Proceedings of the 15th International Conference on Manufacturing Systems – ICMaS
Published by Editura Academiei Române, ISSN 1842-3183

"Politehnica" University of Bucharest, Machine and Manufacturing Systems Department
Bucharest, Romania, 26–27 October, 2006

CONCURRENT ENGINEERING: SPEEDING UP NEW PRODUCT DEVELOPMENT

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Abstract: *New product development times must be compressed if manufacturing firms are going to be able to compete in world markets. A means to shorten new product development that has become more prevalent is Concurrent Engineering. It is not a new concept, but has had to be resurrected in the modern era. When used properly, Concurrent Engineering can enhance a company's reputation and profitability, but when misused, it can cause rework and increased costs.*

Key words: *concurrent engineering, simultaneous engineering, product development, sequential development.*

1. INTRODUCTION

In today's world, manufacturing firms are under great pressure to shorten the time to produce new products after they have been accepted by the firm's top managers. This means that close cooperation must be established between the firm's research and development engineers, the production managers, and marketing managers. If the three groups work separately, much misunderstanding about the end product may occur and redesign of the product, rework of prototypes, and rescheduling of production increase the time for the product to get to market, often with disastrous results for the success of the product. With such a small percent of new product ideas ever becoming profitable, it is necessary to speed the new product to market as soon as possible. One way to do this is called Concurrent Engineering. [6]

Imagine this scenario in a manufacturing firm producing consumer goods. In March, 2006, the Marketing division performs a marketing analysis to determine the feasibility of developing a product that will be very attractive as a family present at Christmastime. The marketers determine that the product will capture a large share of the market if it can be produced by the beginning of October and sold to retailers at a price of 25 Euros or less. This would mean that the cost to manufacture should be no more than 15 Euros for the company's expected profit level. When the Vice President for Marketing presents the findings to the top management team, the top managers agree that that the product should be developed even though there is evidence that competitors are developing similar products and the race to be the first into the market may determine whether the product will be successful and profitable. Late in next month, April, the Vice Presidents for planning, marketing, engineering, and manufacturing meet to formulate the plans for development of the product and production before October. This gives the engineering division four months to complete the development and testing to let the manufacturing division start producing the product in September. During the R&D phase, marketing managers continuously looked in on the work of the engineering division and presented new design changes that they had discovered that would make the product more attractive. When these requests for design change came to the attention of the Vice President for Engineering, he told his designers to use them, since the marketing division had initiated the idea for the product. The result of the design changes caused the engineers to take another month in R&D before they could present the design to the manufacturing division. The Vice President for Manufacturing was bombarded with complaints from his staff who said, "These final specifications were not what we agreed to in April and we cannot manufacture this product any earlier than the middle of November. Furthermore, our estimate of the cost per unit is now 22 Euros. At that point, the top managers gave up on the product and the market was entirely taken by competitors. What went wrong and how could it have been avoided? It would appear that there was little communications between the divisions. That is because the development was "sequential" rather than concurrent. In the history of some successful manufacturers, a guru, such as Henry Ford, or Walter Chrysler kept close watch on all new product development and forced coordination between the functional divisions, thus maintaining complete understanding between these divisions and keeping new product development times short [12]. These CEOs kept very close supervision on their new product development and forced cooperation among all participants.

2. NEED FOR CONCURRENT ENGINEERING TODAY

This close shepherding of new product development by top managers has largely been abandoned in large corporations and the top managers usually allow the lower level managers work out the coordination on their own. Since the tendency of most functional managers is to stay within their "silos" and not work closely with other functions, the sequential method of marketing providing the new ideas, engineering developing the product from the idea, and then giving the plans to the manufacturing department has resulted in delays and longer than needed

new product development. A method that requires that the functional managers work together throughout the new product development cycle, called "Concurrent Engineering" or "Simultaneous Engineering" accomplishes what the gurus were able to do at an earlier time. This method requires better teamwork between the functional divisions and allows actions to begin earlier in the development cycle.

