PEGASE: a prototype of software to manage design system in a collaborative design environment

Vincent Robin[a1], Christophe Merlo[b] and Philippe Girard[a]

[a]IMS - LAPS, University Bordeaux 1, 351 Cours de la Libération. 33405 Talence
[b]ESTIA / LIPSI, Technopole Izarbel, 64210 Bidart

Abstract. The control of the design process requires to take into account three narrowly overlapping dimensions relating to the product, as an object to be defined, the process, as a generator of this object and finally the organization. Within the framework of the work undertaken during the IPPOP project, an integrated model was proposed with a view to development of a prototype of software. We are interested here in the software tool which can be brought to the actors to manage design process by correlating the organization of the company and the definition of product development process with the structure of the design projects and the control of the real process. This tool is materialized by the development of the PEGASE software for which we present an application inspired of an industrial case study in SME.

Keywords. Design organization, design control, performance management, prototype of software.

1 Introduction

Today, to increase performance in design, companies must not only control the design process but also manage the design system. Finalities of design management are to improve the performance of the company and to bring it reactivity to the evolutions of customers' waiting and to the constraints of the market. Control of the design system obliges to be able to understand and evaluate the design process, in particular the activities which make it up but also the context of the design. Thus, the evaluation of the design must propose a whole of elements of measurement, identified thanks to a model of the system, to provide relevant information to ensure a coherent decision-making in comparison with the real state of the system. Difficulty will be in the modelling of the system for its evaluation. Concerning the design process, it is necessary to be focused on the definition of the product and its evolution, on the objectives of design constrained by the

[1] Associate Professor. IMS, CNRS UMR 5218, LAPS department, University Bordeaux 1, 351 Cours de la Libération. 33405 Talence. Tel: +33540003584, Fax: +33540006644, email: vincent.robin@laps.ims-bordeaux.fr

organization of the company [1] but also on the factors that influence the system as technologies, human resources and physical implementations [2]. Considering this viewpoint and the integrated model defined during the IPPOP project [3], Robin *et al.* proposed a model to evaluate the design system [4], a methodology to implement this model and a prototype of software to assist design actors (PEGASE) to make operational this methodology [5]. In this paper, we present some results of the IPPOP project and we focus more particularly on the software application PEGASE. The first part of the paper describes the integrated product – process – organization model of IPPOP project. On the basis of this model we propose then a detailed presentation of PEGASE, a prototype of software supporting actors all along design project. We show how the prototype makes it possible to model and to follow-up the evolution of the design system but also to create a project and to follow-up its progress.

2 The IPPOP integrated product–process–organization model

Our propositions to manage the design process are based on the results obtained during the IPPOP project (Integration of Product, Process and Organization to improve the Performance in design) [3]. This RNTL project (Reseau National des Technologies Logicielles) has been financed by the French Ministry of the Economy, Finances and Industry, between December 2001 and June 2005. It regrouped five academic partners (LAPS and LMP, University Bordeaux 1; L3S, INP Grenoble; LASMIS, UT Troyes; CRAN, University Nancy 1) and four industrial partners (EADS-CCR, ALSTOM Motors, Open CASCADE, ESTIA-Innovation). One of the principal objectives was to formalize a model integrating three complementary dimensions: the modelling of the product, the modelling of the design process and the modelling of the organization where this process proceeds [6] (Figure 1). This model constitutes the core of a collaborative environment having to make it possible to the actors to control the design process and to be inter-connected with the existing applications (XAO tools, PLM systems...). In this context a methodology and a prototype of software supporting the methodology (PEGASE) were developed [5]. Prototype makes it possible:

- to correlate the organization of the company and the structure of the project,
- to structure the project and to plan the design process by integrating performance indicators concerning product, process and organization,
- to ensure the follow-up of the project thanks to this integration and these performance indicators.

To implement this model and to allow the effective control of the design projects, the company, its organization and its resources have to be described. Following section details the development phase of PEGASE based on an analysis of the design process and of the mechanisms of decision-making throughout the product development. A presentation of the prototype of software is also provided.

