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Benchmarking Methodology for Concurrent engineering improvement

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Abstract

Benchmarking is becoming a popular techniques to improve the Business performances. But this technique suffers from a lack of methodology which lead the users to often achieve not satisfactory results. One of the possibility to increase the efficiency of such methodology is the development of customized method for particular domain. This paper presents a benchmarking methodology for concurrent engineering improvement. This method used control theory concepts developed within the GRAI method for Manufacturing system control and design, and provides guidelines for Benchmark definition and Company leaders choice.

Keywords

Benchmarking, Concurrent Engineering, Performance indicators, Modeling techniques.

1 INTRODUCTION

Among the various manufacturing functions, product and process design is a key domain for enterprise competitiveness. Currently, it is crucial to achieve the integration of the product and process design because 70 to 80 percent of the live cost of a product is determined when it is designed. After the design phase, manufacturing engineers and factory workers have very few choices and can affect only a small part of the overall cost.

G. Doumeingts et al. (eds.), *Modelling Techniques for Business Process Re-engineering and Benchmarking*

As they are strongly interrelated functions, product and process design must be performed in an integrated way. The integration of these two functions is called Concurrent Engineering (CE). CE is now a key technique in the global manufacturing process.

One of the main questions the managers of design departments have to answer every day is :

how to improve the results of the product/process design in order to improve quality, decrease costs and lead times...?

One of the possible way of improvement is based on the learning of 'best practices' currently in operation in the industry. This method of improvement is called Benchmarking.

The aim of this paper is to describe a proposal of benchmarking methodology for concurrent Engineering. The goal of this methodology is to allow the performance improvement of a Concurrent Engineering system according to the best practices in the CE domain.

2 - BENCHMARKING

2.1 - Definition and Benchmarking main current lacks

"Benchmarking is the process of continuously comparing and measuring an organization with business leaders anywhere in the world to gain information which will help the organization to take action to improve its performance." [APQC 93]

Historically, benchmarking has first been implemented by Industry before being conceptualized and theorized *a posteriori* by academic researchers. The consequence is the lack of methodology in benchmarking. Today, taken from the above quoted 1992 American survey, a key figure indicates that "95 % of companies admit they do not know how to benchmark". [TIME 93] [Kleinhans 94]

This methodology aims to provide to the users some guidelines in order reach the following objectives :

1 - Detect better CE systems than the studied one.

2 - Understand why there are better

3 - Improve the studied CE system according to the best ones to get equivalent (or better) performances.

2.1.1 - Detect better CE systems than the studied one.

For the first objective, the problem is to answer to the question : What is a better system ? The answer to this question leads to take into account 3 criteria :

A - performance of the system

The first criteria is, of course, the definition of comparison elements. A system will be better if it reaches better performances.

B - Objectives of the systems

For a concurrent engineering system, like for other systems, it is not possible to give an overall definition of a better or best systems because a CE system can be highly efficient in many different ways. For example, a CE system can get good performance in the reduction of the overall development lead time and an other one in the reduction of the manufacturing cost or in improvement of the product quality.

C - Environment of the system

The performances of a CE system, like for other systems, are not independent of the environment (type of product, of market, country...) inside which the system is operating. To compare the performance of a particular system with the performances of an other system operating in a different environment could conduct to some mistakes in the evaluation of the various performances. In order to get an easier comparison, measures must be done within comparable external constraints.

2.1.2 - Understand why one system is better

"The ability to gain superiority is dependent upon a detailed understanding of the company's own operation and those of others, and the ability to incorporate these to develop performance improvements." [Childe 95]

Even if you know that the system A is better than the system B, a detailed analysis of the 2 systems will be necessary to understand and to explain the difference of performances.

To understand a complex system like Concurrent Engineering systems involving many activities, links, resources,..., analysis tools, like modelling techniques, will be needed to catch the better practices.

2.2 - Basic concepts of the benchmarking methodology proposal

Based on the GRAI approach [Doumeingts 84], the activities of the Manufacturing system need to be coordinated and synchronized in order to reach the company objectives as well as the customer expectations. In this aim, we need to take into account the management (or control) aspect of the manufacturing systems.

As for pure manufacturing processes, for product and process design, there is a controlled system (which transform technical or technological state of art into product or process specifications) and a system in charge to control the design activities (Design Management system) (Figure 1).

