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INNOVATION AND DESIGN PROCESSES MODELING: A SYSTEMIC APPROACH.

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Abstract

The main objective of this paper is to contribute at the product design process control, specially with the innovation process modeling. The innovation process is developed as a specific management process of the company. A generic model is proposed for the industrial system. The innovation process is developed on three levels. The links between these three different processes are detailed within the design process framework. In the last our processes models take into account the fact that a lot of companies manage their product development with a project organization. Therefore the processes are integrated in a project approach. Within project management model, the decision flow, the action flow and information flow are structured.

Keywords: Design process, Innovation, project management, company processes model, systemic modeling

1 Introduction and objectives

Today the innovation for the enterprise represents its guarantee of growth. The main objective is to contribute to the product design process control, specially with the innovation process modeling. The innovation process is developed as a specific management process of the company. Moreover this approach is illustrated in a project management organization.

The purpose of this paper is to understand, to describe, and to model decision making and information flows on this kind of project in order to specify recommendations for the organization of the company. We are validating our models on different cases study from CEA (Centre d'Etude Atomique), from TFE (TotalFinaElf) a petroleum company and PSA (Peugeot) an automotive company.

The paper is organized as follows: section 2 draws out a general model for an industrial system and a systemic model Innovation and Design Sub-Systems, section 3 describes our formalization of innovation processes, the influence of the organization on the process structure is illustrated and our management innovation and design processes implemented. A particular application in Project Organization is developed in section 4.

2 Proposal of systemic model of an industrial Organization

2.1 Industrial System

Thanks to the systemic approach [4], an industrial organization is considered as a global system. A generic model is proposed [10] for the industrial system . This complete model, with its 4 views (ontological, functional, genetic and teleological), permits to manage the interactions between its processes, its means (human resources, competences…), and its

evolutions (phases). Processes are, on the one hand, controlled by their added value, to satisfy their customers, their shareholders and their employees, and, on the other hand, constrained by the market, the competitors and the suppliers.

