A CUSTOMER-SUPPLIER SYSTEM FOR DISTRIBUTED GLOBAL PRODUCT MANAGEMENT

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Abstract: Globalization of many industry sectors is increasing competition in manufacturing. Various strategic partnerships and alliances with other companies are becoming very common. There are many critical issues for companies managing the complex business and product development processes. People involved in product development often work in geographically different locations and time zones. Paper-based processes are inefficient, time consuming and cause redundancy in documents and miscommunication. Uncontrolled email without proper coordination of projects and people impede knowledge management.
This paper presents a web-based architecture for enabling streamlined customer-supplier interaction throughout the product lifecycle. Our distributed product management (DPM) approach is designed to minimize time-delays and improve communication during interactions between distributed teams. A secure document repository allows users to upload, browse and download project-related files. Messaging utilities and scheduling modules provide tools for executing and tracking the progress of the project. A web-based multi-user 3D CAD collaboration module allows for documents and CAD models to be associated logically. Customers can share information while restricting access to file level. An implementation of the DPM system is discussed throughout this paper.

Keywords: Collaborative Design, Web-based Collaboration, Product Lifecycle Management, Thin Client, Document Management

1. Introduction

The multi-disciplinary nature of a product requires involvements of people with different abilities located in geographically separated regions

during the entire lifecycle of products. External suppliers now fabricate 50-80% of all components in products from Original Equipment Manufacturers (OEMs) [1]. Geographically and temporally distributed environment results in discontinuity of workflow and higher incurred cost in communication between them.

As products become more complicated with higher customer expectation on them, design and management processes have also become complex to meet these requirements. Many design practices rely heavily on prior knowledge. Hence, utilization of prior design knowledge often becomes related to the efficiency of the company. One of the primary problems is that there is no easy way to manage or organize the history of design data.

We have identified the components needed for seamless multi-company project management process below:

- Ability to find and access documents, especially from previous projects
- Remote access to the project (data and workplace)
- Remote collaboration on CAD/document data
- Controlling access privilege of users on project data
- Message management in project
- Workflow and task management

Use of Internet-based platform, increase in bandwidth of communication, use of scalable architectures, and proper design of software provides a means to achieve distributed project and process management.

1.1 Product and Project Management

Product Lifecycle Management (PLM) is a strategy whose goal is a seamless, electronic-based process for managing the different phases of the life cycle of a product. These phases span concept, design, manufacturing, maintenance, and disposal of the product in the aftermarket environment [2]. The PLM system idea is new in the market and it is expected to grow 20%-30% annually [3]. PLM systems in general provide tools for companies to help in their product development processes. A fully supportive framework in collaborative multi-company interactions has not been developed in PLM implementations. Many systems are still focusing on a repository of product data or on individual components. Since many companies use different software systems internally, interoperability between systems, especially in CAD formats, is a still a major problem in inter-company interactions. *Figure 1* shows the bottom-up approach from the basic components in a collaborative environment to a higher-level project management system.

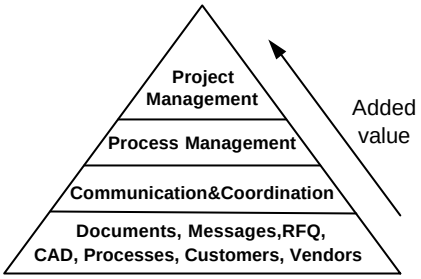

Figure 1. Distributed Product Management

Our vision of distributed product management is a key part of the PLM objective. One of our goals is to keep track of the interactions between vendors and suppliers to promote early involvements of all teams in the product development process. From following discussions, we will describe our work and the modules of the system.

2. Overall architecture of the System

DPM is implemented in a multi-tiered platform. In our present implementation, DPM is structured as a centralized control system using a thin-client architecture. *Figure 2* shows a schematic representation of DPM architecture. A multi–tiered architecture provides for easy development of external modules and better control over the structure.

