# New Product Development Process:
## *Proposal for an Innovative Design Modelling Framework Including Actors Evaluation of Innovation Costs and Value*

Sechi N. [1], Lawson M. [1], Soenen R. [2]
*nathalie.sechi@renault.com; mlawson@univ-valenciennes.fr; rene.soenen@bat710.univ-lyon.fr*
[1] *Laboratory of Industrial and Human Automatics and Mechanics (LAMIH) –CNRS, UMR 8530, University of Valenciennes – France, Renault S.A.*
[2] *Lab. of Information Sciences, Graphics, Image et Modelisation (LIGIM), University of Lyon*

**Abstract:** Firms are facing very short and important innovation cycles, particularly in IT and Telecommunication sectors. Then a question appears: why do some innovations succeed whereas other fail. From offer's point of view, a way could be to evaluate impacts of a decision to innovate for each of the actors involved in this product trajectory. Therefore the goal of such an approach is reducing high Innovation development risks by integrating the diverse stakes of life cycle actors and by helping design teams to integrate the evolution of some key environmental processes. We introduce in this paper the characteristics of the Innovation Process and Engineering Design Phase for high level innovations. In this framework, we propose an Innovation Valuation Model integrating strategic and tactic impacts in term of value and cost.

**Key words:** Innovation process, Innovative Design, process approach, product trajectory, innovation valuation

## Introduction

Firms are facing very short and important innovation cycles, particularly in IT and Telecommunication sectors. Thus, a fundamental question appears : why do some innovations succeed whereas others fail. To try to answer to this question we may adopt the environmental or global point of view (for instance technologies selection by environment) or the innovation process actors' points of view and particularly the offering firm's vision. We choose to study the latter in the light of the life cycle actors' diverse stakes.

The original version of this chapter was revised: The copyright line was incorrect. This has been corrected. The Erratum to this chapter is available at DOI: 10.1007/978-0-387-35492-7_50
G. L. Kovács et al. (eds.), *Digital Enterprise Challenges*

Moreover, our research particularly will be supported with the life-cycle of Automotive Industry and a specific case, the integration of e-services in a vehicle.

In this way, we have to define the innovations we study and their Innovation Process' characteristics (Part 1) . In a second part, we shall focus on the key phase, the expectation phase: the Innovative Engineering Design Process. In fact, we argue that the specificity of 'high level Innovation' Processes conducts to cast doubt over design traditional performance analysis in benefit of an approach using Innovation impacts' estimation. So we propose to introduce an instrumentation of this evaluation model for innovation actors (Part 3). In a fourth part, we present our validation framework, the development of innovative technological-intensive services (Part 4), and finally we conclude (Part 5).

# 1. Analysis Framework

We focus on high level innovations we need to define (part 1.1.). Moreover, we argue that the corresponding Innovation Process also integrates high level innovations' specificity (part 1.2.).

## 1.1. Innovations studied : high level innovations

The term of Innovation includes products which have very different logic and risk for our economic system's evolution. We here focus on high level innovations, as they imply high changes in all the processes of the product's life cycle and in the firm's evolution. On the base of (Tidd 97), we can locate innovations studied in the following representation (figure 1.1).

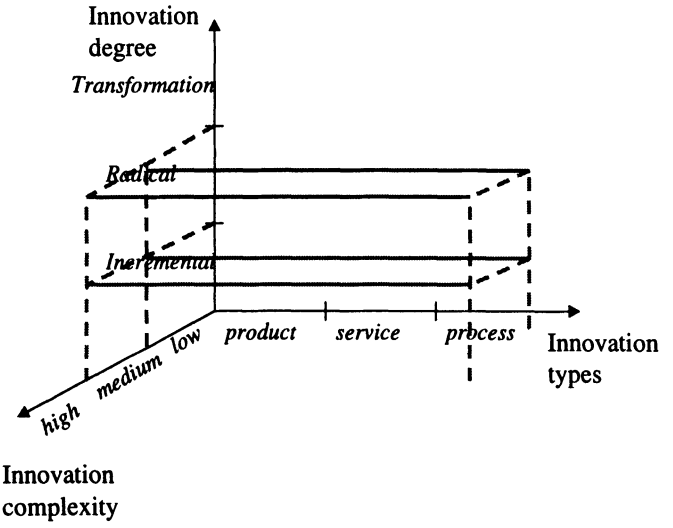


***Figure 1.1.1** : Innovations studied*

We then concentrate on 'Radical' Innovation, referring to Abernathy's definition (Abernathy 78). On the other hand, those high level innovations tend to be a combination between product, service and process and have a relatively high technological level. Typical high level innovations can belong to Information Technology and Communication sectors.

