KEYWORDS project management models PLM lean engineering SME

PROJECT MANAGEMENT AND LEAN ENGINEERING: AN INDUSTRIAL APPLICATION

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ABSTRACT

This paper describes a project management methodology, implemented using a PLM system. The objective of this methodology is to streamline the product development process by introducing Lean Engineering techniques in project management. We are interested specifically in routine design which represents in some companies more than 80% of the design activity. Thus, reducing these tasks will allow more time for innovative design. The methodology was applied in a SME in which two types of projects where identified: long projects and short projects. For each type, a project management model was developed and implemented in the PLM tool. This allows faster initiation of projects in which project planning is automatically performed. Hence, non-added value tasks in project planning were identified and reduced. The use of the PLM tool allows also taking into account the manufacturing issues since the design phase.

INTRODUCTION

In today's competitive market, companies that develop and manufacture new products have to sustain their competitive advantages by reducing product development time and cost without compromising product performance. These requirements drive companies to improve the efficiency of their product development processes. Organizational practices in product development vary from one company to another because of the size, sector of activity, maturity or the history of the company *(Bressy & Konkuyt, 2008)*. Project-product-process data management is considered throughout the life cycle, hence PDM systems evolved to PLM systems *(Gomes, Monticolo, Hilaire & Mahdjoub, 2007)* which corresponds to a real business strategy to create and maintain product definition throughout its entire life cycle, from the establishment of the customer quotation until the end of life. Excellent communication between professionals from different disciplines working on the development process is necessary to implement concurrent engineering. Unlike sequential engineering where tasks are performed in series, concurrent engineering has several advantages. It allows the parallel execution of tasks, which allows time reduction and quality improvement. It also allows for better communication within the project team. This comprehensive vision of product development emerged in the late 80's under various names such as integrated engineering *(Andreasen & Hein, 1985; Tichkiewitch, Chapa & Belloy, 1995)* simultaneous engineering *(Bocquet, 1998)*, distributed engineering *(Brissaud & Garro, 1996)*, concurrent engineering *(Sohlenius, 1992)*, and collaborative engineering *(Li, Lu, Fuh &Wong, 2005; Lu, Elmaraghy, Schuh & Wilhelm, 2007)*. Our contribution focuses on the integration of project management within a PLM system including resource management and task scheduling *(Chvidchenko & Chevalier, 1994)*. This integration is an alternative of the traditional workflow tools *(Serge, 2000)* included in PDM tools that are ill-suited for work in design offices. Resource management, time available for each resource, the load rate and the hourly cost of resources are the basic elements to establish a tentative schedule of the project. By synchronizing schedules, resource workload management will be simplified and the initiation of new projects will be shortened. The goal is to have a uniform and realistic distribution of the workload. Our objective is to experiment these traditional functionalities of project management by the use of a PLM tool in order to automate them. Thus, routine tasks of project scheduling will be reduced. The ACSP tool *(Atelier Collaboratif de Suivi de Projet)* developed at the University of Technology of Belfort-Montbéliard is a PLM system with project management functionalities. The tool takes into account personalized workload rate of resources affected to tasks of different projects. The tool also allows the automatic scheduling of projects using predefined standard scheduling models.

