A STUDY ON CONCURRENT ENGINEERING-BASED DESIGN AND PRODUCT DEVELOPMENT

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ABSTRACT

Business strategies are rapidly changing with the demands of highly competitive globalised market. Industries are facing harder challenges every day. The lifecycle of a product is needed to be shortened to fulfil the customer needs and sustain in the market competition. Obviously the technical solutions are needed to be business driven. Concurrent engineering is recognised as one of the technical solutions to overcome these challenges. The paper is concerned about implementation of concurrent engineering technologies in the field of design and product development. Here the technology approach and the trend of applications are studied. A case is studied and the beneficial effects are also discussed. Finally the paper concluded as recognizing concurrent engineering as the way of achieving long-term sustainability in this highly competitive business climate.

KEYWORDS

Concurrent engineering, Product Lifecycle Management, Product Data Management, Design Environment.

1. INTRODUCTION

With the evolution of computing as an essential part of design and manufacturing engineering, sequential and simultaneous engineering methods of product design and development got replaced by concurrent engineering approaches. Since the 1990s, design methodology significantly changed with the application of concurrent engineering and PLM approaches. To attain proper competitive response to the market, industrial designers started to prefer concurrent engineering with parallel application of CAD-CAM.

In the highly competitive present scenario, business requirements always drive technology solutions. With an ever increasing customer demand, industries are going under high pressure to reduce time-to-market (by providing tailored product), time-to-volume (via mass production) and time-to-profit (by increasing efficiency) [5]. Under these circumstances, the enterprises need to closely collaborate with customers, designers, manufacturers, suppliers and other stakeholders to response as quick as demanded to the dynamic market changes. Beside this, Dr B. Ravi believes that, aggressive innovation by competing firms is leading to more complex products [2].

Delivering the right product to the market or maintaining consistent product quality is only the half job done in today's industrial environment [1]. The solution lies in the connection between the raw material supplier and the product end user. The teams need to work with each other concurrently, to optimise the design and development processes with respect to different life-cycle issues, to lunch the product in the market with least possible time. But, it is very difficult to practice concurrent engineering whether different specialist teams are at different parts of the world, with an increasing trend in globalization.

2. CHALLENGES IN DESIGN AND PRODUCT DEVELOPMENT

2.1 Business Issues

In the current business environment with the pressuring demand of mass customization, companies are facing harder challenges each day. New business challenges are coming with more complex products, geographically departed design teams and growing needs of rapid fulfilment of demand. In this situation business bodies are looking for,

a) Faster design and product development.

b) Enhanced manufacturing capacity and capability.

c) Improved revenue from lifecycle efficiency.

2.2 Industrial Issues

As an obvious situation, industries are also under the pressure of several business issues. Now technologies have to go under the drive of industrial needs. In the modern collaborative enterprise environment, industries need increased speed to respond to the increasing demand. To obtain such capability they need,

a) Replacement of static design by mass customization.

b) Establishment of new approach in design and manufacturing to merge themselves with today's extended business model.

c) To exchange and control product information and to perform real-time project management [5].

d) Effective management of inter-enterprise data, information and knowledge for improved product design and development.

3. CONCURRENT ENGINEERING APPROACH

To face the challenging situations, industries need to recruit specialist teams to handle different issues and activities related to product lifecycle: concept design, engineering analysis, tooling development, manufacturing planning, part manufacture, product assembly, delivery, service and disposal. Through the whole product lifecycle industrial design follows some definite steps: market survey, concept design, detailed design and model preparation, model analysis, correction and re-design. In this concurrent engineering approach, some managing issues play the key role: product lifecycle management (PLM), product data management (PDM) and product manufacturing management (PMM) [4]. Concurrent engineering integrates different modern manufacturing application systems, viz. supply chain management (SCM), enterprise resource planning (ERP), manufacturing execution system (MES), customer relationship management (CRM), demand chain management (DCM) and so on, to work collaboratively to enhance product design and development.

Market survey should continue throughout the product lifecycle. It can provide updated data at different development stages and consequent status of demand. The information are handled by PDM and provided to all the working groups to effectively shorten product lifecycle time and increase efficiency. Concept design helps to communicate with the market and easily retrieve data from the market feedback for detailed design. According to the results of concept design and market survey detailed design is done. A model gets prepared based on detailed design. Feasible analysis is formulated and done on the model. At this stage, from detailed design to model analysis, we need the help of different CAD, CAM and CAE software. At the time of analysis, simple program are implemented in PHP/JAVA and executed in the main server, whereas computation-intensive programs are implemented in C++, followed by exchange of result

throughout the working network [2]. The analysis results provide information and guidelines to the workgroups about product feasibility, use environment, material requirement and cost control and so on. Depending upon the analysis data several correction and re-design works are done. Finally manufacturing is supervised by quality and controlled by cost.

