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INTERNATIONAL CONFERENCE of SCIENTIFIC PAPER
AFASES 2011
Brasov, 26-28 May 2011

THE ROLE OF VIRTUAL COLLABORATIVE ENGINEERING IN PRODUCT DEVELOPMENT

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Abstract: *In the context of network economy (net economy), the society based on information and knowledge products and collaborative work processes are changing their nature by turning through virtualization. The traditional work teams are transforming in virtual teams and are operating within workgroups from/at long distance of the main organizations headquarters. Collaborative Engineering is a virtual methodology that tends to bring to upstream knowledge professions involved in downstream design as preparation of manufacture, production and marketing. It involves effective participation of different professions specialists in the earliest stages of conception.*

Keywords: *collaborative engineering , virtual product,, computer-aided engineering*

1. INTRODUCTION

Virtual Collaborative Engineering (Integrated) is a methodology that tends to bring to upstream knowledge of the professions which are involved in downstream design (the manufacturing preparation, production and marketing). It involves effective participation of specialists from different professions starting with the earliest stages of conception. The highly dispersed and globalized nature of product development today has changed the way that product development teams come together on a design.

Tabelul 1. The components of a collaborative system

Material Component	Human Component	Energy Component	Information Component
Activity	People	Energy Resource	Procedures
Place			Flows
Material Resources			

Virtual meetings, emailed design data and lightweight design visualization have replaced white board sessions as product development departments become complex design chains dispersed across time zones, legal and regulatory boundaries, and languages.

2. THE COLLABORATIVE SYSTEMS

A collaborative system is defined by a large number of users or agents which are engaged in a shared activity, usually located in distant locations. As part of the distributed aplications, the collaborative systems represent a separate category, because the agents within the system are working together in order to achieve a common goal and having a great need to interact each other. Table 1 shows the components of a collaborative system:
Collaborative systems from consciousness society are ordered after collaborative systems from the knowledge and information society, beeing systems that include a uniform set of procedures which are governing relations between components. In the consciousness society, the human component plays a significant role over the conduct of any collaborative system. A collaborative system is one that works with people and other systems to get jobs done faster. Each person and each software program has various strengths and weaknesses. Working alone they can only accomplish so much. Working together, strength combines with strength to increase the likelihood of success [3]. The collaborative systems are an important subject of knowledge-based society and an important part of the human activities is involved in this field.

The collaborative systems in production are designed to increase production capacity and product qual-ity in different units producing goods and services;
Collaboration Engineering is an approach to the design of re-usable collaboration processes and technologies meant to engender predictable and success among practitioners of recurring mission-critical collaborative tasks .
Collaborative/ integrated engineering is defined as a methodology that allows integrated and simultaneous conception of products and production processes and associated maintenance. This ensures consideration, since the origin of all phases of product life cycle, starting with conception and ending with disposal, integrating quality problems, deadlines, demanding user costs, etc.

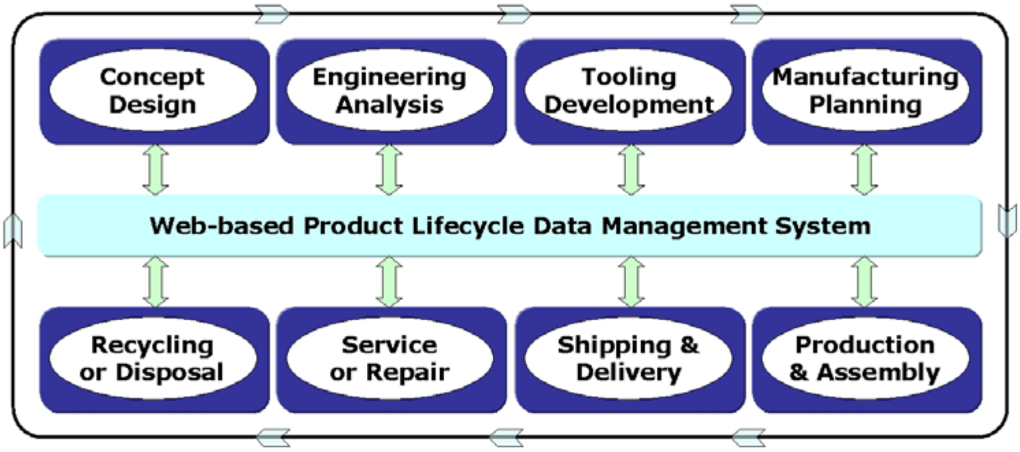

Figure 1. The web-based Product Lifecycle Data Management System

3. INFORMATION AND COMMUNICATION TECHNOLOGIES

Improved information and communication technologies (such as linked CAD tools, shared databases of engineering information, e-mail, and voice mail) can serve to break down common barriers to communication and to increase the capacity of an organization to transfer information [1], [2].
Whitney [4] points to many examples where innovative CAD tools are being successfully used to facilitate concurrent engineering in complex development projects. Though this approach may increase information transfer, it might not be sufficient for coordinating team activities since the transfer of the most

essential and difficult information is not assured. The web-based Product Lifecycle Data Management System is shown in the figure 1.