In this framework, we shall define innovation actors as the agents who have stakes in the innovation development. In this 'actors network' we can find actors of the product's life cycle – as final users, the offering firm, organisation partners - but also actors affected by the firm's results, as shareholders and public authorities. Referring to Normann and Ramirez (Normann 93), we call this group of agents a 'Value Constellation'. The authors remind us that the actors of this value creation-system co-produce the product.

Moreover, we have to note that we can name and define innovations only in reference to an initial state – a product we call As-Is. The As-Is is a commercialised product plus its associated life-cycle processes, introduced by the firm or competitive firms. We then have to observe the product-process As-Is and its 'performance trajectory' (Bower 95) including performance evolution of the product. At the opposite the Innovation is called To-Be.

## 1.2. The Concurrent Innovation

Innovations are often developed conjointly in parallel to others to be finally joined in a final determined time.

As G. Segarra (Segarra 01) explains us, the concurrent service / product development is defined in analogy with the concurrent engineering approach : it will consist in developing simultaneously the product and the services which will be enabled by the product. Following the author, his iterative approach (the product development impacts the service development which will impact the product development (see the figure 1.2 below)) must allow to develop the product in such a way that it will be enough open in order to facilitate the constant development of new services with a reasonable effort.

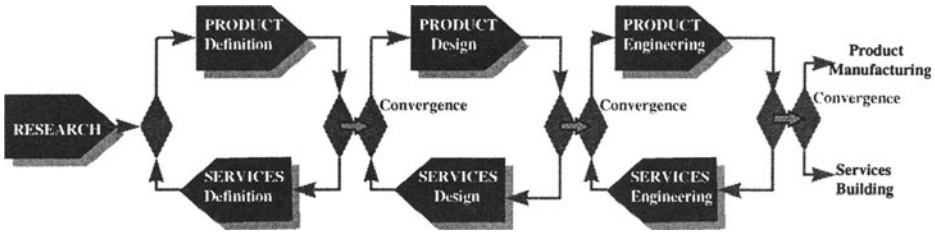


***Figure 1.2** : Concurrent product - services development (Segarra 01)*

The transition from one step to another (i.e. from definition to design) will be conditioned by the convergence of the product - services actors toward

a common view point.

## 1.3. The Innovation Process

As technology intensive innovations in IT and telecommunication sectors show us, the success of an innovation process for high level innovations particularly depends on technologic and competitive environment changes. In addition, the process implies the intervention of diverse complementary agents and resources and generates important exchange of information and knowledge.

This complexity pushed us to choose a process approach in order to represent components of the innovation process and links between them. In this way (cf. the following 1.3 figure), the innovation process depends on offered resources – by the extended firm as by the environment – and drives us to final and intermediate results by the mean of stages. Information and knowledge exchanged and created are defining our solution. Moreover, the process can be viewed as a process highly reactive to its environment. At every process' stage, environment choices – corresponding to information and knowledge flows – curb the product trajectory. At last, we cannot neglect the role of the firm's strategy: its rules have the role of a canal, they conduct the process orientation.