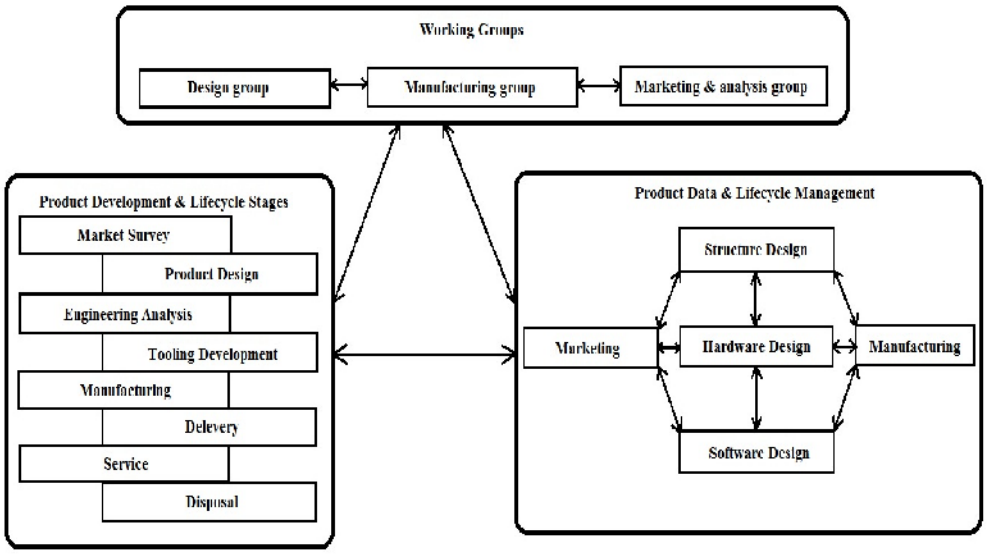

Figure 1. Concurrent Engineering approach of Design and Product Development

4. APPLICATION ASPECTS OF CONCURRENT ENGINEERING

4.1 Medium to Large Enterprises

At the present economic climate, the most important priority for the medium and large enterprises is to respond quickly to the business challenges. Either to expand customer base or to acquire more cost competitive resources, global business conduction is necessary for both the medium and large enterprises. Concurrent engineering is applied in this situation to sustain their advantageous position in market and to overcome the challenges. Application of concurrent engineering enables the enterprises to,

a) Manage design and product development complexity.

b) Control cost and provide usable product at minimum possible cost.

c) Manage introduction of new product.

d) Speedup the process of customization.

e) Provide a platform for product reuse.

4.2 Small to Medium Enterprises

The major problem for the small and medium enterprises to respond to the global challenges is their limited resources. They need a predetermined strategy based best-in-class solution to respond better to their customer needs. Concurrent engineering brings the best advantages for them with the industry's best practices. Concurrent engineering practices enable them to,

a) Sustain in low cost of ownership.

b) Increase their design reuse.

c) Increase efficiency by simple design review and effective change management.

d) Error education through more effective collaboration between different departments.

e) Make customized quick response to market demand.

5. IMPLEMENTATION OF CONCURRENT ENGINEERING: A CASE STUDY

A pharmaceutical instrument manufacturing enterprise in India was facing some disadvantageous situations in global competitive market to sustain better business over its close competitors. The company was getting unable to deliver the market winning product at minimum cost. It was a medium scale enterprise. The enterprise was seeking for a business and technology solution to overcome the challenges. It had to understand the customer requirements and specifications, effective cost control and quicker response to the market demand.

As a solution the company picked up concurrent engineering. One of its key products was surgery knife. The knives were manufactured by injection moulding. The enterprise implemented concurrent engineering for the whole lifecycle of this product. All the steps from market survey to product disposal were followed in proper way. Three different teams were formed for market survey and customisation, design and analysis, development and manufacturing. The enterprise used Pro-E and ANSYS software for product design and analysis. After the end of the lifecycle of the first batch of surgery knives, the enterprise got better business results. Revenue was higher from the same limited resources. Collecting knowledge from this experimental implementation the enterprise implemented concurrent engineering methods for all its products.

6. IMPACT ON INDUSTRY

Business model in the manufacturing industry has shifted from make-to-order, to build-to-order, to engineer-to-order, to configure-to-order, to design-to-order and in near future to innovate-to-order. In this rapidly changing industrial climate the impact of concurrent engineering should be verified on the industrial platform. The technology can be implemented on different industries: market driven industry, technology driven industry, manufacturing driven industry, project driven industry. Different concurrent engineering solutions fit into different industry domains with different characteristics. This indicates that the concurrent engineering solutions have the great potential to be applied to meet industrial requirements. Expected potential advantages for different industries due to implementation of concurrent engineering methods are:

a) Customers get included into the design chain.

b) A higher level of customer satisfaction can be achieved.

c) Nearly 70% of the product cost is built-in during design and development phase [5].

d) Designer, manufacturer, supplier and customer can exchange their ideas about the product.

e) The cost and profit margin can be determined during the design phase.

f) Feedback from suppliers with market experience helps the design group most.

g) Better manufacturability with shorter cycle time and reduced cost.

7. CONCLUSIONS

Concurrent engineering technologies are recognised by world's leading universities, institutes and industries. To achieve sustainability in modern globalised competitive business environment, concurrent engineering applications are proposed in this study. The problem of time-to-market can be solved by product data management, collaborative product customisation, collaborative product development and design chain management. The time-to-volume issues can be solved by collaborative product manufacturing and collaborative component supply. Product lifecycle

management can solve the time-to-profit issues. Implementation of concurrent engineering in design and product development should be done for the benefit of industries. May this study will help other researchers for further improvement in the field of concurrent engineering.

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