4. COMPUTER-AIDED PRODUCT DEVELOPMENT

The virtual product comprises a digital assembly of its part models. The parts are modelled in 3D using computer-aided design (CAD) programs and saved in standard formats (ex. IGES and STEP) for exchange between different programs. Computer-aided engineering (CAE) programs enable simulating the product mechanism and optimising the shape of each part under static/dynamic loads by simulating the internal stresses. The part models can be sent to a rapidprototyping (RP) system for automatic fabrication of a physical replica for form fit and function testing. The tooling models (moulds, dies, jigs and fixtures) can be quickly developed by modifying the corresponding part models. Computer-aided manufacturing (CAM) programs enable planning, simulation and optimisation of process parameters. Finally, computer-aided inspection systems enable automatic comparison of virtual and real parts for quality assurance.
The 3D model is the connecting link in various CAX programs (X=design, engineering, manufacture and inspection). The programs generate a huge amount of data, which includes the solid models of different iterations and previous versions of products, as well as tooling, materials, process plans and results of analysis. This necessitates a systematic approach to data storage, verification and retrieval, which is achieved by a product data management (PDM) system.

The Collaboration Engineering way working describes the steps that need to be taken to design collaboration processes. In other words, the way of working defines the design activities in the Collaboration Engineering approach. Overview of Collaboration Engineering Way of Working is shown in the figure 2.

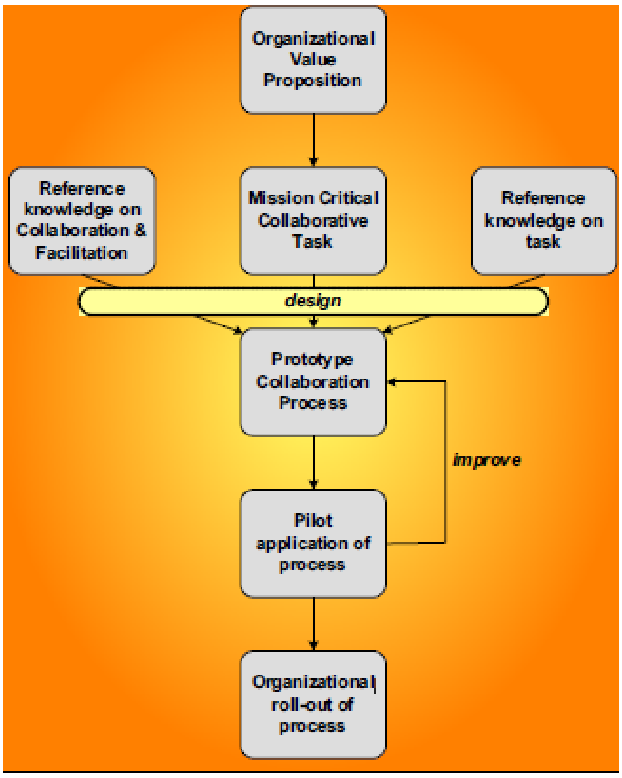

Figure 2: Overview of Collaboration Engineering Way of Working

There are a number of phases that can be distinguished when we are designing a collaboration process for a mission critical collaborative task that will deliver organizational value.

It is expected that these modeling tools, a.k.a. CACE (Computer Assisted Collaboration Engineering), can greatly increase design efficiency and effectiveness. Together these and other research challenges constitute an exciting agenda for the coming years. The practical value of Collaboration Engineering has been demonstrated convincingly. The Collaboration Engineering research community has only recently begun to take up the academic challenge yet the results so far are promising and stimulating.

4. COMPUTER-ASSISTED COLLABORATIVE SYSTEMS

Computer-assisted collaborative systems present a immediate application and major advantages as follows:
1. creative activity in research, design and development of new products and applications in collaboration wit other authors areas such as:
- CAD / CAM (Computer Aided Design / Computer Aided Manufacturing);
- concurrent engineering ;
- CASE system.
2. administrative and economic processes such as:
- marketing, sales, purchasing and financial (management of orders and invoices, etc.). activities;
- transactions processing;
- workflow management ;
- staffing;
- office activities.