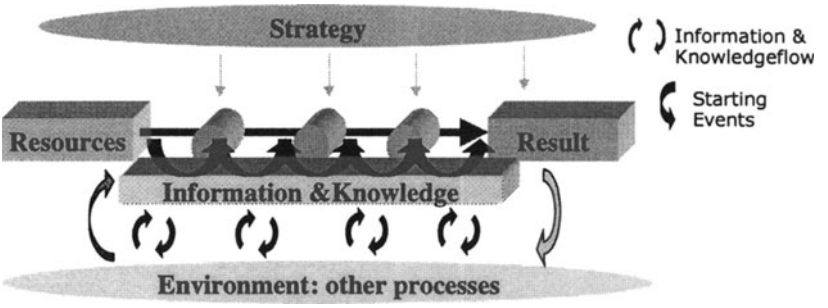


***Figure 1.3.**: an environment reactive process*

In consequence, we may define three levels in environment processes: the internal processes of the firm, some processes of the firms' partners, some processes of the global environment.

Processes which determine the Innovation Process thus have three levels. At a first level, we distinguish all concurrent processes from the extended enterprise. They include on one hand the firm's internal processes – as technology landscape, production processes, other new development processes, knowledge creation process – and on the other hand some processes of partners which interact on our product development process. Moreover, in the light of evolutionist studies (Nelson 82), some processes

from the global environment such as external technologies selection processes or knowledge and competence selection processes (Cohendet 98) should also have an impact upon decisions about product development.

In conclusion, in this first part we have presented the type of innovations we will focus on, as well as the characteristics of Innovation Process. This permits us to bring out our study's scope : high level innovations and the way to develop and manage them, from the offering firm's point of view. More precisely, in next paragraph we will emphasise a key process : innovative engineering design process, and hence introduce our contribution about conducting this process through the estimation of innovation impacts.

## 2. Objectives and methodology

### 2.1. A representation of Innovative Engineering Design

At the heart of Innovation Process, Innovative Engineering Design process is a complex activity implying intervention of actors owning different levels of knowledge and information upon the solution. This process stretches from an innovative idea selection as far as the synthesis of the innovative solution, in such a way that it fulfils life cycle conditions.

Of course, many definitions and descriptions of design processes have been proposed both by academic and industrial authors. As an illustration, a good list of design methods has been realised in (Cross 94). For our part, we are choosing to bring the different visions of stakeholders , and the progressive convergence of these visions, to light. Each actor estimate so his perception of the innovative possible solutions' impacts upon their respective interests and is involved in a negotiation process through impacts estimation process

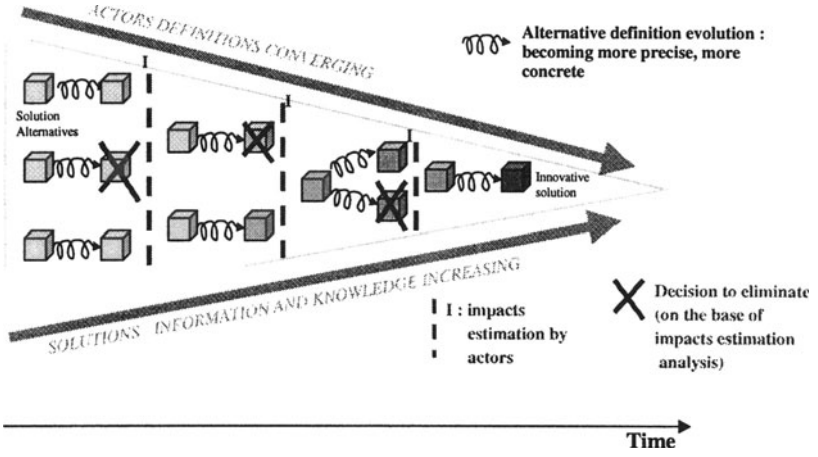


***Figure 2.1 : Innovative Engineering Design Process as a Convergence process***

This impacts estimation process, based upon the different alternatives

definitions, will therefore help decision-makers to validate or eliminate some alternative. Then, from a product development point of view, design process can be seen as a funnel : from the beginning to the end of the process, some product features are chosen whereas others are rejected, until only one product concept is selected (cf. figure 2.1.).

## 2.2. Innovation valuation model methodology

The convergence process inside Engineering Design is conducted by actors' collective evaluations. We propose to pilot those decisions by actors' estimation of value and costs of the innovation. Consequently, one of the original points of our contribution is that the evaluation criteria we choose are the economic value and costs of Innovation for the actors. We define the economic Value as an individual or collective judgement on the product (Mouchot 95) ; (AFAV 89), based here not only on financial impacts but on real impacts too, such as enterprise knowledge development and competencies evolution.

