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PLM infrastructure for Big data in mechanical design

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Abstract

Collaborative design drives the specification and development of increasingly complex and varied support tools. Product Lifecycle Management (PLM) tools offer a wide range of features for collaborative design. These products bring users closer together by providing them with identical software platforms. In addition, the growing need for data reuse leads users to define rules and parameters to enrich their digital models to facilitate possible modifications. However, if expert software offers for the most part the possibilities of defining business rules, it is clear that no PLM, at to the present, offers functionalities of this type.

In this context, this article proposes to compare the main existing PLM architecture on the basis of technical and organizational criteria. This comparison makes it possible to identify a relevant architecture for the development of expert rule management functionalities integrated into the PLM application.

Keywords: PLM, Rule base, Data exploitation, Design

Introduction

Collaborative design methodology requires the development of complex and various applications. The life cycle management tools of PLM (Product Lifecycle Management) make it possible to organize, manage and bring to the life the data of a design project. They meet the needs in terms of data exchange between partners by securing access to data and allowing advanced control of projects.

However, these tools are based on a very restrictive centralized organization for the integration of expert tools and making it difficult to exchange information between the different stages of the life cycle.

In this article, we focus our study on the specificities of exchanges between CAD modelers and PLM. CAD tools allow the definition of the geometry of the designed products. The use of modern CAD also allows the integration of parameters and expert rules that enrich the data generated. Our study proposes, after a study of the different existing PLM architectures, the development of an interface between a CAD modeler and an existing PLM application allowing the sharing of parameters and design rules.

The article is organized into three parts :

- A state of the art on collaborative design, PLM and research in the field of expert rule management ;
- an analysis of the various existing PLM architectures ;
- a comparative analysis of these architectures on the basis of relevant comparison criteria for our study.

In conclusion, thisarticle is presented as well as the scientific and industrial perspectives in terms of re-use of product design projects.

State of the art

Collaborative design and the product lifecycle

Collaborative design is the result of research on design methodology and has been made possible by development in computer technology. It meets the growing needs in terms of data exchange. Collaborative design facilitates the reorganization of design offices by offering dedicated, increasingly efficient tools.

Collaborative design allows for parallel design activities that were previously sequential. [Pahl and al., 1996] propose four design phases : clarification of the need, conceptual design, preliminary design and detailed design. This algorithmic approach has been enriched to make it possible to work in projects, by simultaneously bringing in experts from the different design phases [Roucoules, 1999]. The parallelism of design activities necessarily entails is the needs in terms of exchange and communication between the actors of the different design phases.

ICT (Information and Communication Technology) makes it possible to partially meet these needs through the development of applications facilitating the exchange of information between those involved in design. Initially, research focused on the development of technical document management application, PDM (Product Data Management). [Helm, 2002] demonstrates the importance of PDMs in facilitating collaborative work.

Web-oriented PDM solutions have gradually developed with the emergence of the Internet [Xu, 2003]. These solutions offer interesting portability features and reduce customer support by integrating technologies developed for the Internet.

Most of the commercial products offer a Web version of their PLM client, the server part remaining dependent on the technology used.

The main goal of PLM tools is the management of the product and the data that describes it throughout its lifecycle. The PLM thus encompasses all the stages of product design (modeling, technical data management, simulation, etc.) as well as the components of the digital chain allowing information to be tracked during manufacture, sale and withdrawal of the product. product.

In this context, a PLM tool is a platform for storing, managing and administering a large number of technical documents over a period that may be long. In addition, a PLM tool must have important interoperability functions with the expert tools used during the different phases of the life cycle (tool for help to define the need, CAD, CAD / CAM, digital simulation tool, ERP, etc.).

Expert rule management

The tools for managing expert rules are the results of research work on Artificial Intelligence [Prasad, 1999]. In the field of design, the most used results concern the definition of rules to assist designers. This requires formalizing the knowledge of designers, in order to describe the business rules and their context of use. These rules are called "associative". A rule represents this formalization, the context in which it is triggered as well as the condition which dictates this execution.

The basic form of a rule of this type is:

IF(Condition) THEN (Action-1) ELSE(Action-2).

These expert rule management systems are mainly used in the CAD / CAM (Computer Aided Design and Manufacturing) stages [Park, 2003], [Myung and al., 2001].
However, they do not offer the possibility of connection with the different stages of the life cycle.Thus, the development of research made in the field of management rules and design parameters at the level of product life cycle management and promising. The goal of our research is to allow the sharing of certain expert rules. Thus, the storage of expert rules in the PLM can enrich the data stored in the database [Ducellier et al., 2005]. [Ducellier and al., 2006] details the operation of the rule base.