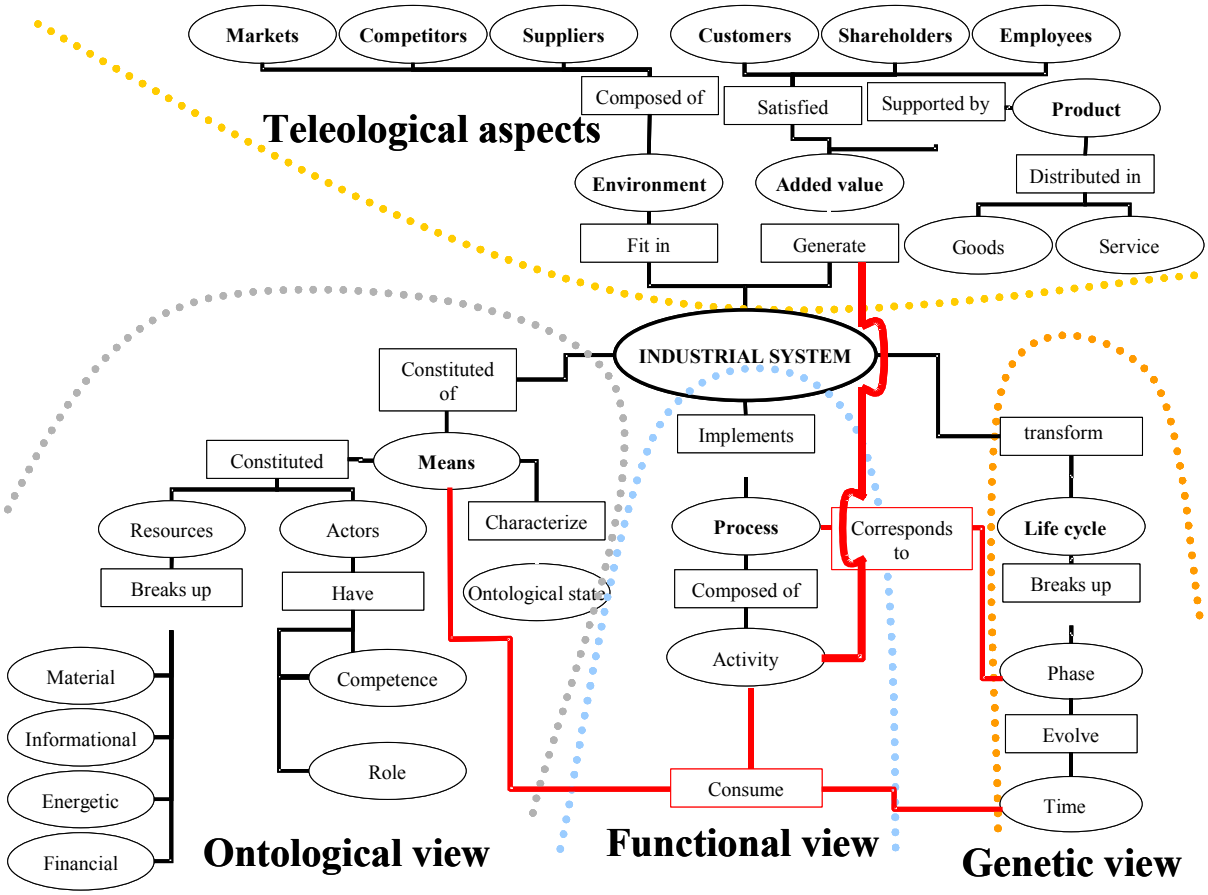

Figure 1. Systemic model of the industrial system of a company.

It is very important to consider the special links (Phase – Process, Activity - Generate, Activity – Consume – Time, Activity – Consume- Means) of this model. These links are the heart of the enterprise performance, and they are the base for the time and competences assignment in order to achieve the goal.

The same model can be used for the general industrial system of the company, and also for its sub-systems as Innovation and Design Sub-Systems. That's way we focus our intention on the Innovation and Design sub-system in the section 2.2.

2.2 Innovation and Design Sub-Systems

The figure 2 illustrates the decomposition of the given industrial system and highlights the links between the different design sub-systems that it is composed of. As we can consider the Innovation and Design Sub-Systems as the operative system, integrating him with the Production sub-system, we have create the whole new system, that we call "principal system" . This way the manufacturability of the designed product is insured. The Innovation and Design Sub-Systems have some explicit interfaces with the provisioning and the distribution sub-systems. These interfaces are the guarantee that the hole designed product life cycle is taken in account. Equally the interface with the support sub-systems ensures the performances

of the Innovation and Design processes. Effectively the support sub-system produces the processes and methodological supports that are the reflexion of the up to date strategy of the company.