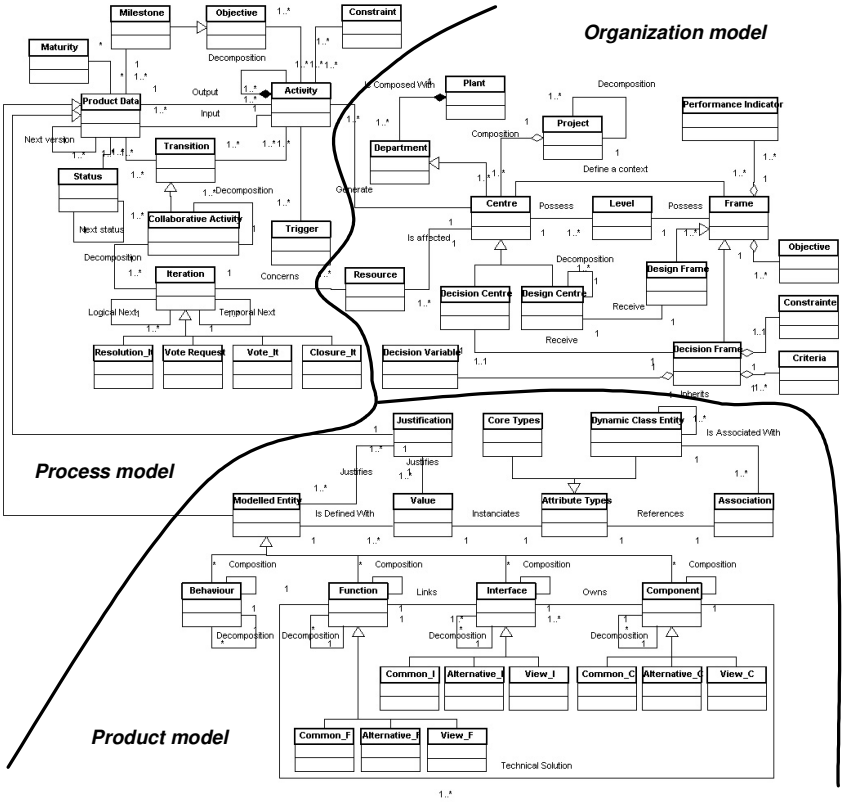

Figure 1. Integrated product – process – organization model of the IPPOP project

3 PEGASE: a prototype of software to control design project

3.1 Presentation of PEGASE

According to the concepts and the models suggested in the IPPOP project we developed a prototype of software to support actors during a design project: PEGASE. To ensure that our prototype respects criterion of conformity, reliability, safety, dimensioning and maintainability [7], the design phase was based on concepts proposed by the creators of UML language [8]. This choice is justified by the fact that this method is very structuring. Moreover, as we wished that the application either based on the open source principles and easily and quickly usable in network of actors, the Graphical User Interfaces were developed in PHP language. This language is used in the development of Internet websites and offers the advantage of being a script language, not compiled, directly interpreted. Finally, the great number of data to be stored and handle implying the use of a data

base. MySQL was retained to manage the data base. The initial objective to which PEGASE must answer is to ensure the connection between the structuring of the organization of the company relating to the design and the control of a design project, such as it is considered in IPPOP project.

3.2 Control the design process thanks to PEGASE

The detailed analysis of design processes and of the mechanisms of decision-making throughout the product development allows identifying elements that have to be managed to control design process [4]. PEGASE has been developed to integrate and manage all these elements. The integration phase concerns the implementation and the configuration of the data base. It is dedicated to the administrator of the system. To manage evolution of the design process, projects have to be structured, planned and resources have to be allocated. This phase is realized by the project manager. Finally, PEGASE controls project evolution by managing the realization of the designers' activities and helping managers to follow-up the project.

In a nutshell, control of the design process thanks to PEGASE results in several actions from the genesis of the project to its closure:

- implementation and configuration of the data base,
- structuring and planning the projects and allocated resources:
  - after the project was initialized and the objectives of the company were specified, the head of project structure his project in order to achieve his goals,
  - he defines several sub-projects for which he specifies the objectives and the persons in charge (as local decision centres),
  - he associates input technical data necessary to the designers to achieve their goals, and output technical data corresponding to the achievement of these objectives,
  - he defines a planning of the activities to be carried out by specifying their technical objectives and their data,
- realize the activities and follow-up the design projects:
  - to allow the follow-up of the project, the designers generate the awaited technical data and valuate the required performance indicators.

These actions associated with the integrated model ensure that the organization of the company, the multilevel management of the projects, the differentiation between the decisions and the transformation of product-process knowledge, the synchronization of informational flows and finally the follow-up of the projects are taken into account.

3.2.1Implementation and configuration of the data base

Within the framework of GRAI R&D approach [9], the modelling of a company makes it possible to formalize its organization (functional decomposition and decisional system) and its technological system (design process). Via an administrator access, the organization is seized within PEGASE (Figure 2). The structure of the decisional system is defined thanks to GRAI R&D grid. Decision centre are identified and their temporal range, their nature and information flows connecting these centres are identified too. This structure is deployed in PEGASE by associating each element of the organization (plant, department, service...) and the corresponding decision centres and by connecting them between specifying information flows (Figure 2). So, the administrator configures information flows which will have to be implemented in the course of project by the various local coordinators implied in order to ensure the coherence of their communication and their decision-makings.