Existing PLM infrastructures

Research in the field of life cycle management is rich and varied. All the systems offered are based on four IT architectures. Research in the field of PLM is numerous and makes it possible to define mainly four types of architectures [Bergsjö, 2006]. Each of these architectures offer an enrichment of the functionalities covered by the PLM by developing new perspectives for life cycle management [Weber, 2002]. These four architectures are described and compared in this paragraph.

An integrating system

An integrating system is a PLM tool that centralizes information from different businesses. This unique system is generally complex to implement but limits the number of connections required. Data management is also considerably easier due to the uniqueness of the information generated. In this architecture, the central server hosts the data safe (Vault) and manages the access rights generally from the definition of the Role/Person pair : to each individual, one or more roles are associated according to these responsibilities. A person can thus be a project manager for a product A and a quality manager for a project B. Depending on their role, they will only have access to certain data in each of the projects. Figure 1 schematically represents an architecture based on an integrating system.

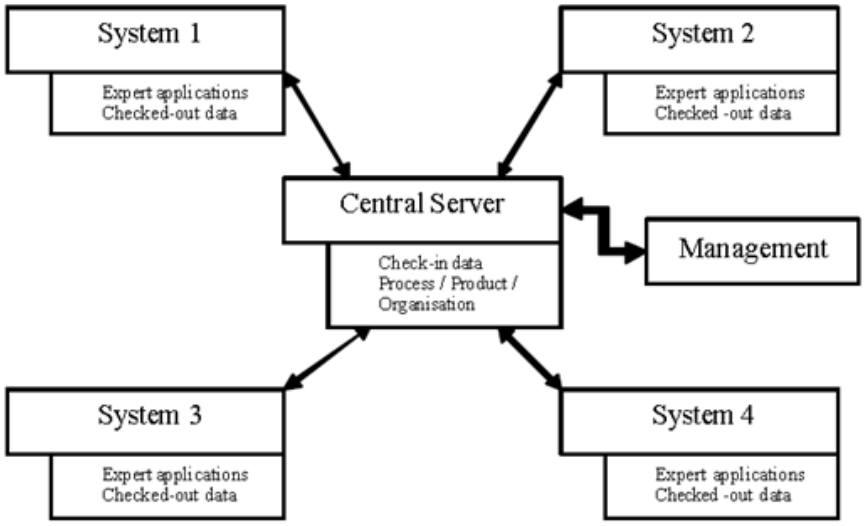

Figure 1 : architecture based on an integrating system.