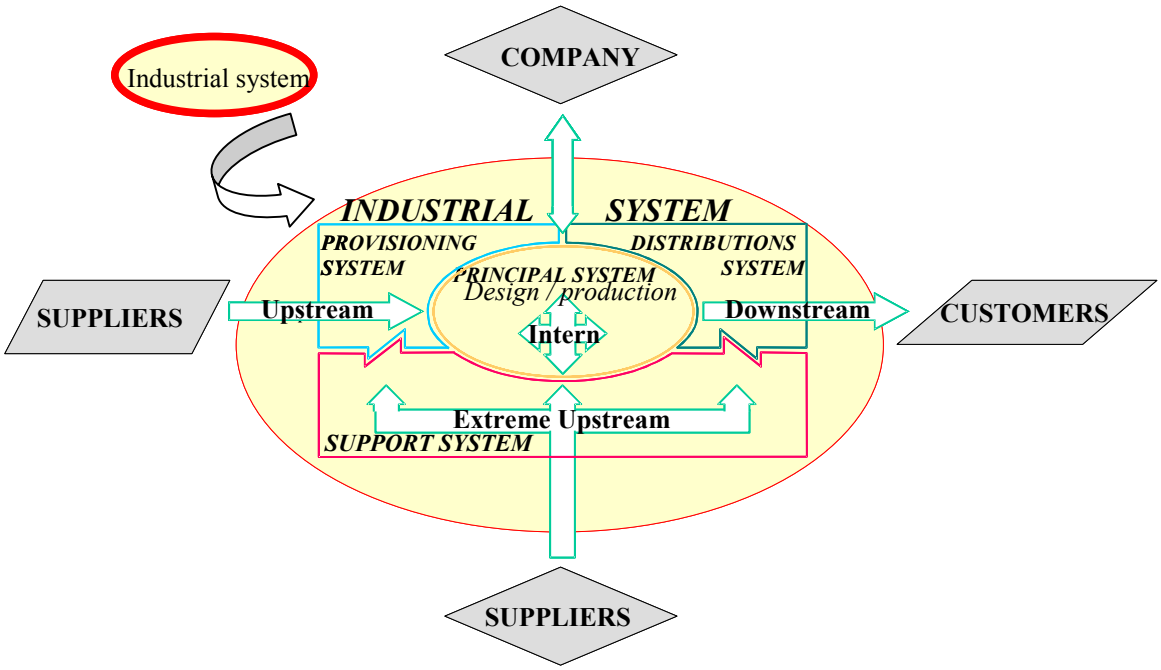

Figure 2. Innovation and Design Sub-System.

3 Innovation Processes formalization

3.1 Influence of the Organization on the process structure

In Figure 3, two innovation process models are proposed in coherence with two different examples of industrial organization. Each innovation process is developed on two levels, for the first innovation process the third level is specified in the next section.

In the fist organization the operative system (here the product design process) is linked directly whit the support process and the management process, and the operative system is only connected with the customers.

In the second considered organization, the links and the connections are different, so the innovative and design processes are necessarily different. For example customers can connected with each process of the processes.

In this model the processes are elaborated to satisfy the customers needs, and the organizations structures are created into consideration the processes themselves. This fact is very important for the process design and consequently for the design processes.