Then we need to know which components are involved in such a decision model based on impacts evaluation. Referring to the 'Rational' Decision Model introduced by B. Walliser (Walliser 86), and the well known IDEF 0 formalism, we have consequently chosen to define the steps of an innovative solution's choice integrating value and cost impacts as follows (figure 2.2.):

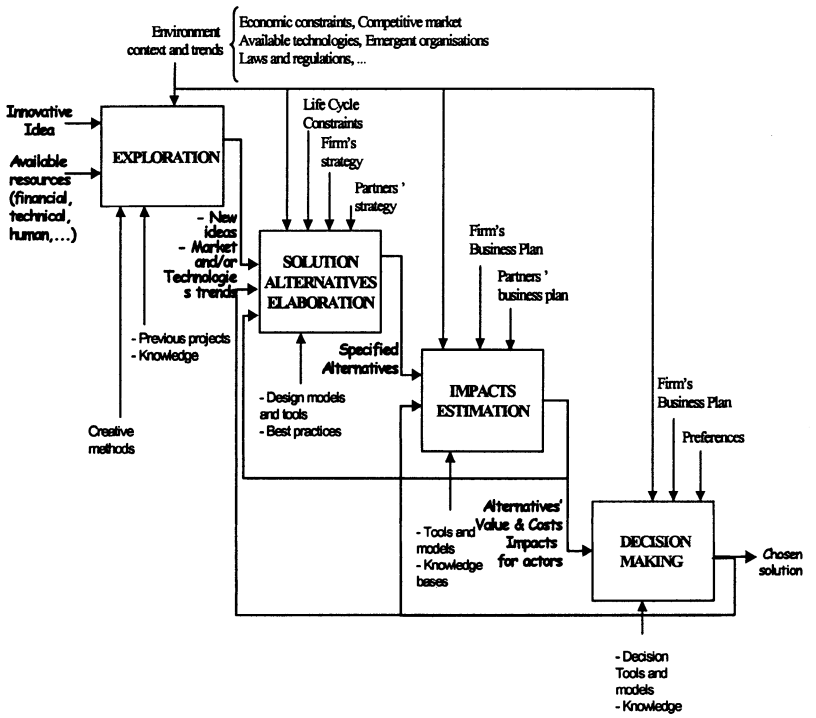


***Figure 2.2.**: Steps of an innovative solution's choice using value and cost impacts*

On the base of system approaches we can consider initial innovative idea and available resources as inputs and the final result – our choice – as the output. The first phase we define is the exploration of the design space, regarding, as following steps, the environment context in terms of market and technologies' trends, available resources or capabilities from the extended enterprises, etc. Then, a second step will be the elaboration of different technical solutions by Engineers also constrained both by technical and economic elements, from the future product's life cycle issues. Each of these solutions, to which are associated some technical specifications, are the inputs for the third phase, impacts estimation (our main topic). The aim of this latter is to provide the global value and cost for actors, referring to our chosen representation models. Finally, the last phase equals to the decision model. Different possible decision models could be used, such as a simple discretionary decision to a collaborative informal choice or a metrics formalised model. We must notice that this overall process model is not sequential : at each step it includes possible returns to a previous step.

The decision process we propose is based on the innovation economic value estimation by the actors and the manner to extract information from the environment so as to feed this decision process. For each stage of the development process, Innovative solution values for the actors network are built in a converging manner.

After locating impacts of the possible solutions inside of Innovative Engineering Design Process, it would be interesting to enter inside the impact estimation's box. We shall thus present in the following part the different types, dimensions, and determinants of value and cost impacts.

## 3. Innovation Valuation Model : critical impacts from a decision to innovate

### 3.1. Impacts levels and dimensions

Each decision, along the Innovation Process, generates impacts on every Innovation Actor belonging to the 'Value Constellation' (Normann 93). In fact, as Normann and Ramirez underline it, innovating today implies an active intervention from all innovation stakeholders on account of final decision impacts on their interests. Therefore, we are facing a value creation system or network which builds a solution through information and knowledge flows. Each decision has an effect on each actor's interests. Let's note that the impact horizon is relatively large, and accordingly we choose here to limit our study to the most impacted actors.

