AN INCORPORATED APPROACH OF CONCURRENT ENGINEERING FOR PRODUCT MANUFACTURING

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ABSTRACT:
Concurrent Engineering or Simultaneous Engineering is a methodology of restricting, the product development activity in an organization using cross functional team. It brings together a wide spectrum of people from several functional areas such as design engineering, manufacturing engineering and other functional area. In today's highly competitive business environment, due to wide variety of customer demand, the product life cycle is reduced and the product launching time should be narrow to accomplish this. To achieve this methodology called Concurrent Engineering is developed. Further with the use of information system and available supporting tools, the integration among different engineering disciplines speed up activities with higher degree of parallelism. The several examples using concurrent engineering are Maruti Suzuki, Fouress Engineering (I) Ltd, Hewlett Packer etc.

KEYWORDS: Concurrent Engineering, Simultaneous Engineering,

1. INTRODUCTION:

Concurrent Engineering is the earliest possible simultaneous work of experts from various functions in an enterprise, concerned with producing a specific product, in order to achieve high quality, functionality and manufacturability in the shortest time, for a minimum cost. Concurrent Engineering is primarily an expression for the desire to increase the competitiveness by decreasing the product lead time, while improving its quality and cost. Traditionally product development cycle starts with developing the product concept, evolving the design, engineering the product, manufacturing the part, marketing and servicing. In reality product development activities form a spiral. The feedback from the marketing and service leads to improvements in design and or evolution of new designs.

Fig.1 A typical model of CE in the realization of a product
One can very easily observe the vast improvement that have taken place in the design of Entertainment, Electronic goods, toys, computers, crafts and even domestic appliances like refrigerators, ovens etc. Since in this type of product development cycle all the activities are carried out one after the other sequentially, traditional product development cycle is called as sequential engineering or “across the wall” method. Where each segment of the product development team (Design, planning, manufacturing etc) completes its task in isolation and passes over the documents to the next segment. There is no interaction among the groups. If a serious mistake in the product is detected during testing, the revision process has to start from design, resulting in wastage and loss of time. In the age of reduced product life cycles the gap between market demand and introduction of product in the market has to be narrow.

Concurrent engineering or simultaneous Engineering is a methodology of restricting the product development activity in an organization using a cross functional team and is a technique adopted to improve the efficiency of product design & reduce the product cycle time. This is also sometimes called as parallel Engineering. Concurrent Engineering brings together peoples from R&D, Engineering. Manufacturing, materials and quality assurance. In the design development and manufacturing of a product everyone interacts with each other from the start and they perform their task in parallel. The process of concurrent Engineering has also been identified by business organization as simultaneous engineering, life cycle engineering, parallel engineering, multidisciplinary team approach or integrated product and process development.

![Diagram of Concurrent Engineering](image)

**Fig.2** Example of design changes as a function of time for an American and Japanese automobile.


Getting the design correct at the start of the development process will reduce downstream difficulties in the workflow. The need for expensive engineering changes later in the cycle will be reduced. Concurrent Engineering aims to reduce the number of redesigns, especially those resulting from post-design input from support groups. By involving these groups in the initial design, less iteration will be needed. The major iterations that do occur will occur before the design becomes final. The overall time taken to design and manufacture a new product can be substantially reduced if the two activities are carried out together rather than in series. The reductions in design cycle time that result from Concurrent Engineering invariably reduce total product cost. Figure below show the saving in product launch time by using concurrent engineering.
Fig. 3 Comparison of: A) Traditional Product Development cycle and B) Product Development using Concurrent Engineering

1. METHODOLOGY FOR INNOVATION

A conceptual methodology has been developed from the seven principles above. From the conceptual methodology (see Fig. 4), it can be seen that the process of undertaking CE is a systematic approach to an integrated, concurrent design of products, process and installation of plant, and processing of products, considering the related downstream aspects and elimination of non-value adding activities.

2.1 Project Scope: Confirmation of customer’s expectation with executive and corporate goals supports the project’s success by avoiding unrealizable date or unallocated resources.

2.2 Project Identification: Executive commitment and goal for project, approval, prioritization and scheduling for all projects.

2.3 Installation and Assessment: Emulate the production environment for capacitance, stress, and performance; improve process for future predictability.

2.4 System Design: Design and validate a technical solution at the high level; define metrics to predict time of implementation and development effort, and to be used later for process improvement; build a test plan from requirement, not from the design or code.

2.5 Construction: Perform regression testing to Maintain quality and avoid rework; track personnel effort, time, and defect rate to monitor project; separate developers from any testing; define a procedure by which QA and the customers approve the release.

2.6 Requirements and Analysis: Get requirements jointly with the use and write a specification that can be implemented, tested and explained; provide traceability between the customers needs, system solution, and testing to enable change management; justify project needs are best met by comparing purchase, build, or hybrid solutions—cost/benefit analysis or vendor proposals.