The administrator access also permits to define the whole of the resources: human, material and software. Humans' competencies are also managed and are specified according to competencies matrix of the company. Through the management of their competencies, human resources could be selected during the design projects.

Finally the administrator deploys the design process modelled in the organization by associating to each decision centre the sequences of tasks. This process could be formalized according to the quality procedures of the company. When configuration is completed, PEGASE is operational in order to ensure the control of the design. So, the administrator creates and initializes a project by sending the decision frame and associated design frame to the decision centres concerned in the organization.

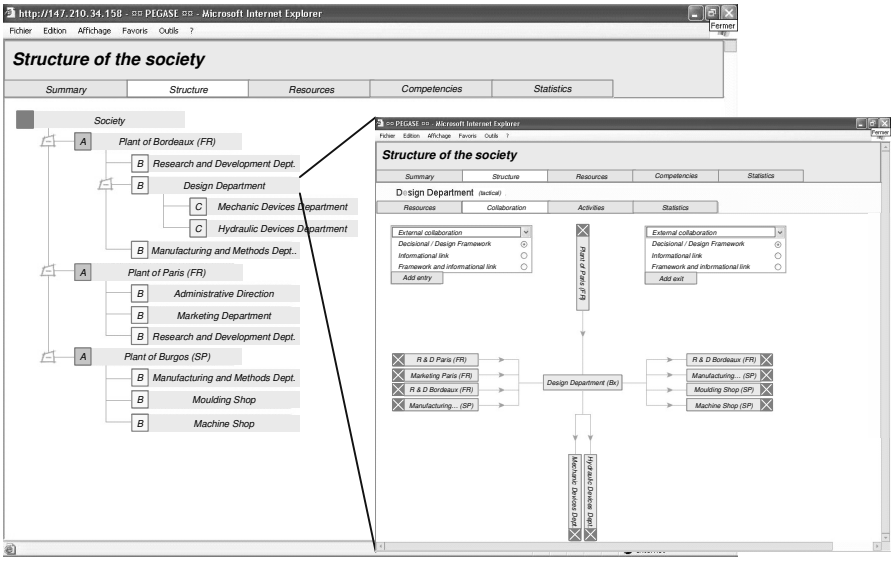

Figure 2. Functional and organizational structure of the company

3.2.2 Structure, plan and follow-up a design project

When the project is initialized, PEGASE systematically informs the users of the new events which relate to them. So each coordinator is informed of his new statute when he is connected. He has information about the organisational structure of the company in order to know the other coordinators with whom collaborations will be established. He is able to reach directly the details of the new project and to reach the decision frame that is sent by the upper decisional level (Figure 3).