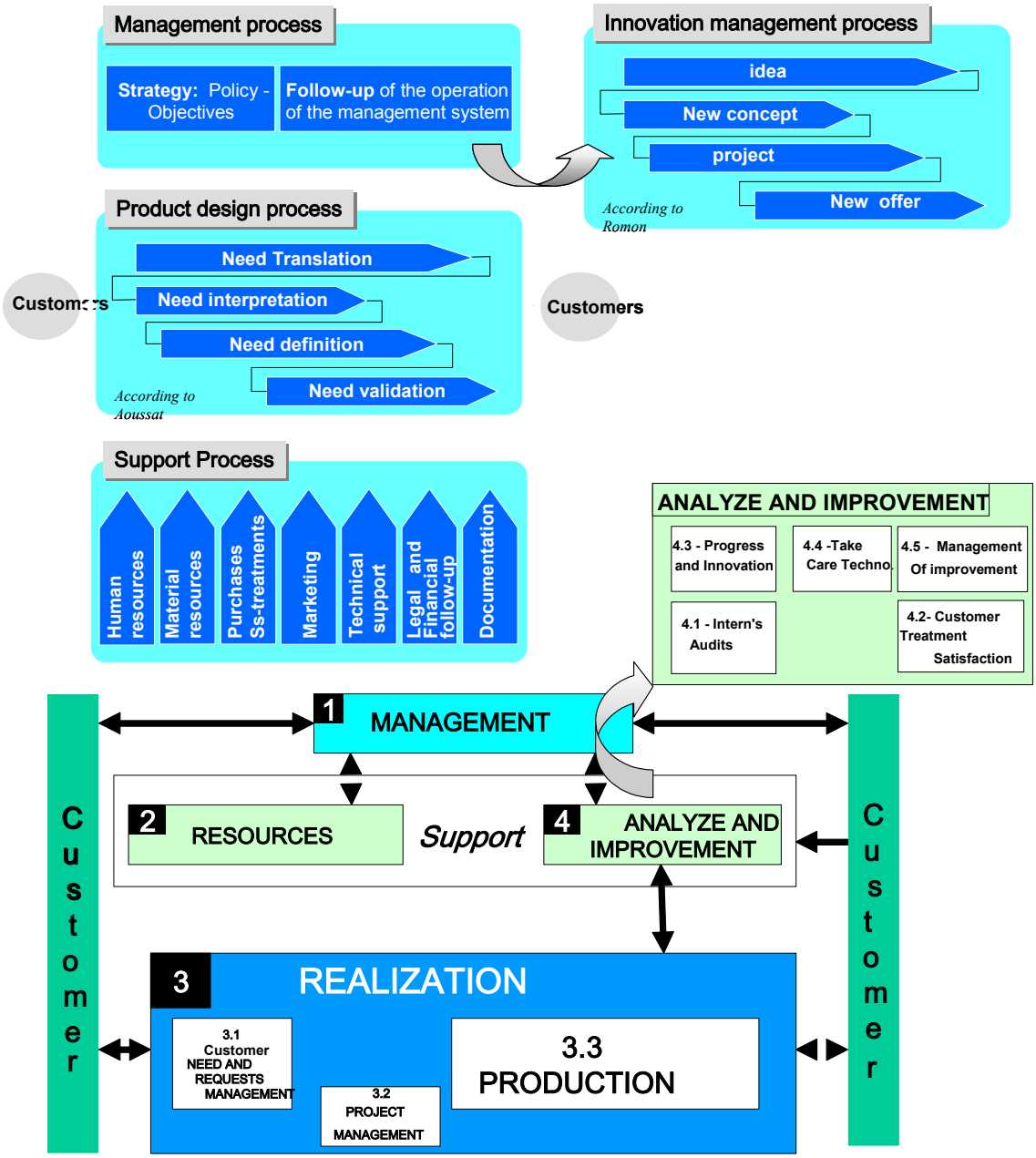

Figure 3. Two innovation process models.

3.2 Innovation Management Process

It is not so easy to understand the process to achieve successful technological innovation [2], or to realize the product development [9] [14]. We have chosen to study the innovation management process and to detail there relationships with the support process and management process. On the figure 4 the support and management processes are detailed [1]. The links between these three different processes are detailed within the design process framework. With the arrival of new standard ISO 2004 (which includes the process management) some questions, as what detail level and what control process indicators have to be discussed.

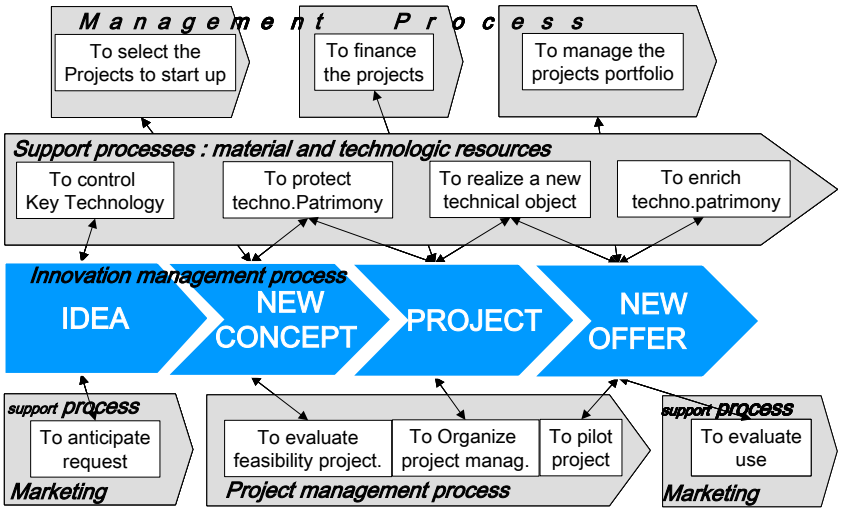

Figure 4. Innovation Management Process.

The Innovation Management Process model proposed by F. Romon [12] contributes this discussion. This model has been elaborated in our research Laboratory and is adequate for the first organizational model. This model treats the links between the sub-processes of the same level. This links will be organized as flows in the next section, in the particular case of the project organization.

4 A particular application in Project Organization

4.1 Project Organization Specificity

A project organization has specific particularities. Indeed, a project is a group of resources (human and material) which work together to reach an objective (defined in terms of quality, cost and schedule). The project manager and his team spend a significant part of their time on the project. A project has one single objective and takes place in a given period of time. The models of processes that have been developed in the upper section to be integrated in this particular organization. Two aspects are distinguished.

