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COLLABORATIVE DESIGN SYSTEMS FOR VIRTUAL PRODUCT DEVELOPMENT IN THE PREMINV PLATFORM

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Abstract: *Development teams involved in the product development are often geographically and temporally distributed. There is a high level of outsourcing in the actual product development efforts .It is then possible to say that enterprises give rise to a special type of virtual enterprise (VE), in which each company maintains the greatest flexibility and business independence. This paper gives an overview of the new Web Services technology based of the software solutions, discusses the critical issues of the virtual product development, presents the roles of the virtual teams, and build a general architecture of an experimental platform for training, research and consulting in the new digital economy, located in the PREMINV center at the University "Politehnica" of Bucharest.*

Key words: *collaborative design system, virtual enterprises, virtual teams, Internet/Intranet/Extranet-based systems, outsourcing.*

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1. INTRODUCTION

Enterprises are now facing growing global competition and the continual success in the marketplace depends very much on how efficient and effective the companies are able to respond to customer demands. The formation of virtual enterprise network is taking up momentum to meet this challenge. The idea of virtual enterprise network (VEN) is meant to establish a dynamic organization by the synergetic combination of dissimilar companies with different core competencies, thereby forming a "best of everything" consortium to perform a given business project to achieve maximum degree of customer satisfaction [1]. In this emerging business model of VEN, the decision support functionality, which addresses the issues such as selection of business partners, coordination in the distribution of production processes and the prediction of production problems, is an important domain to be studied [2]. A virtual product development by the virtual teams in a VE is a temporary alliance of teams that come together to share skills, abilities and resources in order to attend a project opportunity and whose cooperation is supported by computer network and adequate tools, competencies and special application software. VE operates as nodes in a network. A different architecture, engineer and construction organization, a fresh virtual team [3] is needed every time for every new project. Innovative techniques to co-ordinate and manage information, resources and documents need to be developed to integrate successfully and reduce lead times, increase quality and keep within budget constraints [4]. Consequently, the partners in the VE need to exchange legacy data and migrate with other systems outside their own secure corporate boundary. In order to achieve collaboration between different actors in the VE, there needs to be common processes supporting the distributed product development process [5]. In this context a VEN is a way for businesses to achieve virtual scale enabling them to operate as if they had more resources and capacity than they actually have. A Virtual Enterprise Network (see Fig. 1) needs its own Private Member Collaboration System to communicate and develop its projects and bids. We present in the figure 1 a general architecture for the virtual enterprise environment for the collaborative design system implemented in the PREMINV research centre.

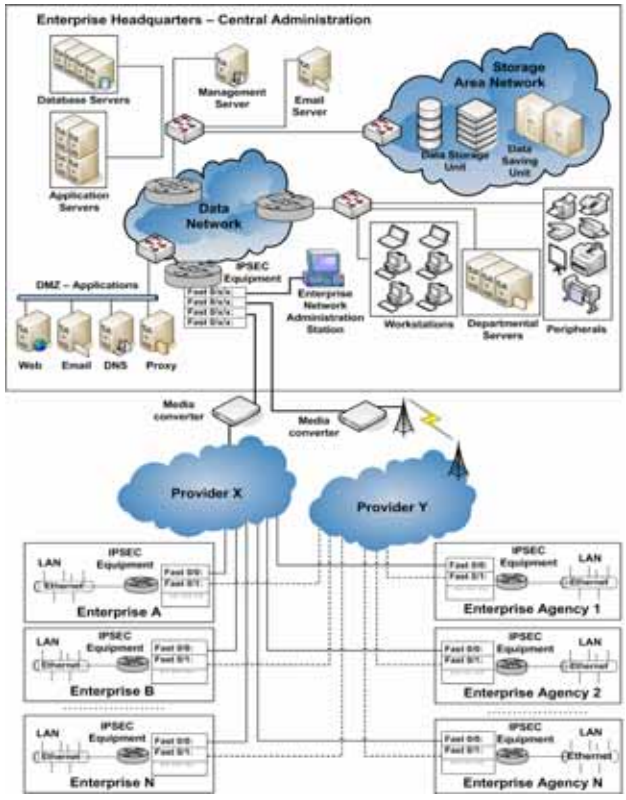

Fig. 1. VEN solution in the PREMINV e-platform.

2. VIRTUAL TEAMS AND VEN SOLUTION

Virtual collaboration for networked business teams is a complex and challenging activity in which there are major important components to be accounted for [6].

Virtual business teams do not operate like traditional physical teams, as their requirements reflect a whole new way of communicating, working collaboratively, sharing information and mutually supporting other team members [7, 8]. The new technologies and approaches required to achieve this are completely alien to most of our present organizational culture (`www.virtual-organization.net`). And this is why they fail. Cooperative processes are not the automatic results of implementing collaborative, real-time communication technologies, but the result of a carefully designed and systematically maintained virtual team development plan (see Fig. 2).