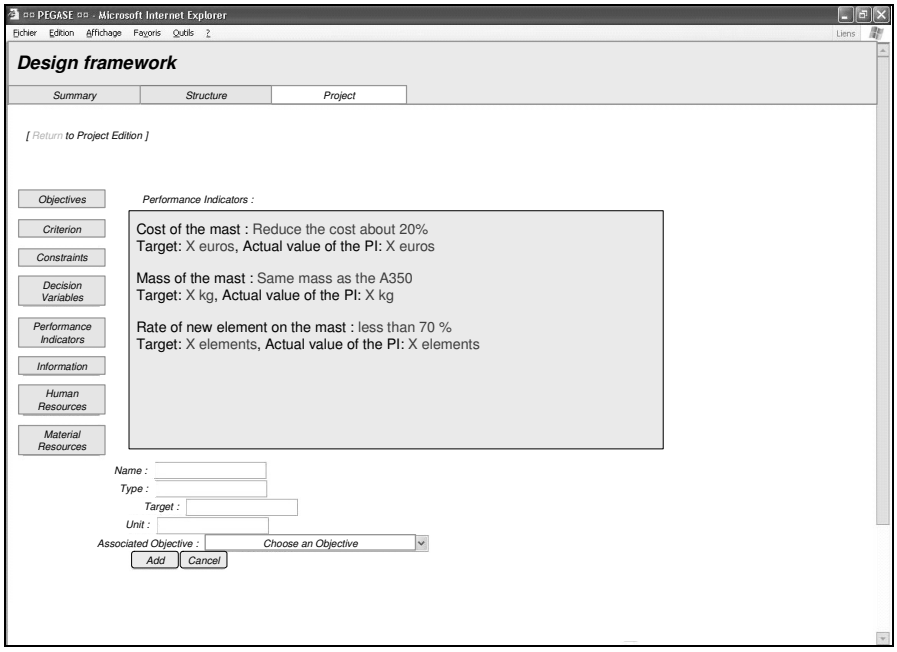

Figure 3. Graphical User Interface to consult the decision frame

The decision frame enables him to know his context of work: his objectives, his criterion and decision variables, his constraints, his performance indicators and the resources which are allocated to achieve his goals regarding to performance indicators. He is then able to begin the phase of control previously structured, assigned and planned. The coordinator has the opportunity to create sub-projects which will be automatically associated to decision centres for the lower decisional level. He defines finally the tasks to be carried out by completing whole or part of the tasks specified by the administrator, or by introducing new tasks depending on the needs for the project. It guarantees the flexibility of the design process evolution during the project. By using the preset informational links, PEGASE informs each new local coordinator of sub-projects and each designer affected to specific tasks of their objectives. Project managers and the designers have the same GUI (Figure 3) to understand the context in which they must carry out their tasks. Difference is that project manager create performance indicators and designer could just complete these indicators. They must, at the end of their task, indicate the values of the performance indicators.

The coordinator is informed of the new values to his next connection. If the indicators don't correspond to the attended values, he analyzes the situation and then could decide: to start new activities, to modify some elements of the decision frame (objectives, constraints, resources...), etc.

4 Synthesis and conclusion

Work reported here constitutes a specific application of the results from IPPOP project in order to make effective the control of the design. The approach suggested is based on an integrated product - process - organization model and on a methodology modelling the design system and structuring, planning and following-up the design projects. This methodology remains however to be validated by an experimentation in a company. PEGASE is a prototype whose first version only takes into account organization and process dimensions. Influences of each element of the design context are considered since functional and decisional structures of the design system are identified and external environment (subcontractors, competitors, customers, etc) is integrated. PEGASE takes part in the project management from the creation of the project to its closure. All the projects of the company could be managed and controlled through the prototype which provides and capitalizes information on the project, on the resources (competencies, availability, etc.) to follow-up evolution of the design system.

Despite, the prototype is perfectible and must be sophisticated. Thus, the product dimension has to be implemented in order to be able to define performance indicators related to the evolution of the technical data. The prototype currently only makes it possible to define indicators manually and it is envisaged thereafter to enrich this functionality by automatisms that permit to identify indicators along the evolution of the process, the product and the organization. Moreover, the taking into account of the material resources for their management is not effective yet and the integration of CO²MED tool [10] – tool for management of collaborations between actors – is also under study. Lastly, the management of the activities only concerns sequential process. The use of workflows technologies such as those existing within the PDM tools should allow a great variety of specification for the managers while providing mechanisms of multilevel synchronization [11].

5 References

[1] Mintzberg H. Le management: voyage au centre des organisations", Les Editions d'Organisation, 1989.

[2] Wang F, Mills J.J, Devarajan V. A conceptual approach managing design resource. Computers in Industry, 2002, Vol. 47, pp 169-183.

[3] Roucoules L, Noel F, Teissandier D, Lombard M, Debarbouillé G, Girard P, Merlo C, Eynard C. IPPOP: an opensource collaborative design platform to link product, design process and industrial organisation information. Proceedings of the International Conference on Integrated Design and Manufacturing in Mechanical Engineering, Grenoble, France 2006.

[4] Robin V, Rose B, Girard P. Modelling collaborative knowledge to support engineering design project manager. Computers in Industry, 2007, vol. 58-2, pp 188-198.
[5] Robin V, Girard P. Managing Design System Evolution to increase Design Performance: Methodology and Tools. 14th CIRP International Conference on Life Cycle Engineering, Tokyo, Japan, 2007
[6] Robin V, Girard P. An integrated product-process-organisation model to manage design system. Proceedings of the CESA Multiconference on "Computational Engineering in Systems Applications", Beijing, China, 2006.
[7] Morlay C. Gestion d'un projet système d'information – Principes techniques mise en œuvre et outils. Edn Dunod, 2001.
[8] Quatrani T. Modélisation UML sous Rational Rose 2000. Edn Eyrolles, 2000.
[9] Girard P, Merlo C. GRAI-engineering methodology for design performance improvement. Proceedings of the International Conference on Engineering Design, Stockholm, Sweden, 2003.
[10] Rose B. Proposition d'un référentiel support à la conception collaborative: CO²MED (COllaborative COnflict Management in Engineering Design), Prototype logiciel dans le cadre du projet IPPOP. Ph.D. thesis, Université Henri Poincaré, Nancy-I, 2004.
[11] Pol G, Merlo C, Jared G, Legardeur J. From PDM systems to integrated project management systems: a case study. Proceedings of the International Conference on Product Lifecycle Management, Lyon, France, 2005.