- The process integration by the flows : section 4.2
- The process integration by the contents : section 4.3

Finally we propose a total integration in crossing these two aspects in 9 generic processes : section 4.4.

4.2 Project Flow structure

Now our processes models take into account the fact that a lot of companies manage their product development with a project organization. Therefore the processes are integrated in a project approach. Within project management model, the decision flow, the action flow and information flow are structured. The organization is represented by different systems in interaction : actor system inside the project system, project system inside the enterprise system, enterprise system inside the competitors and customers system, and at least the

shareholders system connected. The flows circulating between these systems are then represented figure 5.

Three types of flows are distinguished:

- the activities flows that are oriented mainly from the project's actors (it is the operative flow) to the costumers, this flow results from the activities of operative processes
- the information flows which circulate mainly in reverse direction, in our model this flow results from the support processes
- the decision flows which make it possible to control the activities of each system by using available information of information flows. The decision-making is realized by the management processes.

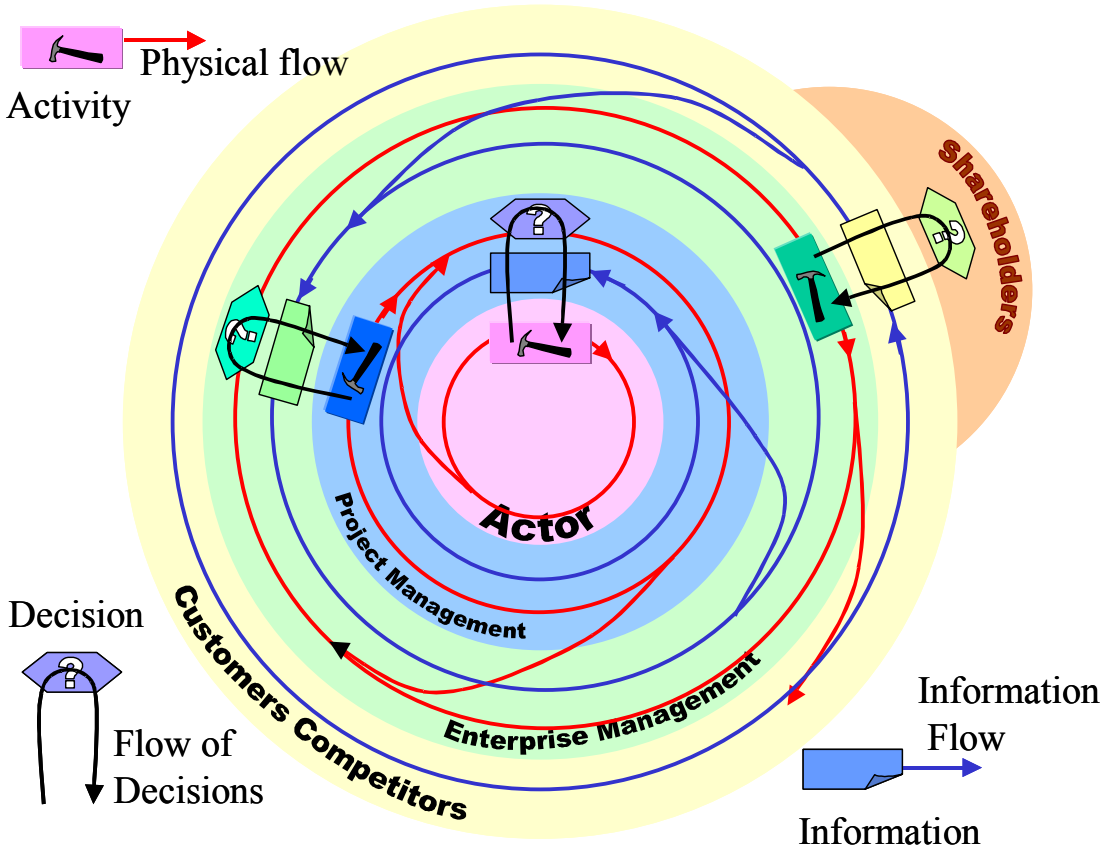

Figure 5. Structure of three flows, decision, action and information.