An example of a simple product was described by Harold Kerzner [7] as having six phases, each taking a certain amount of time:

1. project planning, three weeks;
2. engineering design, three weeks;
3. bill of materials, two weeks;
4. procurement of materials, three weeks;
5. production, three weeks;
6. ship to customer, 1 week.

The total sequential time for accomplishment of development of the product (if everyone agrees with the final product): 15 weeks. Using concurrent engineering, engineering design begins in the second week of project planning, thus saving two weeks. The bill of materials is determined in the second week of engineering design, also saving two weeks. Procurement begins in the second week of creating the bill of materials saving one week. Production begins in the third week of procurement, saving one week. Total concurrent engineering time is nine weeks versus the sequential time of fifteen weeks.

3. CONCURRENT ENGINEERING DEFINED

Harold Kerzner simply defines Concurrent Engineering as "an attempt to accomplish work in parallel rather than in series. This requires that marketing, R&D, engineering, and production are all actively involved in the early project phases and making plans even before the product design has been finalized [7].

Wen Ya of the University of California at Berkely has provided a definition for Concurrent Engineering: "Concurrent Engineering is a business strategy which replaces the traditional product development process with one in which tasks are done in parallel and there is an early consideration for every aspect of a product's development process. This strategy focuses on the optimization and distribution of a firm's resources in the design and development process to ensure effective and efficient product development process" [11].

While these definitions provide some guidance as to the nature of Concurrent Engineering, they miss some important points. First, there must be solid backing for Concurrent Engineering from top management; otherwise, the different divisions will go back to the old practices of working on their own and not sharing information with other involved individuals and divisions [8]. In addition, there needs to be a single individual who oversees the process for each product being developed. This person may be called "Project Manager," "Product Manager," "Product Coordinator," or something else, but should be present during all actions involving the product development to prevent the hiding of information, or even worse, the "meddling" of one functional area in a way that endangers the product's speedy development. We saw this in the example cited earlier.

Many practitioners of Concurrent Engineering have cited the numerous benefits to be obtained from the technique or "business strategy." John Hartley lists the following [5]:

1. products that precisely match customer's needs;
2. shorter time to the market;
3. earlier break-even point;
4. fewer changes late in the program, reducing the cost of development;
5. simpler and cheaper manufacture;
6. assured quality;
7. low service cost throughout the life of the project;
8. less risk of failure than normal.

Most of these benefits have been attained in companies such as Intel, Airbus, and any company that works for the U.S. Department of Defense (DOD). DOD requires in bids submitted that contractors use project management, be organized using a matrix structure, and develop new products using concurrent engineering. These organizations have learned the lesson that "functional silos" that have been in existence for years are like dinosaurs hanging over a company and preventing dynamic solutions from emerging.

4. EXAMPLES OF CONCURRENT ENGINEERING IN PRACTICE

- Top managers of *Northern Telecom* (Nortel) recognized very early that concurrent engineering was a concept that saved the company time in getting new products to market. Nortel required their manufacturing engineers to recognize the designers requirements and vice versa for the designers to recognize manufacturing requirements. Subsequently, they worked together to shorten marketing time for new products [11].
- *General Electric's Aircraft Engines Division* used concurrent engineering for the development of the engine used on the F/A- 18E/F fighter jet. It collocated multi-functional design and development teams to merge the design and manufacturing processes. These teams achieved 20 to 60% reductions in cycle times for design and procurement during the component tests that preceded full engine testing. Cycle times in design and fabrication dropped from the initial estimate of 22 weeks to 3 weeks [6].
- *Boeing's Ballistic Systems Division* used concurrent engineering to develop a mobile launcher for the MX missile system and was able to reduce design time by 40% and costs by 10% in building a prototype [7].
- *Polaroid* used concurrent engineering to develop the Captiva Instant Camera and was able to make hundreds of prototypes in a short time using cross-functional teams.
- *Concurrent engineering* has been used in some major research projects. One of the best known is the DARPA initiative in concurrent Engineering (DICE) at the Concurrent Engineering Research Center (CERC) at West Virginia University. Other such ef-

forts include the Computer Assisted (CAD) Framework Initiative (CFI), the Open Systems Architecture for Computer-Integrated Manufacturing (CIM-OSA), and the Engineering Information System (EIS).