To use and develop computer-assisted collaborative systems we should consider the following key elements:
- group awareness;
- space, collections and types of shared information;
- methods and types of communication;
- knowledge of developing environmental facilities;
- multi-user interfaces;
- coordination within the group;
- support the heterogeneous and open environment that integrates single user applications.

4.1 Specific functional requirements for systems and collaborative engineering development platforms.

To be functional in a given organizational and economic framework, systems and collaborative development platforms must meet the following general requirements:
- possibility of integration with external sources - the information origin for cooperating community is "groupware" external environment (examples: tools for PCs, various collections of information from relational databases, etc.);
- platform independence - "groupware" applications often begin as departments implementations, further results can be extended on a much wider area; platform independence is a basic element to ensure extensive use and investment protection;
- Mobility - "groupware" infrastructure must be able to support many geographically dispersed locations, including a heterogeneous range of equipment;
- common coexistence of multiple drive applications - economic relations are linking economic partners as key actors in business processes automation, requiring the ability to easily extend the application page by successive additions.

4.2 Collaborative Product Development (CPD) . The challenge of keeping an engineering team working efficiently without getting in each other's way can be difficult to manage. Product development projects now involve people from multiple departments trying to collapse product introduction lead times. As if this was not complex enough, many companies are distributing these resources around the globe and forming virtual teams of people from different companies. Global design, a commonly cited alternative to the term of collaborative product design, has cost benefits that are very attractive to today's manufacturing, but adds new communication, control, and collaboration challenges and intensifies existing problem areas such as protecting intellectual property.

The essence of collaborative product design revolves around the need to involve the entire product development team – including the company’s personnel, customers and suppliers – during the development phase when a product’s most distinctive characteristics are defined. More participation by team members early in the process sharply reduces the need for changes later especially during tooling and manufacturing, eliminating delays and potential cost increases.

Product design and development are in the midst of a revolution thanks to collaboration technologies. The tools used for product design, the process of gathering input and revising designs, and the roles of those in the extended enterprise are all changing. A new generation of online collaboration tools integrated with traditional CAD is transforming the product development phase .

Everyone in the product development process participates, sharing and building on one another's insights and ideas.

New technologies allow people from different companies with incompatible computing systems to meet virtually on Web environments. Instead of simply sending data from PC to PC, Web tools let people talk via their computers while looking at shared documents, carry on e-mail chats, and use electronic white boards where two or more people can draw pictures or charts, in real-time, as others watch and respond

The benefits of such collaboration are all encompassing. Using the collaborative platform to optimize communications, schedule and to resource usage, manufacturers can significantly reduce the cycle time to bring new products to market. They can implement solutions like DiFac for design and production tasks in order to reduce costs. By exploring design alternatives together, team members can leapfrog to truly innovative solutions. CPD is in demand because of its potential to cut product development cycle times.

Design collaboration entails all the issues associated with discrete manufactured products, as well as those that are engineered or configured to order. These products can have a long procurement cycle, a seasonal cycle, or a short production cycle, but the key similarity is that they all start with specification documents, e.g., line drawing, schematic diagram and engineering drawing. This type of collaboration requires the specification documents to be shareable and modifiable by both parties, with appropriate audit trails, particularly with respect to the effective bill of materials and process plan referencing the documents.

In this space, computer-aided design vendors such as CATIA can leverage their design products. Traditionally, in this first phase, one party sends the document to another for review and costing via e-mail or regular mail and then collaborates on the document via telephone, e-mail, or regular mail, creating significant delays and cost overhead. The next step in the product design cycle may be to send colour/material samples for approval/pricing, as in textiles which are the industrial sector of PPS. Collaboration tools that support this phase must manage the activities associated with it.

4.3 Product Development Teams.

Collaborative work can be successful if all members show goodwill and responsibility. Collabo-ration is necessary to deal with such large projects. The collaborative and essentially social character of work needs to be appreciated in un-dertaking interactive systems design. A collaborative system creates a environment where people can work better together, can share information without the constraints of time and space, being characterized by three fundamental aspects: joint activities, sharing environment and way of interaction. The solution lies in connecting the team members through a digital communications network and providing them appropriate software programs to create, analyse and modify a virtual model of the product. The model and results are stored in digital form in a central or distributed server and accessible to all team members over a local area network or Internet. This approach to productdevelopment is referred to as Collaborative Product Lifecycle Engineering.

