

FROM WORKFLOW SPECIFICATION TO IMPLEMENTATION: AN INDUSTRIAL USE CASE

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1. Introduction

In the industrial context the use of new approaches such as PLM has brought valuable benefits simultaneously in the cost of product development, the organisation of project teams, the rationalization and the traceability of team work. In the domain of project management, PLM offer functionalities for enabling process definition and execution through the use of workflow. Workflow Management Systems (WMS) help in improving the automation of tasks related to processes.

In this paper, we describe the implementation of workflow module in a PLM application. We highlight the limits of workflow in the context of product development and the necessary difference between the processes identified in the enterprise and the workflow implemented in the PLM.

This work is presented through three specific points: first, we present the research context. Second, the workflow specification is drawn up. This specification is set by conducting interviews and developing a process reference model to enable the communication between the final users and the IT-Support. Thirdly, we analyse the benefits and the lacks of existing WMS and its use in a context of product development.

2. Industrial and Research Context

The paper presents research conducted in the design and manufacturing department of Mefro Roues France, a satellite of the larger group Mefro Wheels. Mefro Wheels is an industrial contractor in the automotive. The department concerned deals with the development of specific wheels for the automotive manufacturer in Europe. The need for efficiency and high level of competitiveness conducted in the acquisition and implementation of a PLM application. This PLM application is used to manage product data from the very first design phases to the planning of the manufacturing processes. The PLM application is splitted into two components. The first manages the product data. The second is a Workflow Management System [Georgakopoulos et al., 1995] that drives the projects and the interactions between experts. The very first component was deployed after a deployment phase. The next phase concerns the deployment of the second component for managing the dynamical aspect of the product lifecycle. The objective of this phase is to improve competitiveness during design projects in Mefro Wheels.

From this industrial context, a survey is performed to identify references in the domain of workflow implementation for driving design phases. These references and their domains of application are summarized in Figure 1.

The first domain concerns the PLM initiative. PLM research domain is large and concerns the product, the processes and the global organisation of the enterprise. This is clearly a very large domain of

research and many journals published special issues on this topic. Concerning methodology, we noticed [Weber et al., 2003]. It presents the property-driven Development/Design theoretical approach. It is based on the clear distinction between characteristics and properties of a product in the PDM application. This approach tends to improve the ability of PDM systems for controlling design activities. In our context, this approach is interesting for the reflexions conducted in the PLM application evolution. As the project we address, we focused our research on PLM initiative associated to automotive industry. In this context, [Chao et al., 2006] referenced the BPEL4WS language as a coordination language to define and manage workflow among grid services. It presents valuable results concerning our research especially in the domain of workflow execution management. As an example, the need for re-launching the whole or a part of the workflow with new inputs or different resources, once design process is already launched.