Innovation success has interested several authors since the 1970's (e.g.(Madique 86)). These authors notably tried to identify the key factors for success. However today we can observe that their main weakness was that

their studies focused exclusively on financial results. Then appeared since the 1980's large studies showing the important role of information relations between system's actors : in firms relations, employer-employees relations, manager-shareholder,... Since the beginning of the 1990's, the dominant tendency has been to take mainly into account knowledge issues ( works on knowledge creation (Nonaka 96), Knowledge Management, and more traditionally, knowledge based firms relations ((Richardson 72), (Prohalad 90) ,(Teece 94),...). Otherwise, new economic models show us how brand value can determine firm value and is becoming a real study center. Our point of view is that all those dimensions of decision impacts are components of an Innovation success.

In conclusion, we define in our paper five dimensions of impacts for a solution choice, relatively to As-Is impacts : financial impacts, informational impacts, knowledge and competence impacts, reputation impacts, time impacts.

Moreover, one can observe that an innovation's development has different levels of impacts. We cannot reasonably integrate impacts on the evolution of a enterprise in terms of core competencies (Prohalad 90), market orientation and effects of product's usability. Accordingly, we just distinguish two levels of impacts for actors : strategic and tactic impacts.

As Hamdouch (Hamdouch 97) reminds us, Evolutionist Economists showed that an organisation follows a path, owns a story. There is an interdependency between its past, present and future choices. On the other hand, this trajectory is conducted by an evolution strategy defined by firm decision-makers at several levels. We touch here an important evolution factor of the firm that the product trajectory has to respect, but also can curb.

Elsewhere, one obviously observes tactic or short-term impacts which integrate direct effects of the innovation's life-cycle phases on actors. In fact, in this part we are not focusing on the product trajectory but on the direct relation of respective actors with the product.

## 3.2. Our solution representation

The decision to innovate implies choices on product characteristics and nature of relations between innovation actors. We shall study the both respectively.

In order to give a receiving structure for an innovative solution's different representation models proposed by actors, we propose a modelling reference framework (Soenen 01) , which is CIMOSA inspired (AMICE 89). This framework's aim is to enable a better circulation of data and information between actors. Their different models are then classified according to three axes as explained in the following figure 3.2.

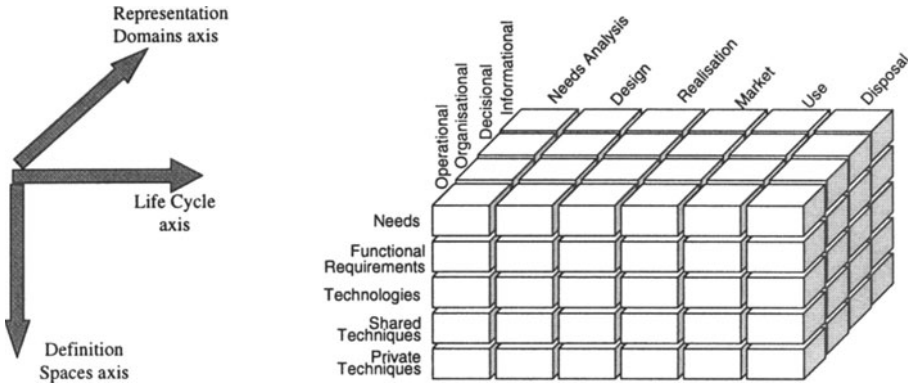


***Figure 3.2** : Our Modelling Reference Framework for innovative solution representation*

In the life cycle axis, co-designers are regrouped inherently to the life cycle phase they refer to. Thus Needs Analysis column deals with needs expression and solutions tracks proposals in terms of news functions or new technologies to be integrated. For example, realisation column is about models and tools used to define and specify forms, surface textures, etc. of product elements and their assembly features. In order to mark out some steps in the product's definition process, we adopt the five definition spaces from (Jacquet 98). Then, covering down this definition spaces axis, product definitions become more embodied, more concrete. About representation domain axis, we distinguish operational, organisational, decisional, and informational domains, according to the product's aspect they represent.