- *The Manufacturing Engineering Centre of the UK* has developed new approaches to concurrent engineering that facilitate simultaneous product and process design methods for structuring and re-using manufacturing information, new machine learning, and data mining of algorithms plus new methodologies for creating and maintaining product support systems using integrate product data. The Centre has collaborated with Daimler-Chrysler, Siemens, Welsh Water, and Allied Steel and Wire. Additional multinational partners recently working with the Centre are Aerosptiale Nokia and Schneider [9].
- *LearnShare* is a consortium of companies that are helping each other train employees to properly engage in concurrent engineering. The consortium includes Motorola, Owens-Illinois, Reynolds Metals, General Motors, John Deere, and Steelcase. Three universities: Arizona State, Ohio State, and Farleigh Dickenson also participate in LearnShare [2].

5. SUCCESS WITH CONCURRENT ENGINEERING

Several areas have been identified where team coordination must exist for the Effectiveness of Concurrent Engineering. They are:

- sharing information – very necessary to attain cooperation among team members;
- collocating people and programs. Some of our best R&D efforts have come about by sequestering key team members away from their normal duties so they devote full attention to the product to be developed. This was the situation in the “skunk works” of Kelly Johnson of Lockheed while he was developing the SR-71 Blackbird in a very short time;
- integrating tools and services of product design and production so that all participants have knowledge of the capability of the tools;
- coordinating the team which is a duty of the team manager to keep all of the team members apprised if the progress being made [3, 10].

Additionally, Stark [6] has a checklist of items that enhance the likelihood of success:

- comparing with competitors (benchmarking);
- developing metrics;
- identifying potential performance improvements and targets;
- getting top management support;
- getting cross-functional endorsement;
- developing a detailed implementation plan.

Kerzner warns against serious and costly risks that may occur using concurrent engineering. The greatest risk he sees is costly rework on projects that were completed haphazardly. For this reason, concurrent engineering is not the norm on most R&D projects. Some disastrous results have occurred due to insufficient tests and evaluations [7]. Ziemke and Spann have shown tendencies that lead to problems in using concurrent engineering:

- unwillingness to institutionalize concurrent engineering;
- maintenance of traditional functional reward systems;
- maintenance of traditional reporting lines;
- lack of training in teamwork;
- unrealistic schedules;
- no changes in relationships with vendors;
- a focus on computerization rather than on process improvement [13].

Despite the possibility of these problems occurring, the rewards realized from a well functioning concurrent engineering system are well worth the effort of doing it right.

6. SUMMARY AND CONCLUSIONS

Concurrent Engineering as a separate technique of new product development has been around for a long time, but under the direction of top managers in the early years. Top managers now usually delegate the new product development tasks to subordinates after the top managers have endorsed a proposal for a new product.

New product development without top management guidance generally became a sequential process that had functional managers in development engineering, production engineering, and marketing working separately, often to the detriment of the product design and marketability. In the 1980’s, companies used project management teams and techniques to coordinate R&D efforts of the separate functional personnel. This led to a new management technique called Concurrent Engineering or Simultaneous Engineering. This “new” technique reduced the time necessary to get new products on the market and reduced development costs. When done properly, Concurrent Engineering has served firms producing new products very well.

However, in many instances, firms had heard of bad experience with costly rework on products developed using Concurrent Engineering, so many do not use it. The scholars who have studied the technique advise that training in team-building be undertaken before heavily engaging in Concurrent Engineering. My own admonition is always to have a capable project manager in charge of each Concurrent Engineering operation.

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