1. Implementation methodology

The use of a tool for task scheduling, and document sharing and management, coupled with a streamlined design methodology, simplifies the achievement of the project, document archiving, and improves communication between actors involved in the project and product lifecycle. ACSP is an organizational tool for collaborative project management providing these features. This tool also provides a software environment for distributed collaborative design *(Gomes, Monticolo, Hilaire & Mahdjoub, 2007)*, centralizing different data related to the design project of the product and its manufacturing process. Positioned in the context of concurrent engineering *(Sohlenius, 1992)*, the goal of such a tool is to support the design process in terms of cooperation between the different actors of the design: engineers, technicians, decision makers, users, manufacturing operators, etc... The ultimate goal is to simplify the communication and exchange of documents within the company. In addition to its vocation of sharing and exchange of data inherent to the design process, the ACSP tool also aims to generate project summary documents for the capitalization of different project data: functional specifications, product design specification files, manufacturing files, etc. *(Gomes, Serrafero, Monticolo & Eynard, 2005; Gomes, Bluntzer, Bassier & Mahdjoub, 2006; Gomes, Demoly, Mahdjoub & Sagot, 2008)*. Meanwhile, ACSP allows classification of information, thus facilitating their research. It also allows a better definition of a project *(planning, project team definition, workload rates, etc...)*, and a better visualization of tasks to be performed by each project member *(Gomes & Sagot, 2002)*. It is necessary that the involved actors in a project collaborate and communicate in order to have a strong cohesion of work and a homogeneous and realistic distribution of tasks. In addition to the basic function of document management and communication specific to PLM systems, the tool must allow to manage the product development process through considering interrelated tasks. Standardization of some project templates, grouping already predefined tasks *(according to various project models in the company)*, the standardization of the duration of tasks, the standardization of documents and intelligent inter-connections of tasks, saves considerable time in developing the project plan. Visualization of the workload profile of each project member also allows to create a realistic schedule estimates, taking into account the implication of these members in other projects.