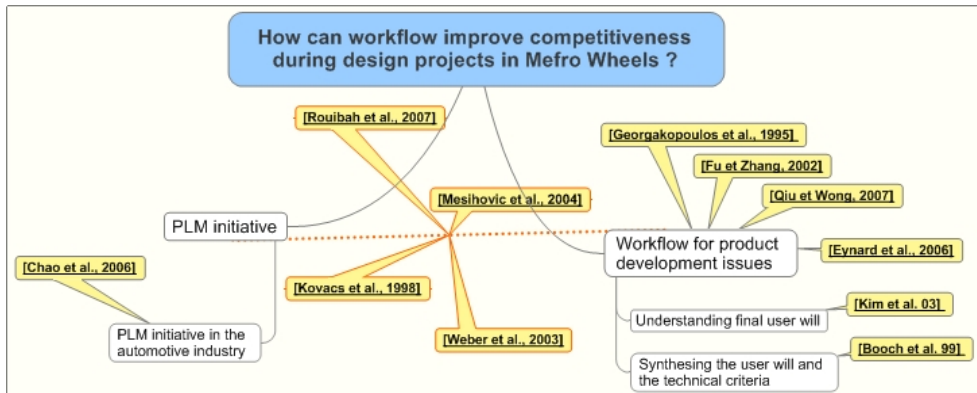


Figure 1. References and domains of application

The second domain addressed by our research concerns Workflow Management. In our strategy for specifying workflow models for design phases, we focused our survey on models dedicated to concurrent engineering. [Kovacs et al., 1998] present a WMS linked to a Product Data Management (PDM) application. This approach is based on the use of PDM application that does not manage processes. Therefore, the introduction of PLM limits this approach. [Fu et Zhang, 2002] proposed the P_PROCE model. P_PROCE is a workflow modelling module offering five different views (Process view, Product view, Ressource view, Organization view and control & evaluation view). The main interest of this approach is the interaction of the P_PROCE model with a PDM application in a context of concurrent engineering. With [Kim et al., 2003] and [Eynard et al., 2004] this approach presents interesting issues in the cross domain of PLM and WMS.

Concerning dynamic workflow change, we noticed [Qiu et Wong, 2007]. This proposition addresses an approach to facilitate efficient dynamic workflow change by minimising repetitive execution of finished workflow nodes. This approach also addresses the data integrity issue by managing various workflow data such as node properties and scripts. These dynamic approach is linked to [Rouibah et al., 2007] when dealing with external WMS.

Based on these researches, we started the project by specifying the workflow. This part is described in the next section.

3. From Workflow Specification...

Workflow specification consists in 3 phases:

- Performing the interview for enabling the understanding of the processes described in the workflow
- Providing the synthesis of the analysis to the final users
- Modelling the workflow to facilitate its implementation during development phases

Performing the interview:

This phase consists in evaluating the need according to final users in the enterprise. In this context, we must first identify the main actors that have to be interviewed and second the questions to ask. We distinguished two types of actors. The first actors are technicians. (These actors include engineer and technicians of the design tooling, manufacturing and quality services), directly linked to activities in design process. The second type concerns the managers of the electronic documents in the design process. Despite the fact that managers do not have the major role in the whole process, they monitor the global evolution of design process.

The actor to be interviewed

The actors interviewed are incorporated into specific departments. These departments are: the research and development department, the manufacturing department, the industrialization department and the quality department. These actors can be classified using 2 levels in the hierarchical level of the enterprise with the first level corresponding to managers and a second level corresponding to technicians. The classification is summarized in Figure 2.

	Managers	Technicians
Research & Development Department	1	4
Manufacturing Department	1	8
Industrialization department	1	8
Quality department	1	8

Figure 2. Departments concerned by the workflow deployment

The questions to be asked

The aim of the questions is to provide a complete set of information for developing workflow suitable for design phases in Mefro Wheels. The questions are directly linked to the hierarchical level of the person to be asked. The managers provide organisational information, milestones and decisions during the design phases. The technicians provide information on actors and resources required for satisfying their design tasks. Figure 3 provides a synthesis of some of the questions asked during the interviews. Some questions are clearly relevant to the managers, some to the technicians. However, questions can also be asked to both, to provide a multi view point of the organisation and the tasks performed during design phases in the company.

	Managers	Technicians	Both
Organisation	How many different tasks are performed during the design phases? What is the typical order of the tasks?	What do you understand about the organization of the design phases?	What are the typical difficulties you encounter during your activity? What are the advantages of the organisation? What are the lacks, the difficulties?
Design Tasks	How do you control the jobs done?	What kind of documents do you need during your activity? Which documents do you create during your activity?	For each task : What are the validation conditions? What are the inputs and the outputs of each task?

Figure 3. Synthesis of some questions

Providing the synthesis of the analysis

The different information identified during the interviews have to be modelled in order to understand the global design process of Mefro Wheels. As stated in [Kim et al., 2003], there are widespread modelling techniques. [Eynard et al., 2004] presents the advantages of IDEF family diagrams and

UML diagrams as a support to workflow modelisation. In this paper, we present the modelisation of the workflow using IDEF0 and UML activity diagram.

Modelling the workflow

Functional view: the IDEF0 modelling

The IDEF0 diagram represents a synthesis of the modelled workflow. The IDEF0 modelling is well-known as an industrial standard for modelling activity and data flows. Two types of diagrams can be used: the actigram to model activities flow and the datagram to model data flow. In the Mefro Wheels context, we focus on the actigram. The actigram is composed of blocks of activities linked one to another with inputs, outputs, controls and resources. Figure 4 presents a representation of the prototype manufacturing order, based on the results of the interviews.

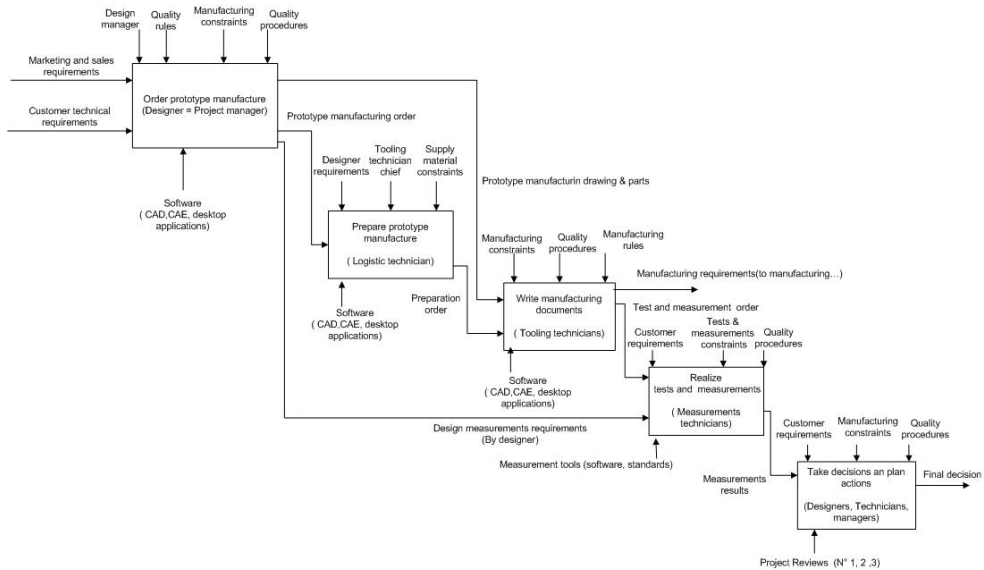


Figure 4. IDEF 0 modelling of the prototype manufacturing order

This diagram describes the activities, actors and their interaction through the global process flowing. At the begin of the process, the customer expresses its requirements. The actors analyse the feasibility of the product, elaborate some prototypes of the product and evaluate their capability through testing and measurements. At the end of the process the project actors take a decision for the next steps of the project.

The actigram is used to assess activities and their links through the whole design process. The IDEF0 representation offers a global view of process functions and is useful for the communication with the final users in order to elaborate a model that best matches the requirements. However, it does not provide substantial model for the implementation in the PLM application. Therefore, once the IDEF0 builded, and considered relevant through the discussion with final users, it appears necessary to transcribe all the process information in a model which is more readable for implementation purpose. This leads to the use of UML-activity diagram for modeling the process in order to facilitate its implementation. [Booch et al., 1999] highlight the UML activity diagram as a relevant technique for representing processes both for user point of view, and more precisely for the implementation. [Eynard et al., 2004] presents UML diagrams as a suitable language for modelling workflow in a PLM environment. Therefore, the UML activity diagram is used to develop another view of the workflow model.

The UML activity diagram: for an implementable model of the workflow

The UML activity diagram gives us a detailed view on the information flow and the documents in the design process. Figure 5 presents the activity diagram of the prototype manufacture order.