For those of you who have already exposed themselves to the positive advantages made available by the use of cutting-edge communication and collaboration technologies, this should sound as a familiar melody. How many times have you been witness to technologically-based collaboration projects that have miserably failed? Why is there so much disjoint between technology potential and the productive use that business team members make of them? If the solution is not in the technology enabling such networked business teams to easily interoperate, where is it then? Who are virtual teams in a virtual enterprise network (VEN):

- Corporate Teams involving a collection of staff from different functions including IT and Key Business Functions;
- Collaborative Businesses Networks involve groups of businesses (SMEs) who have come together to operate as a collective in areas such as business development and product development;
- Collaborative Supply Chains generally centre round a major customer/OEM and a number of its suppliers. The major customer can mandate and encourage technology usage to a certain extent;
- Interdepartmental Government Teams are where a number of central or local government departments such as healthcare, economic development and education come together for a specific project;
- Inter-departmental and often inter-company;
- Inter-disciplinary with a mix of skills and professions from different functions;

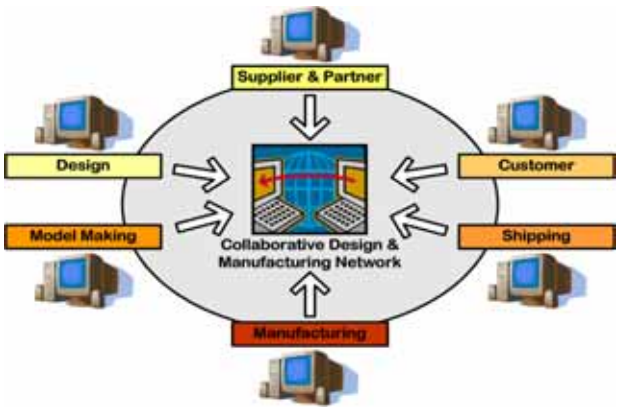

Fig. 2. Web based integration for cooperative systems.

- Project-based - formed to deliver a specific project by a specific deadline (rather than management or best practice sharing-oriented);
- Highly Mobile;
- "Political" with the need to manage the expectations of multiple stakeholders;
- High profile/high risk - engaged in strategic/creative work which is higher risk and more challenging than the typical work assignment;
- Multi-location - not based in a single location;
- Mixed Involvement of full-time and part-time players - typically a small inner core of full-timers complemented by a larger outer core of part-time reviewers and specialists..

The ideal solution framework suggests making a systematic pragmatically reference to the key interdependent components of a successful virtual business team - each of which must be set-up correctly and then kept in constant equilibrium as the team evolves and produces results [8].

3. COLLABORATIVE DESIGN SYSTEM

In order to permit a flexible answer to customer requirements, many products have been modularized in their design to the extend that entire areas of development such as, for example, the design of electrical components can now be outsourced to external suppliers or service providers if required [8, 9, 10]. A majority of consumers and investment goods produced in the engineering domain now consist of a number of modular mechanical, electrical and control software components. For example, in the context of a mechatronics system, the idea is to find the best mechatronic system solution, not the best mechanical solution or the best electronic solution or the best control solution or the best software solution. The solution is the set of values for the variables, which either maximize or minimize, as desired, the value of the objective. In design for competitive advantage the objective would probably be cost, quality or value, which is a combination of the two. Also, both the mechanical characteristics of these modules and the electrical system and software, must be integrated to form a co-operative engineer system. Usually the organizational and systematic division into mechanical and electrical product development is the obstacle to creation of a common virtual product [8].

We propose in the PREMINV e-platform an Internet/Intranet/Extranet based tools, based on the VEN solution, for a collaborative framework for interdisciplinary communication in the conceptual design stage with multidisciplinary optimization [8, 11, 12].

To support multidisciplinary optimization a base definition must be defined as a common ground among the product development actors (see Fig. 5). The base definition contains two major types of information, an entity hierarchy and an entity attributes. The entity hierarchy describes how the components of the system are grouped together and the entity attributes for a part include, for example, moments of inertia, material properties etc. The design parameters are considered as attributes of entities in the base definition, and remain with the entities when they are regrouped in engineering views to

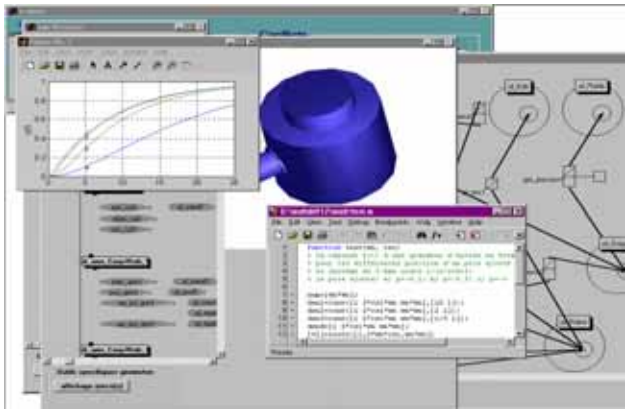

Fig. 3. An example of the Engineering views. create.

assemblies. The feature-based design parameters serve as a common language to support design trade-off across various engineering disciplines where relevant performance of the systems is measured. The ability to work with diverse multidiscipline teams members to successfully reach a goal objective. For a multidisciplinary group, the language of the system must do is independent of the languages of the disciplines, but is common to all. Thus, functional language should be a language of choice for multidisciplinary communication. Based on the integration of entirely separated department within the development a product it is possible to define an enhanced process for the collaborative development of product properties in partnerships. In order to facilitate effective communication across disciplines, this system argues that an integrated software framework should enable sharing and capture of multi-criteria design proposals, design semantics, critique, and explanation and change notifications. The product data to be browsed consists first of all of a base definition and engineering views.