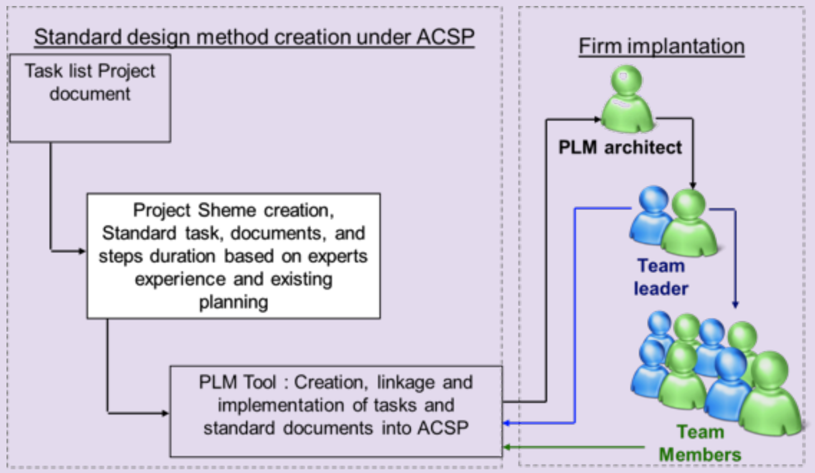

FIGURE 1. *Implementation of the ACSP tool*

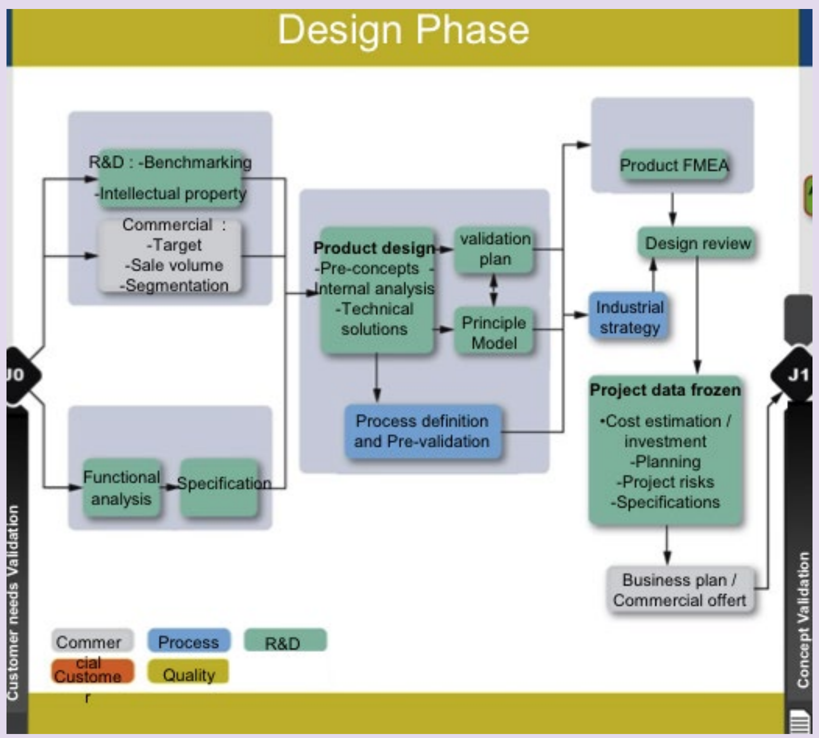

FIGURE 2. *Design phase of the long project template*

Therefore, from standard projects, the creation of a new project including project scheduling is facilitated by a semiautomatic formatting of the project.

2. Industrial application in a SME

This methodology was tested in a SME company. This company does not have a standard design methodology despite the presence of a design office and a process planning office. We were then able to identify several barriers to the integration of a PLM tool in such a company. The main one being the employees' resistance to change *(Balogun & Hailey, 2004)*, but also the number of ongoing projects as well as the amount of data to be added to the PLM by each project member. As actors in the implementation of the PLM tool, we felt it necessary to provide a clear and easily usable tool. It was also necessary to go through several steps, as shown in the model presented in **Figure 1**.

The first task performed in the context of setting up the PLM tool, including project management functionalities related to the specificities of the company, was to list all the tasks and deliverables of any project in the current state. Indeed, the company has no standard design procedure for its projects and project activities can be performed in any order, information may be lost and the communication was not good between the different project members. Once the tasks identified, the next step was to define standard deliverables, using a model that should be shared by all the actors involved in the different product development projects. A standard schedule of the project tasks is necessary to get homogenous and streamlined project information. A Gantt chart was then constructed to organize these tasks as well as search for the standard average duration of each task. Then, using the information gathered, the construction and setup of project tasks in the PLM tool *(ACSP)* was possible. Moreover, the characteristics of the studied company are the number, diversity, and complexity of projects:

- 150 projects are undertaken simultaneously.
- Project durations are very different from one project to another.
- Project complexity is variable from one project to another (from simple to complex).

For these considerations, during the creation of the WBS for the identification of standard activities, two project templates have been created: short projects model and long projects model.

2.1 Long project template

The long project template is a project model including all phases necessary for the proper achievement of a project, from pre-study to concept validation *(**Figure 2**)*. In this model, market and technical environments are unknown. So, this will require further research activities, such as functional analysis or marketing analysis. Long projects involve all the departments of the company from the sales department to the production shop floor. Generally, long projects are mainly initiated by the innovation department, or after a comparative study, or for alignment to standards.

2.2 Short project template

The short project template includes various types of short projects. These projects could be classified into two categories. Projects with lower risks in the design phase where the risks in terms of reliability and consistency are controlled. The technical solution is generally obvious; the validation of this solution is performed by evaluation of its cost, time and performance using analogy or the experience of project members. Projects with strong risks in the design phase, where design risks are vague and require further investigations using product and process FMEA. The difference with a long project is characterized by a better mastered environment because it's much more known, so a phase of information research much more short and simple *(**Figure 3**)*. Reflection on the choice of a path to high or low risk is determined in advance by experts and managers. In case of doubt, the project risk is considered as high and a feasibility study is performed including a product and process FMEA. In the case of short projects with low risk, a solution is evaluated by various experts involved in the product development and the management relying on the company's knowledge and experience. Capitalization of this knowledge is then necessary to facilitate and accelerate the evaluation of future projects. Generally, short projects consist of component modifications, or creating a product variant on the basis of a known model in order to respond to a customer demand. These tasks, which are routine task, mainly occupy 60% of the company's studied projects. Thus, in a short project, the customer quotation is delivered much more quickly than in a long project. Reactivity is the most important factor for the customer.

