A report on concurrent engineering management essay

Traditional engineering relies mainly on a sequential procedure wherein the various tasks involved in the design and manufacturing of a product are performed in a pre defined and set order. This leads to certain drawbacks wherein there is a loss of flexibility in the entire process and this may also lead to severe alterations or even scrap in the later stages of the product development life cycle.

Traditionally, the product design has been considered as a cycle of PDCA (plan-do-check-act). However, the advent of Concurrent engineering, which focuses on working interactively between the various processes in the product development, is relatively new. It is a relatively recent process which employs cross functional cooperation to facilitate the creation of products which are cheaper, better and have a reduced time to market. It is not an isolated concept and encompasses almost all the functions like engineering, designing, support, marketing, accounting, and others. Customer satisfaction is a key factor behind this method.

Example of design changes as a function of time for an American and Japanese automobile. Source: Engineering Modeling and Design, Chapman, Bahill & Wymore

The basic premise for concurrent engineering revolves around two concepts. The first is that the entire product life cycle needs to be taken into consideration in the initial stage of the cycle. This would include functionality, producicitibility, assembly, testability, maintenance issues, environmental impact and finally disposal and recycling.

The second concept talks about the concurrency of the various functions. This flexibility is of immense importance to the success of the process given the fact that it allows for error correction and redesigns to be incorporated in the early design phase without having an adverse effect on the costs, efforts and timelines of the project. In effect, this improves the productivity , the product quality and offers substantial cost benefits.

In a concurrent engineering process, there is no freezing of a particular task and so moving back is not a constraint. It allows design and analysis to take place at the same time and focuses on the collaboration between the teams. The teams are multidisciplinary in approach and composition and allow the employees flexibility to work collaboratively on the various aspects of the project through the life stage of the same.

The need for Concurrent Engineering is especially high in today's world. Businesses must be able to react to the changing market needs rapidly, effectively and responsively. They must be able to reduce their time to market and adapt to the changing environments faster than competitors. Decisions must be made quickly and they must be done right the first time out. Corporations can no longer waste time repeating tasks, which increases the time it takes to bring new products to market. Therefore, concurrent engineering has emerged as way of bringing rapid solutions to product design and development process.

Concurrent Engineering has many advantages and provides benefits such as a reduction in the product development time and the time to market, reduced design rework, reduced product development cost and improved integration in the teams through efficient and effective communications. There are many companies which employ the Concurrent Engineering techniques in the product development life cycle. These firms have shown a significant increase in overall quality, 30-40% reduction in project times and costs, and around 60-80% reductions in design changes after release.

However, there also are times and situations wherein concurrent engineering is not preferred. Some of these can be as stated under:

In such cases, unnecessarily and forciably applying these concepts may not yield advantages. Rather, it may prove to be an unsuccessful approach on the part of the management. This emphasises on the fact that it is very necessary to meet certain pre-requisite conditions in order for the concurrent engineering process to give the desired results. In absence of these, there may be confusions and inefficient product development.

There are a few measures which companies may initially take in order to be successful with Concurrent Engineering, like

Concurrent Engineering has been known by various names over the years and across locations. It is known as the iterative development method (or Integrated Product Development, IPD) as it allows for the correction and alteration in the design and other processes through iterations. Continuous feedback mechanism is employed to discover any discrepancy or fault in the model. The rationale behind it is that the sooner the errors are identified, the lesser effort, time and cost is incurred to correct them. The term " Simultaneous Engineering" has been used since the decade of 1990s. It was based on the idea that the life cycle of the new product must fit in with the pre-existing product program lifecycles.

It was in the December 1988 report ‘ The Role of Concurrent Engineering in Weapons System Acquisition’ by the Institute for Defense Analysis (IDA) that the term Concurrent Engineering was defined . This was an approach which was systematic in nature and focused on the integrated, concurrent design of products and their related processes. This approach is intended to cause the developers, from the outset, to consider all elements of the product life cycle from conception through disposal, including quality, cost, schedule, and user requirements.