Product development teams are no longer constrained within the same four walls of the department. They are spread across different facilities, states, and increasingly across the globe. This has brought new challenges to product development, as designers must find new ways to share designs with collaborators who may never be in the same room. Companies are finding some measure of relief through a number of collaboration technologies that can help bring dispersed teams together. One solution that may often be overlooked but has a lot to bring to the collaboration table is video-conferencing .

5. THE CATIA INSTANT COLLABORATIVE DESIGN

The following scheme (Figure 3) aims at illustrating how the Instant Collaborative Design application works.

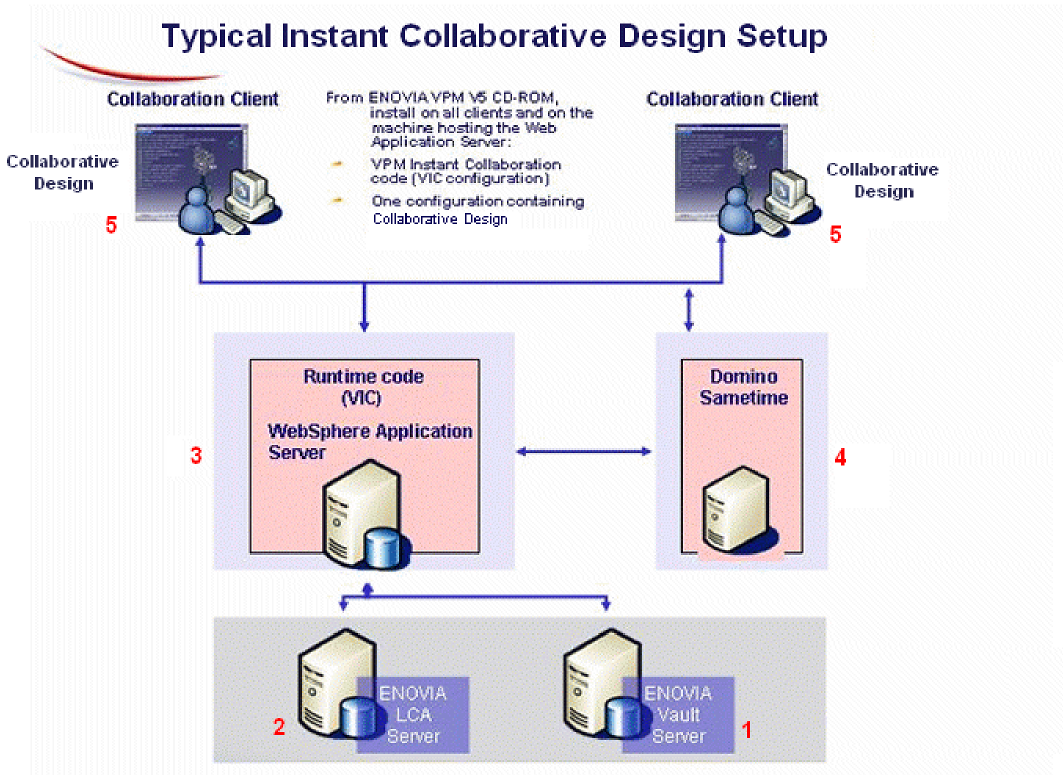

Figure 3. The CATIA Instant Collaborative Design application is based on a 3-layer system.

Storage layer: The first layer is made up of the ENOVIA Vault Server (1) and of the ENOVIA LCA Server (2). The physical data (briefcases created by the users) are stored in the ENOVIA vault (1). Sharing data (design collaboration data, and workspaces, data concerning which briefcase belongs to which workspace) are stored in the ENOVIA LCA database (2).

Communicating layer: The second layer made up of the WebSphere (3) and the Domino (4) servers, enables the ENOVIA Vault Server (1), and the ENOVIA LCA Server (2) to communicate with CATIA (5). Websphere is dedicated to the collaboration, whereas the Domino server is designed to the connectivity.

Design layer: The last layer made up of CATIA (5) enables the user to create Design.

5.1 ENOVIA SmarTeam PDM Solution.

ENOVIA SmarTeam® PDM, the core of PDM Solution, is the leading Windows-based, web-centric product data and workflow management solution for small to medium sized businesses and departments of large enterprises. ENOVIA SmarTeam® PDM leverages a company's knowledge base by enabling effective information collaboration and improved data flow within an organization.