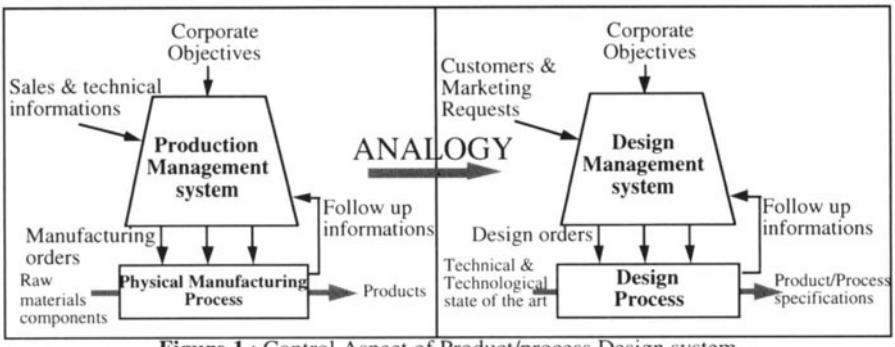

Figure 1 : Control Aspect of Product/process Design system

From this approach, we deduce the four basic elements necessary to the control of a complex system . These elements defined in the ECOGRAI method [Bitton 90] and the IMS project [GLOBEMAN 94] are (Figure 2) :

- The objectives to reach

- The action variables used to reach the objectives
- The performance indicators which show the results of the system and allow to measure the performance gap of the controlled activity with the objective.
- The environment (or Boundary condition) of the activities

Our methodology is based on these four elements. For similar objectives and environment, a system will be better if he has better performances.

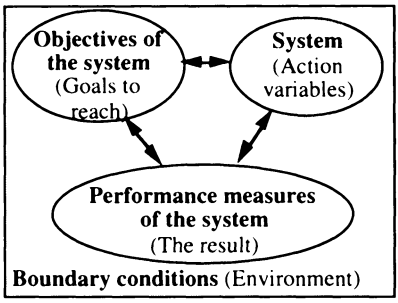

Figure 2 : Links between Objectives, performances, system and Boundary conditions

3 - CONCURRENT ENGINEERING

The Concurrent Engineering is primarily an expression for the ambition to increase the competitiveness by decreasing the lead time and still improving quality and cost.

The main methodology is **to integrate the product development and the process development of the design and production processes**.

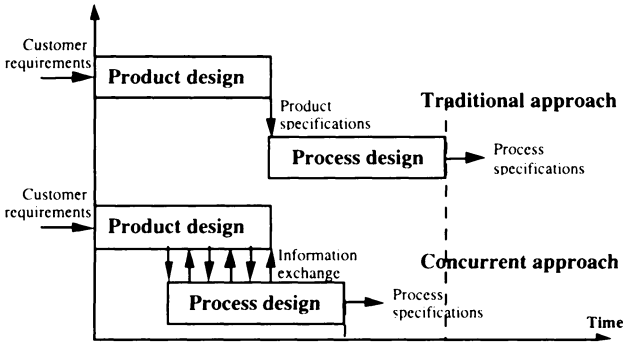

Figure 3 : Concurrent Engineering main concepts

The main characteristics of the Concurrent engineering approach, if we compare with the traditional one, is the simultaneity of the product and process design activities (Figure 3). In the traditional approach, the development phase starts with the design of the product. Then when

the product specifications are ready, they are used for the next phase of the development project, the process design.

On the contrary, in the concurrent engineering approach, the design of the process starts as soon as some information about the product are available.

The advantage of using such approach are the following [Paul 94 & 95]:

- Segregation and isolation between functions are virtually removed from the company, with the result that all the various divisions can now work together in an integrated manner to achieve a more productive team.
- The overall product development process is shortened as steps along the way are handled in parallel. Thus improving time to market.
- The number of product iterations is also reduced.
- There is a reduction in design errors engineering and design changes and product re-engineering as more information is available at the design stage.

4 - BENCHMARKING FOR CONCURRENT ENGINEERING IMPROVEMENT : THE METHOD

In the next paragraphs, we will call the Company Concurrent Engineering (CE) system we want to improve : The studied CE system. The Company Concurrent Engineering (CE) systems representing the best practices for CE systems will be called : Target CE systems.

4.1 - Main steps of the methodology

The first phase will be based on the definition of key performance indicators allowing to compare performances of the studied company and others. From this performance must be deduced a list of company having a better CE system.

In the second phase, the objective will be to understand the functioning of these better CE systems in order to define the key elements which allow them to be better.

Finally, in the third phase, an improvement plan of the studied system will be made, implemented and monitored (Figure 4).

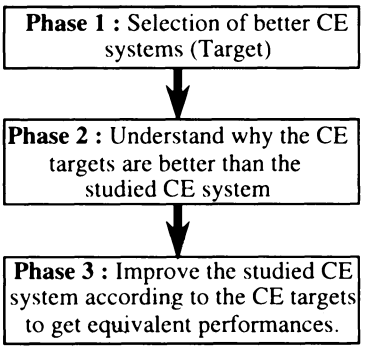

Figure 4 : Main steps of the benchmarking methodology

4.2 - Identify and select better systems in the domain compared to the studied one

4.2.1 - Identify similar CE systems

At it is explain in a previous paragraph, if we want to be able to compare the performances of CE systems, we must check that the performances are comparable, e.g. that the two CE systems operate in similar environment.