In early designs and product development, there was a division of labour among individuals who specialized in various functions. There was little opportunity for interaction between the various departmants and functionalities which often lead to confusions and certain discrepancies between the work done. This at times led to customer dissatisfaction. With an increasing level of competition, the role of new manufacturing process and the need to reduce development lead time, concurrent engineering has become more popular. These justifications are discussed below.

This can be quoted as one justification for the rising popularity of concurrent engineering. With the increase in competition, there is all the more a need for competitive advantages and core competencies at firm levels to ensure meeting competition. Concurrent Engineering gives the firms a cost advantage apart from ensuring quality and efficiency in processes.

With the advent of technology, there are various new production methods which come into service. This makes it important to transfer and share the knowledge about this new service to the various functions and departments. This is necessary because this would ultimately have an impact on the resulting product design. This knowledge sharing would ensure that the various people involved in the product development are at the same platform when information about these processes is concerned. Therefore, the situation where new production processes are used will often be an important area for ensuring that design engineers work closely with production engineers. Concurrent Engineering can contribute its bit here.

Lead Time: Shorter lead time or the time to market is a competitive advantage to the firms. Reduction in the lead time would decrease the length of the development process and would help bring the product to the market sooner. This would also decrease the inventory holding time and would therefore help in cost reduction (or cost advantage). By implementing the concurrent engineering process, the organization can achieve this advantage over the firms employing the traditional methods (sequential process).

Concurrent engineeringis a workflow that relies on parallel processing by performing multiple tasks simultaneously instead of carrying out the various tasks in sequence as has been the traditional workflow. Concurrent engineering is not just related to engineering processes but rather focuses on the integrated and concurrent design of product and the related processes. This requires the clear identification and description of all the tasks and processes associated with the design, manufacturing, support and other functions by the developers.

The developers need to consider the various elements of the product life cycle end to end, varying from the first stage i. e. conception of the product to the last stage i. e. disposal of the product. The various elements which shall be considered will include almost parameters which have an impact on the development of a product and the associated processes, such as quality, cost, scheduling and user requirement. It is worth noticing that the definition encompasses more than just the manufacturing and design of a product. It does not apply only to domains of engineering but is also widely used in the pharmaceutical, paint, food or sneaker industries.

Concurrent Engineering is not limited to the products or goods. Even services can employ concurrent engineering for improvement in productivity and reduction in total time to market. Although this may not lead to reduction in number of employees or the work to be done, the adoption of concurrent engineering would lead to a faster lead time. In the services sector, the concurrent engineering concept applies to insurance sector, banking sector and others.

The difference between the conventional product design approach (sometimes also called the waterfall model) and the concurrent product design approach (sometimes also called the simultaneous engineering approach) has been explained below with the help of a diagram. It is this deviation from the standard and traditional waterfall model (which employs and focuses on a pre defined sequence of processes and tasks) to the iterative and integrated development method of concurrent engineering, which is responsible for the huge success of this model. In the waterfall model, first of all, all requirements are gathered so as to facilitate clear definition of the problem at hand. This is both a time consuming and effort consuming task. Unless and until the data gathering is done (which in itself is a tedious task given the level of uncertainty associated with it and the dynamic nature of the information requirement), one can't proceed to the next level. This interdependency wastes a lot of time.

Followed by this is the design phase wherein based on the requirements, the design of the product is to be agreed upon. The problem here is that in the absence of an option to move back and make changes to the design phase, at times, it becomes difficult to implement the design and subsequently the design may have to be heavily altered or even scrapped. The Concurrent Engineering is better in this case as being cyclic, all the aspects of the product life cycle has already been taken into consideration, thus allowing the design to take a more evolutionary approach.

Then there are the implementation, verification and maintenance phases. All of these suffer from similar problems because of the inflexibility involved in the process. Concurrent Engineering overcomes many of these problems through the approach it employs. The cyclicity allows parallel processing and hence offers flexibility to the system as has been shown in the figure below. The various functions like planning, requirement gathering, analysis & design, implementation, testing and evaluation are done simultaneously and hence the name " simultaneous engineering".