Now, ENOVIA SmarTeam® PDM broadens its PDM functionality into a robust, secure and web-based Collaborative Product Commerce solution. The shift from Product Data Management to Collaborative Product Commerce is as natural as was the shift from paper-based processes to electronic PDM systems. In addition to the benefits that PDM has brought to the product development process, CPC enables "real-times" product collaboration with business partners across the globe.

Rapidly implemented, scalable, customizable and uniquely cost-effective, ENOVIA SmarTeam® PDM provides best-in-class product lifecycle collaboration solutions for product teams in the extended enterprise and across the supply chain. ENOVIA SmarTeam® PDM Solutions address industry-specific business needs by managing all mechanical, electronic and software components in today's complex product development environment of the Fabrication and Assembly (F&A), Electrical and Electronic (E&E), Automotive and Aerospace, Life Sciences and Process industries.

ENOVIA SmarTeam® PDM V5 Solutions impact businesses' bottom-line profitability by managing and leveraging corporate product knowledge, and linking business processes together, enabling companies to improve innovation and product quality, reduce costs and times-to-market, and comply with industry standards.

Smarteam Best Practices Domain extends PLM solution benefits by optimizing product lifecycle processes. This platform use to empower their user communities, applying them in different modular combinations to tackle priority manufacturing & business needs.

Over the years, the concept of PDM has broadened considerably as the technology has evolved.

Once considered convenient way to manage CAD files, PDM buying vision consist of these five capabilities and they are as follows:

5.1.1. Document Management. Data vault and document management provides for storage and retrieval of product information. This discipline encompasses document registration, storage, access, approval and distribution.

5.1.2. Product Structure Management. Product structure handles Bill of Material, product configuration, and associated versions and design variations. It also handles the hierarchical organization of functions and systems or parts and assemblies.

5.1.3. CAD Management
It provides seamlessly integrated PDM solutions to CAD mainstream and office applications in order to supply a common collaboration platform among engineering teams. This will in turn, create synergy between people, information, applications & business processes by providing an affordable easy-to-use data management solutions.

5.1.4.Workflow and Process Management
Workflow and process management controls procedures for handling product data and provides a mechanism to drive a business with information. Change management is a form of Processes Management of formalizing and securing product definition data. Workflow - the method of assigning and executing work in a desired sequence.

5.1.5. Configuration Management
The process of managing products, facilities, and processes by managing their requirements, including changes, and assuring conformance in each case. There are two basic related

concepts in Configuration Management. The first is effectively and this is defines when a change is effective, either as a range of dates or by ranges of product units, using serial numbers. The Second being its' Features, Variants and Options and the ability to add "fluid" configurations by allowing an item in an assembly to only apply to some of the final products. (ex: a car may have a feature called "roof" where the variants are "convertible" or "hardtop". One of the variants is required to build the product. The "pin striping" option may be added without affecting other items. Based on issues of concurrent engineering methods and tools , and current ITCs performances, collaborative design is increasingly integrated within in automotive and aeronautics industries in order to reduce costs and lead times, but also to improve product quality and value .

6. CONCLUSIONS

Collaboration Engineering is a design approach for recurring collaboration processes that can be transferred to groups that can be self sustaining in these processes using collaboration techniques & technology. The above sections have presented the different 'ways' of the Collaboration Engineering approach.

The collaborative conception or co-design of products and associated processes takes place in space, through meetings of experts of different professions and in time, by organizing parallel activities.

In this way now arises the new products development issue. The integrated approach is ensuring short terms for products conception and launch, increasing quality and reducing production costs.

The timely relevant and easily accessible obtained information is a key element in the operation of modern companies. In the company systemic approach, information system is linking the components of management and other systems at the micro level.

REFERENCES

1. Hauptman, Oscar, and Thomas J. Allen. *The Influence of Communication Technologies on Organizational Structure: A Conceptual Model for Future Research*, Working Paper, MIT Sloan School of Management. 1987.
2. Jakiela, Mark J., and Wanda J. Orlikowski. *Back to drawing board? Computer-mediated communication tools for engineers,* Working Paper, MIT International Center for Research on the Management of Technology. 1990
3. Cristian Ciurea, A Metrics *Approach for Collaborative Systems*, Economic Informatics Department, Academy of Economic Studies, Bucharest, Romania, Informatica Economică vol. 13, no. 2/2009 41
4. Whitney, Daniel E. *Electro-Mechanical Design in Europe*, University Research and Industrial Practice", ESNIB. vol. 93-01, pp 1-52.
5. www.aberden.com