

BM_VE Architecture Reference Model for Concurrent Engineering

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INTRODUCTION

To support the requirements for the new organizational forms of enterprises, the cooperative work and work groups approach has appeared. Cooperative work may be defined as one where a group of people, physically separated or not, articulate the accomplishment of a common task in a synchronous or asynchronous form. In order to cooperate, a previous agreement should be considered. All should be committed to work to reach a common objective (Borges, 1995).

It is supposed that the agility, that is, dynamics, with which these work groups may be created and reconfigured, makes it possible to use the best “resources,” the (best) individuals capable to add value to one defined task, independently of their (the individuals’) (geographic) location and, consequently, contribute to the product and process quality. In that sense, it is supposed that application of virtual enterprise (VE) organizational principles contributes to the agility of the work teams, that is, to the concurrent engineering (CE) work teams, or team work, organization.

With the objective to test the potential of virtual enterprise (VE) organizational principles, in accordance with the BM_virtual enterprise architecture reference model (BM_VEARM), for concurrent engineering team work organization, three different work groups had been created: (1) CE distributed team (virtual team according to literature); (2) CE agile team (agile organization according to BM_VEARM), and (3) CE virtual team (virtual organization according to BM_VEARM), and to each group were equally attributed the same project: to create a Web site (a page or Web site that adds several links and services). It is an entrance gate, or starting point, for navigation called “Virtual University,” making

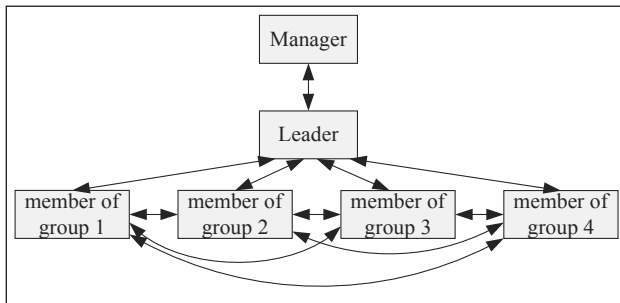
use of information technology to support the education organization and process (Pithon & Putnik, 2005). This experiment was carried out by computer science students in their last year and undertaken in the period of October 27-30, 2003. The experience simultaneously involved three work groups, specially the agile and virtual groups of the BM_VEARM model, with the application of diverse software. The only asynchronous communication tool used among the members of the groups was e-mail.

CONCURRENT ENGINEERING

The concept of CE defines that various activities are developed in parallel, interactively, involving professionals from different specialties, covering the entire cycle of product development in opposition to the traditional method of sequencing stages. Therefore, there is feedback among the activities. This new form of working is very beneficial, since it avoids the possibility of wasting time and resources, originated from a lack of complete involvement of the different sectors in all the stages of the project. Besides improving the quality of the development process itself, it also improves the quality of product. On the contrary, the time and resources wasted in the execution of tasks, that later would have to be redone, will never be recovered (Pithon & Putnik, 2006).

The model that is being developed in this study is guided by work groups, also designated as the “task force” (Figure 1), which has the group leader as: (1) a linking element between the members of the group and the company higher level management, and (2) the group, or CE process, management (or manager).

Figure 1. Management model of concurrent engineering teams



BM_VEARM MODEL OF VIRTUAL ENTERPRISE

A VE in accordance with BM_VEARM (Figure 2) is defined as a hierarchical model of multiple levels of the enterprise with the broker inserted between two consecutive control, or management, levels (principal/broker/agent) of the enterprise, or manufacturing, process control system, which ensures integrability, distributivity, agility, and virtuality (Putnik, 2000). Integrability is considered the capacity of an enterprise to access (interconnect) existing heterogeneous resources. From an enterprise point of view, a resource is an object that is used to conduct or support the execution of one or more processes (e.g., materials, machines, tools, computers, human operators, time, money, software, etc.). An enterprise is also a resource if it is contracted by another enterprise to render a service. In this work, a member of the group is a resource inside and outside the organization. The integration of heterogeneous resources should occur at low cost. This is a characteristic of *open system* architectures.

In the context of virtual enterprises, distributivity is considered as the capacity the enterprise has of integrating and operating needed resources at a distance, remotely. The concept of a competitive enterprise implies the ability to access the best resources: simply seeking the cooperation of other enterprises, purchasing components, subcontracting other companies, or creating consortiums, as well as the capacity to manage all business and manufacturing functions, *independently of distance*, using wide area network (WAN) technologies and corresponding protocols, for example, the Internet. Therefore, the distributed manufacture/enterprise system is defined as a system in which performance

does not depend on the physical distance between the elements of the enterprise.

It is necessary for an (virtual) enterprise to be *agile*, that is, to have a capacity of rapid *adaptability* or rapid reconfigurability between two operations (*off-line*) to quickly respond and/or proactively act upon dynamic market changes.

Virtuality is introduced with the objective of further improvement of the performance of an agile enterprise; that is, virtuality should provide the system with the capacity of reconfigurability during the undergoing operation (online reconfigurability) without the interruption of the operation and, in this way, improve the “response” time. Virtuality, combined with agility, distributivity, and integrability provides the enterprise with highest level of flexibility and proactivity.

The main agent of agility and virtuality is the broker, whose role is to reconfigure the (VE) organizational structure during an operation in real time or between two operations. The broker acts as an interface between two hierarchical control layers in a way that one layer is hidden from the other and with the capability to reconfigure the VE architecture without interruption of the operation on the other control level in order to avoid any loss of time due to the reconfiguration. The broker action between two operations, which obviously implies interruption of the process, is permitted by BM_VEARM, but it is a relaxed case in terms of the VE by BM_VEARM.

To resume the above, we can now better define what we think a virtual enterprise (Putnik, 2000) is:

The virtual enterprise (VE) is an optimized and synthesized enterprise on a universal set of resources (a set of “universal resources” is understood to be any type of resource, primitive or complex, that can be distributed globally and can be located both inside and outside the frontiers of the enterprise. This implies VE as a network, or consortium, of enterprises, that is, networked enterprise over globally distributed independent enterprises, or partners, in the VE) with its physical structure substituted in real time. The project and control of the system is executed in an abstract or virtual environment.

The expression, “its physical structure which can be substituted in real time,” combined “in a virtual environment” provides the high level of flexibility and agility that the enterprise requires. The specific archi-

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