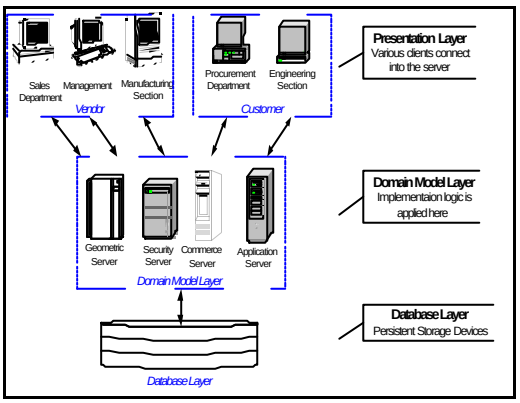

Figure 2. DPM System Level Architecture

DPM is a platform that streamlines collaborations and interactions for inter-organizational product and project management. An industrial project

can be broken down into a set of well-defined interactions between two classes of users, i.e. the customer who wants a specific product or service to be developed and the supplier who is capable of delivering it. Furthermore, in a typical industrial environment, the types of users largely depend on the different processes involved during the course of the project. DPM models this complex user structure by first broadly classifying clients into two representative categories – Customers and Suppliers. Individual users are then modeled into the system based on a hierarchical mapping structure. Depending on the role and access rights, users can be dynamically grouped into different categories enabling secure and safe management of users.

2.1 Implementation

The web-server currently hosting DPM is Apache Jakarta Tomcat [4]. Development of the domain layer is using various technologies including JSP (Java Server Pages), Servlets and Java Beans etc. JNLP (Java Network Launching Protocol) and JSDT (Java Shared Data Toolkit) are employed in communication between the web-server and collaboration server [5]. Oracle™ database system is used to implement the database layer. Since the deployment is a thin-client, the presentation layer is essentially the web-browser. Currently, DPM is tested for Internet Explorer™ 5.0 and Netscape™ 7.0.

2.2 Modules of DPM

DPM is structurally separated into many modules based on the functionalities. Each module was designed and developed based on the feedback received from the numerous visits of manufacturing companies. Each module maps to a certain requirement, which already exists in brick-and-mortar form or to functionality the industry believes it will benefit from. The modules currently deployed are:

- Project Administration
- User Management
- Group Management
- Document Management
- Change Request Processing
- Activity and Task Scheduling
- Message Mailing and Archive
- Instant Message Exchange
- 3D Collaboration

The modules communicate between each other according to user specifications. A high degree of interaction between modules makes DPM distinct from existing Product Data Management (PDM) and PLM Systems.

Project administration module encapsulates in it, the working of Activity and Task Scheduling module along with messaging which in turn works based on the definition of *Project* and *Group*. For example, documents stored in the system have links with a project it belongs to and in the same manner any communication such as messaging also tags along with it destination (group or project) information. Information can be exchanged among users in many ways. The most common form is sharing document repository and messaging. Information exchange is central for successful project management [6]. DPM provides a rich set of tools for the same. CAD collaboration is enabled by the 3D collaboration module and is complemented by the instant message exchange system. Asynchronous messages are handled separately. In this paper we will discuss some primary modules among those listed above.

3. Document Management

One of the problems in a multi-project oriented business environment is to streamline the flow of information through the course of a process. A majority of product information exists in the form of documents. As a project progresses between a customer and a supplier, there is a frequent exchange of documents between users or groups across companies and also within a company. In a paper-based system, it is difficult to systematically maintain these paper documents and make sure that the right document reaches the right person at the right time. The fact that different people need to access these files and work on them leads to a lot of confusion. For example, files may get lost since no history is maintained and it will become very difficult to search for a particular file among a large number of files. If many versions of a document exist at the same time, different people might have different versions with them, which leads to inconsistencies.

The growing complexity and magnitude of projects has resulted in an increase in the problems associated with manual document management and retrieval [7]. However, communication to and from third parties is still dominantly based on conventional means, such as telephones and faxes, Only 18% of all document transfers are based on true networking [8].

In order to make a project oriented business process successful, it becomes imperative to manage these documents in a way that they are accessible easily.

