Workflow and Product Data Management in Heterogeneous CAx Concurrent Engineering Environments

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Abstract
This paper presents a research approach to manage heterogeneous computer aided environments for companies that work simultaneously with different CAx applications and parallel projects that change with clients and time. We analyse a procedure to succeed in the workflow management from customer requirements to manufacturing based on a pilot project with a commercial PDM.

Keywords
Collaborative Engineering, Workflow, Product Data Management.

1 Introduction

The new global economy has redirected companies strategy to implement changes in order to support Concurrent Enterprising philosophy based on web technologies. As a result, in the context of the Extended Enterprise, the diversity of partners and software tools leads to a complex flow of product data. Moreover, the hierarchical structure dominant in many industrial sectors increases the complexity because different data requirements, design responsibilities and CAx tools appear according to the considered tier [Contero, Company, Vila, Aleixos, 2002].

In order to improve the design processes and product data exchange, to achieve Collaborative Engineering, Original Equipment Manufacturers (OEM) in the automotive, aeronautical and aerospace industries oblige suppliers to achieve the technological level of “digital product” paradigm working with their own CAD systems and exchange only native data. Therefore, the closer the integration of suppliers with different OEMs the more CAD tools they have to use. Consequently, they have to maintain several CAD systems that must coexist with their main CAD/CAM/CAE system. Obviously, this situation supposes not only an extra cost in many ways but also a real barrier for the basic Concurrent Engineering (CE) deployment inside the company. Circumstance that requires a perfect co-ordination of data flow in the Product, Tools and Machinery Development Process between the different responsible departments.

2 Workflow Background and Management Problems

The assessment models for CE implementation empathise the needed of a good product and process management as one of the key factors. In order to get the maximum success of these new practices, techniques and tools for CE Teams have to be adopted so the product quality and innovation can be achieved [Prasad, 1996]. One of these techniques and tools, the Workflow, aids in the total or the partial automation of a process where documents, information or tasks are transmitted through a series of actions determined by some rules or procedure norms [Manheim, 1998]. Engineering Workflow Management Systems provide project management,
engineering change and release management and communication support, entailing a competitive advantage for the companies [Ader, 2001].

The Workflow is managed by a PDM System, which is evolving to take into account Internet, Web-based technologies, and the new extended/virtual enterprise paradigm. This evolution leads to the concept of “collaborative Product Definition management” (cPDm) [CIMdata, 2001] which is a broadening of PDM capabilities to support the management of product definition and associated processes in the extended enterprise framework.

Despite this System has the key for process supervision, the problem appears when it has to store and organise different CAD/CAM/CAE data flow [Sadiq, Marjanovic, Orlowska, 2000] at the correct moment. In this case it is needed to adapt currently available products in the market and define a new procedure to establish the controls and to drive the process. The procedure has to manage not only all the information and the knowledge generated during the design process but also co-ordinate the workflow with different native CAD data.

3 Research Approach

The problem summarised above has been faced as one of the main objectives during a CE implementation research project. Although the main achieved objective was assessing an automotive subsidiary company to change form current practices to Collaborative Engineering practices, we had to develop a procedure to manage this heterogeneous environment, where parallel projects can be running inside the company, using a commercial PDM system (Pro/INTRALINK 3.0® from PTC) with some Workflow capabilities.

The methodology used during the research was based on Reengineering principles [Davernport, 1993]. For the Product Development Process analysis a four steps work was followed. The first step implied a detailed modelling of activities, drawing an IDEF0 model, identifying customer information requirements and transformations. The second step of the survey shown us how the product development process really operated inside the organisation, how of sequential and repetitive were the different activities, what design tools were installed and how integrated they were with other systems.

The third step was focused on the workflow, modelling a new integrated product development process. The model shown the customer driven projects, the tasks (sequencing, timing and interaction between different parallel projects), the responsibilities of the engineers in each task (including revision and promoting) and, what is more important, where the performance measures could be defined in order to evaluate the new process.