In order to find as fast as possible CE systems operating in a similar environment, we propose to define a classification allowing us to understand in what kind of environment the CE system, we want to improve, operates and in a second step, to find CE systems with similar environment in order to make performances measure and evaluation.

This kind of classification, also called Typology, already exists for manufacturing systems.

For example the AFGI (Association Française de Gestion Industrielle) [Gallois 88] has defined a typology for Manufacturing system.

One of possible Typology for Concurrent Engineering can be based of the classification made by Fujimoto and Clark in "Product Development Performance" [Clark 91].

Because the environment of Concurrent Engineering is directly linked to the type of Product, some criteria must be defined to classify the product..

Clark & Fujimoto define the type of product by complexity (Figure 5) according to 2 criteria :

- Complexity of internal product structure
- Complexity of Product-user interface

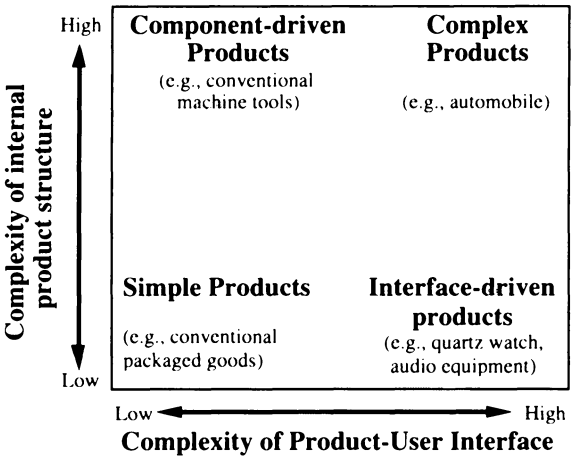

Figure 5 : Type of product by complexity [Clark 91]

An other criteria to define the environment of Concurrent engineering will be the production volume as well as the market type because they influence directly the manufacturing process design.

4.2.2 - Definition of the performance indicators (benchmarks)

The performance indicators must be defined according to the objectives of the CE system. The objectives describe the performance levels to reach and the performance measures (key factors) give the real levels of performance. Before to define the key factors to measure it is necessary to know the objectives to reach.

The objectives of the Concurrent Engineering process will be deduced from the strategic (or Manufacturing) objectives of the company (Figure 6).

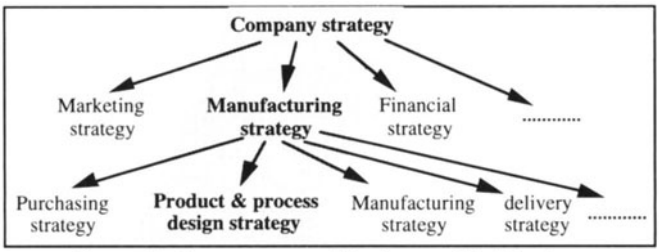

Figure 6 : From company objectives to CE objectives

According to the objective decomposition, it will be possible to link each objective with one or many performance indicator(s) [Bitton 90]

As we have an objective decomposition, we will have a performance indicator decomposition.

4.2.3 - Measure and selection of the best CE practices

If the measure of the studied CE system performances does not seem to be a problem, the measure of other CE is much more difficult. These difficulties can be decompose as follows

A - Position of Concurrent Engineering within a company

B - Data collection

At this step of the methodology, the goal is not to measure other CE performances but only to find better CE systems.

For practical reason, among thousand of companies, it is not realistic to want to study in detail all the CE systems. The approach of this methodology is based on two steps : firstly a selection of the potential companies with a better CE systems, and then, in a next step, detailed study of these CE systems

For these reasons, the evaluation and comparison of other CE system will not be based directly on Concurrent Engineering performance measures but on company apparent performance evaluation (mainly the products of these companies).

Because a company must be considered as a complex system, the product performance of a company will be the result of the performances of the various elements inside this company.

Based on the control theory and the System theory, we can write that :

Company performances = $\sum$ various function performances + $\sum$ performances of the links between the functions.

For example, in the figure 7, we can consider that the company's product performances will be mainly based on the product/process design performances and the manufacturing performances.