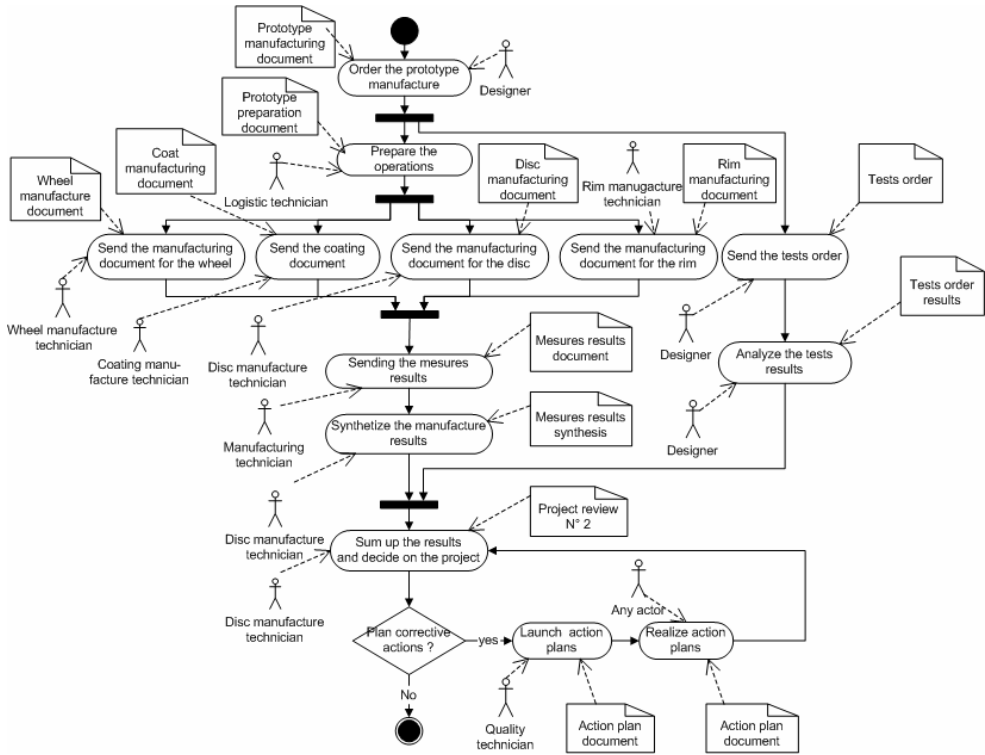


Figure 5. Activity diagram of the prototype manufacturing order

This model describes the flow of information through the whole process. Actors and documents from the PLM repository are presented for each activity. On this model it appears necessary, in the process definition to take into account information about documents and users. For instance, as users interact with the PLM application, documents’ status evolve during the workflow execution. Manufacturing documents status evolve from “in progress” to “completed” when the activity called “prepare the operations” is ended. Document status management is strategic for workflow efficiency. In this context, the workflow engine must take into account:

- The evolution of the document status, according to the PLM application organisation (project, roles, securities).
- The possibility for cancelling and re-launching the workflow at a particular phase if needed. That is dynamic change during workflow execution in the PLM context.

These requirements must be satisfied during the workflow implementation. This step is described in the next section.

4. ...to Workflow implementation

The Workflow implementation phase consists in developing a workflow model that matches both the UML activity diagram specifications given above and the technical constraints. The technical constraints firstly concern the PLM context in Mefro Wheels: the PLM application must be strongly connected to the workflow application. Indeed, the workflow manages the design process by querying

information on product data in the PLM application. Secondly, technical constraints concern the compliance of process information to quality procedures: this means that workflow reflects the design process according to the quality procedures. The constraints have been identified during the implementation of the prototype manufacturing order. Figure 6 presents this workflow chart implemented in the workflow management system used by Mefro Wheels.

