Introduction

Concurrent Engineering was first implemented by Japanese companies in the late 80’s and early 90’s. According to [2] total lead time of Japanese product projects at that time was 43 months as it correspondingly was 63 months in Europe. There were of course many things affecting but one of them was sc. Simultaneous Engineering nowadays called Concurrent Engineering (sometimes term Parallel Engineering also used).

Concurrent Engineering presented a new team-based approach and implementation of certain technologies and methods that aimed to shorten total lead time with also improved quality and market entrance capability. As in traditional sequential engineering the engineering results are usually poured “finalized”, non-changeable, to next step, Concurrent Engineering approach tries to capture need for change in early phases using constant interaction between departments. Concurrent Engineering collects many features of engineering philosophies and technologies under one umbrella. Methods like Quality Function Deployment and Taguchi method or technologies of CAD/CAM integration and Collaborative Engineering are examples of elements or “tools” in Concurrent Engineering.

Concurrent Engineering should be seen as business strategy facilitator. In world today, it is not enough to make excellent products. You have to be in the market at the right time – and market is changing. Therefore companies must adapt to change in their processes – the faster they are the less time there is for market change. Concurrent Engineering aims to optimize the resource use in the product process providing an environment for agile product introduction [1].

Concurrent Engineering

Concurrent Engineering or simultaneous engineering is simply said organizing design phases to overlap. The big picture is not this simple. Concurrent Engineering is a business strategy facilitator, an enabling method that possible shorter time-to-market as well as better products. Concurrent Engineering is defined by [3]:

Concurrent Engineering is a management/operational approach which aims to improve product design, production, operation, and maintenance by developing environments in which personnel from all disciplines (design, marketing, production engineering, process planning, and support) work together and share data throughout all phases of the product life cycle.
Concurrent Engineering can be used with differing focus and using different elements to build the system. The focus can consist of one or more (adapted and fulfilled) [2]:

- Shorter total lead time
- Products improved overall quality
- Decreased manufacturing costs
- Earlier brake-even point
- Life-cycle cost reduction
- Better customer satisfaction
- Reduced changes / changes earlier / less changes after ramp-up
- Less risk of failure
- Lower risk to flop with product in general
- More predictable / accurate results / process (e.g. in feasibility)
- Global engineering environment development

Common elements to all Concurrent Engineering environments are interaction between different functional departments (sales/marketing, design, production, purchase and also main suppliers). Typical for Concurrent Engineering is that there is more time used to define the product [2]. This increased allocation of resources in the beginning of the process but decreases needs for changes later in the process where they are expensive to perform. When e.g. manufacturing sees also the first sketch manufacturing function can comment issues requiring manufacturing knowledge and start relevant preparations earlier. Also when marketing sees that same sketch, they can respond with market knowledge e.g. about the possible prize or volume – cross department issues definitively affecting to design issues. Basically this is done through cross border interactions – overlapping of functions.

One must though be careful with overlapping. It must be remembered that use of resources is to be optimized – not wasted. The essential is not to assign marketing and manufacturing to all design meetings. Essential is to link knowledge domains of different functions, which can happen for example through team involvement. Concurrent Engineering requires constant monitoring and management following with enhancing changes to environment.

Actually, there is quite much freedom in creating a Concurrent Engineering environment. E.g. Japanese auto manufacturers have their own solutions. Honda introduced sc. SED method that introduced “guest engineer” – an engineer from supplier taking part in the product team and acting as knowledge domain link. The features to deploy depend on focus and organization.

CAD/CAM technologies, providing today sc. digital mock-ups, are today a key element of Concurrent Engineering. Virtual products and collaborative environments allow different expertise’s to contribute to product design. As one of the principles was to share information early in the project the three-dimensional geometry is unambiguous to all participants and therefore central part of interaction.
Concurrent Engineering benefits
An extensive list of Concurrent Engineering benefits is available at [1].
- Faster time to market which results in increased market share.
- Lower manufacturing and production costs.
- Improved quality of resulting end products.
- Increased positioning in a highly competitive world market.
- Increased accuracy in predicting and meeting project plans, schedules, timelines, and budgets.
- Increased efficiency and performance.
- Higher reliability in the product development process.
- Reduced defect rates.
- Increased effectiveness in transferring technology.
- Increased customer satisfaction.
- Ability to execute high level and complex projects while minimizing the difficulties.
- Shorter design and development process with accelerated project execution.
- Higher return on investments.
- Reduction or elimination of the number of design changes and re-engineering efforts at later phases in the development process.
- Reduced labour and resource requirements.
- Ability to recognize necessary design changes early in the development process.
- Increased innovation by having all players participate in the concept development phase.
- Ability to design right the first time out / First time capabilities.
- Overlapping capabilities and the ability to work in parallel.
- Increased cohesiveness within the firm.
- Improved communication between individuals and departments within the firm.
- Lower implementation risks.
- Faster reaction time in responding to the rapidly changing market.
- Lower product and process design and development costs.
- Improved inventory control, scheduling and customer relations.