2.7 Development and Planning: Collect work plans for testing, customer acceptance, development, and documentation,
And ratify with all involved; get written consensus on the project plan specification from all involved; define a strong QA policy to ensure process compliance and product correctness; establish configuration management for changes, Defect resolution, and project control.

The CE approach can be achieved through a multidisciplinary team approach which intends to motivate process designers, plant designers and installations and participants throughout various design processes, to consider all elements of the product life cycle from the inception through to disposal of product, taking into consideration quality, cost, time effectiveness, rapid adaptation of system to evolving business environments and end user requirements.

Fig. 4 Conceptual Methodology for Concurrent Engineering

2. IMPLEMENTATION OF CONCURRENT ENGINEERING:

The implementation of Concurrent Engineering addresses three main areas: people, process, and technology. It involves major organizational changes because it requires the integration of people, business methods, and technology and is dependent on cross-functional working and teamwork rather than the traditional hierarchical organization. One of the primary people issues is the formation of teams. Collaboration rather than individual effort is standard, and shared information is the key to success. Team members must commit to working cross-functionally, be collaborative, and constantly think and learn. The role of the leader is to supply the basic foundation and support for change, rather than to tell the other team members what to do. Training addressed at getting people to work together in team’s plays an important role in the successful implementation of Concurrent Engineering. The multidiscipline approach has the advantage of several inputs which can be focused effectively early in the design process. [1]

Concurrent engineering (CE) gives marketing and other groups the opportunity to review the design during the modeling prototyping and soft tooling phases of development. CAD systems especially 3D modelers can play an important role in early product development process. In fact, they offer a visual check when design changes cost the least. Further for satisfactory implementation of concurrent engineering needs intensive team work and co-ordination among product development, production planning and manufacturing people. At the same time systematic application
of special methods such as DFMA (Design for manufacturing and assembly) and FMEA (failure mode and Effect analysis) ensures quick optimization of design and early detection of possible features in product and production planning. This additionally leads to reduction in lead time which reduces cost of production and guarantees better quality.

2.1 THREE T’S OF CONCURRENT ENGINEERING:

The three T’s of concurrent engineering are dynamic by nature, that is, the type of tools, areas of training, and realistic estimates of time constantly change in light of new innovations and discoveries. Even though the three T’s are also product-specific and company-specific, certain basic generalizations may be recognized. Concurrent engineering preaches the simultaneous progress of activities required in getting new products out to the paying customer as quickly as possible. An examination of successful concurrent engineering transformations in industry revealed the presence of and interaction between three underlying elements. [2] These elements, worthy of consideration as the three T’s of concurrent engineering are:

![Diagram of Process Innovation for concurrent Engineering](image)

**Fig.5** Process Innovation for concurrent Engineering

CE, in the context of a process innovation, revolves around three fundamental elements, sometimes referred to as the three Ts—tools training and time—of CE. The T elements of CE are structured as shown in Fig. 5.

**Tools** involves the material infrastructure,

**Training** relates to the human aspect and includes educating personnel on the use of appropriate tools.

**Time** considers realistic expectations in terms of setting targets.

2.2 METHODOLOGY FOR CONCURRENT ENGINEERING:

Following point should be considered by companies to implement CE successfully,

- Compare themselves to their best competitors (i.e. benchmark)
- Develop metrics
- Identify potential performance improvements and targets
- Develop a clear Vision of the future environment
- Get top management support
- Get cross-functional endorsement
- Develop a clear Strategy to attain the envisioned environment
- Get top management support
- Get cross-functional endorsement
- Develop a detailed implementation plan
- Get top management support
- Get cross-functional endorsement

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2.3 OBSTACLES IN INTRODUCING CONCURRENT ENGINEERING:

Following are the obstacles observed in the companies.

- Unwillingness to institutionalize Concurrent Engineering
- Maintenance of traditional functional reward systems
- Maintenance of traditional reporting lines
- No training in teamwork
- Unrealistic schedules
- No changes in relationships with vendors
- A focus on computerization rather than process improvement.

3. INFORMATION TECHNOLOGY AND CONCURRENT ENGINEERING:

The challenges to engineering informant system today is to have the ability to handle very large amount of information such as design changes, status reviews, their effects on cost, delivery and quality. Similarly it has to be made sure that the workplace of each engineer, planner and manager is not overloaded so as to make the work informative. The principles and methods of concurrent or simultaneous Engineering integrate the activities of work i.e. information flow, storage, retrieval and decision making through information technology. Hence the information technology is the backbone of these activities. [3] It assures increase in productivity and shorter overall cycle time with improved quality. The product design is currently carried at places using a wide range of design support tools. Although a number of tools exists in the market which address the specific requirement of design activities, no system exists that brings together available tools into a comprehensive design approved facility. Therefore it is necessary to identify the tools required for the design of product and include all of them in some kind of integration platform. Concurrent Engineering is a creative design environment in which teams of designers or Product developers can develop products from initial concept to prototype and to final product with the integration of manufacturing engineering and design of production facilities. Similarly at every phase of product development from concept to final design sufficient information has to be provided to the designer which enables him to take the right decisions with respect to production planning and product support. Special attention has to be given to the adoption of new production technologies.[4] As a result of these requirements information system have to be developed which integrate the different engineering disciplines and their support tools promoting and pushing a conversion of the current processes, sequential work flow into a more concurrent work flow with a higher degree of parallelism to shorten the whole product lead time. Presently, there are varieties of tools for implementing some form of concurrent Engineering. The tools can be broken into following main technological groups:-