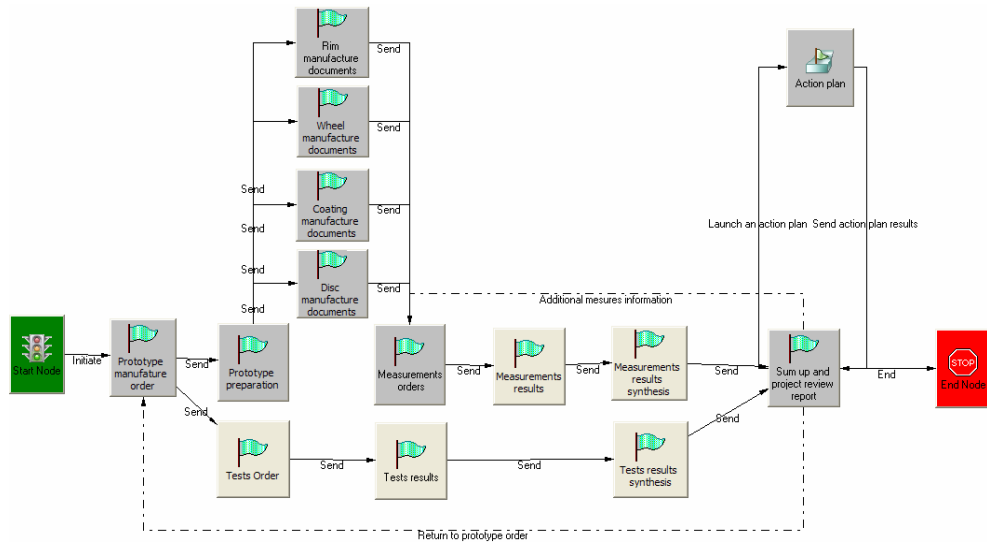


Figure 6. Diagram of the implemented workflow in the PLM system

On the workflow model in Figure 6, we identify the activities presented in the UML activity diagram in Figure 5. The first node and the end node respectively, the “start node” and “end node” are made for starting and ending the workflow. We can identify on the second node “prototype manufacture order”. This is followed by the realization of manufacturing documents and so on. Some technical constraints have led us to the slightly rearrange nodes to match the modelling definition of the workflow in the workflow management system. The questions regarding the compliance of UML activity diagram with technical constraints remain opened.

This workflow satisfy some of the requirements of the workflow specification phase: it is possible to handle parallel or serial tasks, to reassign task and to handle loops between activities through the whole process.

Nevertheless, this workflow implemented still presents some limits:

- The first point is that there is no dynamical link between the document lifecycle and the workflow: the workflow management systems associates the documents with the workflow model. However, during the design phases, the documents evolve and new versions are created. As the association does not provide any update functionalities for the links between workflow and documents, the workflow is then set on old versions of documents.
- The second point concerns the lack of flexibility of the workflow management system: design modifications may imply major updates on one or more tasks in the workflow. Therefore, it is necessary to provide alerts and notifications to the managers. These managers must then have the possibilities to suspend tasks, to demote or promote tasks depending on the context.
- The third point concerns the lack of human interface customization facilities: as the workflow implies different actors with different roles in the organization, it is necessary to provide different types of information to the users. As an example, different rights are defined for each role. This implies that the system should provide the functions available with respect to the role.

There are other limits concerning the implementation of in PLM application. These limits were not addressed in this paper and will be exposed in the future.

5. Conclusion and future works

In this paper, we presented a project conducted in an automotive company for implementing workflow facilities at the design phase level. Based on the use of a PLM application already implemented in the company, this project tends to support design process according to quality procedures. The project, in its early phase, enabled:

- the identifications of major workflow processes, using interviews with experts and final users
- the implementation of a relevant use case, the prototype manufacturing order process
- the identification of limits concerning the use of this workflow in real conditions.

The paper presents the limits of the actual workflow management system on three different layers. The first layer concerns the management of the dynamical links between product documents, in the PLM application, and the workflow. This limit is directly linked to the lack of integration within the PLM application and the difficulties for managing versions of documents. The second layer concerns the lack of flexibility of the workflow management system in a context of product development. The third layer concerns the need for customization of the human interface, depending on the organization of the design teams.

The next step will concern:

- the adequacy of the specified workflow with quality procedures. This step is fundamental for the acceptance of the workflow approach for strategic issues
- the specification of a workflow management system supporting design phases. This system should take into account the limits of the actual WMS and provides solutions to handle them
- the acceptance of the proposed WMS with the final users by providing information on the final issues of the WMS project and providing basic tutorials for each role in the organization.

The next researches will especially concern the adaptative workflow for product development in a context of PLM.

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