The industrial organisation is a determinant point at the time of solution choices. The type of competence asked define a correspondent type of actor, the nature of contract between complementary firms – buying, cooperating, long term contract,...– as well as the type of contract between offer and customers have significant effects on all dimensions of impacts. Those points have been developed within several points of view. The types of organisational relationships are what we note External Industrial Organisation (EIO) – forms of partnership between firms –, Internal Industrial Organisation (IIO) – relations between firm's internal departments –, and the Customer Relation Management (CRM).

## 3.3. Strategic impacts

We can analyse strategic impacts of offer from two points of view : objectives view (1) and global position view (3).

On base of N. Malhéné's study (Malhéné 00) about firms' evolution system, we situate the Innovative Product's trajectory in a Strategic Period, as we are going from a base position – the As-Is – towards an expected result – the To-Be target. Moreover, the firm's target objectives are defined in a

Strategic Horizon and are periodically casted in doubt over. So expected results of our product trajectory are supposed to be an answer to a part of target objectives. Then a first level of strategic impacts is this answer degree.

Secondly, we can compare product trajectory's choices and environmental (public authorities visions, legislative directives, competitive firms,...) global choices, notably in term of technologies evolution.

## 3.4. Tactic Impacts

Tactic impacts include all the direct effects of a decision to innovate for life-cycle actors – users, leader department, internal customers, partners – in the several cited dimensions. As we said previously, the decision to innovate is characterised by a solution representation. So concerning for example a final user, in the life-cycle usability phase, we can ask ourselves what impact does the product's level of technologies have, from a learning or reputation point of view. In addition, has he gained time or money through this transaction and how much the gain could it be? Does the offer receive more frequent information returns by commercialisation of that new product; does it increase its reputation capital ?

Through tactic impacts estimation we are therefore trying to expect as much as possible the direct and short term value and cost of an innovation for life-cycle actors.

# VALIDATION FRAMEWORK

In this part, we focus on our research IT Innovative solutions that will be integrated in a vehicle. We shall firstly show that those innovations are high level ones, according to our precedent definition. We shall secondly see what particular questions we can consequently ask ourselves in this framework. We shall also be able to notice the interest of our approach's integration.

## 4.1 Innovations in IT and communication

Innovations in IT and communication are characterised by: a high level of technologies, a constantly changing environment, a high level of dependence between technologies, a both services and physical products.

Therefore, we are facing new types of services that we can call technology-intensive services (see Segarra (Segarra 01)). In fact they are services which need technological product innovations to support them. They are particularly present in new technologies industries, but more and more in manufacturing industries, and auto industry. In such services, the innovation includes both a new technological product and accompanying services to be delivered to the customers. So high changes in services require frequently changes in product configuration and in the overall infrastructure (i.e. IT and Telecommunication). On the other hand, new technologies boost changes in services. One can observe a mutual interdependence between services and

technology, which is important in the creation of new services delivery possibilities. In this way, innovative technology intensive services are a particular example of multiple potential strategic and tactic impacts in term of value and cost.

## 4.2. The automotive industry: a complex products and actors system

Introducing new services in an existing commercialised product – in occurrence a vehicle – implies both concurrent product-innovative services management and new competencies management. If we refer to G.Segarra's study (Segarra 01), we can apply the representation of the concurrent product-services development to innovative technology-intensive services (see figure 1.2). In our framework, the innovative developed product would be the trajectory of a particular vehicle. It includes other concurrent R&D projects which will be effectively introduced in the initial vehicle- the As-Is. Therefore, we need to integrate our results step by step in the global design. So, technology-intensive services' Innovation Process and Vehicle's Innovation Process are converging at each phase to permit a continuous common view point.

On the other hand, as G. Segarra shows us too, new actors will be involved in the convergence process. These new actors will be all the partners of the services development.