3.1 Solution for better document management

We aim to facilitate project-oriented business process management through electronic document management. We have developed a document management module where all the documents related to a project are kept in a central database. Originator of the document uploads the file to the central repository giving access rights to specific users or groups of users. The originator can also specify the earlier files, the uploaded file is related to. Some features are as follows:

- Any user within a project can upload any kind of file to a central database for the project - shown in *Figure 3*.
- While uploading the file, the user will be given an option to link the files to the CAD files that have already been uploaded for the project. When another user accesses that document file he will get a link to the CAD file it is related.
- The user will also be given the option to restrict the access of files to a few users as shown in *Figure 4*. This is important because in a company people do not tend to allow everybody to see all files. Some documents containing sensitive information are classified and only certain designated people in the organization have access to them.
- A collapsible, modifiable and expandable tree node structure as shown in *Figures 5* has been developed for the easy access of files.
- When a saved document is retrieved, the system shows users the available options. For example, if it is a MS-Office document, the system will allow users to view it in the web-browser or save in the client's system. And if the stored document is a CAD file, the system will show the possible options such as viewing or 2D/3D collaboration. (The 3D collaboration will be explained in Chapter 4).

Figure 3 shows the process snapshot where the current file (clampingset.stp) is to be loaded. The file is later to be linked to the CAD files that already exist in the project repository.

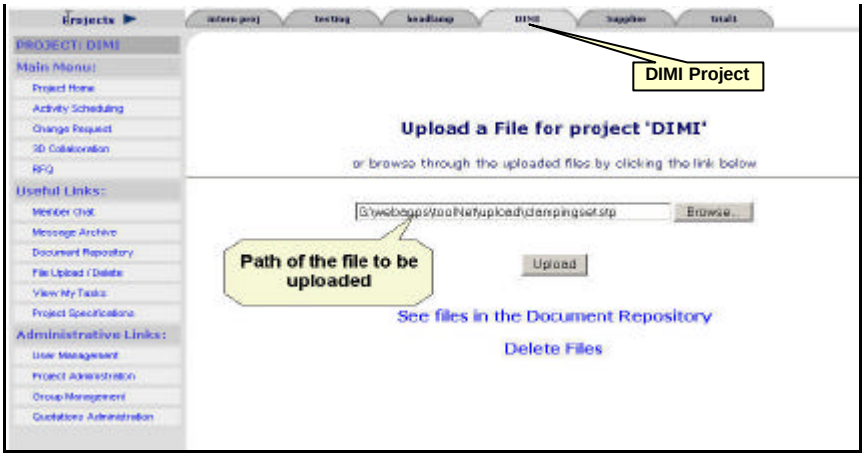

Figure 3. Uploading a file into system

The process we have developed has the ability to provide access to specific users or groups (see *Figure 4*). This gives security to the files because everybody cannot access them. A tree structure allows for access to the files (see *Figure 5*).

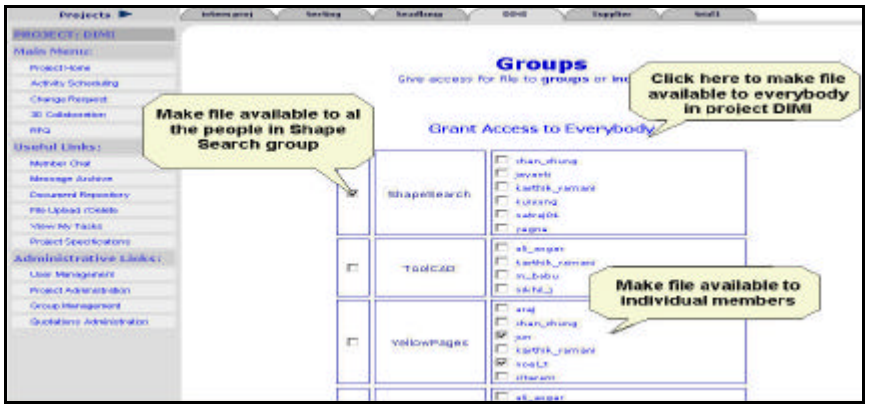

Figure 4. Setting Access Rights

The files have been divided into four main categories, Snapshots, CAD files, other documents, and Change Request Documents. Other Documents are any documents related to the project but are not snapshots (*.jpg files) or CAD files. Below these broad categories are the subfolders for different users within a project. Below in these subfolders one can find the files that have been uploaded by these users, see *Figure 5*.