Concurrent Engineering process
In Figure 1 a normal sequential engineering process is described. In sequential engineering each functional phase goes through reviews or gates in which the phase is locked and next phase is allowed to start. This approach has three deficiencies 1) communication between expertise’s throughout the process is not supported 2) total time used per product is long 3) possibility to change is locked in gates.

Figure 1: In sequential engineering different phases follow each other – the text in boxes may vary or more phases can be included e.g. sales, quality or testing.
To meet these deficiencies concurrent engineering was presented. The basic idea leans on two corner stones: 1) start design phases before predecessor is closed 2) Efficient communication between phases. There are a lot of nuances that follow the operative actions of these such as team approach over individual execution.

Figure 2: In Concurrent Engineering phases are organize partly parallel and communication and team approach is supported reducing total lead time

Stoll has developed 4C’s of Concurrent Engineering (according to) [4, 5, 6] which help to understand the elements of Concurrent Engineering process:

- **Concurrence**. Product and process design run in parallel and occur at the same time frame.
- **Constraints**. Process constraints are considered part of the product design. This ensures parts that are easy to fabricate, handle, and assemble and facilitates use of simple, cost-effective processes, tooling and materials handling techniques.
- **Co-ordination**. Product and process are closely co-ordinated to achieve matching of the requirements for effective cost, quality, and delivery.
- **Consensus**. High impact product and process-decision making involve full team participation and consensus.

**Implementing Concurrent Engineering**

There is no easy way to build a superb Concurrent Engineering environment. It usually goes through small steps, needs refinement and requires time to change organizations’ culture and actual practices. Three main issues in implementation are presented by [1] as follows:

**Commitment, Planning and Leadership**. As all successful projects a commitment from leaders is essential. This provides enough funding and allows needed decisions about resource use changes to happen. A plan is needed. The plan defines the steps to take and presents the goal. The metric must be embedded into plan and followed.

**Continuous Improvement**. Concurrent Engineering is not some method that can be directly implemented – the variations of products and organizations are too great. Concurrent Engineering must be designed to fit the company, not vice versa. Concurrent Engineering merely sets the targets and offers philosophy to follow – actions must be defined case-by-case, benchmarking and set of known methods can of course be used. Monitoring should give data for refining the engineering – constant improvement flows a path of planning, implementing, reviewing and revising [1].
Communication and Collaboration. Interactions emphasized in Concurrent Engineering require efficient ways to collaborate. Into an organization an infrastructure and information sharing environment need to be built to meet the needs of communication and collaboration. The environment development can gain from the ideas of collective intelligence and collaborative effort.

Eversheim [8] illustrates the realization of Collaborative Engineering as six different and coupled fields (adapted): Change in organizational structure, Project (Portfolio) Management, use of ICT, Information synchronization, new technology / knowledge introduction and co-operation between departments and companies (Figure 4).

![Figure 3: An illustration of issues in Concurrent Engineering implementation](image)

Future of Concurrent Engineering

Engineering has its roots in craftsmanship where design and manufacturing was truly integrated. An example is a blacksmith with journeyman designing the product in interaction with manufacturing (“the sledge hits”). Then there was an industrial age period of separated design and manufacturing which leaned to sequential process and standardized information carriers (drawings). Concurrent Engineering is a tuned version of sequential engineering implementing features of craftsmanship. The trend is that engineering will go through one more change. When considering the content producing methods one can find different types of knowledge building. It is not sequential, it is not parallel – it is networked. Content creation in knowledge communities is directed with competence and motivation and supported with knowledge sharing. The actions lean on efficient communication using networks as main infrastructure.

Eigner [7] presents future engineering with term Cross Enterprise Engineering (CEE). It introduces efficient collaboration to support competence use, Communication and data exchange to support knowledge sharing and Co-existence with legacy systems – the infrastructure. Figure 3 presents the idea of CEE. It should be reflected against Product Life-cycle Management and distributed engineering in global environment emphasizing sc. Front Loading and Virtual Product Development.
Figure 4: An illustration of networked design phases in Cross Enterprise Engineering – a successor of Concurrent Engineering

References


