

APPLICATION OF CONCURRENT ENGINEERING IN PRODUCT AND PROCESS DESIGN

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Abstract— Traditional methods applied to the development of new products are becoming obsolete, being necessary advanced methods based on a new approach that allows work cooperatively. This is called Concurrent Engineering and this paper intends to carry out a review of the integration of this discipline in the new ways of working.

The main objective of the new forms of work is to systematize the design by interdisciplinary teams simultaneously working the products, the processes, getting the right design, with a corresponding reduction in costs and time.

The introduction of CAPP systems (Computer Aided Process Planning) facilitates process design tools. Therefore, some previous work incorporating such systems are included.

Keywords— Engineering, concurrent, design, product, process.

I. INTRODUCTION

ACCORDING to Ken L. Keyes [1], concurrent engineering can be defined as a systematic approach for simultaneous integrated design of a product and related processes, including manufacturing and other support functions. This approach requires the formation of multifunctional teams of specialists representing all activities of the organization.

Concurrent engineering requires that products, processes, facilities, customer service, maintenance, and sellers involved with the project in the early stages. It also requires companies to follow this sequential process, will have to make substantial changes to its management approaches to product development. The mythology of the process requires the simultaneous work of all operators based on periodic meetings to achieve a common goal.

The fundamental concepts of concurrent engineering have been evolving over the years and sits bases in project management. The main objective is to get the right product at the estimated time, with reduced costs by providing the right information, personnel, materials and equipment from the most appropriate sources, who and

where you need it.

Concurrent engineering is a management philosophy and not limited to manufacturing companies. It is a systematic and simultaneous focus on the development of a product or process, educating all people should be involved in the first place.

The production of current company has become a matter of effective and efficient application of information technology and knowledge engineering. On the one hand, this will increase the competitiveness of a company in terms of quickly meet dynamic changes in the market. Concurrent engineering is performed to enhance the product design process with the intention of improving organizational performance.

Following the proposals of the study of A.R. Young [2]- [3], Napier University, introducing a new product on the market is inefficient using traditional methods; to eliminate the problems that arise from traditional methods the new approach appears engineering concurrently.

The development of a new product is a major cost, when you consider the total cost of a new product, 80% of the cost invested in the early stages of the process [4], [5], in generating ideas. For best results the process should be studied well [6], [7].

II. RESULTS AND DISCUSSION

Until the late 1970s, the simplicity of the projects made it possible that the information of the project could be divided into a few operators and exchange of information were simple. With increasing complexity of projects, the work was divided in small workgroups, resulting in a lack of communication and a worse outcome [1], [8], [9].

The new method of dividing labor camps did not work and a new approach was needed to optimize the process. With the help of "systems analysis" and the concept of "life cycle", together with the principles of project management and discipline, improvements began to be

incorporated to the problem of the development cycle of the product / process [10-16].

Once the project is treated as a system with predefined elements and activities, the next significant improvement in project management is the recognition that the project should be managed by a "project team" that represents all significant participants (element / organization) identified by the system approach. These are the people who run the detailed planning, organization and control of the project [17].

The documentation hitherto known on concurrent engineering has been collected and documented recently by the Institute for Defense Analyses (IDA) [18-19], introducing below the general areas covered by concurrent engineering:

- 1) *The dependence of the multifunctional teams to integrate the designs of a product and its manufacturing and support processes;*
- 2) *The use of computer-aided design, engineering and manufacturing methods (CAD / CAE / CAM) to support the integration of design through products and process models and databases;*
- 3) *The use of a variety of methods of analysis to optimize the design of a product and its manufacturing and support processes.*

A. Model development

AR Young proposes some methods of application to product design that follow a sequence of methodology in a systematic approach. Some of these models deal specifically with the design process itself, while others take into account the whole process of introducing a product, including manufacturing. The steps that are required during the development process are the following ones:

- 1) *-Identification of the need of the product*
- 2) *.-Development of a document of specification product design*
- 3) *-Generation and evaluation of design concept*
- 4) *- Detailed Design of the most promising concepts*
- 5) *-Design and development of manufacturing plant*
- 6) *-Distribution and sale of the new product.*

B. Advantages of using the concurrent engineering

According to information gathered at the Institute for Defense Analyses (IDA), as well as the studies and efforts of Ken L. Keys [20], they emphasize the following expected benefits to implement concurrent engineering:

- 1) *Improving the quality of designs which resulted in a drastic reduction of engineering change orders*

(over 50%) in early production.

- 2) *Reduced cycle time of product development [21-22], so a 40-60% through concurrent design, rather than a product design and sequential process.*
- 3) *Manufacturing costs reduced by up to 30-40% by having MFPs that integrate product and process design.*
- 4) *Scrap and rework reduced by up to 75% through the products and process design optimization.*
- 5) *Maintenance / serviceability efforts and reduced warranty costs (ie, lifecycle cost savings) [23].*

C. C.A.A.P. Systems

One of general areas that covers concurrent engineering is the use of computer-aided design, engineering and manufacturing methods (CAD / CAE / CAM) to support the integration of design through shared products and process models and databases.

YB Liu [24] conducted a concurrent engineering study based on the CAPP systems (Computer- Aided Process Planning), providing an explanation of the use of such systems to obtaining an optimal plan.

Today the use of CAPP systems is very practical for the development of product design. The CAPP systems include a variety of activities in a production environment. CAPP acts as the source of information and interacts with the computer-aided design (CAD), computer- aided manufacturing (CAM), the material resources planning (MRP II) and other activities in the product life cycle.

Many of the CAPP systems ignore the multiplicity of design processes and do not evaluate a plan of processes, so it will be difficult to obtain an optimal plan. To overcome the problems, CAPP systems perform concurrent design with the fundamentals of data and product information, this results in the design stages and the following processes, including manufacturing feasibility, costs, manufacturing resources etc., if defects are found in the process they must be modified as soon as possible.

Construction and functions of CAPP systems:

First, there is the database depending on the model and process, after using the experience and knowledge the process is redesigned, this plan is evaluated using a synthetic evaluation model. At the same time, the manufacturing information is shown. The designer must select the optimum process according to the evaluation of results and proper process is modified with the right conditions.

Once the plan of the process is completed, the information data related to the process is obtained and administration documents are generated automatically. The next step is to check and detect possible defects to remove them. When the process is finished, the

information related to the process provides a shortening of itself, reducing costs and improving the product quality.

Critical review of CAPP systems:

The Engineering School at the University of Abertay (Dundee, Bell Street, Dundee, UK) [25-26] presents a critical review of models of CAPP systems revealing the current limitations, reviewing the machining modeling, the facilities, database system technology, focusing on the goals and techniques of geometric reasoning.

The FOCM "Feature-Oriented Capability Module" is part of a CAPP system. The focus of CAPP as an optimization problem is a function of FOCM to provide solutions on a viable space in the manufacturing plant on which the optimizer will work. This means that the overall cost is considered, ie, instead of choosing the cheapest process feature by feature, the cheaper overall plan is generated.

The FOCM takes as argument a targeted function B-rep solid model of description of the component to be scheduled. Several "knowledge sources" containing sets of rules on manufacturing specifications are consulted, in addition to databases on processes and limitations.

This database provides enough information so that the existing facilities at the plant, tools and machines available are described. The model provides information on geometrical constraints and provides another Way of performing the operation.

D. Models of application

Philippe Belloy [27]- [28] present a study about the optimization of the roughness on the surface of a material implementing CAPP systems in 2000. The choice of a manufacturing process, in the design process many parameters are taken into account: the surface, roughness, dimensional tolerance and the material of a mechanical piece are essential data, which influence the behavior and lifetime of the mechanism. The algorithm presented in the work allows the integration of surface quality by a CAD / CAM system, using models to predict surface roughness. Different theoretical and empirical models of roughness which allowed estimating the manufacturing parameters were presented.

Another study by Jung-Seok Kim [29], working together the University of Los Angeles and the Institute of Science and Technology of Korea, about the development of Concurrent Engineering for the design of composite materials explains the development of a concurrent engineering system for the design of structures of composite materials. The concurrent engineering system has been developed to satisfy the demand of better quality products with lower production

cost and time. The system of concurrent engineering included the design of several modules such as design / analysis of structures of composite materials which use CLPT and finite-element method (FEM), buckling and post buckling analysis, thermo-elastic analysis of carbon composite and optimal design using the expert system. For integration and program management, a design environment was built based on the graph that provides the ability to multitask interface and the graphical user.

ZJiang [30], Department of Engineering, University of Glasgow, with the Engineering School at Leeds Metropolitan University applied Concurrent Engineering for the development of manufacturing a scroll compressor widely used in refrigeration and appliances of air conditioners, this study was carried out due to the complexity of designing and manufacturing their components and high accuracy requirements they entail. The article presents a concurrent engineering approach for the design and manufacture of computer assisted compressor. The authors used C programming tools and Pro / ENGINEER as engineering tools to implement the proposed approach and the development of associated design. A solid display model of the compressor was developed. The designed pattern was improved by using an optimization system. Finite element analysis and an expert system was used to study the model, it was useful for improving the manufacturing quality and assembly of precision of the stages.

M. Sadegh Amalnik [31] introduced a system based on the intelligent knowledge to evaluate the wire dissolution by wire EDM (WEED) using concurrent engineering on the environment and on the basis of object-oriented techniques. Nine different kinds of design features were acquired interactively. The attributes of steel as a working material, copper wire as a tool material, a single electrolyte solution, a type of weed machine and machining conditions such as current pulse in and out of time and distance from the nozzle were stored in a database. For each design feature, the necessary information in manufacturing, such as machining cycle time and cost, the rate of removal of material, maximum cutting width and working feed rate, cutting area were estimated besides the efficiency of the operation.

Finally, J.X. Gao [32] discusses the application of concurrent engineering in the automotive industry suppliers. The cost of introducing new approaches such as Concurrent Engineering and the adoption of new technologies such as computer-aided engineering (CAE) is substantial, as this cost is in addition to operating costs. The authors have examined a number of available frames of Concurrent Engineering and they observed that these frameworks address different aspects of Concurrent Engineering in varying degrees of detail. This project was based on the recognition that a different approach is necessary for the implementation of Concurrent Engineering speaking of suppliers. A framework of three levels has been proposed. The levels are: the environment in which suppliers work, a focus on five

stages of implementation, and a portfolio of tools of Concurrent Engineering.

III. CONCLUSIONS

The new approach to concurrent engineering applied to the design of new products, provides an optimization of both cost and process to follow. This has led to companies to use Concurrent Engineering to improve their production. In this bibliographical review the development of the model has been shown and the main stages are specified, besides listing some of the advantages of using Concurrent Engineering. Work carried out by several research groups mentioned in this article check for practical purposes the effectiveness of this new approach.

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