If we make an hypothesis "For every decision making, it is possible to associate a decisional process" [13] [8], generally this decisional process will be include in management process of higher level. In this case to decide it is sufficient to apply this high level process. But some times, the decision processes cannot be included, so a specific process must be developed or some times a specific organization.

Organizing the flows is not sufficient because the result (the product in product development) also depends on the content of the project. The management of this content must be structured in processes.

4.3 Proposal for WBS elaboration

This approach refers to project management approach developed by PMI (Project Management Institute) [11]. The PMI proposal (figure 6) for the definition of the content is to elaborate a Work Breakdown Structure. None real structured approach is proposed. However we think that is very important to distinguish the targets, the activities and the deliverables. Because it is not the same thing to define what you have to do, that what you do and what you have produced. In this case the reference frames are different, in the first case the reference frames are the global project and the company performance, in the second case they are the means, the trade made competences of the company and in the last the reference frames are the costumers satisfactions.

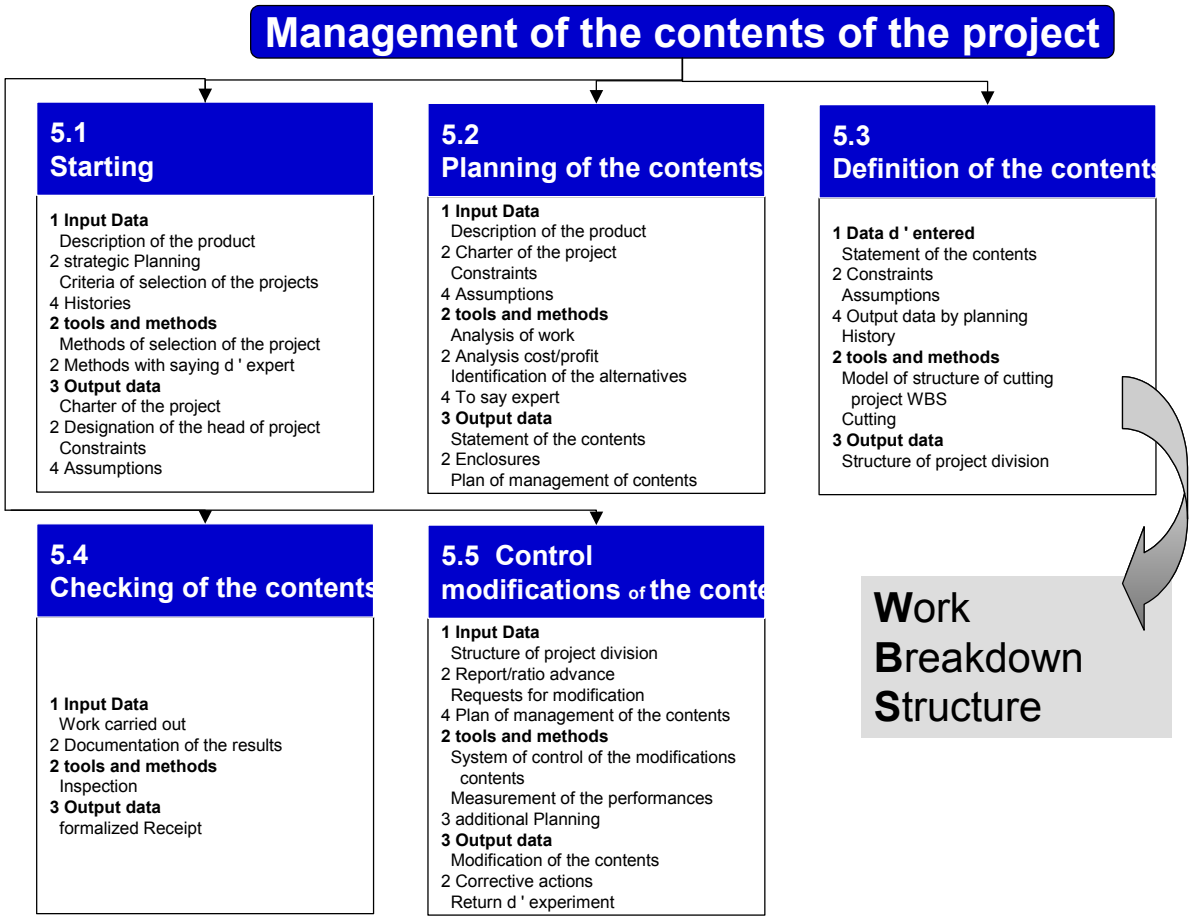

Figure 6. Specificities of the action, decision and information flows.

So we propose to build three structures :

- a Work Breakdown structure with only the activities which are necessary to realize the targets and the deliverables of the project
- a Target Breakdown structure with only the activities which are necessary to manage the targets (to elaborate, to control, to affect resources…)
- a Deliverable Breakdown structure with only the activities that are necessary to manage the deliverables (to specify, to control, to affect resources…)

This differentiation allows a real control of the responsibilities. One cannot be a judge and a party. The affected resources for the targets and the deliverables will be the persons in charge, while the affected resources for the activities will be the makers, the executives.

4.4 Contents and flows crossing

We had proposed three kinds of flows (activities, decisions, information), we had proposed three kinds of breakdown structure (work, target, deliverable). If we cross flows and breakdown structures we obtain the nine needed processes to manage the project realization (figure 7).

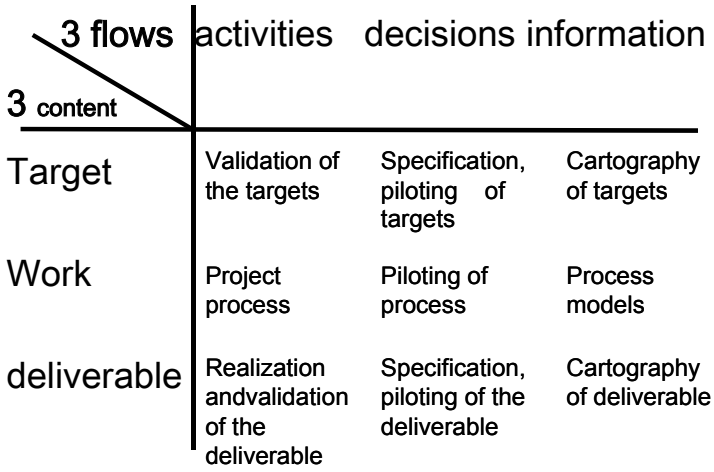

Figure 7. nine needed processes to manage the project realization .

For each content type, targets by example, the sub-processes of specification, validation and cartography elaboration are activated by the management process, the design process and the support process respectively.

In the same way for each flow, decisions for example, the sub-processes targets specification, project process piloting and deliverable specifications are activated to resolve the different contents.

5 Synthesis

In the general systemic model of a company we underlined the importance of the special links (Phase – Process, Activity - Generate, Activity – Consume – Temps, Activity – Consume-Means). To control this links in the design sub-system, we have proposed innovation processes formalization. This formalization emphasized the necessity to take into account inter-process flow (resulting from the organization). As the product development is essentially organized in projects, the project flows have crossed with the three types of contents (work, target, deliverable). In result the nine generic process to manage the project could be applied to the innovation processes and even on the links between this processes.

One part of these concepts, conferring to the information system, was developed with success in the automotive department PSA that controls and has an overview of all the projects apart from the new car projects. The part that refers to the decision flow is now developing in innovation department au PSA, see ICED 03 conference [5].

6 Conclusions

This paper have proposed some structuring method to organize the enterprise processes, and specially Innovation Processes. At first a generic and systemic model of the industrial organization was proposed. A focus was made on processes, and particularly on innovation processes within product design management. We have explained how to model the innovation and design processes according to the organizational structure of the company. Different levels of modeling have been developed, and two examples of company have been illustrated.
With the same approach, the project management process was presented. The innovation and design processes integrated. The different categories of flows have been detailed.
Also, the interest of such an innovation process modeling was elaborated.
The modeling innovation design processes within a generic and completed model of industrial organization permit to take into account simultaneously all the different points of view (management, support, operational..), that way the complexity is controled[3]. The integration of this approach into a project management context allows to measure its performance.

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