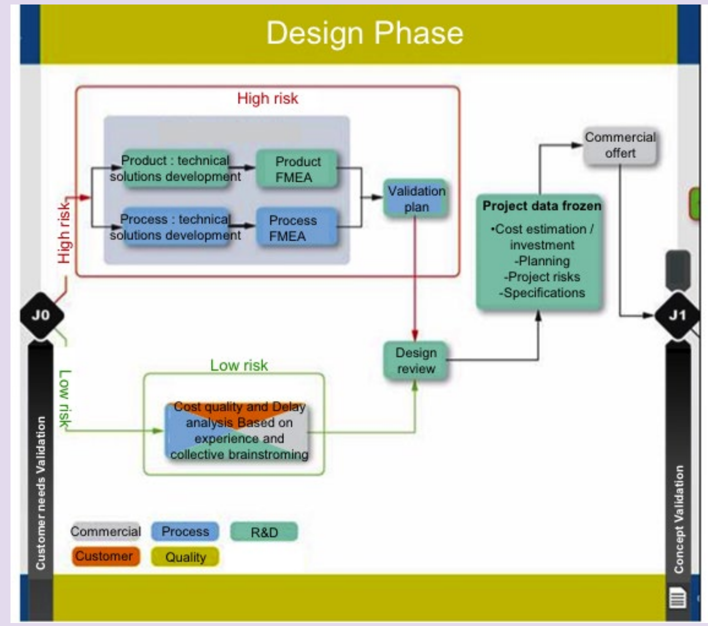

FIGURE 3. *Design phase of the short project template*

2.3 Experimental protocol analysis of projects

The ACSP tool is instrumented in order to quantify the evolution of different types of projects. Indeed, performance indicators, based on the respect of planned deadlines, were set up for each project. Other performance indicators are expected to perform a qualitative analysis of the design process, for example through the documents most frequently exchanged by the designers. These analyses will then improve the proposed models *(**Figure 4**)*, highlighting the tasks that are sometimes omitted, and the redundant deliverables.

Moreover, additional deliverables provide efficiency to current and future designs. Performance indicators will confirm whether task segmentation is appropriate. Using these analyses, we can also identify critical paths and predict more precisely the standard durations of the different stages of the model. The reliability of the scheduling will be then improved with a more homogenous workload of the project team members. Other analysis tools will highlight the phases of the pro-