- Knowledge based Engineering, production tools and communication tools.
- Relational data base management systems for data management.
- Work flow automation and project management software.
- Decision support system.

The various software tools with which product and process behavior can be studied and effectively used for product development is as shown in table 1.[5]
Table 1. Shows the available technology in the market for implementation of concurrent Engineering:-

<table>
<thead>
<tr>
<th>Design</th>
<th>Planning / Manufacturing</th>
<th>Visualization / Simulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid modeling</td>
<td>Process planning</td>
<td>Work center simulation</td>
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<tr>
<td>Surface modeling</td>
<td>ERP</td>
<td>Factory simulation</td>
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<tr>
<td>Assembling modeling</td>
<td>Generative machining</td>
<td>Simulation software for</td>
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<td></td>
<td></td>
<td>- Welding</td>
</tr>
<tr>
<td>Sheet metal design,</td>
<td>Shop- floor data collection</td>
<td>- Costing</td>
</tr>
<tr>
<td>Drafting</td>
<td>Human machine interface</td>
<td>- Forging</td>
</tr>
<tr>
<td>Tolerance Analysis</td>
<td>Job tracking</td>
<td>- Forming</td>
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<tr>
<td>Mechanism Design</td>
<td>WIP tracking</td>
<td>- Plastic / injection molding</td>
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<tr>
<td></td>
<td></td>
<td>- Robotics Operation</td>
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<tr>
<td>FEA</td>
<td>PDM and VPDM</td>
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4. CHARACTERISTIC OF CONCURRENT ENGINEERING:--

The concurrent Engineering approach can be characterized by the following factors:[6]
- Integration of different groups working for product development, process development and logistics support.
- Closer attention of needs of customers and new technologies.
- Continuous review of design and development process.
- Risk analysis at important stages of product development.
- Rapid and automated information exchange through LANs, Internet and intranet.
- Design team consists of members drawn from different disciplines.
- Rapid prototyping.
- Reduced product development time,
- Reduced design rework,
- Reduced product development cost and improved

5. EXAMPLES OF CONCURRENT ENGINEERS:

There are several examples of successful implementation of Concurrent Engineering. Hew let Packard is one such Example. Its joint venture in Japan yokogawa Hew let packard, reported amazing improvement after implementing Concurrent Engineering. Over a five year period R&D’s cycle time decreased by 35%, manufacturing costs declined 42%, inventory dropped 64%, and field failure rates fell by 60%, meanwhile its market shared tripled and profit doubled.[7] The development of Neon car in USA is a typical example of success of concurrent Engineering.
Another Example for successful implementation of concurrent Engineering, is the development of scooty Moped and other products by TVS-Suzuki (I) Ltd. and Suzuki (I) Ltd. As per survey conducted at MIDC, Aurangabad, the
various industries implementing concurrent engineering successfully are Fouress Engg. (I) Ltd, MIDC Paithan, Dist. Aurangabad, Verrock Engg, Johnson & Johnson-Ethic on Division, BCL Springs.

**Honda** (Marsville, Ohio) is designing and cutting dies for its Ohio plant at Marsville using CE. They begin die making production at the same time they start body design. The die designer knows the approximate size of the new car and the approximate number of panel so they go ahead and order blocks of die steel. Then they begin to make rough cuts in the steel, so it's ready to move to final cutting as soon as the final panel designs are ready. Also die makers seem to be much better at scheduling production in the die cutting shop and the die cutter have special quick-change cutting tools, allowing one machine to handle many different types of cuts, so the dies that are being cut spend much less time in queues.

6. **CONCLUSION:-**

As under this review paper we have studied Concurrent Engineering process and industries implementing it, we argue that sustained improvements in project performance require integration of both the physical and informational structure of concurrent development process with the behavioral decision rules of the engineers and managers who work within them. The industries have realized that at the initial stage it requires to convince the management and people to understand the methodology. Once they try it for any project or product, people understand the benefits of the same and implement it in succession. The main objective of this paper has been to motivate and instigate researchers and practitioners to apply CE concept which has been ignored in the past for improving the overall performance of their organizations. A future work will be to explore the business process management in small and medium sized enterprises so as to present a model for the implementation of the methodology.

REFERENCES: