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# A Comprehensive Study on Concurrent Engineering

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***ABSTRACT: Concurrent engineering, often known as simultaneous engineering, is a products development method in which the different stages are completed simultaneously rather than sequentially. It cuts the time it takes to create a product and bring it to market, leading in higher production and cheaper costs. The industrialization has reached its saturation point due to design and manufacturing engineering. Due to increasing industrial expansion and market needs, millions of items are manufactured every day throughout the globe. In order to meet demand, the input and output rates must be equal on a broad scale. Alternative solutions are required to enhance production rates with more efficiency and in less time. Concurrent Engineering allows for increased production rates, better quality, and shorter lead times. Achieving sustainable business operations while keeping the environment in mind is also critical for any organization's long-term survival and profit while reducing negative environmental consequences. It is the development of a product and a process at the same time. This study's major focus is the formation of cross-functional teams. Concurrent engineering's efficacy in industrial processes and the environment has been shown. In the future, Concurrent Engineering is a product development technique in which all activities and tasks are carried out concurrently.***

***KEYWORDS: Concurrent Engineering, Communication, Environment, Industrialization, Sustainability.***

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## 1. INTRODUCTION

There should be a supply when there is a demand. To meet the difficulties of global competitiveness, product and process technology is critical. People's tastes in products will shift over time, with some preferring a low-cost product, some preferring a readily accessible product, others preferring a free product, and so on. Customers are putting a greater premium on quality and dependability while also searching for better value. The capacity to swiftly bring a product to market has become a key sign of world-class manufacturing. In response to this dynamic and challenging environment, manufacturers are using concurrent engineering approaches to reduce design cycle time and increase product value. Concurrent engineering encompasses design for manufacturability (DFM), but its concepts are focused on the whole product life cycle, from conception through disposal. Contemporaneous engineering is a way for concurrently developing commodities and their related processes, such as production and support. This method is intended to encourage developers to consider all parts of the product life cycle, from conception to disposal, covering quality, cost, schedule, and user demands, from the beginning. Increase the velocity of production, product design, and product diversity to decrease technical complexity, respond quickly to customer demands to market, enhance quality, and save costs(Duy et al. 2020; Sharma et al. 2020; The Phan et al. 2021; Van et al. 2020).

Concurrent Engineering is a long-term business approach that helps any company or manufacturing process in the long run. Several teams inside a company work on developing goods and services at the same time using this process. The most essential elements that influence an organization's profitability are product design, quality, unit cost, and production time. Concurrent engineering helps organizations enhance these elements, providing them a major competitive edge. In this article, we'll learn about concurrent engineering's definition and principles, as well as its benefits, elements, and challenges, as well as the concurrent engineering product development method. Concurrent engineering is a method of developing and manufacturing engineering goods in which many departments collaborate on different stages of product development at the same time. It has the potential to dramatically increase the efficiency of product development and marketing, reducing time and total development costs while improving final product quality, if correctly managed. Concurrent engineering supports and enables cross-disciplinary and cross-departmental cooperation in order to accomplish a single goal of achieving engineering product requirements. To describe important components of concurrent engineering, a PPT framework like the Golden Triangle might be utilized. Concurrent engineering saves time, reduces costs, improves product quality, and meets customer expectations by combining people, process, and technology (Jain, Goyal, and Pahwa 2019; Jain and Sharma 2020; Meenu et al. 2019; Nagamanjula and Pethalakshmi 2020; Sharma, Sharma, and Dwivedi 2019).

### *1.1. Concurrent Engineering:*

It was a collaborative, interdisciplinary approach to technology and process adoption that intended to reduce overall lead time while simultaneously improving quality and market entry capabilities. Concurrent Engineering attempts to capture the need for change in early stages utilizing continual contact between multiple departments, as opposed to conventional as well as sequential engineering, where engineering solutions are frequently "finalized," not-changeable, and moved on to the next stage. Feedback is collected from many departments, and the need for change is determined on a regular basis; if necessary, manufacturing methods are altered to execute the modifications to the product. This aids in the prevention of comparable errors in both bulk and batch processes. Concurrent Engineering brings together various aspects of engineering technology and new mindsets in a single location. Concurrent Engineering features such as the Taguchi approach, CAD/CAM integration, as well as Collaborative Engineering may all aid with quality function deployment (Dahmas, Li, and Liu 2019; Fischer et al. 2018; López-Fernández et al. 2020; Rihar and Kušar 2021; Rihar, Žužek, and Kušar 2021).

### *1.2. Purpose of Concurrent Engineering:*

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Making a powerful, exceptional product is no longer enough to please clients in today's market. We must satisfy market needs at the appropriate time and at the appropriate price. As a result, new approaches and methodologies for changing corporate processes are required. When opposed to sequential engineering, decisions will be made faster. It reduces work repetition and, as a result, increases the productivity of the firm. It must be utilized as a business strategy facilitator. Simultaneous engineering is another name for concurrent engineering(Borchani et al. 2019; Dongre et al. 2017; Sapuan and Mansor 2014; Sohlenius 1992).

### *1.3. Concurrent Engineering's Major Elements*

Concurrent Engineering is applied in a variety of ways by different companies, as well as there is no uniforms protocol or typical models for concurrent engineering. However, we should anticipate certain aspects from the following Concurrent Engineering stages to appear in any implementation:

- The Front End Procedure of Concept Development
- Identifying Customer Requirements
- Producing Product Stipulations
- Conceptualization
- Architecture of the Product
- Prototyping that works

The Economics of Product Development is a book on the economics of product development. All Concurrent Engineering environments need contact between distinct functional divisions. The more time spent defining the product, the more difficult the work for Concurrent Engineering becomes. There is a requirement for resource allocation at the start of the process, but the demand for adjustments lessens as the process progresses and they become more costly to implement. This is accomplished mostly via cross-border contacts — function overlap. Everyone must be familiar with the concept of overlapping. The basic objective is to make efficient use of resources; utilization is optimized rather than squandered. All design meetings do not need to

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include marketing and manufacturing. We should connect knowledge domains of various roles in the meeting or review, which might happen, for example, via team participation. Because conventional engineering evaluates outcomes at the end phase, concurrent engineering collects input from all departments at all times, it necessitates ongoing monitoring and management in order to improve changes to the environment.

### *1.4. Process of Concurrent Engineering:*

Each functional step in sequential engineering passes through reviews or gates, after which the phase is locked and the next phase may begin. There are three components to this strategy deficiencies

- There is no assistance for communication between experts throughout the process.
- The overall time spent on each product is excessive.
- Changing anything is quite tough.

Concurrent engineering is presented as a solution to these problems. The fundamental concept of concurrent engineering is based on two pillars.

- Begin the design process before the predecessor is completed.
- Effective phase-to-phase communication.

The 4C's of Concurrent Engineering were defined by Stoll to assist comprehend the principles of the Concurrent Engineering process:

- Concurrence:

Product and process design occur at the same time and simultaneously.

- Constraints

Process constraints are limits or restrictions that are taken into account throughout the product design process. This assures that components are straightforward to

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manufacture, handle, and assemble, and that simple, cost-effective methods, equipment, and materials handling techniques may be used.

- Co-ordination

To meet the objectives for efficient cost, quality, and delivery, the product and process are tightly coordinated.

- Consensus

Full team engagement and consensus are required for high-impact product and process decision

*1.5. Concurrent Engineering Implementation:*

Creating a fantastic Concurrent Engineering environment takes time. Implementation and maintenance generally takes incremental stages, involves refining, and takes time to alter the culture and real behaviors of an organization. The following are three major implementation issues:

*1.5.1. Dedication, foresight, and leadership:*

A commitment from leaders is required, as it is for all successful undertakings. This provides sufficient funds and enables for necessary resource usage modifications to be made. A strategy is required. The plan lays forth the actions to follow as well as the end aim. The metric must be included into the strategy and adhered to.

*1.5.2. Ongoing Improvement*

It's not an approach that can be used directly since there are so many different items and organizations. Concurrent Engineering must be tailored to the needs of the firm, not the other way around. Concurrent Engineering just outlines the goals and provides a philosophy to follow — actions must be established on a case-by-case basis, with benchmarking and a set of well-known methodologies available. Continuous improvement follows a route of planning, executing, evaluating, and revising, and monitoring should provide data for perfecting the engineering.

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*1.5.3. Collaboration and Communication*

Concurrent Engineering emphasizes interactions, which need effective collaboration methods. To address the demands of communication and collaboration, an organization's infrastructure and information sharing environment must be established. The concepts of collective intelligence and collaborative effort may benefit environmental development. To construct a concurrent engineering system, several methodologies and focuses may be used.

- One or more focal points may be used (adapted and fulfilled)
- Total lead time is cut in half.
- The overall quality of the products has increased.
- Manufacturing expenses have decreased.
- Previously, there was a break-even point. Reduced life-cycle costs
- Customer satisfaction is higher.
- Reduced changes or fewer changes after ramp-up
- There's a lower chance of failure.
- In general, there is a lower likelihood of product failure.
- Development of the global engineering environment

## 2. DISCUSSION

Concurrent engineering should be considered by organizations engaged in long-term processes. There will be problems and expenses connected with developing and stabilizing the system at first. Concurrent engineering is an effective method for achieving results while lowering expenses. Concurrent engineering was used in a business and resulted in favorable outcomes such as increased market share, customer satisfaction, and a decrease in manufacturing lead time.