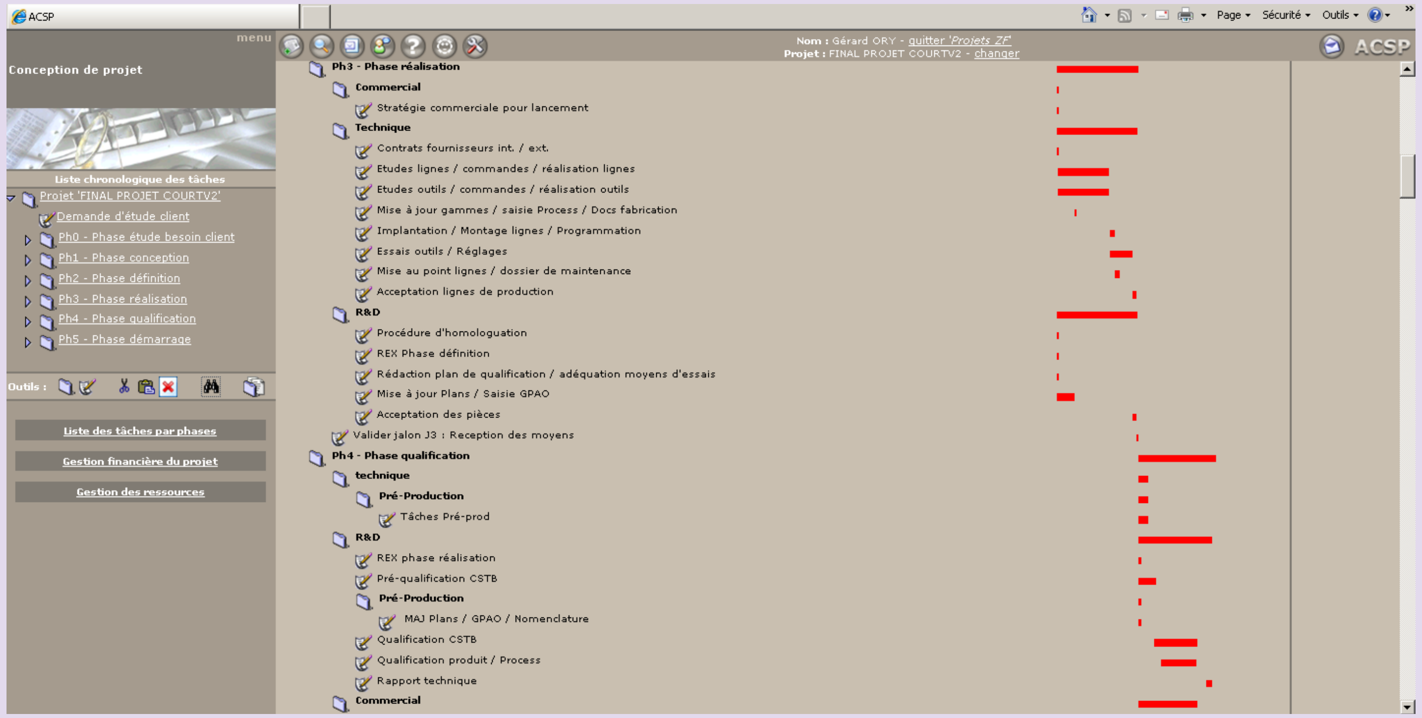

FIGURE 5. *Automatic scheduling of the project on ACSP.*

cess where delays are recurrent, then target them to develop an action plan to avoid them in the future.

2.4 Automating the implementation of projects

A module for creating projects allows the quick and easy initiation of projects. Based on performance indicators which allow knowledge capitalization of the company, the project templates *(long and short)* are continuously optimized. This adjusts the standard duration of tasks, the actual workload, and the management of standard documents. This automated implementation allows having a look ahead of the whole project, thereby improving the timeliness, the organizational quality of the project, and also being more reactive to customer needs in terms of, quality, cost, and time. Moreover, by using a module for project duplication, projects of different lengths can be created from standard project through automated coefficients, thus setting the length of the tasks automatically for new projects. Thus, the user avoids performing an update of the duration of each task of a new project and can extract quickly a schedule of the project (**Figure 5**).

3. Conclusion and perspectives

Adding semi-automated project management functionalities in a PLM generates a significant time savings in the implementation of new projects. Resource management and automatic verification of workloads allows for project initiation with realistic durations and avoids resource overload. In parallel, the performance indicators allow for continues improvement of standard project templates. Once the ACSP tool is set up in the company and used by all team project members, the prospects for a highly productive engineering design can be deployed in the product development process. Indeed, after company knowledge capitalization by coupling the ACSP tool with KBE *(Knowledge Based Engineering)* techniques *(Gomes, Serrafero, Monticolo & Eynard, 2005)*, it becomes possible to automatically generate engineering applications. The goal being always the reduction of the time dedicated to routine tasks.

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Toufik Boudouh received the engineer degree in mechanical engineering from the University of Batna (Algeria). He then received the MSc and PhD degrees from the University of Bordeaux (France). He conducted his research at the National School of Engineers of Tarbes before taking an Associate Professor position at the University of Technology of Belfort-Montbéliard (France). His research deals with the management of the design process, concurrent engineering, and project management.

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