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UML based specifications of PDM product structure and workflow

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Abstract

The paper deals with the use of a UML approach for the specifications of a PDM system (product data management) implementation. A PDM system enables the management of the whole product data and related information about its entire lifecycle.

The main goal of this paper is to highlight the added value of using an object-oriented approach for modelling, specifying and implementing a PDM system on a business case study. The chosen object-oriented approach and the used UML diagrams for the modelling and integration of product, process, and resource data is detailed for a turboprop aircraft project.

Keywords: PDM; Object-oriented modelling; Product structure; Workflow; Aeronautics

1. Introduction

The turbo-prop engine market is increasingly competitive. ‘‘Time to market’’ is becoming one of the most important business and strategic key elements for product development and manufacturing. At the same time, customers want a more customized product with a higher security level. Companies therefore have to reduce design lead-time and provide a better-configured product with an enhanced level of quality and safety [1,2]. These points represent especially high stakes in turbo-prop manufacturing as it is a niche market; in 2001, the sector total sales were equivalent to the sales of General Motors alone.

1.1. Brief PDM overview

A PDM (product data management) system manages and stores product design, manufacturing and support data [3,4]. Two main functionalities of such a system are:

- a product structure manager, which organizes and stores the whole product data. It manages the bills of

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material and the various product configurations. It provides functionalities for versioning and linking the various parts and documents in the product structure. It also ensures the management of data status (available, frozen or obsolete);
- a workflow engine which, according to the product structure, sends the right available data at the right time to the right user. This functionality allows the implementation of ISO oriented processes in product development: from the preliminary design phase to the production engineering phase.

Many others functionalities are also currently available, such as integration with a mail server that notifies an event occurring on a given document (i.e. a check-in, check-out, promoting, etc.).

1.2. VPM-Chains project

At the end of the 1990s, Snecma Moteurs, one of the world leaders in turbo-prop manufacturing, has chosen to implement a new PDM system called VPM-Chains, mainly based on ENOVIA VPM from Dassault Systèmes. Snecma Moteurs wants to have a huge customization of VPM functionalities in order to integrate the digital mock-up manager with a workflow functionality. Earlier, Snecma Moteurs was using a legacy PDM which did not fulfill the current and future needs of aircraft engine development. The company requires a single and secured storage of product data enabling an early access of production engineers to the design choices or allowing to share product data with its main contractors and suppliers.

As specified in [5], the main benefits of VPM-Chains implementation are:

- Reducing development lead time and non-quality according to ISO oriented and predefined processes. Nowadays in aeronautics, this kind of ISO oriented process is required by the Federal Aviation Authority and Join Airworthiness Regulatory (JAR) before product certification [6].
- Sharing the right updated data between the relevant users group regarding the product development process, e.g. between mechanical designers and computational fluid dynamic (CFD) designers to minimize their iterations; between engineering designers and production engineers to validate as soon as possible the decision-making involving manufacturing process specifications, etc.
- Enhancing reactivity and customer supports with a high level of traceability and an efficient product configuration management during the whole development cycle.

1.3. Research objectives

This paper aims at highlighting the added value of a UML approach [7,8] for modelling and specifying the product structure [9,10], the workflow [11,12] and the interoperability with CAE and scientific software [13]. Considering its applications to enterprise modelling and business process reengineering [14], UML has been chosen for several reasons. First, it provides a fairly complete modelling notation for specifying the product breakdown structure (parts) with related product data (documents). Second, it provides an efficient language for modelling generic workflow with activities and transition criteria before their implementation in a workflow engine. Finally, UML enables to detail the overall class diagram of the VPM-Chains system and a framework for collaborative design with suppliers in an extended enterprise approach [15,16].

Basically, the tasks of each involved person have been identified in a use case diagram (Fig. 1). The various kinds of functional user needs regarding VPM-Chains system have been clarified. This work has been carried out based on several interviews of design team members: mechanical designers, CFD designers, production engineers, project leader, design manager, etc. All these interviews have been analysed and provide a fairly good overview of the user needs and design project running based on data and process modelling. The method used for this work was based on a classical BPR approach [17].

One of our challenges was to explain and to communicate about this complex project and also to ascertain the various users' level of understanding. A good way to explain the functionalities and the running of a PDM system like this has been found in the use of UML [14,18]. Its various views and diagrams enable the choice of a relevant way of explanation. These explanations are heavily dependent on what kind of information users want to share.