*2.1. Current Environmental and Sustainability Engineering*:

*2.1.1. Long-Term Sustainability:*

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A procedure or situation that can be sustained forever is said to be sustainable. Sustainability arose as a means of improving human existence while remaining within the carrying capacity of supporting ecosystems. Industrialization necessitates the acquisition of resources, particularly raw materials, which are now concentrated mostly in impoverished countries. The most difficult issue to long-term growth is natural resource management. Only 49 of the world's major economies are states, with 51 businesses. This shows that natural resources are being used on a bigger scale.

However, there has been an unrestrained exploitation of natural resources throughout the development process, which has proven to be destructive and has resulted in considerable environmental damage. Technology and development are inextricably linked, therefore environmentally beneficial technologies are required. To achieve this, a concerted effort is required to create and disseminate environmentally beneficial technology. Concurrent engineering takes up residence in this area. Concurrent engineering for sustainability produces the following results:

- Prompt reaction to market demands
- Production is decentralized.
- More effective utilization of local resources
- Less negative impact on the environment
- A boost in energy efficiency

Materials management is concerned with making the best use of existing resources. Manufacturers enhance material usage efficiency by building reuse and recycling elements into product features via concurrent engineering. Concurrent engineering decision-making processes also favor the environment by picking suppliers that provide recycled resources to the organization. Because the designer and the supplier do not communicate, there is no way to consider alternate materials in typical engineering procedures. This is solved in concurrent engineering via communication amongst all members of the team when important designs are created. Everyone is

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encouraged to provide thoughts and proposals so that items might be saved, repurposed, or otherwise reused.

*2.1.2. Environmental Aspects*

Our basic resources come from the environment. The Quality Function Deployment might encompass environmental factors of a product. The environmental impact of a material should be addressed when choosing a material for a product design. For example, while developing a product, the material we choose for producing it may generate landfill or recycling issues due to its hazardous behavior, reusability, and so on. As a result, while selecting materials for manufacture, priority should be given to those that have the least negative environmental effect.

*2.2. Environment-friendly design*

There are three key components of environmental design:

- Environmentally friendly manufacturing design
- Packaging design for the environments
- Recyclability and disposal design
- Non-toxic manufacturing procedures and materials
- Use as little energy as possible
- Reduce emissions as much as possible
- Reduce waste, scrap, and by-products.

*2.2.1. Environmental Packaging Design:*

- Use the bare minimum of packing materials
- Pallets and packaging that may be reused
- Materials for packaging that can be recycled
- Packaging that is biodegradable

*2.2.2. Disposal and Recycling Design:*

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- Component and assembly re-use/refurbishment
- Material selection for reusability and low toxicity
- Use the smallest amount of materials/colors possible to make sorting and reusing materials easier.
- Design for serviceability to reduce the amount of time non-working items are discarded.
- Identification of materials to make re-use easier
- Designed to make it simple to separate materials
- Disassembly-friendly design
- Adhesives should be avoided.
- Keep impurities to a minimum, such as additives, coatings, and metal plating of plastics.

### *2.3. The Importance of Concurrent Engineering and Long-Term Sustainability:*

- Our surroundings are always changing.
- Reactions to any change must be swift, effective, and accountable.
- To accomplish things correctly the first time.
- To shorten response times and act quickly
- Continuous improvement is required at all times, and concurrent engineering aims to achieve this.
- "Is it possible to design goods and processes such that waste from one is utilized as an input into another?"
- Making choices based on environmental and social restrictions as well as economic factors

## 3. CONCLUSION

With concurrent engineering and green design, there are several ways to enhance the company. With the present pace of industrial expansion and consumption patterns, natural resources will be depleted for another fourty years, necessitating alternative material arrangement techniques as well as efficient material use and re-use. Concurrent engineering recommends reusing and recycling resources while taking into account a variety of factors such as supply and demand. Many people may be interested in a product that is developed with the environment in mind.

The environment should not be seen as a design constraint, but rather as an opportunity for manufacturers to grow and become more competitive while still being environmentally conscious. Its roots may be traced back to a period when design and manufacturing were really integrated. Then came the industrial period, when design and manufacturing were separated and sequential procedures and standardized data carriers were prioritized (drawings). Concurrent Engineering is a refined version of sequential engineering that includes handmade elements. Engineering is set to experience another anothers shift in the near future. Different sorts of knowledge building may be found when evaluating content-creation processes. It's neither sequential or parallel; instead, it's networked. The development of content in knowledge communities is guided by expertise and motivation, and it is aided by knowledge exchange. The activities rely on effective communication, with networks serving as the primary infrastructure.

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