoustically count cars that passed through a certain area. Sparton finished the mechanical concept model in less than three weeks, prepared three working prototypes in twelve weeks, and launched production in twenty-eight weeks.

Concurrent engineering made things easy for the company in that it helped reduce design cycle-times due to parallel design efforts, cut costs through the early implementation of design changes, and improved overall quality.