Due to customer’s requirements several CAD systems had been integrated: Pro/ENGINEER 2001®, CATIAv5® and Autocad®. Besides, another CAE and CAM tools are used during the product development by different departments. Problems appeared when we tried to manage the dynamic workflow (several projects, proposals against manufacturing orders, customer’s prototypes, engineering change orders, etc) with a limited PDM system.

Despite the PDM workflow restrictions, a general procedure framework was developed to deploy all the tool possibilities so the information and work flow can be simplify and unify across different projects finding an optimised global design.

Using the data base portfolio structure a customer’s project schema, metamodel, was defined. It permits to assign access control to the documents depending on customer and type and quality data received. For each project a template of release levels was designed. Within this templates the designers roles (tasks, revisions, control of changes, etc.) were defined in order give project accesses. This eases the workflow management (approvals, release promotions and email notifications), although with this tool some important actions, such task redesing or time control, characteristics of dynamic workflow tools, can not be done.
The final step of the research was a pilot project experience that has been extended to the main projects of the company. Clearly, there is no point of innovation with defining a workflow procedure itself, but the knowledge acquired during experience worth to be exposed.

4 Case Study and Findings

In this section we briefly present the results of applying the framework to one of the most general cases procedure. For the pilot project, the product development process has been divided in three release levels: conceptual design, detailed design and manufacturing (cf. Figure 1). In order to decide which is the most suitable template, a preliminary stage is defined. As a result of the research we have found several interesting aspects in the workflow and product data management.

The first release level is characterised by many modifications because product designers deal with several CAD models. The CE Team has to review all the previous models and standard parts in the main CAD system and merge them in the customer’s native CAD model. In this internal process data exchange and modifications do not suppose a change of the number of revision of the part since the client has not still received the definitive model. The problem here is just defining parts heterogeneous interrelationships in a large assembly inside de PDM and modifications affect only to customer’s native CAD model.

The promotion to the next release level has been automated through an electronic release approval form and email notifications to the CE Team. New problems appear in the second release level when the customer has decided to order a preproduction of the product. Then tools, dies and machines have to be developed using the main CAD system and experts find a barrier.
because they have to integrate customer’s native CAD model with it. Dimensions and especially the dimensional and geometric tolerances are critical. We’ve found many ECO and a continuous modifications and STEP exchange has to be done since they can’t modify the original model.

Besides, we found continuous customer modifications to fit the product in the digital mock-up that have to be transferred also to the tools, dies and machines. The only way to manage this phase is defining a revision procedure and promotion authorisations based on the new process model. The third release level has been easier to control since manufacturing engineers capture main CAD models and minimal modifications are allowed.

As one might expect main barriers, apart form above exposed, have been cultural. Firstly, a system administrator is needed and, sometimes there is no one who wants to play this role because is just bureaucratic and a new project management ability has to be developed. Secondly, common failure modes also emerge since CE Team members return to past practices. For example, they forget to promote parts and, as a result, triggers (email notifications, access to a portfolio in a new release level, etc.) can not be activated.

However, important results have been achieved during the research project thanks to the procedure. Problems have been gradually reduced, the communication between members has been increased and, thanks to the electronic co-ordination during, detail and manufacturing phases have been considerably reduced working with the limited PDM workflow capabilities.

5 Conclusions

This research shows how to manage heterogeneous CAx environments defining a procedure using commercial tools. As CE implementation has many aspects to deal with it is very important to notice that the way of manage work, tasks and time has changed.

The study has confirmed other studies that indicate that a successful implementation of Concurrent Engineering environments needs a well-defined procedure for co-ordinating the process. In consequence, the CE Team must have a documented methodology establishing the procedures and the communication channels among the members.

Changing to a new product development environment implies technical and cultural barriers that we can identify and overcome with an assessment model. However new barriers appear with the rapid advance of the collaborative product commerce and, as a result, the issue of heterogeneous knowledge management should be further investigated as well as commercial Workflow performances.

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References