Part of view model is the construction of an entity hierarchy starting with the database definition entity hierarchy according to the needs of the particular engineering discipline at the actors [10]. The actor executes the simulations and analyses in his working environment (Fig. 3).

- The "product model" is composed of a knowledge model (features and production rules) and of data model. The different actors can use a set of predefined features and those can be shared. Some rights are given to specific actors in order to read, to add or modify a particular or universal feature. A main interest in using feature is to be able to declare the instance of this feature without to be immediately obliged to define the values of their characteristics. Instead of specifying a value for a characteristic, an actor can use the constraints on this characteristic.
- This system can be developed in two models alternative:
- In the first model alternative, the different team members will perform varying engineering analyses with local compute resources. These local compute resources include hardware such as workstations and PCs and software such as simulation and analysis tools. Different team members need access to the some of the same computational analysis servers such as an element solver on a supercomputer, besides the process management and server utilities. Their tools should be integrated with the tools of other team members and the shared servers through the common intelligent repository of product and process data and agreed-upon protocols.
- The second model alternative of product development environment considered was a fully distributed development environment (There would not be segregated local computing resources for each team member). All computing resources would be distributed across the network (Through an entry point to the network all simulation and analysis tools may potentially be accessed).

In addition to the team's full-time members, the team also includes contributing members who are recruited for specific components of the project. As such, a core group is responsible for leading the project and a sub-group is involved in specific components of the project [1]. While the full time employees form the central core of the team, experts in the different problems of the project (control systems, mechanic systems, electronic systems, programmer's etc.) are also team members. The system enables the different team members to retrieve a wide collection of product system data to start engineering analyses, and store the analysis results. Other team members, thus allowing for a collaborative design of the product system can use simulation results stored by one team member. The system provides a catalogue of independent objects, i.e., models, simulation scenarios, analysis results, and the product configuration hierarchy, stored in the global database and manages versions of each of these objects produced during the course of the design analysis and development process. It gives the members of an enterprise-wide product development team a convenient, uniform interface to the global product data from different platforms. The product model is composed of a knowledge model and of data model. The major functionality of the engineering views are view model creation, data consistency with base definitions to support multidisciplinary design trade-off and mapping definition to automate view model creation during design iterations. As the translation task propagation and coherence management have to assist each professional team.

The idea of virtual enterprise network (VEN) is meant to establish a dynamic organization by the synergetic combination of dissimilar companies with different core competencies, thereby forming a "best of everything" consortium to perform a given business project to achieve maximum degree of customer satisfaction. In this emerging business model of VEN, the decision support functionality, which addresses the issues such as selection of business partners, coordination in the distribution of production processes and the prediction of production problems, is an important domain to be studied. Innovative techniques to co-ordinate and manage information, resources and documents need to be developed to integrate successfully and reduce lead times, increase quality and keep within budget constraints [13, 14]. Consequently, the partners in the virtual enterprise need to exchange legacy data and migrate with other systems outside their own secure corporate boundary. In order to achieve collaboration between different actors in the Virtual Enterprise, there needs to be common processes supporting the distributed product development process.

Virtual teams do not operate like traditional physical teams, as their requirements reflect a whole new way of communicating, working collaboratively, sharing information and mutually supporting other team members. A virtual product development by the virtual teams in a virtual enterprise is a temporary alliance of teams that come together to share skills, abilities and resources in order to attend a project opportunity and whose cooperation is supported by computer network and adequate tools, competencies and special application software.

4. CONCLUSIONS

In the PREMINV platform, we are creating a hardware-software environment for implementing the above-presented concepts, imposed by global collaborative manufacturing and Internet/Intranet technologies. This platform demonstrates an approach to solve many of the problems of interoperability, heterogeneity of platforms, and data sharing. Organization and storage of technical knowledge in such a way that it can be used in different situations and for new products being developed and Knowledge based assistance in developing new products and processes [15]. The integration of workspaces in a co-operative environment has been demonstrated through the use of internet/intranet/extranet technologies. In the paper we define a hardware-software platform needed to train students, the future engineers, who must be able to work in the virtual enterprise (VE), imposed by the globalization of the manufacturing and competition. Within the framework of its activities on collaborative engineering, the PREMINV set up training projects aiming at developing competence's in this field with objectives of education training but also research, and industrial transfers.

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