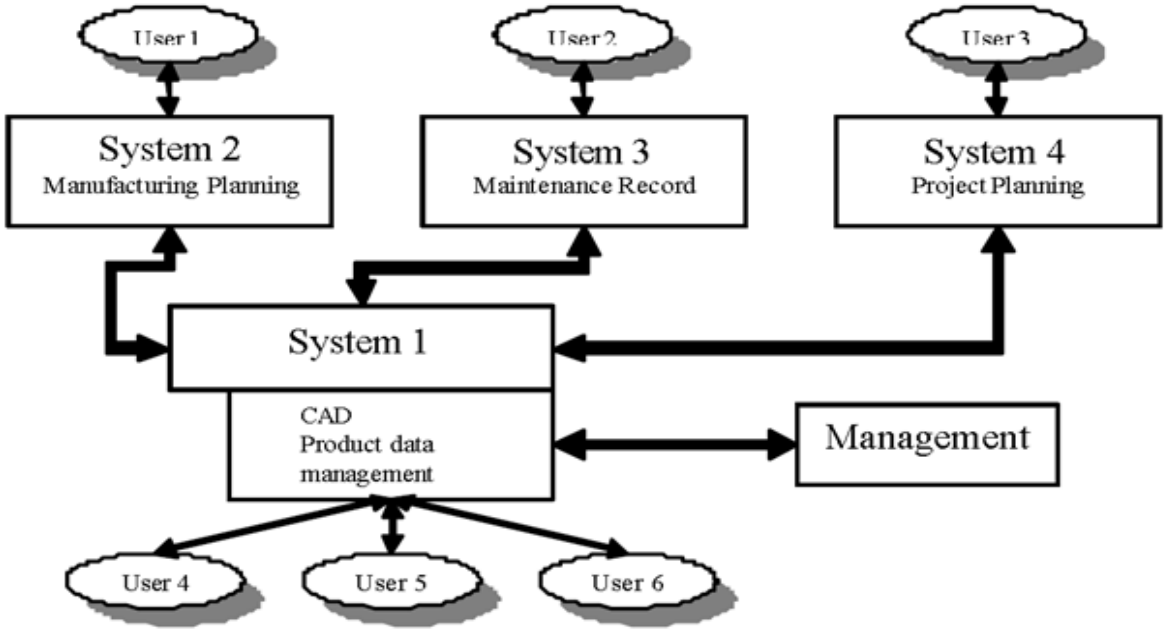

Figure 2 : architecture favoring a system.

A domain as an integrating

This architecture favors one of the existing systems in order to define a centralized organization around it [El-Khoury, 2005]. It is an architecture very commonly adopted in professional offering. This architecture has many advantages, especially in the field of deployment, since the integrator system is generally already adopted by users. However, the end result is completely tied to an existing system. If this system is modified, the entire PLM infrastructure can be compromised. Figure 2 schematically represents an architecture favoring a system as an integrator.

The best in each area

This organization makes it possible to focus on the most effective tools in each field. The integration of each system is then done according to the needs of the company [Burr, 2003]. This architecture makes it possible to guarantee maximum results at each stage of the life cycle, locally. However, integration difficulties (CAD - Calculation for example) lead to significant additional development costs and greatly reduce the flexibility of PLM.

Peer-to-peer

The Peer-to-Peer architecture is based on peer-to-peer functionalities developed primarily for file sharing between remote users. This type of architecture does not require a centralized system for the management of products and processes. However, in an industrial context, this architecture does not meet the requirements of reliability and information security.

Comparative analysis of PLM architectures

The infrastructure chosen for the development of our expert rule management application is based on a comparison based on three criteria:

- the platform used;
- the possibilities of customization;
- the possibilities of integration with external software.

Software platform

The first point of comparison concerns the software and hardware platforms on which PLMs operate. This criterion is particularly important since it conditions the choice of the operating system and the computer technologies used. The choice of material makes it possible to provide information on the cost of final development.

Possibility of customization

The PLM software studied are complete and offer a very wide range of functions. However, in order to guarantee the implementation of our management system of rules and design parameters, we studied the possibility of customization, that is to say of enrichment of the functions, interfaces, according to the user needs.

Integration with external software

The integration of PLM with external software conditions the ease of implementation of our rule base and saves time. For this, we were particularly interested in the possibilities of accessing PLM data through external software.

Summary and specification of the chosen architecture

The architecture used in our comparison is the integrating system. Indeed, a PLM tool based on this architecture does not depend on any expert software. Thus, integration with expert software can be standardized. In addition, the software platform is unique and the technologies used are limited. Finally, the possibilities for customization are improved in this type of architecture due to the unification of the platform and the standardization of interoperability.

Expert rule management tool

The study of PLM architectures provides an interesting classification for our research.

We propose to use Dolibarr for the development of a module allowing the creation and management of business rules. The possibilities of customization are essential. In addition, the rules are intended to be used in the different stages of PLM, so it seemed important to us to focus on an independent tool. The technologies used are based on strongly adopted programming languages in which the developer communities are very active. NET technologies are very interesting at this level and offer a wide range of functions allowing the customization of PLM environments.

Data and rules are stored in the PLM. Access to the rule base can be done through PLM, or through an expert tool (CAD, Simulation).

Link between rules and data

The developed system allows a data to be linked to one or more rules of the rule base. This link is specified by an XML document stored with the data and grouping together all the parameters used to execute the rule. This interaction is identical to that specified in [Duceliler and al, 2006] for the management of simulation data.

Integration with expert applications

Integration with expert applications requires the development of plug-ins adapted to the types of software considered. We have so far developed an interface linking the parameters and rules described in our rule base to those that can be defined in the CATIA V5 tool. The link is made from the data and the XML file found in the PLM safe. The update is bidirectional, depending on the specific rights of the user. The update of a parameter can thus be done in the PLM or directly in CATIA.

Conclusion

Collaborative design is a key component of business competitiveness. PLM applications offer an interesting panel of features to meet the needs in terms of exchange and management of product data. However,

existing architectures make it difficult to interoperate data between multiple expert tools. Based on a study of existing PLMs, this article proposes to compare each available architecture using three criteria: the platform used, the possibilities for customization, and integration with expert software.

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