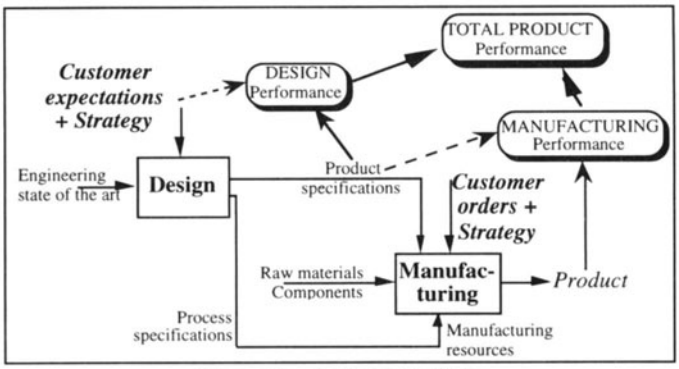

Figure 7 : Performance links

In our case, if we make the assumption that we are able to evaluate the company's product performances, we must be able to deduce the CE performances in order to detect the better CE systems. Practically, according to the total product performance evaluation, we must approximate the CE performances, then we will deduce what are the companies with better CE systems.

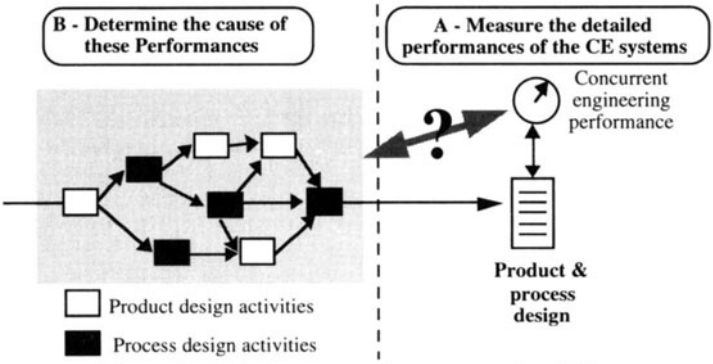

Figure 8 : Links between performances and activities

4.3 - Understand why the selected companies CE systems are better

When the companies with better Concurrent Engineering system have been selected, the next task is to understand why their CE systems are better. From this analysis, it will be possible to understand and evaluate the lacks of the studied CE system in order to improve it. The figure 8 shows the 2 steps necessary in order to understand why the selected companies CE systems are better :

A - Measure the detailed performances of the CE systems

B - Determine the cause of these performances

4.3.1 - Measure the performance of the selected companies Concurrent Engineering systems

During this task, the goal is to measure the CE systems (studied and target) in order to know in detail the various performances. For example, the following table gives some detailed performances that it will be necessary to evaluate for the Quality.

Product/process design	Production	Overall
- Design product performance - Design product interface - Design product styling - Product Innovation rate - Product Variety (options) - Component reutilization rate - Lead time (total design) -...	Conformance quality	- Reliability - Attractiveness . *novelty (rate, frequency)* . *Performance* . *comfort of use* . *styling* . *personalization*

4.3.2 - Analysis of a Concurrent Engineering system

At one step of the methodology, the performance gap between the studied and the target CE systems are known. The next task is now to understand the elements and the behavior which allows one CE system to get better performances. These main elements which characterize a CE system are the action variables of the CE system.

The action variables are the parameters on which the designer or the design manager (which are the decision makers) can act in order to reach their objectives (or the objectives they have mission to reach). For this detailed analysis, we will used modeling techniques allowing the description of the activities, the resources, the information and decision flows, as well as the study of the organization. Besides, we will study also in detail the various methods, communication, human factors...which have an impact in the performance of the CE systems.

To perform this analysis, we will used modelling tools for the 2 sub-systems described in the figure 1 : the Design Process (DP) and the Design Management System (DMS). These methods could be SADT/IDEFo, GERAM, Petri-nets for the DP and PERT, GRAI.. for the DMS.

4.4 - Improve the studied system according to the best ones to get equivalent performances

Until now, the methodology application has not bring anything concrete to the studied CE system's performances. It is now time to transform an intellectual exercise into valuable actions for the company which applied this methodology .

This improvement plan will be based on a structured approach allowing to define a particular solution based on the best practices we have studied in the previous phases. Besides, there are some basic rules to follow in order to increase the success of the improvement plan definition and implementation.

a) Obtain commitment of management and employees for the implementation of the plan

b) Keep a global view of the industrial system during implementation - The performance of the product/process design department in itself is not the most important. It is its contribution to the whole company performances which is necessary to take into account.

c) Monitor results - Monitor periodically the results of the plan and the performance of your CE system in order to know the performances progress of the Product/process design department.

5 - CONCLUSION

In this paper is described a proposal of benchmarking methodology for Concurrent Engineering system. This first methodology emphasizes on the following points :

- Based on the control system approach, definition and use of the Design objectives, CE environment and Performance indicators for the benchmark definition
- Proposal of a Product/process design typology to define CE environment
- Modeling of the CE system for action variables description and evaluation also based on the control system approach

The next step is to implement this benchmarking methodology in order to check its applicability and, besides, to determine the most appropriate modelling techniques for Concurrent Engineering description.

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