The implementation of concurrent engineering requires the combination of people, technology and business methods. It relies on cross-functional working and teamwork rather than the traditional bureaucratic and hierarchical organizations. Collaboration rather than individual effort is standard, and shared information is the key to success. 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 teams plays an important role in the successful implementation of Concurrent Engineering.

The Concurrent engineering process mainly focuses on three aspects, viz. people, process and technology. People are given a wider say, a sense of gratification and ownership of their work in the overall design process taking into account the collaborative nature of simultaneous engineering. The success of concurrent engineering depends to a vast extent on the effectiveness and the efficiency of the organizational teams formed. The three basic attributes which a CE team must have been enumerated as under:

The teams formed are Cross-functional team. The team is formed to work on a specific project, and stays together throughout the development of the product. The smaller teams comprise of 5 – 20 people and employ an efficient technical communication. For the implementation of larger projects, a network of teams is formed (a total of 100 to 1000 people). Larger projects are sliced into smaller projects and measures are taken to ensure the integration of separate pieces into a system solution. Presence of Liaison Personnel facilitates timely and proper transfer of information within the team. Apart from this, job rotation is also an inevitable component of the process. The team members are assigned temporarily or permanently outside of their accustomed functional specialty. This ensures the integration of various knowledge bases without making significant structural changes to the organization.

Design for Safety – The designer must develop the habit of constantly evaluating the design for safety, considering not only the design itself but the personnel involved in fabricating the product, using the procedure, and in maintaining and repairing the product or system as well as the end user or purchaser. Developing the manufacturing processes as well as the maintenance and operating procedures early during the design process will assist in revealing safety problems at a time when corrective action can be taken at minimum cost.

Design for Reliability – To ensure successful performance over a given range of conditional range, specific environment.

Apart from all these, the technology and tools also play an important role in the success of the Concurrent Engineering. Integrated Computer Analysis is used for modelling the steps required for the development of the manufactured product.

Although the Concurrent Engineering Strategy does not necessarily reduce the amount of manpower required for a project, it does drastically reduce lead times and thus time to market. This has been illustrated in the diagram shown as under: The better the collaboration between the various phases, shorter is the time to market and higher is the efficiency.

Another advantage of Concurrent Engineering is that, while knowledge is being built up about the design of the product, additional knowledge is being acquired about the other aspects of its life-cycle. As the design progresses, the manufacturing expert will learn more about how to manufacture the product, and the packaging expert will know more about how to package it, etc. This accumulation of knowledge will help in speeding the product through the development process and get it out to the customer more quickly.

These are not only benefits which the company experiences, but ultimately the end users or customers also reap the benefits by having a quality product which fits their needs and in many cases, costs them less to purchase. Therefore, concurrent engineering produces a profitable corporation and a satisfied consumer.

Concurrent Engineering is not a quick fix for a company’s problems and it’s not just a way to improve performance. It’s a business strategy that addresses important company resources. The major objective this business strategy aims to achieve is improved product development performance. It is a long-term strategy, and it should be considered only by organizations willing to make up front investments and then wait several years for long-term benefits as it involves major organizational and cultural change.

An example of the use of Concurrent Engineering can be found in General Electric’s Aircraft Engines Division’s approach for the development of the engine for the new F/A-18E/F. It used several collocated, multi-functional design and development teams to merge the design and manufacturing process. Their teams achieved 20% to 60% reductions in design and procurement cycle times during the full-scale component tests which preceded full engine testing. Problems surfaced earlier and were dealt with more efficiently than they would have been with the traditional development process. Cycle times in the design and fabrication of some components have dropped from an estimated 22 weeks to 3 weeks.

Another example concerns Boeing’s Ballistic Systems Division where Concurrent Engineering was used in 1988 to develop a mobile launcher for the MX missile and was able to reduce design time by 40% and cost by 10% in building the prototype.

Polaroid Corp.’s Captiva instant camera is also the result of a Concurrent Engineering approach, as a result of which Polaroid was able to make literally hundreds of working prototypes. Throughout the process, development was handled by cross-functional teams.