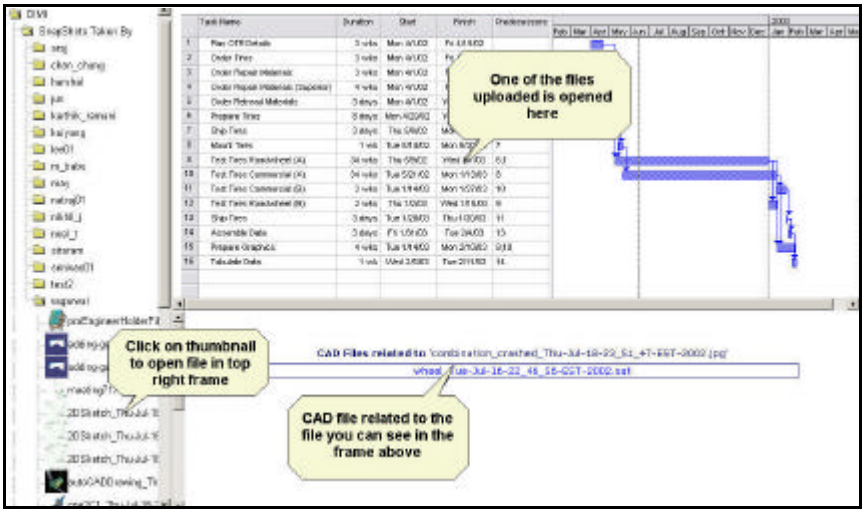

Figure 5. Adding image files into repository

As shown in *Figure 5*, a file in the collapsible tree structure can be opened on the right side of the window. Associated links for any related CAD files are shown in the window frame below.

4. 3D Collaboration and Chatting

Another important problem facing many companies is the amount of un-productive back and forth communication delays with their suppliers, especially on design changes. We have observed that increasingly more companies have started outsourcing their CAD design work. Through our interaction with companies in mid-west, it has been found that it typically takes 1-3 days for a customer to respond to supplier's questions regarding part geometry. An exchange of snapshot of actual CAD geometry is usually not sufficient to resolve the problem. Directly dealing with a three-dimensional model would give a better perspective in many cases. Hence, a web-based CAD collaboration tool is proposed that would allow users to bring in their CAD geometries and collaborate in real-time. Some of the needs identified are listed below:

- Eliminating non-productive time delays in communication between customer and the supplier.

- Reducing the frequency of face-to-face customer-supplier meetings, a very time consuming and costly affair.
- Hardship in keeping track of disparate discussions involved during the course of the project.

The functions targeted and achieved in our web-based 3D collaboration tool are listed below:

- Allowing different CAD file formats to be viewed in the standard, neutral format using a web-browser and collaborate on them.
- Providing mark up, annotation, 3D manipulations (zoom, rotate, and pan) and collaboration capabilities.
- Maintaining the history of discussions with suppliers and within the company for future reference (saving of CAD snapshots in association with the chat discussion).

The current prototype that we have developed addresses most of the needs identified above. The next section describes the current implementation.

4.1 The system architecture for the Collab-Viewer

The Collab-Viewer uses distributed MVC (Model-View-Controller) architecture to achieve collaboration. The user input, the system function/state, and the visual feedback to the user are separated and handled by the controller, model, and view respectively. The Server Collaboration Manager and the Client Collaboration Manager on the clients handle collaboration and session management responsibilities. The communication between client and server uses distributed command objects. *Figure 6* shows the system architecture [9]. Server provides support for most of the core computational operations, such as solid modeling. The server is the hub where data from all the clients comes in and is sent back to the clients after processing. The server has the master CAD model that is used to update the approximate version of the shape model on the clients. The server uses ACIS™ for solid modeling operations. Since the computationally intensive components reside on the server, the clients are thin, freeing them from installing and maintaining software at their end.

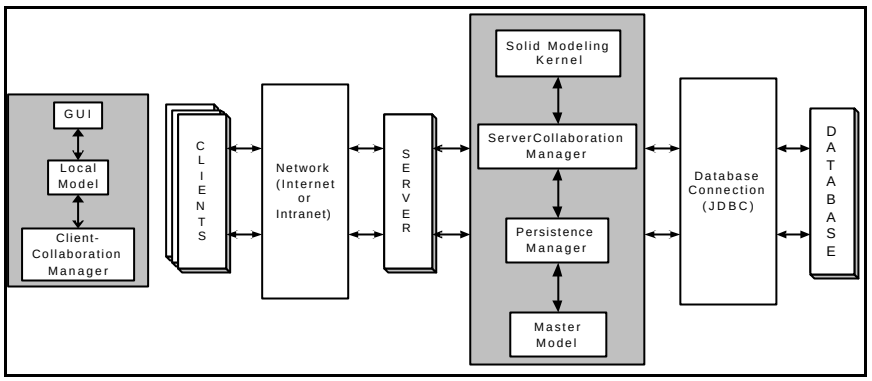

Figure 6. System architecture of Collab-Viewer [9]

4.2 Implementation

In the current prototype, we have implemented a 3D collaboration tool, where users can upload CAD files in different file format, and collaborate using them. There are two ways to start collaboration on CAD geometry. A 3D collaborative session can be initiated from a document repository by a user or a user can initiate a collaboration session directly from the Collab-Viewer menu. Starting 3D collaboration session from a repository ease the systematic use of the discussion history in the future. Once a collaboration session started users can invite other users in the system to collaborate. All invited users receive an instant message in the messaging system inviting them to join the collaboration.

The login screen for 3D collaboration has been shown in *Figure 7*. In the login screen users can either start a new collaboration or join an existing session. Once different users have joined a room, they can chat and at the same time markup on the 3D CAD geometry. Users can send group messages or individual private messages. Apart from markup, our current prototype also supports zoom, pan, rotate, and other basic functionalities.

Figure 7. Snapshot of the login screen

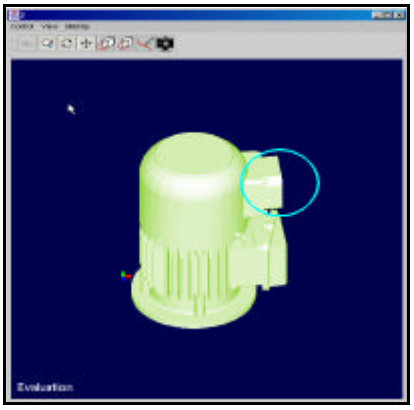

Figure 8. Snapshot of the 3D CAD viewer

Figure 8 shows the 3D CAD viewer window. During a chat session, users can save snapshots of the screen. All saved snapshots can be browsed in the document repository. Clicking on the snapshot opens the chat history linked to it thereby enabling users to relate the snapshot with earlier discussions

5. Conclusion

In this paper we identified the current state of product design market and the need for better tools to manage it. PLM systems are in general methodologies to handle problems caused in design processes and production. However, in many cases, lack of proper understanding of real business processes and functions like interoperability, failure in identifying users and many other reasons, result in non-utilization of these resources. Our efforts were focused on identifying the critical needs and then developing components to solve them. We have successfully developed modules to create an integrated system that handles varied company processes, such as document handling, collaboration with CAD geometry, messaging, and others. Modules introduced in the paper have been tested for months internally and also with some industry partners for realistic feedback. We now foresee an advent of distributed systems that can evolve and adjust themselves as the real life business processes change.

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