## Conclusion and perspectives

We argue that traditional economic performance's evaluation are not sufficient for all types of innovations. Our particular experience of IT innovative solutions in the Auto Industry also shows us that innovations characterised by an high level and high complexity generate important impacts for all innovation actors. It thus would be interesting to estimate them during the Engineering Design process.

In this framework, the Innovation Process must be particularly vigilant to movements of its environment and strategic objectives of the offer. Otherwise, the Innovative Engineering Design process is characterised by the intervention of all innovation actors – the 'Constellation Value'- which converge to a final unique solution. We have proposed to pilot this convergence process by introducing impacts' estimation. Strategic and tactic impacts are defined in terms of value –positive returns- and cost-negative returns-, may have several dimensions –financial, informational, knowledge, reputation, time -, and are determined on the base of a solution representation.

Posterior steps of our research – that will be the object of a doctorate thesis – are to enter more in details in the instrumentation of the innovation valuation model and, conjointly, to validate our proposal in an industrial case.

## References

Abernathy W.J. et Utterback J., 'Patterns of industrial innovation ', in Tushman M.L. et Moore W.L., *Readings in the Management of Innovation*, 97-108, HarperCollins, New York.

AMICE 89, Amice Consortium, 'Open System Architecture for CIM', 688 ESPRIT project research report

Association Française pour l'Analyse de la Valeur (AFAV), *Exprimer le besoin, applications de la démarche fonctionnelle*, coll. Afnor Gestion, AFNOR, 1989.

Bower Joseph L., Christensen Clayton M., ' Disruptive Technologies : Catching the Wave *Harvard Business Review*, January- February 1995, pp. 43-53.

Cohendet P., « Informations, connaissances et théorie de la firme évolutionniste », *L'économie de l'information, les enseignements des théories économiques*, Sous la direction de P. Petit, ed. La Decouverte, Paris, 1998, 406 pp.

Cross Nigel, 'Engineering Design Methods', Strategies for Product Design, ed. John Wiley & sons, 1994

Hambouch Abdel-Illah, « Les frontières fonctionnelles de l'entreprise : esquisse d'une approche évolutionniste » , *Working Paper du CRIFES-METIS*, Paris 1 University, n°88, décember 1997, 20 p.

Jacquet L., 'Contribution à l'élaboration d'une démarche de spécification fonctionnelle', PhD, LAMIH, University of Valenciennes, 1998

Maidique M.A. et Zirger B. J., « The New Product Learning Cycle », Research Policy, December 1985.

Meinadier, *Ingénierie et Intégration des systèmes*, ed Hermes, Paris, 1998, 543 pp.

Mouchot Claude, *Les théories de la valeur*, ed. Economica, coll. Economie Poche, 1994, 112 p.

Nelson R.R., Winter S.G., *An Evolutionary Theory of Economic Change*, Cambridge, Harvard University Press, 1982.

Nonaka Ikujiro, Takeuchi Hirotaka, *La connaissance créatrice : la dynamique de l'entreprise apprenante* , ed. De Boeck, 1997, 303 p.

Normann R., Ramirez R., ' From Value Chain to Value Constellation : Designing Interactive Strategy ', *Harvard Business Review*, july 1993.

Phahalad C. K. & Hamel Gary, ' The Core Competence of the Corporation ', Harvard Business review, 1990.

Richardson G.B., ' The organisation of industry ', *The Economic Journal*, 1972

Segarra G., Sechi N, 'From Product to Service engineering: Innovative technology-intensive services in Automotive Industry', FEATS 2001 Conference, Valenciennes, june 2001.

Soenen, Lawson, Sechi, 'From Needs Expression to Design', Proceedings of MICAD 2001 Conference, 2001

Teece D.J., Chesbrough H.W., ' When is virtual virtuous ? organizing for innovation', *Harvard Business Review*, January-February, 1996.

Tidd J, Bessant J, Pavitt K., ' Managing Innovation : integrating technological, market and organizational change', ed. Willey, 1997, 377 p.

Walliser B, *Anticipations, équilibre et rationalité économique*, ed Calmann-Levy, 1985.