The design and construction of a ship involves a high degree of concurrent engineering. To cater to such needs companies like Tribon Solutions develops, markets and supports CAD/CAM/CIM software solutions, with the mission of increasing overall efficiency in the maritime industry. Tribon uses a Product Information Model (PIM), which is the central repository and single source of information for designers, planners, administrators of material, manufacturing personnel, and others working on design and construction. Tribon began work on its API in 1995. It considered two different paths at that stage: Either to publish directly the libraries used by Tribon, or to create a wrapper on top of existing code.

The first approach would make all our functionality available to the user, but users would have to use the same development environment as Tribon Solutions, change compiler versions when Tribon Solutions did so, and so forth. This would have been an expensive and complex solution, only usable by the largest shipyards in the world, those that had their own large IT and development departments.

The second approach was preferable, as long as a tool could be found or developed that covered most of the given criteria. Tribon already had a geometry macro language that was developed in-house, but to extend it to the desired level of functionality would have been costly to implement and maintain. The remaining option was to find a 3rd party solution that fulfilled the API's needs.

During investigation of options, Python was discovered quite early when a member of the development team read about Python in a computer magazine. After some initial experimentation there were really no other contenders. Python had it all. It was a beautiful programming language that was extensible, embeddable, platform independent, and had no license cost.

When it came to incorporate Python into the Tribon software, They found the integration to be quite easy and problem-free, and it was achieved with very little effort. The result of this merger between Tribon and Python was named Tribon Vitesse, and the first version of Python used was 1. 2.

Today Tribon Solutions has customers that have, by utilizing the power of Tribon Vitesse, been able to reduce design time of certain complex ship structures from four weeks to two days, while improving overall quality. This enormous reduction in design time has been possible by automating more of the design, calculations, information search, and result checking.

As suggested by its name, the CDF usesconcurrent engineeringmethodology to perform effective, fast and cheap space mission studies. Equipped with state of the art network of computers, multimedia devices and software tools, the CDF allow team of experts to perform design studies during working sessions.

The spacecraft design is based on mathematical models, which make use of custom software and linked spreadsheets. By this means, a consistent set of design parameters can be defined and exchanged throughout the study, and any changes which may have an impact on other disciplines can immediately be identified and collectively assessed. In this way, a number of design iterations can be performed, and different design options can easily be analysed and compared.

CDF activities are conducted in sessions: plenary meetings in which representatives of all space engineering domains participate, from the early phases (requirement analysis) to the end of the design (costing). Even those disciplines that were traditionally involved at a later stage of the process are given the opportunity to participate from the beginning and to identify trends that might later invalidate the design.

The CDF design room has been designed and equipped with all the relevant hardware and software tools, with the aim of creating an effective communication and data interchange environment among team members.

ESA's Concurrent Design Facility (CDF) has successfully demonstrated the capability to use Space System Concurrent Engineering to overcome the communication gaps between the “ designer” (who produces design information) and the “ user” (who utilizes the design information) enhancing the in-house capability to perform feasibility studies in a very effective and interdisciplinary manner. Many candidate missions have taken advantage of the new capabilities offered by the CDF, reducing the pre-Phase A (preliminary design) study duration from several months to a few weeks while increasing design quality. This has been in part due to the use of the CDF-IDM, the integrated design model. The Open Concurrent Design Server (OCDS) is the next generation of the CDF design model.

The CDF-IDM was built on an experimental basis and makes use of spreadsheet technology, both as data storage and as engineering tool. The OCDS on the other hand makes use of a Service Oriented Architecture (SOA) using web services, a centralised database and many client tools such as the OCDS Study Manager (OSM) and OCDS enabled spreadsheets.

The growing interest of ESA partners, Industry and Academia in the ESA CDF core IDM, standardised data representation and exchange, and common design methodologies is one of the reasons that has motivated the creation of the Open Concurrent Design Server. For this purpose an ECSS Working Group was formed responsible for creating a Technical Memorandum (TM) which defines the recommendations for model based data exchange for the early phases of engineering and design. This provide a basis for: