Innovation and management constraints

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SUMMARY

The present paper lists management constraints that impact on innovation in business firms. Some of these constraints may slow down innovation or thwart it altogether, others may accelerate the process or increase innovation in the firm, others still may influence the nature of the innovation. Only management constraints are considered here, i.e those constraints pertaining to the interface between intention and really implemented action, as well as those influencing the intention in a partially predictable manner. The related interfaces may be formalized (e.g. management tools and methods like the business plan), they may be partially or totally informal (e.g. the power system, or the innovation process itself). It may be that some of the actors in the innovation do not perceive, or perceive with a bias, the very existence of the constraint, i.e. of the link it has with innovation.

The first part of the paper is devoted to the constraints that impinge upon senior managers, middle managers and other individuals involved in the innovation process (paragraphs 1 and 2). The constraints are then viewed from an organizational standpoint. We examine what they are in different types of organization structures, in different organizational coordination systems, and in various types of innovation processes identified in empirically valid organization research (paragraphs 3 and 4). The paper ends with considerations on the origin of innovation ideas and on the usefulness of constraints for innovation.

This paper is a substantially revised and enlarged version of Romelaer (1998d, 2002c).

RÉSUMÉ

Ce papier répertorie les contraintes de gestion qui pèsent sur l'innovation. Certaines de ces contraintes freinent l'innovation ou la découragent, d'autres l'accélèrent ou en augmentent le nombre, d'autres encore peuvent inférer les sujets sur lesquels il y aura innovation dans l'entreprise. Toutes les contraintes traitées ici sont des contraintes liées à la gestion, c'est à dire aux dispositifs qui s'intercalent entre une intention et une réalisation, voire même ceux qui influencent l'intention de façon en partie prévisible. Les dispositifs en question peuvent être formels (par exemple les outils de gestion comme le business plan), ou informels en partie ou totalement (par exemple le système de pouvoir ou le processus d'innovation). Les effets des contraintes de gestion peuvent ne pas être perçus, ou peuvent être perçus de façon biaisée, par tout ou partie des personnes impliquées dans l'innovation.

Dans un premier temps, nous abordons la question des contraintes de gestion pesant sur l'innovation en nous focalisant sur les cadres dirigeants, puis sur les managers et les autres acteurs de l'innovation (paragraphes 1 et 2). La question est ensuite abordée sous l'angle organisationnel (les différents types de structures, les systèmes vitaux), et des modèles de l'innovation comme processus (paragraphes 3 et 4). Sont enfin abordées la question des origines des idées d'innovation et celle de l'utilité des contraintes de gestion.

Ce papier est une version fortement révisée et augmentée de Romelaer (1998d, 2002c).
**Introduction**

When an executive or a manager thinks of an innovation, to what degree is he able to get it developed and implemented by the firm or unit he manages? What is the answer to the same question for a plant manager, a regional sales manager, a plant worker, an engineer or a technician? Does the organization's functioning allow for substantial participation of its middle and lower level collaborators to the development of innovations? If the answer to this question is 'yes', then have today's firms a tendency to allow such participation? Is such participation useful and profitable? Will more of it be useful and profitable in the years to come?

We shall see here some of the responses management research brings to the above questions.

By definition, research in management has the objective of improving or increasing something. When it works on the role of executives and managers in innovation, management research has a tendency to look for management tools which may increase the control they have, to look for incentive schemes and organization methods which they may implement to induce their teams to innovate more and better. Some books by consultants claim that they have such methods, basing themselves on half a dozen success stories about which they only present the good sides.

Our objective here is slightly different. We want to appraise the degree of initiative and control managers and other actors really have on innovation in today's organizations. The necessities of organization functioning and the daily work schedule of managers being what they are, what power and what constraints has a given actor in the area of innovation?

The questions treated here are of relevance to practitioners. The elements presented enable them to appraise the field of forces which they will have to deal with if they want to push for an innovation. Depending on cases, the analysis may show they have substantially more power (or less) than they thought they had, it will help them identify the forces they will have to fight and the help they may enlist. More generally, the analysis will show what bias they are led to have because of the organization they live in.

An executive may for example use this paper to diagnose the constraints to which he is submitted, and he can then use this diagnosis in several directions: he may reappraise his ambitions with respect to innovation, decide whether the "natural slope" leads him to
interesting places, or else he may direct his efforts at relaxing or enhancing some of the constraints to which he is submitted. The validity of what we present comes from the fact that all statements made here come from the results of empirical research conducted in a wide array of different firms.

The tendency organizations have to push for innovation or refrain from it, to induce or restrain the possibilities their members have for involvement and initiative, is often at variance with the official declarations and the intimate convictions and objectives higher level officials have. Many firms do not understand why they do not obtain more innovation in general, or more innovations of such and such types, given the efforts that are made to push in this direction, and given the apparent will collaborators have to involve themselves.

Some responses to these questions are found in this paper. Some responses only, for two reasons: first because one paper is too short to present the wealth of knowledge management research has developed and the multitude of different cases that can be encountered in the real world, second because our knowledge, even if already very rich, is still incomplete.

The practical use of what we present here must be made with precautions for the following two reasons:

- first because the constraints identified here necessarily come from the observation of a limited number of cases. We really have scientific laws, but we also have to remember that their validity is more probable (indeed highly probable) than absolute.
- second because, as always in management science, the existence of constraints and other regularities is often measured as an average effect empirically observed on samples of firms. Each individual case requires its specific analysis. It is possible that a management constraint does not operate on a given firm although it has been witnessed to have a strong effect as an average.

The questions treated here are also relevant for management sciences. When we have identified the nature and strength of management constraints, then we deduce important consequences for “the space of possibilities of the decision-maker”, the nature and role of management tools, the impact of the forms of organizations on innovation. Consequences can also be drawn for the creation, circulation and capitalization of knowledge, for the formalization and dynamics of groups, languages and memory in the firm, for the
Finally the question of management constraints on innovation is at the heart of fundamental questions such as “What collective actions are possible?”, “What is the place of the individual actor in organizational action?”, “What is freedom in a system of constraints?”, and “What degree of control do firms have on themselves?”

In our inquiry we attack the question from four angles. First we make an as systematic as possible list of the constraints which individual actors face when they want to push for innovation. These constraints may have an impact on the intensity of their will to involve themselves in innovation, on the type of innovation which may come to their mind, in the choice of ideas they will be inclined to push for, of the methods they will be inclined or able to use. We shall essentially examine the case of the executives, although we shall also see the aspects pertaining to the lower level members of the organization. We shall then move to study the impact organization structures and innovation processes have on innovation, and end with an exploration of the processes through which innovative ideas are generated and selected in the firm and in wider social structures.

Two remarks may be useful before we proceed to our presentation:
1) we only develop here the list of management constraints that impinge on innovation. The analysis of the interaction of all constraints that operate in any particular case is beyond the scope of the paper. Also, even if the paper contains management tools and methods that may be used to measure the constraints, to keep them under control or to relax them, the size of the paper does not allow us to present as many tools and methods as we would have liked to.
2) what we present here is relevant to the whole range of innovations: product innovation as well as process and administrative innovation, radical as well as marginal innovation.

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2 Non-technical competencies include the capacity to develop and to use networks of internal and external relations, the coordination capacities, the ability to simultaneously master incompatible languages, etc.
3 Such analysis is not simple. The constraints operating in a given case do not simply “add up”. They also have combined effects and cannot be managed or relaxed independently. Hence a great number of pratical situations may be encountered. It is not even sure that there exists a typology of situations.
4 Product innovation leads to a new or to a modified product, process innovation leads to a new or improved production process, organizational innovation leads to a change in the functioning of the organization (moving to a “client-centered organization”, increasing “knowledge management”, decentralizing decision-making and management initiative, re-engineering, etc). Among the organizational innovations, those
The paper by Damampour (1991) identifies the many differences that exist between these various types of innovation. Accordingly, the management constraints may have different natures and forces in these different cases. The examples provided in the paper will touch on each of these types of innovation.

1) Innovation and management constraints at the executive level

In the exploration of management constraints on innovation we first deal with the situation of executives. Among all organization's members, they are the ones supposed to undergo the least amount of constraints. As we shall see, this does not mean at all that their innovative behavior is free of pressure.

Executives are submitted to external constraints that orient the type and intensity of innovations in which they may launch their firm. They also have constraints which, for lack of a better qualificative, we shall call “personal pressures”. Last, they have pressures coming from the organization they manage, from the power system of the organization, and from the individuals they would like to enlist in the development of the innovation. They are presented in turn below.

1.1) External pressures

Innovation is sometimes perceived as a necessity dictated by the external pressures of the strategic field. For example the Sales Manager of the French subsidiary of a multinational food company declared to us: “We all launch a great number of new products. Everyone does the same, our competitors as well as ourselves. But when you look at all the costs incurred for the development of these products which have a market life of about one year each, no one knows whether it is profitable“.

pertaining to functional activities are sometimes named “administrative innovations“. They include moving to activity-based costing, changing the format of the daily reporting made by the salespeople, implementing a new personnel appraisal system, etc.
Since we are also concerned with organizational innovations, we may at times be at the frontier of the theme of organizational learning. The question of management constraints on organizational learning will however not be treated here. The reason is lack of space, and not lack of interest in this important question (see for example Romelaer, 1998a). I thank Norbert Alter for pointing out this frontier of our topic.
Pressures by shareholders and by financial markets (transmitted through the Board and the financial analysts) may also push executives to engage in more (or less) innovation than they would be inclined to. The direction of this constraint is variable: some pension funds and operators are “short-termists”, others more focussed on medium to long-term returns, still others on ethical criteria. The portfolio of investors behavior and of behavior of asset-management firms, the constant flow of opinions and judgements transmitted in the financial press, all these elements have to be taken into account by the executives when they chose innovations they will push for and when they select among the projects proposed by their subordinates. If an executive feels that he risks being demoted if financial return falls below 12%, then consequences will result in the domain of innovation. The restructurations recently made by Danone Biscuits or by Procter and Gamble Europe were both presented in the press as direct responses to such pressures. The same holds if maximizing EVA or MVA (economic value-added, management value-added) is felt to be the rule of the game, or when a behavior is considered a must (investing in Eastern countries, becoming an e-company, etc).

One potentially important constraint, not identified so far in management research to our knowledge, can be identified from two internal declarations made by the CEOs of EdF and Air Liquide5. Each of these CEOs explicitly made a reference to the revocation of IBM's CEO, IBM being at the time the world leader of its industry. And each of these two CEOs launched a large scale change program in his firm. It can be that the firing of the CEO of a comparable company produces a kind of earthquake in the microcosm of large companies' executives, then felt by the survivors as a constraint leading them to change even if they are not pushed to do it by bad performance or by strategic necessity. Such large scale changes obviously have an impact on the innovation in the firms mentioned6.

It should be noted that when the need to innovate is felt, the question of the intensity of the feeling is not clear, and neither is the question of the link between the pressure and the type of ensuing innovation. The reactions may be very different depending on the executive and on the context. It may lead to product or process innovation, innovations concerning presently active or new markets, technical or organizational innovations, etc.

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5 EdF is an electricity company, and Air Liquide a producer of liquefied gases. Both are among the world’s largest firms in their industry.
The pressure may also be simultaneously internal and external: newly appointed CEOs may feel they “need to do something different”. The need is felt in a different way depending on whether their predecessor retired and was considered adequate by the Board, or whether their predecessor was fired (Simons, 1994).

Executives also receive pressures from the social, professional, economic and political environments in which they live or where they come from. These environments influence and have influenced their mental maps. And the executive often depends on these environments for possible help and for the following steps of his career as an executive.

External pressures on innovation also sometimes influence executives through more subtle channels. For example in some industries there may exist very similar strategic behavior for all firms, or a small number of groups of firms, called “strategic groups”, in each of which the firms have very similar behavior, and hence similar intensity and type of innovation. When an executive has an innovative idea or sees a firm “like his“ (i.e. belonging to the same strategic group) making an innovation, obvious constraints come from the very fact that he asks the natural questions: “Should I do it if the others don’t?“ and “If they do it, should I not act myself?“. Dumez and Jeunemaître (1996) thus show us that in the cement industry two groups of firms coexist: on the one hand the traditional firms all continuously introduce marginal innovations and imitate each other rapidly, and on the other hand deviant firms occasionally appear that introduce major innovations. But other modes of reactions also exist. I heard Seb's CEO declare: “I look at what my competitors do, and above all I will not do the same“.

### 1.2) Pressures on the executive as a person

The first constraint on the executive is the one of his schedule: as it is loaded, it leads him to arbitrages which will have an impact on the innovations he will launch. From a purely logistical point of view, if the usual functioning of the firm already requires sixty hours

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6 We only have the coincidence between declarations and changes. The CEOs did not declare they have been induced to change by the fear of suffering the same fate IBM’s CEO had had.

7 Child (1997) calls that “the industry recipe”.

8 Seb is a company making appliances.
work weeks⁹, he is unlikely to launch the firm on innovations requiring still more of his
time, for fear of losing control of his own activity.
Expressed in other terms, the executive must find time to follow the innovation, enough
time to control the work done by those of his subordinates involved in the management of
the project, enough time to involve himself when the development of the innovation
requires it: high level negotiations with outside parties, internal and external pushing when
the project is stalled or the motivation falters. This is a personal problem for each executive.
It is sometimes a problem for the whole executive group in the firm. In this domain one
executive of a French chemistry group of more than 50,000 employees told us the
following: “At the end of the 80s we realized that we were on a bad track. The investment
committee had to decide about so many projects that at each session we had more than a
foot thick of project files on the table. We came to realize that none of us had sufficient
time to read all the project files and to be really able to judge their value. It is one of the
reasons which led us to decide shrinking the scope of our activity, and to decentralize the
organization.

A little more distant from our topic, the executive is also constrained by his own
personality. Sometimes he may be unable to engage in an innovation even if he would
want to from a business point of view, because of a profound aversion for the object of the
innovation or for the competencies and interpersonal relations he would need to mobilize.
The reverse also holds true: some executives have great difficulties not to innovate. Such is
the case of the CEO of a cardiac stimulators company we met near Minneapolis. After a
dozen years of development, his firm had around a hundred employees and the product
portfolio was beginning to stabilize. As he felt the company was at a crossroads, he then
had a study made among the workforce to obtain the view they had about the company.
This study revealed two things. First that on average they were happy and proud of the
firm, of its management, of its development and performance. Second, it revealed that the
employees were afraid because the CEO was constantly innovating while they felt the need
for some more stability. According to this study, the CEO was a kind of "innovation
machine" having new ideas almost every day, and acting with clout and determination till

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⁹ There can be many causes of such an excessive workload: numerous variations and problems in the
environment, strong personal orientation in favor of perfection and homeostasis, internal conflict, size and
structure of the firm, low competence of subordinates, large turnover, etc. On the workload of executives, see
the research by Barabel (1999), based on a 95 items questionnaire answered by 110 CEOs of companies
having each annual sales larger than 150$M.
they were implemented. The CEO was also conscious that the cardiac stimulators business required less innovation during some years. In fact the CEO then drew the lessons of these data and changed the structure and management of his firm as well as his own role.\(^{10}\)

Another imperative for the executive is to maintain himself or herself in power. Because of this he may rationally hesitate to launch an innovation, even if potentially profitable and making sense from a strategic point of view, if the development of this innovation would require a large-scale involvement of a division or department whose manager could become a rival if the innovation is a success. It may then be that the innovation is possible only after the manager in question is transferred to another position or replaced by a member of the CEO's clan. Such a change may require months, or even years.

The “actor's lassitude” identified by Alter (1994) also affects executives,\(^{11}\) as well as the declining of his physical force and the drift towards other horizons (political activities, representative functions in business associations, etc.). These constraints may lead an executive to modify the direction and intensity of the innovations he or she will launch. He may also move towards a decentralization of initiatives, a move which can induce an increasing of (potentially poorly coordinated) innovations.

Controlling the organization and guiding it through the phases of its development is sometimes felt as a constraint by executives. The CEO of a medical equipment company in which I gathered data thus found himself in the following position.\(^{12}\) He had taken the helm of the company after its founders had gone bankrupt: they had failed to develop an artificial heart and they had used up all the capital they had been granted by an investment-fund. The CEO then devoted a dozen years to identify the knowledge produced by this unsuccessful effort, and to convert it to various products progressively developed and

\(^{10}\) See the case Cardiex1 in Romelaer (1994).

\(^{11}\) Alter defines the “actor's lassitude” as follows. In companies there often exist “semi-clandestine innovators”, whom Alter names “the actors”. These are individuals who, alone or in groups, develop innovations outside any formal mandate or even outside any authorization. Because these individuals do not respect the formal rules, they may at all times be punished by the hierarchy, and even fired. This possibility, added to the necessity to work overtime without additional pay to develop the innovation, makes things such that they have a lot of stress and fatigue. When their innovation works, then management extends it to the whole organization. The actor is rarely thanked, or payed, or promoted for his extra contribution. He nevertheless often begins again, and again, hence bringing to his work a much higher performance than average. This process may continue for years. But at one point in time the actor all of a sudden gets discouraged, “burnt out” and “broken”. His performance then passes overnight to a much less than average level. This is precisely what Alter calls “the actor's lassitude”.

\(^{12}\) See the case Cardiex2 in Romelaer (1994).
The CEO describes as follows the second phase of his action: he spent four to five years to find a high caliber executive for each of the top positions in his company. When I interviewed him he was completing his last recruitment, and his upcoming plans consisted of buying several companies in the medical business, finding himself a successor, and moving to the position of CEO of the newly created group. It is clear that the implementation of such a plan has important consequences on the type and number of innovations he will launch.

Last but not least, an executive is also submitted to economic constraints even if he is both CEO and sole owner of the firm. The CEO of a constantly innovating industrial company thus declared: “When I have an idea or when I am proposed a project, I determine a ceiling for expenses I will allow. For extremely interesting projects this ceiling is the amount I think I can afford to lose. When this is done I will allow every justified budget overrun, and stop immediately as soon as I reach my maximum”.

### 1.3) Constraints on the executive coming from the organization and from the power system

The organizational constraint most strongly felt by the executive comes from the strategic agenda (Dutton, 1988, 1997): the work of the “strategic apex" of the firm is often organized in a way which specifies at which level, at which dates and according to which method various questions will be treated by the headquarters. Questions relative to innovation are frequently treated in budget meetings, in decisions taken by the investment committee, in recruitment of specialists, in negotiation of partnerships.

Several elements linked to the management of the strategic agenda thus impact on innovation: the formal and informal work mechanisms at the top levels, the existence or absence of discussion areas where innovation ideas can emerge and be processed, the degree of consciousness top managers may have of the link between their behavior and

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12 See Romelaer (1994).
13 These products were all related to cardiac surgery. They included extra-corporal blood circulation equipment, monitoring equipment, artificial valves, etc.
14 We use here the expression coined by Mintzberg (1979): the strategic apex is the set of people conducting, part-time or full-time, activities which contribute to the determination of the raison d’être of the organisation. Top managers and executives belong to the strategic apex as well as the people who help them and members of headquarters. Members of executive committees and of task-forces on strategic questions also belong to the strategic apex, although most of their work may be devoted to middle level management, operational work or staff activities.
innovation. For example, Peters (1978) observed the case of a large oil company which had poor performance in exploration although internal communication regularly stressed the importance of this activity. Peters explains this paradox in the following way: content analysis of discussions in the executive committee reveals that the company's top managers discussed exploration very rarely, and, according to Peters, the subordinates of the top managers did not follow the "official demand" on exploration contained in the internal communication, but the "real" disinterest about exploration expressed in the discussions held in the executive committee. Executives were apparently not aware of the organizational effect the content of their discussions had on the intensity of innovation.

The maintaining in power of the dominant coalition (to use the expression coined by Cyert and March, 1963), as well as the necessity of neutralizing rival coalitions, may influence innovation: the proposal for a new product may have a very different treatment whether it is emitted by the former or by one of the latter. An executive, even at the very top of the firm, is not always in a position to decide about an innovation. Pettigrew (1985) thus describes the case of the British chemical group ICI, where one of the executives pushed for an innovation for years without any success. He only met success when the composition of the top group had sufficiently changed\textsuperscript{15} and when the company encountered severe problems: the innovation then appeared as the solution. Likewise Laroche (1991) describes the difficulties with which a decision was accepted and implemented in a geophysics firm of 6,000 employees, presumably because the executive who pushed for it had not the "field geologist" career and culture all the other executives shared.

The power game, and the "accession to the top" game, also provide constraints on innovation.

If only marketing people have a chance, then high potential finance and production managers probably will have to secure the informal endorsement of marketing people before proposing their innovative idea.

The organizational constraints on innovation will not be the same in a firm if the route to the top is open to people who do not rock the boat, to managers who succeed in process

\textsuperscript{15} The top group was initially very homogeneous, composed of members who were all engineers coming from the same "public schools", with a domestic professional experience. Over several years the group got to
innovations which increase productivity, or else to people who explore and open new markets.

Some divisionalized structures naturally encourage innovation. Galunic and Eisenhardt (1995) describe five cases in which some division managers spend part of their time and resource to try to invade the others' markets and product portfolios. Promotion is apparently linked to proving to headquarters than you can do better than colleagues. Such inter-divisional competition increases innovation, with the obvious risk of devoting resources to invent the same product twice, a risk on which the authors do not give data.

Confronting the critiques of the investment committee is not necessarily simple when an innovation meets budget or delay overruns. The other executives, pushing for their own innovation projects, may strongly protest against any extra budget for other innovations. They may even protest against the CEO as we observed in one case. The risk of being fired if an innovation fails may be quite real for an executive, although this risk does not necessarily deter him.

Innovation is only one of the many possible objectives of the firm. It may thus conflict with other goals, and these goals then become constraints for the executive who has a “deviant” innovative idea. If the CEO wants to increase the internationalization of his firm, he may be led to reject an innovative idea which has only domestic implications, even if it promises good returns, even if he likes it, just to maintain a clear and coherent message to the other executives and to the financial markets.

Related to the preceding constraint, firms sometimes choose to refuse an interesting innovative idea because it would endanger strategic or organizational coherence (Reger and Huff, 1993), and an executive may reject an idea because he thinks it would lead to more changes than the firm can deal with. All these are self-imposed constraints.

Another constraint may limit the possibilities of an executive: an innovative idea may be abandoned if its development would require the collaboration between departments who are notorious rivals. The “Premier” case described by Gouesmel (1996) is close to this situation. Of course it is also possible to seize the innovation as an opportunity to get the departments to learn to collaborate with each other, and to look for outside collaborations:

gradually coopt more and more executives having a marketing background and sizable international experience.
assuredly none of these ways are easy, as is shown in the case of the Barton firm (Romelaer, 1994).

Organizational inertia is often mentioned as a management constraint: some people and departments, and even some executives, resist change and innovation. In the area of strategic innovation, Rumelt (1995) thus mentions more than twenty sources of inertia which are common within firms.

However, since the work of Crozier and Friedberg (1980), management research has had a tendency to treat resistance to change in another way: these authors have shown that forces which push for innovation, forces that curb it, forces that stabilize it or prevent it from being stabilized, have the same nature.

Another research avenue to understand and to manage resistance to change goes through the notion of organizational learning. For example Pennings and Harianto (1992) have shown that the adoption of an innovation by a bank is more likely if the bank has gone through more innovations during the preceding years. If an organization is used to innovation, it will make it inclined to innovate more. Conversely, if his organization has “unlearned“ to innovate, an executive may have to push for innovation for three years almost without result before his firm begins to be capable of innovating.16

1.4) Constraints weighing on executives because they use or mobilize subordinates and outside actors

Each person who acts is, at the moment of his action, a prisoner of the organizational means he has at his disposal. This claim made by Crozier and Friedberg (1980) also applies to the case when an executive wants to enlist subordinates or outside actors in the development of an innovation project. For sake of brevity, I shall only develop the case of subordinates in the following.

Depending on cases, the executive for example must:

- find a person whom he trusts sufficiently to carry out the innovation. It is not always easy to find a project manager who has the necessary talent and who is available. Developing “a

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16 In paragraphs 3 and 4 we shall see other organizational constraints impinging on innovation, this time without specially concerning ourselves with executives.
stable of entrepreneurs\textsuperscript{a}, as the Texas Instruments' CEO did (Mintzberg, 1994), is not a simple task, and only bears fruit in the long term.

- find and assemble the necessary competencies, i.e. among other things lead people to cooperate and work together in a coordinated manner, although they may come from different departments and functions for which the projected innovation is not necessarily a priority.

To find the appropriate collaboration, the executive may rely on the organization he heads, or on the set of people he knows and trusts or controls (this set of people is sometimes called his \textquoteleft clan\textquotefrighth)\textsuperscript{b}, two methods which do not bring the same contraints. The first one has the legitimacy of the formal organization, and maybe the efficiency of well-oiled management systems. The second has the legitimacy of trust and commitment, with all the associated flexibility and limits.

Some general constraints are present in the mobilization of subordinates:
- the executive and his subordinates must collectively possess the necessary competencies: technical competencies, management capacities, information networks, inside and outside contacts, adequate knowledge of relevant professional circles, etc.
- it is better if organizational procedures help the innovation, or at least do not impede it (see paragraph 3).
- it may be necessary that the suggestions come from below. In some cases the executive's subordinates do not make any suggestions, or do not make enough suggestions\textsuperscript{c}. In such cases the executive may have to spend several months and some energy to develop an \textquoteleft innovative spirit\textquotefrighth and restore his credibility. The success of such endeavors is not guaranteed.

Last, in the management of an innovation process, the executive is uncertain of the reactions of the subordinates he wants to enlist. Of course classical management tools are key elements to control them and to reduce this uncertainty: direct supervision, job definitions, procedures, individual objectives and project specifications. This question also

\textsuperscript{a} There may be several rational causes for such behavior. A small amount of initiative is for example understandable when in the past collaborators who had proposed innovations (1) have been robbed of their idea by the executive, who attributed to himself all the merit; (2) have been insufficiently supported by the executive; (3) have been sanctioned as the innovation failed without their responsibility. The Imprimantex case-study in Romelaer (1994) depicts case (3).
includes other important elements, like motivation, incentives, communication and trust. These elements are important because the management of innovation calls on non-controllable behavior like creativity, going beyond the strictly required tasks, helping others by lending equipment and giving information, internalization of change, and the will to cooperate and to communicate in a complex world. Even though we do not deal with these questions completely, we shall nevertheless include in the rest of the paper many examples showing how organizational structures and innovation processes may interact with the motivations of employees.

To conclude, we saw in this paragraph that executives, even CEOs, are not at all free of constraints when they want (or do not want) to launch their organization on an innovation. It may be useful to remember that our objective is not to prove that “management is a constraint which prevents innovation from blooming as it should”. This claim is false, and the reverse claim is equally false. Indeed, some of the management constraints we identified above push executives to more innovation than they may want. What we may prove, however, is that the regularities in the functioning of the organization, in the innovation process, in the situation in which executives are placed, all induce constraints which have predictable effects on the nature and success of innovation.

2) Constraints on managers and on other actors of the innovation

The constraints on innovation are not the same when the innovative idea is first pushed by an executive or by a middle manager. To examine management constraints on innovation at the level of middle managers and other actors, we can begin by taking the list we established for the executives in the preceding paragraph, and adapt its elements to the situation of lower level members of the firm. For example when a regional sales manager wants to develop an innovation, he then meets, among others, constraints coming from headquarters, from the functional services of the company, and the same is true each time he wants to enlist his own subordinates in his project.
For a subordinate, the possibility of proposing an innovative idea, of making things such that his ideas are taken into account, of implicating himself in some personal initiative in innovation projects proposed by others, all these elements depend among other things on the organization and on the coordination systems (see the following paragraphs).

The first other constraint we see is the one coming from the internal power system. Alter for example (1990) showed that innovators acting outside officially prescribed mandates and rules have to confront strong opposition from departments like Management Control, Information Systems, and Methods, all of these defending the established order, and being labelled “the legalists” by Alter.

It has however to be remembered that the internal power system is not only structured around innovation. For example, in the Bolet case-study, Bernoux (1986) describes a small firm producing wood-cutting equipment, where the power structure is organized around the contrast between pairs of groups: “the ancients“ and “the moderns“, the founder’s family and the others, the workers and the others. This group structure has a profound impact on the method which the marketing director may use to introduce a new machine into the company. It should be noted that, in the Bolet case as well as in most organizations, the power structure today is the result of a process spanning over dozens of years, partly natural and partly managed, and that the impact of this power structure is not felt only on innovation.

In the power system, a constraint often felt strongly by the actor is to obtain the agreement, or at least the neutrality, of his hierarchy. He may also launch sufficiently small innovations so as not to be too visible, or to remain within the bounds of his personal zone of decisional freedom. Such innovations may be marginal. They may nevertheless have a strong impact on the firm in three cases:

1) when marginal innovations accumulate and progressively coalesce. Such is the case in a company making large-size industrial boilers (Romelaer, 1994): the development of computer-aided design has been done over three years, beginning by disconnected initiatives taken by small groups of designers, the initiatives being progressively harmonized between the groups. These initiatives could be taken because the cost of equipment was modest enough to be decided upon at the local level without the interference of higher level managers, management systems and functional departments.

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18 We use the word “actors” to designate all the people contributing to the innovation, inside as well as outside the firm. The definition used here is much more general than Alter’s (see note 11).
2) when the local initiatives taken by “mavericks” (the semi-clandestine innovators discovered by Alter; see note 11) and gradually stabilized into workable solutions, are taken over by top management to be systematized and generalized to all the firm. The only innovations that can be developed through this “method” are by nature such that the initial development can be done by a handful of people almost without any resource outside those they have locally. It would surely be unwise in many firms to count on these sole innovations.

3) when top management has a policy which consists first in encouraging local initiatives, and then in searching systematically the good ones to generalize them throughout the company. Concerning strategic innovations this method is mentioned as a possibility by Mintzberg (1994), and an application at First Boston is mentioned in Romelaer (1997a). This method is close to the “knowledge management” developed in one of the branches of Air Liquide19: on several themes like “project development”, “technologies” and “exploitation”, groups of people involved in operations work part-time on (a) the analysis of completed projects, in order to identify new knowledge acquired, problems met and solutions developed; (b) the systematic search20 for knowledge in books, seminars and the professional press; (c) the incorporation of all knowledge in a rather systematically organized knowledge base; (d) the diffusion of knowledge in the group through responses to demands for help as well as through presentations and seminars. Such a management technique allows local initiatives both to happen and to be diffused, and hence may permit local innovations which have wide consequences.

The last two cases are rather close to each other in that in both one has a local innovation which gets generalized. The difference between the two lies in the fact that in Alter the process may be informal and quite unconscious, while in the other case it is consciously managed.

The informal rules in the power system may constitute strong constraints on lower level actors when it comes to innovation. The people interviewed by Doz and Pralahad (1987) had only begun to launch their innovation when they had reached the executive level. It is likely that in some firms, it is not considered legitimate for a subordinate to express

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19 This branch designs and builds gas liquefaction installations for industrial clients like steel plants, large hospitals, etc. See data on this case in Metais (1997).
20 This systematic search is sometimes named “scanning “.
innovative ideas, whether on any topic, or at least when these ideas interact with domains of expertise and action considered by others as their exclusive domain.

Even in such situations the lower level manager or actor is not necessarily totally deprived from the possibility of acting.

One of the possibilities he has is to launch a semi-clandestine innovation as seen above in note 11.

Another is the “foot in the door” tactic. The actor slices his innovation in many steps which he accomplishes without revealing his final goal. The idea is to justify each step by itself or in relation with another change. This “technique” may be interpreted in two ways. It can be said that it consists in “advancing masked”, progressively creating an irreversibility through apparently disconnected moves. Contrary to this “hidden agenda” presentation, it can also be said that for the innovator this method consists in creating progressively learning and interest among people in his organizational environment, including his hierarchy, given that such learning would not be possible if the innovation idea was revealed at the outset.

The method of the foot in the door is more efficient for actors who have a high hierarchical level or a flexible job definition. More generally, innovation proposals by lower level organization members are more likely and possible if the structure is more "organic" and if the firm experiences more change. This possibility of lower level initiatives is surely more probable if the organization has “slack“, i.e. if there exist some unused resources and imperfect coupling between units.

Partly comparable to the preceding cases, distance\textsuperscript{21} often allows more autonomy, among other things in the domain of innovation. We have for example observed, in a local unit of a large industrial firm, the radical modification of a large piece of equipment done by local personnel through informal collaboration with the supplier, without passing through the Central Technical Services as they were supposed to\textsuperscript{22}. These Services were not only geographically distant (several hundred miles away): they were also locally considered as distant from a social and cognitive point of view, i.e. non cooperative and devoid of

\textsuperscript{21} The word “distance“ refers to four notions: physical and geographical distance, hierarchical distance, differences in mental maps and languages, and social distance.

\textsuperscript{22} The equipment is worth more than ten thousand dollars. Any problem in implementation can create very important safety problems. Both the local people and the supplier knew that the discovery of their behavior
understanding of local realities. In the same vein, Orr (1991, 1996) has observed the autonomous development of procedures for diagnosis and repair of photocopiers by technicians who considered that the repair manuals elaborated by the technical services were unusable.

Another constraint on innovation by a subordinate comes from the lack of clarity of the rules of the game, i.e. from the difficulty he has in weighing \textit{ex ante} the pros and cons of his implication: a technician may wonder whether it is worthwhile to mobilize himself for an innovation project if he doubts that the Methods Department will support it, or if he knows that even the attempts made by some of his superiors have been scuttled by the Information Systems people.

Participation of subordinates is nevertheless possible. Decision and change methods presented in Romelaer (1997a) may be used in this area to develop a controlled participation in the innovation ideas generation, development and implementation. These methods will probably be increasingly used in the years to come\textsuperscript{23}.

There are also exist cases in which participation of subordinates is a kind of “natural obligation“, i.e. circumstances where it is proved that more participation is necessary to increase performance. Higher level managers are thus possibly led to introduce more participation than they would naturally be inclined to. This happens:

- when subordinates have information or competence decision-makers do not possess,
- when management needs to prove that the innovation is concretely feasible (this point is inspired by Doz and Pralahad, 1987),
- when subordinates necessarily have autonomy in implementation. In this case management needs to make subordinates understand the necessity of innovation if it wants success in implementation.

by the central services, as well as any accident that could be traced back to an action performed outside the rules, would lead to severe adverse consequences on them.

\textsuperscript{23} These participative practices will be more widespread in the years to come for five reasons: (1) the development of innovation requires more and more diverse knowledge; (2) the average level of competence is increasing in most OECD countries; (3) the need for reactivity imposed on business by competitive conditions leads firms to manage the conception and implementation of innovation as close to the field as possible, hence to decentralize more and more at the level of operators; (4) new management techniques are known that allow framing and coordination of innovation processes which involve several decentralized actors (see paragraph 4); and (5) increasing the number of innovative ideas possibly requires increasing the intensity, randomness, and freedom of communication, which requires a substantial level of participation. See Paragraph 6 on this last point.
For example Hartwick and Barki (1994) establish that, in the area of new computer programs whose use is not mandatory, there exists a strong correlation between the degree of use of the program and the intensity of users' participation in the conception of the program.

Likewise, Kim and Mauborgne (1993) and Korine (1995) show that managers' objectives are more efficiently implemented when their relations with their subordinates have high "procedural justice". Among the elements which characterize procedural justice figures the possibility for subordinates to discuss decisions, and the quality of the knowledge managers have about conditions in the field, where subordinates work. These conditions suppose a minimal amount of participation. Beyond that, an excessive absence of participation deprives managers of necessary information on pressures the power structure exerts on implementation.

Beyond what we saw above, the mode of management of the firm may introduce very indirect constraints which partly condition the actors' identities: recruitment, socialization, career management and internal mobility systems are processes which influence the values and competence managers and subordinates have. The proclivity to have innovative ideas and to implicate oneself in innovation partly depends on these elements.

In a fundamental way, the question of subordinate participation is linked to such questions as: what room exists for individual initiative in organized systems? What is the place of the individual in collective action?

In this paragraph, we have placed ourselves at the level of lower level managers and other actors. We could identify management constraints which condition the propensity they have to propose innovations, to implicate themselves in innovations proposed by others. These constraints sometimes slow down innovation, sometimes mobilize people and give them appreciable action possibilities.

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24 These research results are also interesting because they were obtained in very different management situations. Kim and Mauborgne studied the relations between headquarters and subsidiaries in large international groups, while Korine studied information systems innovations.
In the two preceding paragraphs we have examined the constraints on innovation from the point of view of the individual actor. We have found many such constraints, and this finding is very important since the “theory of the single decision-maker“ is still widespread in public opinion and beyond: the natural tendency is often to look for one single individual when one is asked questions like “who has decided?“, “who should be rewarded as the father of this innovation?” and “who is responsible for the fact the innovation does not work?“. But this “folk theory“ is false, as Allison (1971) proved long ago. In some sense, through the identification of management constraints on innovation which touch executives and other actors of the firm, the first two paragraphs have verified Allison's result in the case of innovation.

Allison's research goes on to showing the importance of some organizational elements on decision-making. The next three paragraphs will attack a question comparable to Allison's about the organizational constraints on innovation. Since much organization research has been done since 1971, our analysis will identify much more elements than Allison found.

Our starting point is the fact that the innovation takes place in an organization, and that it is a process, i.e. a set of actions conducted by various people over several weeks or months. Organizations and innovation processes are submitted to laws of functioning. Relations between their elements are not random, and their advantages, problems and performance are partly predictable when one knows the context in which they exist. Models of organizations and of decision processes produced by research are a precious help to identify management constraints on innovation.

The theory of organization we use is a modified version of Mintzberg (1979). We have been led to make some modifications and additions to take into account published research and personal observations. Some elements of this “modified Mintzberg“ organization theory are presented in Romelaer (1996, 2000, 2002a, b).

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25 In fact, partly expressed in Mintzberg's language (1979), Allison showed the importance of regulated systems and of the power system on decision-making.

26 The principal modifications we make to Mintzberg’s theory are the following: (1) standardization of competence is much richer than long education programs sanctioned by a degree; (2) simple structures are not always entrepreneurial; (3) adhocracies are not identical to “innovative organizations“: innovation exists in all other types of structures.

The principal additions we make to Mintzberg's model are: (1) the “structure based on result“ and five forms of divisionalized structures other than the one mentioned by Mintzberg; (2) the addition of six “coordination systems“ to the five Mintzberg considers.
Our work will begin in the following paragraph, devoted to the management constraints on innovation in various types of organization.

3) Management constraints on innovation in the different types of organization

Concerning the types of organization, the central theme developed below is that each type of organization has specific effects on innovation. Twelve types of organization are identified in the organization theory initially developed by Mintzberg (1979) and modified by Romelaer (2002a, b). There exist links between the intensity of innovation, the types of innovation developed and the type of organization. We shall see many of them below. We hasten to say that these links are neither absolute nor mechanical. Executives, managers and other actors preserve a degree of freedom, but it remains true that certain intensities and types of innovations are more natural than others in any type of organization.

To push for innovations that are not in line with the type of organization requires more time and energy than to push for innovations that are “natural” in the organization: more efforts are needed to explain, to convince people, to guide the project and to find the relevant information when the innovation is not considered normal in the structure. Extra efforts are required to “fight the management systems” or to avoid them. Management tools appropriate for the innovation are less likely to be felt proper for most people in the organization. Since time and effort are such important resources for the manager, it ensues that there is a natural tendency to witness innovations that are in line with the type of organization.

In other words, a manager or another actor who has an innovative idea must take the structure into account. This may lead him to reappraise his project because it shows that is would be too awkward to be too much at variance with the structure, or it may lead him to a better appraisal of the energy and time he may have to devote, as well as the management methods he may be wise to use. If he does not take these organizational constraints into account, the manager will have to pay the price in the form of increased coordination and increased risk of failure.
On the other hand, innovations which are not in line with the type of organization are not altogether impossible. Their development, even if difficult, may be successful and lead to an evolution of the organization.

3.1) Innovation and simple structure

A simple structure is an organization managed by the strategic apex through direct supervision. Such structures cannot be equally effective for all activities. For them to function it is required that the following conditions be reasonably satisfied:

- each task to be done by subordinates should be understandable by the general manager. If not, the general manager would not be able to use a coordination mechanism like direct supervision.

- the tasks of the different subordinates should not have too strong and rapidly changing interdependencies. If this were true, the manager would have to spend an enormous amount of time to direct the subordinates in such a way that they keep doing coordinated work. It is then often more economical to use another coordination mechanism: for example to have more competent employees and to let them coordinate themselves by mutual adjustment. Such a change leads to a completely different type of structure (“adhocracy” in the case above).

- the organization should not be too large, indeed not so large that the work of ordering, coordinating and controlling subordinates takes more time than the top manager or the top group can give. Beyond two to three hundred people, the organization cannot in general survive as a simple structure.

- in a given society at a given time, a simple structure is able to function if there is a sufficient power differential between the top manager and the other members of the organization. Individuals as well as societies may vary widely in terms of will to command, acceptance of authority, knowledge and competence, property rights

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27 See the definition of the “strategic apex” in Note 14 above.
28 This means that low and medium technology activities may be accomplished in simple structures. But organizations close to simple structures are also adequate in high complexity activities where “the boss”, since he or she has more competence than any of his subordinates, can manage the organization in a fairly directive way. Some departments in hospitals and clinics, and some departments in consulting firms, are very close to simple structures.
possessed by the top, legal rights of hierarchy, or mastering of “zones of uncertainty”.

The above characteristics may vary as time passes.

The simple structure generally has middle level managers in small number and/or with little power: each of their orders may be at each time overruled by an abrupt decision of top management. Generally there is no technostructure in such organizations, i.e. no department like Methods or Management Control, which standardizes work procedures or results. When such departments exist, then their work is regularly destroyed by circumstancial decisions taken by top management.

It is not uncommon to see the top manager of a simple structure rely on a set of of trusted people to get information about what happens in the firm and in the environment, to get advice and discuss ideas and preliminary plans concerning decisions and innovations, or to get information diffused: these persons “have the ear of top management”\(^29\). Some of these “relays” may be outside the organization. And, concerning the organization members, all relays do not necessarily belong to the hierarchy, and all members of the hierarchy are not relays.

There may exist parts of the organization that totally or partially escape management for a number of reasons: lack of competence or interest from the top, work overload at the top\(^30\).

Intensity of innovation in simple structures essentially depends on top management: its competence, inclinations, mental maps, networks of inside and outside contacts. It may well be that the intensity and nature of innovation is conditioned by the portfolio of outside contacts of the top manager. For example Lorton (1991) studied small fabrics producers. One of them produces delux fabrics with historical designs, some of which are sold to historical mansions and places like the Versailles castle. Lorton rightly links the absence of diversification of the firm to the complete concentration of the top manager’s outside contacts with actors of his narrow industry segment. By contrast, in another firm he studied, the top manager simultaneously diversifies, and has a wide array of contacts in multiple industry segments, as well as contacts with bankers, consultants, various professional associations and management research institutions. Simple structures may be

\(^{29}\) Some examples of such people are found in the “Agricolex” case study in Romelaer (1994): a company which innovates, produces and distributes agricultural equipment like those used in spreading fertilizers and pesticides.

\(^{30}\) For example a technically oriented manager may let things go in finance and marketing.
very innovative if the top manager is himself innovative. It has no chance of being innovative if top management is not\(^{31}\). There almost always exist “secret innovations” in simple structures, i.e. innovations carefully hidden from top management, through which subordinate “self-organize”, escape the pressure of the top, develop autonomous ways to deal with problems in the absence of top management\(^ {32}\). The emergence of innovations (secret or not) is more likely in the parts of the organization that escape control from the top. In simple structures there may exist innovations conducted on the basis of initiatives taken by subordinates. These will rapidly be submitted to top management, directly or through the “relays” top management has among the workforce. If authorized by the top, the innovation will normally be developed under his close scrutiny and direction. Hence by definition innovations will only be very partially “bottom up” in simple structures.

Innovation in simple structures will be severely limited if top management fears that it risks giving too much importance to the people involved in idea generation, innovation development and implementation. It may be so even about innovations which would be very good for the organization. Hence it may be that once the idea is given by a subordinate, the rest of the work is performed under the strong guidance of the manager, who works with more malleable people or even with outside people. The subordinate will often sadly see that good ideas may not be recognized.

From this description numerous management constraints on innovation in simple structures can be deduced. We shall only mention a few of them:

- If a subordinate wants to make his case for an innovative idea, most management books will advise him to develop a detailed technical and economic “brief” to justify the idea. This is not necessarily the best way in a simple structure. The essential thing is to express things in words and concepts which are in the mental map of the top manager, and maybe to begin by convincing some of the top manager's “relays”. The advice can

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\(^{31}\) Many simple structures have been observed which are not innovative: top management has clung for decades to the same technologies, clients, products and services. Hence many simple structures cannot be labeled “entrepreneurial” as was proposed by Mintzberg (1989, 1994).

\(^{32}\) Such arrangements are kept secret if the top manager strongly reacts each time subordinates confronted with a problem decide by themselves on the spot. Sometimes such arrangements are “public secrets”: everyone knows they are there; and everyone exactly behaves just as if they did not exist. The top knows that they are there, he informally keeps an eye on them through his personal “relays”, but he does not say anything since he knows that it is better that people proceed with the work when he is not there instead of blocking everything and waiting for him. Maintaining the innovation as a “public secret” is a way of maintaining the myth saying that all decisions are taken by the top.
be given to abandon the idea if there is not enough chance of getting it through these relays without being robbed of it.

- For a consultant called in by the manager to “dynamize innovation” in a simple structure, the best actions are not, by and large, necessarily to advise the recruitment of engineers who will be granted budget and time to work on new products, the use of market research and design consultants, or listening to ideas of operators. More natural techniques consist in inducing top management to introduce new types of individuals and organizations in the network of people he regularly sees outside the firm, i.e. in making contacts with new facets of the environment through discussions with consultants, professional associations and research labs. In the same vein visiting comparable but more innovative firms may suggest ideas.

- It is useless to fight to introduce innovations which require the use of procedures, standards, or any systematic management methods which may limit top management freedom. The same holds true for innovations which would require the development of fairly autonomous competence groups and initiatives by lower level employees. Of course this limitation does not hold if one thinks that the situation is ripe for the organization to change, to move from a simple structure to another type of organization. Then such innovation may be one good opportunity to help the organization to move.

3.2) **Innovation in “structures based on competencies“**

We could present the special characteristics of innovation in any of the eleven types of organization other than the simple structure. For our second example we chose to detail the management constraints on innovation in “structures based on competencies“ (hereafter SBC). The principal characteristics of SBCs are presented in Figure 1 below.

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33 These actions may not be the best if the objective is to get quick natural implementation without organizational change. The objectives of a consultant may be different. Some may want to use the innovation as an opportunity to get the firm to move to another organizational structure. No doubt there may also exist consultants advising the actions we mentioned although they know it will not work easily: hence the action will result in an increase of the need to have recourse to consultants.
Structures based on competencies (SBCs): definition and principal characteristics

Definition and examples:
An organization is a structure based on competencies (SBC) if it has the following three characteristics: (1) the nature of its activities is rather stable; (2) the work which is the *raison d'être* of the organization has to be done by highly qualified people which by nature are rather free of constraints when they are working; (3) the coordination between professionals in operation is done in rather stable ways. This type of organization is frequent in hospitals and clinics, in some consulting firms, craft activities, universities, architecture firms, front offices of asset-management firms, law firms, etc. Operators are consultants, doctors, professors, architects, etc. Sophisticated restaurants and theaters with stable repertoire or style (the “Comédie Française” for example) have the same type of structure. Starting in the 90s, banks have gradually changed in the direction of SBCs, even if they keep many aspects of the “mechanistic structures” they had initially.

Structural configuration:
As professionals are generally expensive and not very interested in the simplest parts of their job, SBCs generally also use less qualified personnel who are in charge of the simplest parts of the work: assistants, secretaries, nurses, drawers, middle- and back-office personnel, etc. Since the work of these “support personnel“ is also generally most programmable, it is often managed by direct supervision and standardization of work processes.

By nature, SBCs do not have “Methods Department“ and other “technostructure units“ who standardize the work processes used by professionals. Technostructure units nevertheless exist, which take care of administrative and logistical flows: accounting, occupation of teaching and surgical operations rooms, etc. But, that standardize operators' competence are at present not very common in SBCs. The weekly meeting devoted to reading the professional literature in hospitals is one such activity. Future developments of these structures will include developments in this direction: working with knowledge-bases bought on the market, developing local knowledge-bases, etc. Some consulting firms have made strong moves in this direction. Andersen Consulting (now Accenture) already had more than 3000 knowledge bases at the end of the 90s.
Structures based on competencies often have a wealth of permanent part-time committees and commissions. Each of them has a decisional area in which it contributes to top management's work. Members of these committees and commissions often come from several departments and units of the organization. In hospitals, for example, are found committees that deal with general policy, patients' well-being, computerization, drugs policy, investments, etc. In most SBCs the set of these committees and commissions form, together with top management, a complex "political arena" where mutual adjustment and conflict are intense. Strategic decisions are generally not simple in SBCs.

The operating core of the organization is generally split between units according to the type of expertise required: cardiac surgery, pediatrics, nephrology, etc.

Forces which influence the professional:
Although fairly independent when he performs his work, the professional is nevertheless influenced, if not controlled, by his organization and by his professional community. The means of influence are however rather indirect, and markedly different from the control and coordination mechanisms found in other types of organizations. Direct supervision can be used in SBCs to allocate work between operators, but is not a practical means of influencing the method used by the professional when treating a patient or a client. Standardization of results may partly be used in SBCs for coordination purpose: the organization may standardize the number of clients or patients seen per day, or the work-time by type of work. But even though these means exist, it looks as if the professional is rather free when he or she is operating. In fact, the professional is nevertheless controlled by five mechanisms, the first mentioned being probably the most powerful: (1) the maintenance and development of professional reputation; (2) the culture of the professional community to which the professional belongs; (3) the limits put on the exercise of the professional activity by the procedures and resources of the organization (space and equipment, accounting and logistics, possibilities of participating in outside professional activities like colloquia, seminars, meeting of national and international professional associations. The professional is also partially determined by (4) the initial training he followed and the continuing education, and (5) by the regulation bodies of his profession.

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35 As we saw in the preceding paragraph, the main coordination mechanism in simple structures is direct supervision. Other coordination mechanisms play this core function in other types of organizations, like standardization of work processes in mechanistic structures and standardization of competencies in SBCs.
profession. It is not by chance that many activities in which structures based on competencies flourish are also activities which have “professional orders” and accreditation bodies.

Stars:
Professionals have not only shared knowledge. They also have shared values. Collegiality and equality are often among these values. This egalitarian value does not prevent professionals from recognizing the presence among them of some colleagues who are “more equal than others”. These persons are generally called “professional stars”. They are people who have greater professional reputation inside the organization, and often also outside. They write in professional journals, give conference papers and speak in professional meetings, they also have roles in professional bodies.

The presence of stars has many consequences on the way SBCs function. Stars play important roles in the organization in general and in innovation in particular, as we shall see below. The difficulty of being a department manager is not the same depending on whether the incumbent is or is not a star, on whether some of his subordinates are stars, depending on the quality of the relations he or she has with the stars in the organization and in the profession. Stars participate more than others in permanent commissions, and even if they do not participate, they are quite often informally consulted.

In structures based on competencies, innovative ideas apparently come more often from the stars and from the hierarchy, and they are less often individual ideas than ideas which have gradually ripened in the professional community.36

But an innovative idea may come to the mind of any professional at any time during his period of activity, and we shall begin with this situation even if it is not the most frequent. When a professional has an innovative idea and may proceed to the implementation with the resources available to him, then the probability that he will indeed proceed to implementation depends on several factors:
- the innovation may be more or less acceptable for the professional culture and values, within the organization as well as within the professional community,

36 These two phenomena go in the same direction: stars and members of the hierarchy are often those who have the most intense links and contacts with the professional community outside the organization.
- the innovation may be more or less acceptable to the hierarchy, depending on the time needed to develop it, and the flexibility of work allocation mechanisms in the department where the professional is working,
- the development of the innovation may require more or less organizational resources,
- the development of the innovation may more or less interact, or interfere, with the areas of competence and decision formally controlled by top management and by the permanent committees and commissions of the political arena.

In the latter two cases, the decision to go on with the innovation will be taken through an implicit or explicit negotiation with top management, with people deciding about the use of resources, and with members of the committees involved. This negotiation will often have to be done with the endorsement and active support of some key people like influential committee members and professional stars.

Possibilities of efficient development of the innovation also depend on the following elements:
- the consequences of the innovation on the other members of the organization, in particular if it modifies the nature and quantity of work of the support personnel,
- the attitude hierarchy has about innovation in general, and specifically about innovation developed by subordinates.

An example which remains famous is that of the doctor who discovered hygiene during the XIXth century. Intuitive remarks followed by systematic observations had led him to discover that washing hands between deliveries reduced women's death rate by more than a third. But when he tried to extend the new practice to the service he was working in, he was violently opposed by his superior, who managed to fire him.

Management of innovation is very different depending on whether the resource needed for its development and its potential implications (1) are all in one department of the organization, or (2) are partially in other departments or in outside organizations. For example, in a surgical department of a clinic, the development of an innovative idea may require using electronics, and in a consulting firm an innovation may require expertise in object-oriented programming of knowledge bases.

In the above cases, innovation development will require formal or informal negotiations with the other departments or organizations concerned, or even with some stars, higher level members of management, committees or commissions of the “political arena”. Child
et al. (1990) show this vividly in the study they made of innovation processes in SBCs, specifically in biological analysis laboratories of hospitals and clinics in eight countries.

Actors outside the organization frequently play an important role in the development of innovation. First through equipment suppliers who try to maintain good relations by lending up-to-date material to their “key contacts” in the organization, or who try to get their new generation equipement placed in some organizations before it is commercialized. This placement helps them to obtain early client feedback on “beta versions”, it also helps their subsequent sales efforts with the “professional references” thus obtained. Second, outside actors play a key role because innovative ideas circulate in the professional community:

- formally through professional journals and continuing education,
- formally and informally in congresses and professional meetings,
- informally through contacts between professionals.

Thus Kreiner et al. (1993) have observed that researchers in biotechnologies exchange information very freely, and even have conversations on confidential matters with friends who are professionals in competing firms.

The above elements on innovation in SBCs allow us to identify management constraints on innovation for the various actors of such structures. Some of them are presented below.

If a professional has an innovative idea and wants it to be extended to the organization, his best first move will probably consists of enlisting informal support from professional stars inside or outside his organization. Enlisting informal support from members of the hierarchy and from key committee members comes a close second. Such innovations coming from “rank and file” professionals may be strongly deterred if stars discourage or block innovation coming from subordinates, or if they steal the idea and attribute to themselves the merit of the discovery. Hierarchy may have a tendency to maintain its “local star” status by blocking the development of talents, which may also mean blocking innovation proposed by talented people. This tendency opposed to innovation may be general in the organization, for example if an important proportion of the professionals have let their competence decrease over the years by lack of continuing education, lack of striving to keep abreast of progress in professional practice. The innovative and talented professional recruited in such an environment may well feel alone, if not a complete
stranger. He may probably survive only if he has a very solid professional reputation and ties in the professional community.

In some structures based on competencies, stars may be strongly induced to innovate because their professional reputation depends on innovation. Chefs of sophisticated restaurants are a good example.

But other SBCs place a much higher value on regular high level performance with well oiled techniques and no frills. Innovation may be discouraged in such structures.

We saw above that some innovation in SBCs has to go through the complex political forum composed of top management, commissions, department heads and stars. In such cases, the innovation will take place among the often heteroclitical set of problems, solutions, preoccupations and values of power centers and influence sources. The way innovation will be treated then crucially depends on the composition of this set at the moment when the organization is working on the innovation. One has then typically what organization research calls “garbage-can situations”. It is not at all by chance that this decision-making model was first observed in structures based on competencies.

Observation of several empirical cases suggests that, in these rather disorderly garbage-cans, convergence of action to an ordered decision is eased by the following elements:

• the creation of a circumstantial coalition,

• great energy devoted to focus the organization's attention on the project (if one thinks he can have a winning coalition)

• the slicing of the innovation in steps that are so small-size that they do not induce opposition (hence not much energy is needed to ensure their acceptance),

• the launch of the project at the time the organization is experiencing large-scale change. If the innovation is closely associated with the larger project, then it benefits from the impulse this change provides. Sometimes the situation of the innovation is equally good if it is outside the large change, for it benefits from the fact all the

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37 The garbage-can model was discovered by James March and colleagues through research on universities and colleges (Cohen, March and Olsen, 1972; March and Olsen, 1976).
attention is on the change itself. The innovation has a higher probability of passing because it will be unnoticed by potential opponents.38

- the presence of one individual or small group who constantly pushes in the same direction, for months and years if needed. In a chaotic and fast moving situation, stubborn actors can get their projects approved even if their formal power is rather small,
- real-time management, with total attention and information on the questions which are active in the political forum, with instant response to each menace and instant seizure of each opportunity,
- long-term action to modify the organization's competencies, culture and cognitive representations (i.e. mental maps).

The latter point comes from the fact that, in a globally erratic decision-making arena, when numerous decision-makers, problems and solutions are activated and un-activated at all time, then every rather stable element is a winner. March and Romelaer (1976) thus see decision-making as fairly close to Brownian motion which predictably drifts in directions given by the professional culture. We can extend this finding and say that the acceptance of innovation is enhanced when it is in line with whatever “stable collective elements“ may exist in the organization. From this, one can deduce the probable effectiveness of management methods like the following:
1) developing a critical mass of professionals,
2) providing incentives to innovate in some areas, for example through the massive and coordinated sending of organization members to education programs and to professional congresses,
3) using one or several “management tools“ which encourage collective coherence and networks. One example is provided by the “Technology Fairs“ held annually in the high-technology company Bell&Howell. In these internal company events, each unit presents the projects it is working on, the objective being to create both synergy and an innovative spirit.39 Other techniques include inter-department mobility when possible, and encouragement for cross-functional project-groups.40

38 But being outside the large change gives worse results on average. It is often the case that, when the organization is proceeding with a large-scale change, the attention of all decision-makers is strongly focussed on the suppression of all other innovations and change.
Means like the above only have medium to long-term effects. They can only partially influence the “natural slope” in the direction of which innovation will drift in the organization. By the nature of such decision settings, results remain essentially determined by conditions that obtain at the time and place of innovation, by the possibilities open through contacts with stars and with the professional community at large, and by tactical games in the political arena. These limits to short-term management and control are inherent to garbage-can situations.

To finish on innovation in structures based on competencies, let us mention that, if the number of innovations increases, then the stability condition is no longer present: the structure then moves to another type of organization (adhocracy), where the management constraints on innovation are markedly different.

We presented above specificities of innovation, and management constraints on innovation, in simple structures and in structures based on competencies. Similar specificities and constraints exist in each of the ten other types of organization. Lack of space prevents us from presenting these equally important cases, and the models of innovating organizations developed by Leonard Barton (1995) and by Nonaka and Takeushi (1995), both close to adhocratic structures. Different in each type of organization, there exist management constraints whose tendency is to lower the intensity and speed of innovation, others which have the opposite effect and encourage it, pushing things in such a way that there is even more innovation than some actors may be inclined to launch, and still other constraints which modify the types of innovation that come to the mind of the organization's members and managers, selecting some types of innovation and filtering out other types.\textsuperscript{41}

\textsuperscript{41} The interested reader may refer to Desreumaux and Romelaer (2001). This reference presents, among other things, specificities of investment decision processes in the six divisionalized structures. Some of the results presented there give indications on specificities of innovation processes and of management constraints in these structures.
4) Innovation and regulated systems

We saw in the preceding paragraph which management constraints come from the type of organization in which the innovation takes place and on the place occupied by the person pushing for the innovation. Other management constraints can be identified if we go in detail inside the structure, within the functioning of what we call “the coordination systems” presented below (the first five come from Mintzberg, 1979):

<table>
<thead>
<tr>
<th>1) hierarchical system</th>
<th>2) regulated systems in production, communication, decision and control</th>
<th>3) work constellations, sets of people involved in processes, activity systems</th>
</tr>
</thead>
<tbody>
<tr>
<td>4) informal relations</td>
<td>5) ad hoc decision-processes, action systems, innovation processes</td>
<td>6) non-hierarchical work relations</td>
</tr>
<tr>
<td>7) groups, power systems</td>
<td>8) external relations</td>
<td>9) cultures</td>
</tr>
<tr>
<td>10) objectives and projects</td>
<td>11) competencies</td>
<td></td>
</tr>
</tbody>
</table>

Because of space restrictions we shall only present here management constraints coming from “regulated systems“ and from “innovation processes“. The innovation processes will be presented in Paragraph 5. Regulated systems, also called “formal systems“, are presented in this section. They include:
- production management systems, like scheduling of production orders, MRP I (material requirement planning), MRP II (management resource programs), ERPs (Enterprise Resource Programs, like SAP), and logistical and transport systems,
- information systems including inventory management, data bases on clients and prospects, periodical market studies, ABC (activity-based costing), etc.
- decision systems, like standard procedures for capital investment decisions, strategic planning.
- control systems like management control systems, market share control, project advancement control.

Many of the regulated systems induce constraints on innovation because they specify behavior, information and control which have been designed for the management of regularly occurring activities other than innovation. Hence in some cases the people
pushing for the innovation have to use data which are not tailored for their needs, are pushed to behavior and submitted to controls which are counter-productive with respect to their objectives. Sometimes a regulated system is an integrated set of procedures which the innovation would need to modify only in part, but modifying a part of it would require an improbable modification of the whole system. It is more probable that an innovation will be developed if the following conditions are satisfied:

- the innovation is compatible with the regulated systems it has to use,
- the innovation can short-circuit the regulated systems. For example production of prototype parts can place reservations on the production lines outside of the regular MRP,
- the regulated systems are partially de-coupled from innovation. For example a specific cost monitoring system is used for the innovation.

Production and information systems are fairly rigid nowadays. Frequently they may be modified only by specialised “technostructure” departments (Methods, Information Systems, Management Control).

In some cases exceptions may be negotiated. In other cases, there exists a management system designed to propose modifications. Thus a large bank may have more than 5,000 program modifications each year (Demeestere and Mottis, 1997), each such program being a modification to a regulated system. Such an amount of work possibly leads to a rather heavy and slow administrative machine, not as quick, flexible, evolutive and adapted as needed to the people pushing for the innovation.

In some cases the systems modifications are managed responsively with real participation from internal clients and by “system correspondents“ in the operational units. These cases are the best for innovation.

That the above issue is important for innovation is illustrated by results presented by Jonathan West (2000). The innovation capacity of American semi-conductor firms have increased in direct proportion to the firms testing capacities. American have lagged behind foreign firms when these capacities were below that of their competitors. In a lecture he gave in 1998 at Dauphine, West insisted on the difficulties R&D people had to introduce their tests runs discretely as a favor without attracting attention amidst the regular programmed use of production facilities. In this area as in many others, it seems that
developing a *modus vivendi* between innovative and regular activities is key to innovation performance\(^\text{42}\).

From the above we can infer two management constraints on innovation coming from regulated systems:

- middle management and rank and file people pushing for innovation have to analyse the demands their project will make on the various regulated systems and to evaluate compatibility. If they conclude that the incompatibilities are so large that the project is unfeasible, they may be led to try to obtain the same services from outside the firm, or to negotiate *ad hoc* temporary modifications of the regulated system. They then need to program time to introduce their demand, to discuss informally its technical feasibility and social acceptance, to identify the persons whose support may be useful. Such actions may be quite time and energy consuming\(^\text{43}\).

- the executive who wants to increase innovation in his firm may make an audit of the compatibility between the regulated systems and innovation. He may then possibly create special information and support systems for innovation projects if standard functioning of these systems is seen to impede innovation.

Some research point at the necessity to adapt regulated systems to innovation, at least during the conception phase and during the first few months of implementation\(^\text{44}\). Kanter (1989) mentions several firms, Raytheon for example, which have a fund specially dedicated to innovation, which is managed in a fairly flexible manner. The firm 3M allows any innovative idea to be presented at any time, independently of the investment budget decision cycle and procedure.

Suggestion systems are close to the above methods: the French electricity company EdF has thus implemented many innovation projects presented by lower level units, about 150 each year between 1991 to 1996 (Durieux, 1997). Decisions about these projects were made with *ad hoc* regulated systems.

\(^{42}\) This fact is a special case of the balance to be found between exploration and exploitation in any activity (March (1991)).

\(^{43}\) We are close here to the results obtained by Dougherty and Hardy (1996): within large groups in mature industries, one key to the success of innovations pushed for by lower level organization members is the integration of the innovation to the existing formal organization.

\(^{44}\) For a new product, this corresponds to the first months after market launch.
Other research, unsurprisingly, shows that the very existence of regulated systems may impede innovation development, or even diminish the willingness people have to speak out on their innovative ideas. We have data on two firms in which (1) management says that innovative ideas by rank and file members are more than welcome; and (2) each person having an innovative idea is asked to complete a detailed standardized file describing the idea. These files were up to eighty pages long, almost requiring the elaboration of a five year business plan. The informants all said that such a requirement was a deterrent for someone who had just a fairly vague innovative idea, when he was still unclear about the predictable return rate and market size. Formalization may prevent people from volunteering ideas.

Management constraints sometimes come from the distance between the regulated system and the requirements of the innovation project. Some research identifies such cases, together with management methods which may be used to circumvent difficulties:

- Doz and Pralahad (1987) mention the fact that, in sixteen firms which innovated by developing markedly international operations, executives at the origin of the project began by having “special studies” done to show the need for internationalization. The fact was that information systems in use, because they had been created for another purpose, were not giving the adequate messages concerning the need to internationalize. It thus seems that information systems can be inadequate outside the narrow area for which they were created, to the point of giving biased messages in areas normally within the domain of expertise they cover. For example strategic information systems do not give adequate messages on all strategic questions: they only give adequate answers to questions that can be asked within the present strategy.

- Tyre (1989), studying innovation in American, German and Italian plants of an American mechanics firms, sees that innovation is quicker and more successful in Germany. In our opinion, it is not by chance that Germany is the only one of the three countries

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45 One of the firms is a small business in biotechnology, the other the local unit of a large group of consumer products. See Romelaer (1994).
46 On the other hand, the executive taking responsibility for a unit which has been managed this way by his predecessor may discover that there exists a “gold mine” of innovative ideas held by his subordinates, ideas which could not blossom because of the formalized management, with subordinates who have been frustrated for months or years and who are quite ready to unleash their creativity and motivation if given the opportunity and support to do so. But such a favorable situation does not always obtain: the new executive may also see that creative people have all left the firm, and that the subordinates remaining have learned not to have ideas. Hence a careful audit is probably in order before the executive knows what is the real value of the unit he has just inherited.
where the organization has the following characteristics: (1) technicians of the Methods Departments work on the shop-floor, amidst the workers and the machines; (2) there is a kind of knowledge accumulation mechanism concerning technical knowledge in the plant, with some organizational memory of problems and solutions. The first characteristic encourages Methods people to be socially much closer from the workers in Germany than their counterparts in other subsidiaries in the group.47

- I once interviewed managers in a plant producing electric contactors for industrial clients. It had happened in this plant that an industrial worker had an idea about a possible improvement of one production method. She then quit her work, walked to the Methods Department (located outside the shop-floor) to talk about her idea. As soon as she begun explaining her idea, she was strongly rebuffed. A conflict erupted, where Methods people shouted that things can work only if workers work and Methods do the methods. Such a claim about the uselessness of workers' ideas, and about distance between Methods and the workers, surely will have enduring consequences on the management of innovation in the plant and in the processing of workers' innovative ideas.48

We have mentioned so far only the adverse effects regulated systems have on innovation. It should not be inferred that they only have such negative effects. Many of them have indeed the objective of pushing the organisation in the direction of innovation:

- productivity progress objectives at the group level as in Renault, coupled with productivity measure systems, force managers and their teams to reconsider organization and technology,
- product costs measures and activity-based costing, possibly coupled with benchmarking, direct attention to weak points that need innovation,
- data bases on clients and prospects, possibly aided by competition analysis software, help identify commercial targets. Clients' tastes analysed through consumer research tools can be fed into new product specifications.

47 The second characteristic is linked to the management constraints on innovation coming from the "competence system". We do not deal here with this other "coordination system" (the 11th in the list of Figure 2).

48 Other characteristics help to analyse management constraints on innovation in this situation. (1) The worker was a member of the sole semi-autonomous group in the plant, a group physically identified in the middle of the shop-floor by glass panels, named the "fish-bowl" in the workers' parlance, and decorated with plants. Questions like social appropriation of space and experience of initiatives surely have an impact on the propensity to have innovative ideas. (2) The social distance between the shop floor and the Methods department is enhanced by the fact that the Methods are more than fifty yards away from the shop floor. Physical distance may facilitate social distance if not counterbalanced by coordination mechanisms.
The list of cases where regulated systems have a useful influence and foster innovation is probably very long.

Regulated systems may also induce other management constraints on innovation than the direct intended effects mentioned above. Short term returns requirements and rapid rotation of managers encourage the selection of technological innovations which have quick effects and of marketing innovations that “skim” the market, even at the expense of long term viability of the firm. Parts of these are present in the research Noda and Bower made on two of the “Baby Bell” companies (1996). Management constraints may even be more difficult to detect: Fiolleau and Mevellec (1995) claim that accounting procedures based on direct costs, which are widespread in French firms, profoundly condition the innovations these firms launch.

Three other research results signal non-intuitive management constraints on innovation which regulated systems sometimes have:

- Simons (1991) studied thirty strategic business units in large health-care groups. Nineteen of them have one, and only one, of its control systems\(^{49}\) which is used in an “interactive“ mode: data from this control system are not used formally to evaluate distance between objective and realization. Quite the contrary, they are used during frequent face to face work sessions, at successive levels of hierarchy, to appraise results, build interpretations, collect suggestions for actions. Such a use of control systems allows real-time formation of an emergent strategy. Innovative ideas are more than welcome in this setting.
- In a research they did on nine large scale innovation projects, Van de Ven \textit{et al.} (1989) discovered a vicious circle worth mentioning. If the finance department has little sympathy for a project, then financial resources will be below demand and possibly late. Then the project fails. The financial department may claim they were right not to believe in it, since the failure proves that the project was not viable. They may even add that they are not responsible for the failure since the project has been financed.
- Gersick (1994) has studied a small biotechnology firm financed by a venture capital company. She directly observed the firm for fifteen months and gathered additional data on a five year period. Her research shows that strategic reorientations, most of them linked to

\(^{49}\) Control systems in Simons are all regulated systems in Mintzberg's definition. Among the examples mentioned by Simons, one finds management control systems, audit, strategic planning, project planning, budgetary system, market-share monitoring, profit planning, intelligence systems, etc.
innovation, are made precisely half way through the fiscal year. It seems that the firm systematically persists in its course of action during six months periods, and possibly decides a change if results are disappointing or if the situation has changed. This behavior appears to be informal and natural, not at all a conscious formalized management method. This behavior seems to be linked to a “temporal marker” (here the fiscal year), strongly linked to a regulated system (here accounting) without being confused with either of the two. From research like Gersick’s we see that regulated systems may be considered as “organizational clocks” which periodically focalize the firm’s attention on specific elements of the firm’s functioning, of innovation process characteristics, and of the environment. In this view regulated systems are very useful. They are not “Procustean beds” which calibrate behavior and can only dampen innovation.

Concerning regulated systems, let us end by mentioning that so-called “project management softwares” are far from being sufficient to manage innovation projects. As Roy (2000) mentions, they are useful tools to focus dialogue, to explore the possibilities, to reveal preferences, to help the convergence of individual efforts toward a collective project, but in this aim they are no better than many other management tools. Likewise the “business plan”, considered by some as the alpha and omega of innovation management, is only as we shall see below one of the thirteen elements of the simplest innovation processes.

The ten other coordination systems we mentioned at the beginning of this paragraph likewise induce management constraints on innovation. Some of these constraints are difficult to perceive even by the people immersed in daily work, even if they have been identified in organization research.
5) Management constraints coming from the innovation process

We name “process“ a set of actions linked to each other in some ways, and “innovation process“, a process in which some of the people involved have the intention of innovating at some moment.

Over the years, management research has identified several empirical models of innovation processes. Each person who wants to intervene in an innovation will feel management constraints because of the nature of the innovation process. The present paragraph is devoted to a presentation of these constraints. It begins by a section in which we outline the constraints common to all innovation processes, and follows with a more detailed account of the constraints pertaining to specific types of innovation processes.

5.1) Management constraints common to all innovation processes

Let us begin by listing the basic characteristics of an innovation process.
- the end-state of an innovation is often partially defined at the beginning of the process. It is frequently re-defined during the process itself.
- the innovation process interacts with numerous contexts and must be “framed“ within these context.
- the various actions of which the innovation process is composed must be coordinated with each other.
- the firm must have competence and resources for each of the actions of which the innovation process is composed, and the innovation managers must secure the right to mobilize the former and to use the latter. If the resources and competence do not exist within the organization, the firm must be capable of obtaining them on the market, often with the additional requirement that some people in the firm define the contract, negotiate it, monitor and control its execution.

This vision of the innovation process leads us to identify the constraints of coordination, of framing, of context, of definition, of competence and resources for the innovation as a whole as well as for the actions of which the innovation process is composed.

We shall examine these constraints in turn below.
The coordination constraint

Numerous management research papers are focussed on the coordination in the innovation process. The central idea is that there must globally exist enough coordination between the actions in the process, given that it is possible that the “total quantity” of coordination may be obtain through different “mixes” of coordination mechanisms.

Numerous such mechanisms have been identified that may contribute to coordination:
1) the five basic coordination mechanisms identified in Mintzberg (1979): mutual adjustment, standardization of results, standardization of competence, direct supervision and standardization of work processes, mentioned in the order of decreasing effectiveness as far as is known today.
2) some of the roles played by project managers (Ancona and Caldwell, 1992) and by intrapreneurs (see section 5.3 below) are close to direct supervision. The same may be true of some roles of the functional managers (Allen et al., 1988), when they act as internal consultants in their technical area. Some amount of direct supervision is often performed by a “management committee”, which possibly shares its powers with the project manager. Executives who “protect” the project and occasionally wield their power to unblock thromy situations also exert a kind of direct supervision\(^{50}\).
3) mutual adjustment plays an essential role in “multi-functional project groups“, concurrent engineering, and in the external relations of the project team (Nonaka, 1990; Clark and Fujimoto, 1991; Romelaer, 1994, 1999)
4) standardization of result is found in business plans, as well as in the development of common languages, mental maps and group norms\(^{51}\).
5) numerous management tools use a mix of standardization of work processes and of standardization of results: quality procedures, “kick-on, kick-off“ procedures\(^{52}\), project planning, project management softwares, market studies, feasibility studies, “house of quality“ (Griffin and Hauser, 1992), etc.
6) a mix of standardization of result and standardization of competence is found in “decision support systems”.

\(^{50}\) The importance of such “sponsors” of innovation processes is mentioned in Roberts and Fusfeld, 1981; Van de Ven et al., 1989; Mintzberg, 1994; Dougherty and Hardy, 1996. I owe the first reference to Françoise Durieux.

\(^{51}\) These developments may be natural or managed. The groups mentioned may be formal or informal.
standardization of competence is present in the selection of team-members by the project manager, and in methods like the management of competence portfolios by functional units or by partially autonomous groups of operators. Coordination is a management constraint (there needs to be enough of it) with some flexibility (a given quantity of coordination may be obtained through a variety of means). Coordination is also a management constraint in another sense: the firm may be used to one or two coordination mechanisms or management tools producing coordination, and it may be that these means and tools are not adequate and that familiarization with others would be costly, lengthy and problematic.

The constraint coming from the framing the innovation with respect to contexts

The innovation process must be framed with respect to its contexts, i.e. with respect to the numerous “systems” to which the innovation as a whole as well as its parts belong. The most common way to see this framing is the necessity to adapt the innovation to its technico-economic environments (strategic, marketing, finance, technological, etc.). To mention just one example, the creation of a new model of microcomputer must take into account the competition context (the relative forces of competitors, their strategic moves), the marketing context (the evolution of clients’ tastes, the style and cost of advertising agencies), and the industry context (conceptors and producers of related hardware and software elements such as hard disks, screens, bureautics software, videogames, etc.), and this list is not complete.

Many means are used by firms to perform this framing. An incomplete list of examples could include strategic agenda management (Dutton, 1987, 1997), yearly strategic planning cycle (Mintzberg, 1994), daily top management meetings (Bourgeois and Eisenhardt, 1988), interactive use of control systems (Simons, 1991), market research, market segmentation, and more or less formal and intense contacts with clients: - through frequent open informal relations with key accounts or major clients, the firm hopes to be informed of their wishes concerning new products, of problems they have with

52 One names “kick-on, kick-off“ any set of standard procedures used to decide that a project may proceed from one phase to the next. This type of management tool is quite common.
53 See for example the knowledge management at Air Liquide we presented in paragraph 2.
54 We presented them in paragraph 4.
present products, and even be informed of the ideas and projects of competitors they may have heard of.

- through specific intensive work conducted with a handful of “representative clients” or of “lead users” (Von Hippel, 1977, 1986): testing prototypes and pre-commercialization versions (“beta-versions”), and even co-development.

- striking an alliance with a client is a good move for a subsidiary. It helps present headquarters with more solid and convincing arguments for the innovative idea (Birkinshaw and Ridderstrale, 2000).

An extended version of framing may be considered if we use the notion of frame as developed by Goffman (1971). Such extension leads us to go beyond taking into account the competitive structure and its evolution: one then must also take account of the institutional environment, and the history and social structure of the industry (DiMaggio and Powell, 1983; Granovetter and McGuire, 1998; Whittington, 1992; Autissier and Wacheux, 2000). Social structure can be found in the notion of “industry recipe” proposed by Child (1997). Carr (1990) alludes to the institutional context when he asserts that the legal limitations on mergers in Japan led Japanese firms to remain distinct legal structures while developing very strong relations, notably when it comes to supplier-client relations in the automobile industry. According to Carr, this situation is the main explicative factor for the enormous development of client-specific marginal innovations developed by suppliers. The know-how thus developed over a ten to twenty year period is of value to clients and very difficult to imitate by competitors. This success factor of Japanese industry hence appears as an unintended by-product of institutional constraints.

Other elements contribute to the framing of innovation with respect to its contexts:

- the phase of strategic and organizational integration at the end of the Burgelman type of innovation processes (1988) (see below). Angle and Van de Ven (1989) mention the same concept when they advise innovation managers to take care to “link the new with the old”, and such need for integration of the innovation to the existing organization is proved essential by the empirical research conducted by Dougherty and Hardy (1996).

- the set of relations existing between innovations and between decisions. As proposed in the research carried out by Quinn (1988) on the decisions in the Pilkington company, two decisions and/or innovations A and B may have three types of mutual dependencies: succession dependency (when B must follow A, as is the case when the firm creates the
“third generation” of a product it has already developed and improved); community dependency (when A and B share a resource which is managed independently, like R&D personnel, top management time, or advertising budgets); and “precursive” dependency (when A precedes B and influences it although the link between the two is not of necessity). Another example of community dependency is the already mentioned annual programmation of software modifications in a bank within the constraint of total resource of the Information Systems Department budget and personnel (Demeestere and Mottis, 1997).

Still other management constraints common to all innovation processes come from the framing of the actions in the process with respect to the people involved in the innovation:
- the set of activities of an individual during the days or months when he contributes, full-time or part-time, to the innovation process has a logic of its own. Hence questions have to be resolved, like agenda compatibility, the meaning of the overall activity for the individual and the motivation for him to implicate himself in the innovation rather than in other assignments. To mention a single example, a problem frequently met in innovation management is keeping the project team fully operative when the end of the project is in sight. Much work then remains to be done, but team members, as they are understandably worried about their immediate future, tend to devote most of their time to the identification and negotiation of their future assignment. They sometimes even begin their new job while still officially belonging to the present project team (which pays them for full time work). They may leave the project team without notice or authorization to begin their new job.
- the set of activities of the people involved in the innovation process must also be considered with a longer time span. For each individual, the activities linked to the innovation process must find their place with respect to long term professional and personal development.

Framing must also be considered with respect to each physical object used during the innovation process. For each piece of equipment and type of material the context is made up of various elements linked to each other: suppliers, maintenance technicians, experts, transporters, technical publications, etc. If we go into detail, suppliers comprise regular suppliers, other suppliers who can modify products to make them more suited to the innovation, still other suppliers who can deliver on very short notice, etc. Taking into
account the objects' contexts leads us for example to include in the new product only those items for which there exist at least two dependable suppliers in the world.\textsuperscript{55}

To say that the innovation process must be framed with respect to the various contexts mentioned above does not mean that it has to passively adapt and conform to the environment. The innovation may partly shake out some of these systems. But management constraints come from these contexts precisely because these “outside systems’’ function as systems: they will react to demands made on them by the innovation process, and their compounded reactions may have such intensity that managers and other people involved in the innovation process will not have enough time and resource to accomplish the work needed for the development of the innovation and at the same time palliate the perturbations coming from the reactions of these environments.

To end our discussion on this point, let us say that the taking into account of contextual constraints on innovation processes is still in its infancy. Some “field models”, potentially applicable to the study of the framing of innovation, have been proposed by researchers like Lewin (1951), Bourdieu (1971, 1976), Porter (1980), Pettigrew (1987), Strebel (1992). But none is sufficiently general and precise so far. We do not even know if the list of types of contexts we considered above is complete and coherent.\textsuperscript{56}

The management constraints following from the definition of the innovation

An innovation process achieves in the end a change compared to the initial situation (new product, new service, new organization). The initial definition of this final state is often incomplete and uncertain. It indeed often happens that the definition of the objective pursued changes as new opportunities occur to the people involved, as new information is gathered about potential clients, but also as problems develop which appear to be intractable, when unexpected difficulties are met, or delays and budgets overrun.

\textsuperscript{55} For reasons beyond the scope of this paper, the context of objects has the same structure as “action systems” defined in Romelaer (1998b) or Romelaer and Huault (1996, 2002).

\textsuperscript{56} To summarize, our list includes the following contexts: technico-economic (including marketing, finance, etc.), organizational, personal, social, historical, and institutional contexts, as well as the contexts of physical objects and equipment.
The definition of the innovation project creates management constraints because habits and techniques, management tools and diagnosis instruments specify which data and information have to be gathered and monitored to define an innovation project, including for example which minimum technical and economic standards, and maximum delay, have to be attained. The elements considered in the innovation definition necessarily influence the deployment of the innovation process. Elements not taken into account may have an influence too, if they pertain to contexts of the innovation whose reactions may induce consequences unforeseen by the actors, even though research results and management techniques have shown their possible impact.

Little research has been devoted to the definition constraint. Let us signal only Mintzberg’s remark (1994): from the metallic ski to the IBM 360 and the float-glass technology, many innovations would not have been developed if the firms had taken their decision on short term financial return calculations. This remark shows that improper definition of the innovation may hamper profitable developments.

There exist numerous items currently used in the definition of innovation, among many others:
- financial elements: forecast return, payback period\(^57\),
- marketing elements: tastes of potential clients, market segmentation, potential market and market share, etc.
- production elements: target costs, technical specifications, functionalities, production feasibility, etc.
- strategic elements: potential market viability, strategic strength of the product portfolio when it includes the innovation, compatibility between the innovation and the strategic orientations of the firm,
- elements linked to time: conception delay, future maximum delay between client orders and delivery.

The elements taken into account in the definition of the innovation sometimes also include some or all of the following:
- ease of production and of distribution, ease of maintenance and repairs, flexibility of production facilities and adaptability to demand fluctuations. In the latter element we

\(^{57}\) See many such financial elements in Charreaux (2001).
find the great importance recently gained by late differentiation, and by process innovations whose objective is to reduce the required time for changing tools on production lines.

- the possibility of “modular development”, the choice of gradual development, the choice between “development in depth” on one site (followed by duplication on other sites) vs. “development in width”\(^{58}\),

- the contribution of the innovation to the development and maintenance of workforce competence, the position of the innovation with respect to the core competencies of the firm,

- the simplicity of the innovation, the capacity the innovation has to be understood by employees, clients, prescriptors, investors, bankers and capital market. In other words the innovation's “readability”.

The innovation definition does not include only the objectives pursued. The nature of the innovation also includes specification of the actions to be conducted during the development process. This topic will be covered in a following paragraph, when we deal with the “steps” and phases of the innovation process. These steps and actions actually differ depending on the type of innovation process the firm follows.

The criteria taken into account in the innovation’s definition are constraints the firm imposes upon itself. The tendency they have to be accepted is greater if they are usual in the firm, actively endorsed and shared by executives, incorporated in the standard systems used in acceptance, financing, evaluation and management of projects.

**The resource and competence constraints**

The firm needs resources and competence for each action required in the innovation process, as well as for each of the tasks which will have to be completed when the innovation is operative. These are not only technical and marketing competence. They also include the competence necessary to identify and understand the relevant contexts, to

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\(^{58}\) The latter two possibilities are mentioned in Angle and Van de Ven (1989). The authors advise managers to first develop and test the core of the innovation, before trying to create market interest. In one of the cases we studied in Romelaer (1994), the firm launches its innovations as soon as they are basically ready, confident that clients’ remarks and complaints will help it to identify the remaining problems which require modifications.
define the innovation and frame it with respect to the contexts, to mobilize and coordinate the actions and the people involved, and to manage the innovation in a way compatible with the rest of the organization.

When the required competence and resources do not exist in the organization, they may be developed or acquired. Such development or acquisition always requires important time and resource, and is fraught with considerable uncertainty. Their integration with the organization is not obtained without difficulties, and neither is their coordination with the other competencies and resources in the innovation process.

Other constraints come from the fact that the resources and competencies needed during the innovation process cannot all be predicted at the outset. Needs appear as knowledge of potential clients is refined, as technical difficulties and coordination problems are met, when the innovation's definition is modified as a function of the emerging problems and opportunities. From this fact Chew and Leonard Barton (1991) deduce that management should not only assemble the competencies which appear *ex ante* necessary, but also general competencies which will allow adjustment as need appears.

The list of resources necessary or useful for innovation includes for example those concerning production and distribution of the future product, as well as those concerning the innovation process itself: space (offices, labs, storage, etc.), equipment, information, support and relations (from executives and experts, within the firm and outside).

The list of competencies useful for innovation may be endless:

- François *et al.* (1999) have a list of more than hundred competencies coming from various research in economics, sociology and management,
- many others may be found in the book directed by Foray and Mairesse (1999), as well as in the references mentioned in Romelaer (1998c).
- each management constraint mentioned so far is associated with competencies which may be useful or at times mandatory, such as how to detect the constraints, how to evaluate their probable impact, how to neutralize them or how to modify the innovation project to take them into account, how to arbitrage between different constraints weighing on the same innovation process, how to coordinate the actions of the innovation process, etc.
Given the number of competencies thus identified, it is no simple matter for a firm to find which are the most necessary or useful for the management of innovation. When it comes to the competencies useful to generate innovative ideas, the question is even more complicated (see some elements on this in paragraph 6).

One the one hand, it may be said that individual creativity is a genuine quality no competence acquisition may improve, but that it will be more effective if the individual has greater competence and information about the relevant contexts. A higher level in fundamental sciences (maths, biology, mechanics, etc.), as well as competence and information on management matters (clients tastes, marketing techniques, functioning of existing distribution channels, etc.) will help the individual to frame his initial idea, generally rather imprecise, in a way which is compatible with relevant contexts and sufficiently legitimate and precise to induce others to listen to him. As (imperfect) indications that more competence leads to more creativity, we may mention the link between the average level of education in a country and the number of patents submitted, as well as the often naive character of technical innovations developed by amateurs.

But on the other hand it may also be that, on the contrary, a less educated individual is possibly more creative because his imagination has not been restricted and biased by the intellectual structures, values and beliefs he internalized during knowledge acquisition. As the saying goes: “He did it because he did not know it was impossible”. When they invented the plane, Clément Ader and the Wright brothers probably did not know that the Academy of Sciences had proved scientifically that flying was impossible. From this point of view, the lack of competence or information of the individual who has the innovative idea is a tractable problem: when the idea is there, the firm may mobilize competent people to discard uninteresting ideas, and to use selected parts of the others after applying to them relevant knowledge.

Constraints coming from definition, coordination, contexts and framing, resources and competence are common to all innovation processes. In a sense, they respond to the fundamental, if mundane, questions below:

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59 If the innovative idea is precise, more competence allows the innovator to perform much quicker and more effectively the test of the technical and managerial viability of his idea.

60 The question of creativity is also dealt with in Paragraph 6 on the origin of innovative ideas.
- “What innovation do we want to develop? What actions are necessary or useful for this development? How can or should these actions be coordinated?“ (definition and coordination constraints)
- "With what resources and competence shall we develop the innovation? What resource and competence will be necessary when the innovation is operative?“
- "In what contexts will the innovation function? In what milieux will the innovation process take place? What characteristics of these milieux and contexts should we adapt to, or should we try to change? In other words, how shall we position and frame the innovation and the actions in the innovation process with respect to the relevant contexts?“ (framing and context constraints)

Following the above presentation, we can now proceed to examine in the next sections what specific management constraints exist in some types of innovation processes.

**5.2 Management constraints in stepwise innovation processes**

Several models of organizational decision-making processes have been proposed over the years in the research literature. These models differ with respect to several elements:
- the nature and number of actions or types of actions in the process,
- the actors or types of actors involved,
- the degree of separation between the decision steps, their “time-pacing“ and the coordination between them,
- the predictibility at each moment of the future actions that will have to be carried out,
- the possible existence in the firm of standard steps and coordination mechanisms. Such steps and mechanisms may be mandatory, more or less respected and enforced in practice, or simply informal for use by managers.

Numerous models describe the innovation process as a predetermined set of steps. Implicitly or explicitly, many of them see innovation as a succession of steps which must be performed in a prescribed order. We name them sequential (or linear) innovation processes. All such models begin with an innovative idea, or with the specification of opportunities and problems which the innovation responds to. The origin of the innovation idea does not belong to the steps of the process (we shall deal with it in paragraph 6).
Linear models of innovation processes have as common ancestor the linear rational decision-making model in six steps:
1) Problem or opportunity detection
2) Diagnosis
3) Elaboration of all solutions
4) Specification of the decision maker's preferences
5) Choice of the best solution, by definition the one which maximizes the decision maker's preferences. This step is sometimes named “the decision”. It is assumed implicitly that the solution identified as the best will be implemented.
6) Implementation
7) Comparison between the decision taken and the results of implementation. A feedback loop to “Step 1” is activated if there is a discrepancy.

This rational model is itself a version of Herbert Simon's IDC model (Intelligence, Decision, Choice).

One model of this family has been developed by Cooper and Kleinschmidt (1986) after they observed 203 innovation processes. Half of them had had great success, half were more disappointing. Among the authors' conclusions figure the following:
- each innovation process is composed of some of the 13 steps listed in Figure 3 (possibly all of them),
- the proportion of successful innovations is much stronger when the innovation process includes a greater number of steps among the 13 in the list.

The study of 80 innovation processes in three countries by Dwyer and Mellor (1991) corroborates the above conclusions.\(^{61}\)

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**Figure 3**

AN EXAMPLE OF STEP MODEL OF INNOVATION PROCESS:
THE 13 STEPS OF COOPER AND KLEINSCHMIDT (1986)

An innovation process is composed of the 13 following steps:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Initial screening</td>
</tr>
<tr>
<td>2</td>
<td>Preliminary market evaluation</td>
</tr>
<tr>
<td>3</td>
<td>Preliminary technical evaluation</td>
</tr>
</tbody>
</table>

\(^{61}\) It should be noted that the strength of the link between success and the number of steps is not the same in Cooper and Kleinschmidt and in Dwyer and Mellor. For each of the 13 steps, the proportion present in successful and failed innovation is not the same in the two research results.
Research based on data concerning 203 new product innovation processes shows that innovation processes have a higher frequency of success when they include a greater number of steps. For example, 55% of success innovation processes include 9 steps or more, where it is the case for only 38% of failure innovations.

It may be remarked that if we name the set composed of Steps 1 to 5 “Group 1”, and the set composed of Steps 6 to 11 “Group 2”, then Groups 1 and 2 are each very close to Simon’s IDC model. It can thus be said that the Cooper and Kleinschmidt innovation process is composed of two iterations of the IDC process, followed by production and market launch.

Cooper and Kleinschmidt do not specify whether the order of steps is completely mandatory. They do not tell either whether there may be repetitions in part of the process, although Mintzberg et al. (1976) have observed this in decision processes. Hence we may say that data are lacking on the frequency with which a given step is followed by feedback rather than by proceeding to the next “normal” step, on the most common processes and reasons for feedback decisions, or on the consequences on performance.

It may be remarked that the Cooper and Kleinschmidt model is not complete concerning definition, coordination and contexts. It does not specify whether the work is best if performed by a dedicated temporary project-team, or if it is better to allocate each activity to a specialized department which will program it among its workload composed of other activities.

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62 Who detects the problem? What regulated systems and management tools are used for this purpose? Who decides?

63 Presumably the definition of the innovation is fixed in Step 5, where it may be supposed that technical and marketing opportunities and constraints are confronted to each other, and then coupled to strategic and financial analysis. Nothing, however, is said on what is done if good or bad surprises appear later.

64 Coordination is presumably done during Steps 5 and 11 (the two business plans). However nothing is said on how technical and marketing explorations (Steps 2 to 4) and tests (Steps 7 to 10) take into account their mutual objectives and results. There exists no overall arbitrage mechanism (project managers or project committee for example) in case incompatibilities between the orientations of different steps appear in Steps other than 5 and 11.
activities of the same kind. In the latter case attention to the specific needs of one innovation may be superseded by the standard ways of working of the departments and the need they have to balance their workload.

Each “step model“ of the innovation process induces management constraints for the following reasons:
(1) first, because it contributes to the innovation's definition through the actions it includes and the actions it omits. For example Cooper and Kleinschmidt do not explicitly mention strategic diagnosis, specification of the elements linked to distribution, advertising and logistics, flexibility and quality analysis, legal and property aspects, or else conception of the production facilities. As a reminder, the conception of production facilities represents very heavy costs in the automobile or chemical industries.
(2) second, because each model implicitly attracts decision-makers’ attention to the competence requirements relative to each of the mentioned steps, and comparably little attention is given to competence relative to actions not mentioned in the list.
(3) third, because some of the “step models“ encourage decision-makers to be as complete as possible in terms of the mentioned step. Such is the case for the Cooper and Kleinschmidt model.
(4) fourth, because “step models“ induce the necessity to manage the transition between successive steps, and the coordination between steps conducted simultaneously (although many authors do not deal with these aspects).

Other management constraints are indirectly induced by step models of innovation processes:
(5) the research method induces respondents to indicate that, according to them, the firm, if it wants to improve innovation, should use more formal management tools and controls in each step of the process. In our opinion such statements are spurious consequences of the model structure. Although it may be tempting to follow these opinions of professionals who are daily immersed in action, it should be noted that such increased formalization contradicts other innovation models which have been proved successful in some settings, for example Nonaka's model (1990).

65 Marketing and technical contexts are reasonably developed. The production context appears only through production testing and launch. All the other contexts are implicit.
(6) a firm managing innovation around a linear model is inclined to plan the innovation development delay as the sum of the delays required for the steps in the model. Such behavior strongly decreases the incentive to devote attention, resource and time to actions not explicitly mentioned, and strongly increases the incentive to go from one step to the next even when results obtained are not satisfactory. Of course it may be that proceeding according to plan while at the same time acting to correct the still-unsolved problems is an efficient behavior. But it is also possible that such conduct leads management to proceed with a project ridden with problems, while better results would be obtained by “clean work” even at the cost of going back to preceding steps each time it appears necessary. Hence more research is needed to see which behavior is best in what circumstances.

(7) the structure of step models of innovation processes normally induces the firm to look for ways to improve its competence and performance in each step. It may however lead to internal battles where each manager tries to get more resources allocated to the step he or she is responsible for, with possible inefficiencies. Beyond this, linear models, especially when different managers and departments are in charge of different steps, draw attention to ways to decrease the time spent on each step, and do not induce people to look for ways through which shorter total project time may be obtained through “overlap” between steps. Some Japanese practical examples (Nonaka, 1990) later theorized as “chrono-competition” and “concurrent engineering”, have shown that this avenue, discouraged by the very nature of linear models, may lead to tremendous success.

(8) the nature of “step models” may lead the firm to assign the responsibility for each step to different managers or departments. Such behavior may be detrimental for performance, specially if it leads to fights where department and managers each try to get their point of view to prevail over the others.

(9) “step models” decrease the incentive of the firm to develop competence and to allocate resources to actions not included in the standard set of steps in the model. Such action may nevertheless be crucial to some projects’ success. If evolutions of the environment and contexts create new constraints or opportunities outside the “grid” provided by the predetermined set of innovation steps, then the firm may be much slower than competitors in perceiving them and learning how to address them in a proper fashion.
If a firm has a tradition of using a step model as the backbone for the management of innovation, constraints ensue on the possibilities a middle manager has if he wants to push for a personal innovative idea. He may of course bring it to the attention of higher levels where executives have the power to launch a standard sequence of steps, thus probably losing all control and influence on the idea. He may also try to develop informally on his own the part of the innovation he may be dealing with. Taking into account the severe limitations he has in terms of resource and competence at his level, this may lead to problems. He may also “strike an informal alliance” or “secure informal help” from colleagues with complementary resources and competence. This behavior amounts to gradually moving to an innovation process which differs from the “step model” (as we shall see in the next section).

To summarize, “step models” confine incentives for improvement to ideas centered on how each operator may improve his performance relative to the narrow step he is responsible for.

Beyond that, specializing people and managers on predetermined steps may lead the firm to have insufficient people (in numbers and competence) capable of having global ideas. “Step managers” promoted to project managers’ positions may be unduly biased by their former experience, and be myopic (if not blind) to the requirements of the other actions needed for innovation development.

The above remarks should not be taken to mean that “step models“ are inadequate. However a firm functioning with a “step model“ will not easily perceive the problems induced by its use of such a model, and will not easily realize that radically different innovation processes may be very effective. We present one of these in the next section.

5.3) Management constraints in Burgelman-type innovation processes

The second model of innovation process we shall present is the one identified by Burgelman (1980, 1988). This model comprizes three phases P1 to P3 below. The frontier between phases is rather fuzzy, and the nature of phases is substantially different from that of the “technical and functional“ steps in the Cooper and Kleinschmidt model.
P1 ("Definition" phase):
The innovation begins with an idea which emerges locally. During all of P1 the idea is dealt with locally and informally. There is no specific budget or personnel allocated to the innovation. Work is done as needs appear, by people who take the necessary time and resource from the regular work they continue to perform.66

During P1 there is a person, named the “intrapreneur”, who is at the same time the driving force of the project, the information node and the coordination center. He or she is generally the person who has had the idea. The intrapreneur may be rather directive, i.e. he defines what needs to be done, tries to elicit contributions and commitments from others, sees to it that promises are kept, takes decisions and arbitrates when incompatibilities or problems appear. The odds are, nevertheless, that the intrapreneur is at least partially participative, since he has neither all necessary competence, nor the hierarchical authority. Hence he has to take into account the others’ opinions, for contributors can withhold resources, information and help.

It cannot be said, however, that the intrapreneur and the people who help him are on their own. During all of P1, the intrapreneur is in frequent discussion with his or her superior, who helps him to identify the relevant contexts and frame the project with respect to them.67 The superior may even test informally the acceptability of the idea with experts, contacts and higher-up executives. Hence the project, while very free and fluid, is nevertheless done in partial coordination with the firm’s strategy.

All of P1 is devoted to exploring possibilities and constraints. The idea gradually matures as objectives get more focussed, potential clients are more precisely identified and technical options become clearer. The definition of the innovation may change several times during this period. Phase P1 stops when the definition of the innovation is sufficiently precise and viable.68 69

66 We may remark that all this time and these resources are “stolen” from regular work, but that they are nevertheless crucially useful for the development of innovation. It is a case where “organizational slack” is very productive.
67 These contacts with the superior exist from the early stages. The process normally begins when the intrapreneur tests his idea with the superior and gets the authorization to “try to see if there is something interesting there”.
68 It can be said that phase P1 is equivalent to all or part of Steps 1 to 5 of the Cooper and Kleischmidt model. The originality of the Burgelman model lies in the following aspects: (1) it mentions the intrapreneur with his multiple roles, and his superior overseeing the process; (2) it identifies successful innovations where P1 lasts several months, where in Cooper and Kleischmidt Steps 1 to 3 may not exceed a few days; (3) it shows that serious work may be done outside formal channels, outside hierarchical prescriptions, and without strong separation between specialized departments.
69 If we refer to the types of organization in Mintzberg (1979), we see that the type of organization which functions during phase P1 is a mix of the simple structure and of the adhocracy. Mintzberg’s theory may not
P2 ("Impetus" phase):

In the second phase the innovation is locally developed. Formal organization appears: budget, plans, part-time or full-time personnel, contributions formally required from various departments and possibly from outside organizations. The intrapreneur usually is the project manager.

Several characteristics present in P2 are original compared to “standard” innovation processes depicted above in classical “step models”:

1. the innovation is developed where it was born. This is true even if the nature of the innovative idea is such that another localization in the firm would be more logical from an organizational or strategic viewpoint. It is thought that the possible drawbacks are more than offset by the advantage coming from having committed people who have already acquired much knowledge. In other words, it seems that it is difficult to transplant such a project, “still in its infancy” and fragile, without risking killing it.

2. informal collaborations keep being solicited and obtained. The formal organization partially normalizes and coordinates a still existing informal organization.

3. as the project gains momentum, it needs to be defended. The superior therefore plays a crucial role in Phase 2, to give the impetus, fight opposition, get executives’ approval, mobilize support in departments outside the local organization, fight to get the investment committee’s approval.

4. beyond the “power activism” mentioned above, there continues to exist frequent informal exchanges between the intrapreneur and his superior, and between the latter and higher-up executives. This “informal management tool”, if we dare call it that, ensures that the innovation development remains reasonably in line with the firm’s strategy.

5. the formal organization and management tools applied to the innovation project may be the ones which are standard in the local organization. It may also be that they are tailored to the innovation’s specificities.

6. the definition of the innovation may still change in phase P2, although the “blueprint” obtained at the end of P1 is a strong guide.

In fact be the best to analyse this organisation, since the intrapreneur and the innovation deployment are severely dependent on the mix of other activities the contributors have to perform at the time of P1. It may well be that the garbage-can model developed by March is best suited. One clue to this is the fact that Smith and Zeithaml (1997) have shown the relevance of this very model for the first phase of sweeping internationalization movements launched by some of the “Baby Bell” companies. One can also link these results with Cheng and Van de Ven (1996), who established that the first half of the innovation process they studied was chaotic.
Phase P2 ends when at least a first viable version of the innovation is completely developed and on the market, with a beginning of regular sales and income.

P3 ("Integration" phase):
During Phase 3, the innovation is integrated to the regular functioning of the firm. It is submitted to industrialization, normalization of technical and marketing procedures as well as of control systems and financial evaluation.
The innovation may then be transplanted to a place in the organization where it “makes more sense” from a strategic and organizational point of view. Such change may take the form of a redefinition of the boundaries between the departments, divisions and subsidiaries of the firm. For this reason, top level executives play a crucial role in phase P3.

With the above description, we see some specificities in Burgelman-type innovation processes as compared to the elements common to all innovation processes, those we saw in section 5.1:
- the identification of relevant contexts and the framing of the innovation are made continuously during P1 and P2, by the intrapreneur, by the contributors he allows to participate, by the superior and higher-up executives. The same people ensure the coordination between the innovation and the rest of the firm, and the definition and mobilization of resources and competence.
- the coordination between the actions of the innovation process is organized by the intrapreneur in phase P1 (eventually with the participation of contributors), and in phase P2 by the intrapreneur and the formal systems.

From the above we can deduce management constraints on innovation in Burgelman-type innovation processes:
- the middle manager or operator who wants to push for an innovative idea has large openings. He must nevertheless be ready to commit himself intensely, to negotiate contributions from others, to show that his idea is in line with his superior's idea and/or with the firm's strategy.
- an executive who has an idea must be able to find an intrapreneur who has the will, the
capacity and the time to involve himself\textsuperscript{70}.

- Burgelman-type processes may over-select innovative ideas whose initial development
may be done with local forces. These may be limited by the local views and competence
local people have, and fail to produce ideas more relevant from an overall corporate
viewpoint. In other words, the fairly decentralized character of the innovation process may
lead to dispersion of creative efforts (Romelaer and Lambert, 2002).

- from an executive’s point of view, adopting Burgelman-type innovation processes
throughout the firm requires that a sufficient number of people down below be authorized
to propose their ideas and devote precious time and resources to exploring them. Likewise,
the selection between the emergent projects must be understood by intrapreneurs and felt
legitimate, otherwise innovative ideas will no longer be proposed.

- the performance in innovation development depends on the competence of intrapreneurs,
and on the trust and intensity of helping relationships. It may be that the people who have
ideas (and even very good ideas) do not have the necessary competence to carry them out.
It may also be that excessive attention to consensus drifts towards conformity and
“groupthink”.

- another deviation may plague Burgelman-type innovation processes. If the intrapreneur’s
superior feels or sees that the idea is not readily acceptable to higher level executives, he or
she may nevertheless proceed with the project in a clandestine manner, betting on the fact
that once he has demonstrated its usefulness and feasibility\textsuperscript{71}, top management will have to
adapt to it. Top managers would be wise to have dependable informants way down the
organization to be kept abreast of what really goes on.

- close to the preceding remark, the “right to initiative” granted to many people in the firm
should not lead to a widespread impression that all ideas are acceptable. This requires a
rather strong management of values, as well as resources devoted to continuing education
programs ensuring that would-be intrapreneurs can refrain from proposing too “wild“

\textsuperscript{70} As far as we know, Burgelman does not mention this possibility. His work emphasizes “initiatives from
below“. In our view however, nothing prevents an executive from entrusting a subordinate with the
development of an innovative idea he or she has had. Informal contacts in firms show us that this is even
rather frequent. The “deal” is frequently that an employee may be promoted to managerial ranks if he accepts
full charge of an innovation, and likewise for the promotion of middle-level managers or the identification of
managers as being “high-potential”. From an organization theory point of view, we recognize in
intrapreneurs the managers in Penrose (1959, 1995): as soon as they master their present assignment, they
decide to involve themselves in projects, and this “driving force” is the main factor contributing to the firm’s
development.

\textsuperscript{71} The French expression would be: “as soon as he has proved the movement by walking”. 
ideas. Beyond this, innovation is not the only work to be done in the firm, and hence close scrutiny should be given to guaranteeing that basic work continues to be done with adequate performance: selling present products and services to clients for example.\(^{72}\)

As a conclusion of this paragraph, we saw that any type of innovation process induces management constraints. Some are generic to all processes, others are specific to the two types of processes we presented.\(^{73}\)

The constraints linked to the innovation process may lead to more innovation than desired, may hamper innovation or, more generally, may influence the nature of innovation which will be developed in the firm. The conclusion here is the same as the one we arrived at in paragraphs 1 to 4 concerning the management constraints on innovation linked to the executive's position, to the type of organization or to the coordination systems.

All the models of innovation processes we have examined begin when there already exists an innovative idea. The origin of this idea is not explored, and neither are the management constraints which may influence the volume and the nature of the innovative ideas which are produced in a firm. This question will be dealt with in the next paragraph.

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\(^{72}\) As a final remark on Burgelman's processes, we note that the core of the model is incomplete on numerous elements. The contexts taken into account and the actions performed in Phase 1 are defined only in very general terms: do whatever is necessary to develop a workable innovation. The status of activities like strategic analysis, market studies and the use of finance tools is not as precise as in “step models”. Similarly, the Burgelman model often insists on innovation projects one at a time and pays relatively little attention to the relation between different innovations. Even if Phase 3 concerns organizational and strategic integration, we see for example Noda and Bower (1996) explain the development of portable phone in two Baby Bell companies without explicit references to the other innovations and strategic moves at the same time. The importance of these other developments is proved by the research Smith and Zeithaml carried out during the same period (1997) on the same companies: the latter research shows the great importance of resources and attention devoted to internationalization. This strategic move was undoubtedly balanced with the portable phone, but we do not see that appear strongly in Noda and Bower: they almost only mention internationalization aspects of the portable phone. The reason is presumably that researchers working with Burgelman's model gather data on a single innovation process, and have a natural tendency not to gather data on the complete context.

\(^{73}\) Discussion of Cooper and Kleinschmidt and the Burgelman model may be continued with still other models, for example that of Mintzberg, Raisinghani and Théoret (1976) or that of Nonaka (1990). We could also mention the innovation processes developed by Van de Ven et al. (1989) and the transposition to innovation of the model developed by Bahrami and Evans (1989) for strategic decisions. These two models actually have many similarities with the Burgelman model.
6) The origin of innovative ideas

As far as we are aware, all published management research on innovation begins when an innovative idea already exists. Van de Ven et al. (1989) place the beginning of their research interest at a “kick-off” point where active work on the innovation is launched. Yet, the innovations which will be developed in a firm strongly depend on the set of innovative ideas which appear and stay around in people’s minds and conversations. Thus management research should get interested into studying the origin of innovative ideas.

In our view, different organizational milieux, contexts and management practices have differing impacts on the number, quality and type of innovative ideas which people will have, will express and exchange. There are in each firm “production systems of innovative ideas“, even if for the most part they are informal, unconscious and difficult to analyze. As little empirical research has been published on this topic, we give in this paragraph some ideas on core elements these systems may include, without contending to present a firmly established, complete and coherent picture. The elements we found are listed in Figure 4 below.

6.1) Individual creativity

Innovative ideas may be seen as coming from the creative spontaneity of individuals. Paul Valéry (1894) had a naturalistic view of this creativity, based on the representation of the human mind (at least of Leonardo da Vinci’s mind) as being constantly busy varying and combining forms. Mintzberg's vision of creativity is romantic, centered on the leader who has instant “vision“ of an innovation or of a large scale strategic change, and who is capable of implementing it rapidly without any problem worth mentioning\(^7\).

\(^7\) See the cases of Edwin Land’s invention of Polaroid and of Steinberg’s instant strategic decision in Mintzberg (1994) See Romelaer (1995) for arguments against this representation of innovation.
### Figure 4: List of elements influencing the apparition of innovative ideas

<table>
<thead>
<tr>
<th>Individual creativity</th>
<th>Initial definition</th>
<th>Innovative personality, helps to individual creativity, production and survival of curious people in groups and organizations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>The case of the immediate innovative idea obtained by chance and complete at the outset</td>
<td>The social origin of the inventor's knowledge and information</td>
</tr>
<tr>
<td></td>
<td>The case of the innovative idea obtained by research and complete at the outset</td>
<td>The sources where the inventor may find knowledge and information during his or her quest</td>
</tr>
<tr>
<td></td>
<td>The case of the innovative idea incomplete at the outset</td>
<td>The sources where the inventor may find knowledge and information to complete his initial innovative idea</td>
</tr>
<tr>
<td>The individual will to innovate</td>
<td>Free will to innovate</td>
<td>One-shot innovative ideas</td>
</tr>
<tr>
<td></td>
<td>Constrained and influenced will to innovate</td>
<td>Permanent innovators</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lower-level innovation in daily life</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The motivation of deprived people</td>
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<td>Social pressures on innovations</td>
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<td>Confrontation with variety</td>
<td>External variety</td>
<td>Time spent with outside actors</td>
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<td>Partnerships, alliances, co-development</td>
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<td>Buying innovative firms or products, imitation or adaptation, diffusion</td>
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<td>Benchmarking, reverse engineering</td>
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<td>Internal variety</td>
<td>Brainstorming, participative decision-making and problem-solving</td>
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<td>Formal and informal groups, collaboration, conflict, diversity in work-groups, technology fairs, strategic conversations</td>
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<td>Knowledge bases, expert-systems</td>
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<td>Many human resource processes and methods</td>
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<td>Technology transfers</td>
<td>From inside or outside, by replication or with adaptation</td>
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<td>Military research, universities and firms</td>
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<td>Collective origin of innovation</td>
<td>Managed innovation, management tools</td>
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Some authors work on the domestication of creativity, supposedly possible in their view. Senge’s and De Bono’s writings are in this direction, and many techniques to enhance creativity as well as procedures to invent creative alternatives have been developed over the past fifty years, Gordon’s synectics for example. On average, people who have curiosity or who are constantly trying out new things have a better chance of having a new idea, and such people are very unequally produced and welcome in different firms, departments, nations, social groups. It is not by chance that innovative ideas come more often than not from so-called excentric people.

In line with the above, a widespread, albeit false, “folk theory” says that all innovation can be traced to the genius of an inventor, with two characteristics: (1) only one person is involved, and (2) the innovative idea appears in one shot to the mind of the genius, already complete when it is there. In our view, real processes through which innovative ideas appear are in most cases different.

Some innovative ideas do indeed appear as a (whether sudden or otherwise) synthesis of an astounding number of elements which may all be in the mind of a single person. Even if only one person is involved, it is impossible to understand creativity without asking oneself such questions as: (1) where do these elements come from, (2) how were they gathered, (3) what is the “starting point” for the search for an innovative idea, and (4) what forces drive the individual to develop the will to engage in this activity. The answer to these four questions provides interesting clues to the origin of innovative ideas.

Let us suppose first that the innovative idea comes to a single person's mind. Then the elements which are in his or her mind are the product of his or her past activity. Many of them come from personal observations, experiments, trial and error, but also from

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75 We only mention here methods which may be used to enhance individual creativity. Brainstorming is probably a better known creativity method. The fact that it is fundamentally a collective method leads us to present it later, in the part devoted to the origin of innovative ideas based on confrontation with variety.

76 Individuals with high curiosity spend more time than others asking themselves “Why is this as it is? Could it be different? What else could this be used for?”. People who constantly try out new things devote more time than others to acting differently from yesterday or from required or usual behavior. It seems that most firms and social groups, probably because they need some stability, rarely welcome wholeheartedly such behavior, and that they often get rid of these people, normalize them, or isolate them in special units. R&D departments are a case in point, and even in R&D most people are often expected to “do research in normal ways”. Another example is the group of so-called “wild ducks” IBM had in the 80s: a group of people allowed complete freedom and originality, albeit very isolated from the mainstream organization and culture. To conclude this remark, it is not by chance that the questions mentioned above, even if a mundane expression of curiosity, are the crux of Aristotle’s “philosophical astonishment”. There is a lot of proximity
scientific traditions, business and professional communities, chance encounters, professional publications, discussions with peers, clients, friends, neighbours. Social links and embeddedness of the individual is then a crucial element in the formation of the knowledge of the individual who has the idea. This knowledge is more often than not made up of a myriad of partly connected “bits of knowledge and information”, collected through processes unconnected to innovation (doing one's work, living one's life), and, simply by chance, producing a set of “knowledge bits” which at some point in time “click together” into an innovative idea. Indeed stories abound of such “chance discoveries”.

The innovative idea may also come to the mind of an individual after he or she has been “searching for something” for weeks, months or even years. A biography mentions that Newton declared that he invented gravitation theory because he thought about it all the time. Such “researcher attitude” produces ideas which partly depend on the knowledge the innovator may gather from social and organizational links. Hence again the importance of embeddedness of the individual.

Even when an individual has a fairly precise innovative idea, the first version of it must be tested, then proves faulty or incomplete with respect to objectives, ridden with scientific and practical problems. Much work remains to be done to straighten out these problems. Proved possibilities, possibilities caught in a glimpse or intuitively guessed, and objectives pursued all may change many times in the course of the generation process of the innovative idea. Dozens of partly independent alternatives may exist at any point in time for each of the myriad aspects of the idea. This process may take place in a few hours or be spread over years. It may be done by a single person or involve many individuals in many organizations.

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77 This view is in line with the one developed by WvO Quine (1964).
78 It is commonly said that an apple falling on his head led Newton to suddenly invent gravitation theory through a sudden stroke of genius. This mythic version of the story reveals the popular tendency to associate innovative ideas with instant individual ideas.
79 In such cases it may be said that “chance favors the prepared mind”, as the saying goes.
80 Because of the sometimes enormous work involved in “getting a prepared mind” as well as in testing and modifying the initial imperfect idea, it results that the statement “Science is 1% of inspiration and 99% of perspiration”, made by Thomas Edison, makes plenty of sense.
81 Edwin Land developed his invention of Polaroid in less than an hour. It took him then more than six hours to write down what he had “seen” during this completely exalted creative phase. See this in Mintzberg (1994).
Other scientific laws exist concerning innovative ideas produced by people who are searching for something. The probability of several people come up with the same idea depends on the similarity of their knowledge, objectives and methods. The probability is much higher when there exists a densely connected set of individuals searching in the same area who exchange ideas, i.e. who depend on each other in the formation of their knowledge. The probability is then also higher that they get comparable objectives, use similar search heuristics, and get similar spontaneous glimpses about possible ideas to work on.

Hence it is not at all by chance that some innovative ideas get to be “in the air” in such settings. Examples exist concerning scientific ideas: “scientific schools of thought” sharing the same paradigm (Kuhn, 1962; Bourdieu, 2001) as well as more informal groups like “the Viennese School” in philosophy, “the Copenhagen Group” in physics, and the alumni of the Ecole Normale Supérieure in France.

At least six examples are of practical importance for innovative ideas usable in firms: professional and business communities, communities of practice, industrial districts and networks of firms, organized “clubs” or networks associating firms and research labs, and “innovative regions” like the Silicon Valley (initially through Stanford, Berkeley and defense industries), Road 128 (with MIT, Harvard and the East Coast industry) or the Edinburgh area at the end of the 50s (Burns and Stalker, 1961).

In social settings as above, any single innovator is so dependent on the ideas and results produced by others that, even if the innovative idea may be traced to one person, it may still be said that the idea is a collective product and that the idea would inevitably have been produced by someone. The innovator is just the first who got it.

To summarize, we have seen in the present section that innovative ideas are probably never the product of a single inventor’s mind. Many other people, groups and organizations are necessary for a workable innovative idea to emerge. Concerning innovative ideas mainly produced by one individual, another question is why this individual has the will to have innovative ideas. We turn to this question below.

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82 The “Phase 1” in Burgelman-type innovation processes has a structure very similar to this “initial innovative idea exploration”. Observation in work-place settings shows it may last several years.

83 A community of practice is a group of people who exchange on their practice. Some of these groups are formal (as in the Air Liquide case we saw in Paragraph 2), others are informal (as in the case of Orr’s groups of photocopiers repair technicians we saw in Paragraph 2).
6.2) The will to innovate

Individual creativity is not enough. Apart from chance innovation, it is necessary for some individual to have the will to innovate. Above, we linked the individual innovative ideas to the social milieux. This should not lead us to downplay the importance of the individual will to innovate. This will may be free or constrained as seen below.

**Free will to innovate**

Some individuals devote decades of hard work trying to develop an innovation. We mentioned above the case of Isaac Newton. Another legendary example is the one of Bernard Palissy, who almost ruined himself inventing enamel, going as far as burning his furniture to make the test which finally succeeded. Most innovations in firms are assuredly less heroic, but there nevertheless exist individuals who, for the sake of an innovation, devote a lot of energy and accept to confront unbelief and opposition.  

Opposition to innovative ideas is probably more the rule than the exception, and it would be a mistake to oppose “the good innovator“ to the “nasty, incompetent, conservative“ people opposing the idea. Opposition to an innovation may be quite understandable and rational: some people may fight it because it is outside their understanding and values, others because it would endanger their power position or diminish their revenue, still others because they feel it is too risky for the firm or undesirable from a strategic viewpoint. And it must be admitted that the innovative idea in its infancy is often imprecise if not false. Chalmers (1976) gives several examples of scientific discoveries whose initial “proofs“ were erroneous or almost inexistent. Closer to management, consider the CAPM (Capital Asset Pring Model), a management tool widely used by brokers, capital asset firms and finance departments. The model was invented by Sharpe and Markowitz, who were awarded the 1990 Nobel Prize of Economics for it. The invention was made in two steps. Sharpe considerably extended the initial model developed by Markowitz in his PhD research. This initial model considered the case of a market with only two securities. Indeed some members of Markowitz’ dissertation

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84 Dougherty and Hardy (1996), after studying 40 innovations pushed by low level individuals in firms belonging to mature industries, conclude that the innovations were achieved in spite of the firm, through
committee expressed disbelief, and among them Milton Friedman (another Nobel Prize winner), who told that Markowitz' work should not be awarded a PhD in Economics since portfolio theory was not Economics, and not even Maths or Management Research.

Aside from the case of individuals whose will to innovate is centered for months or years around the same “innovation area”, one also finds “permanent innovators”, i.e. people who seem to be “innovation machines” having new ideas almost every day. We mentioned in paragraph 1.2. the CEO of a cardiac stimulators company with such behavior. Other examples of the kind may be mentioned. In a large high-tech group (more than 10,000 employees, active worldwide), the head of one of the three main research labs told us: “Among the around 200 people in the lab, 90% of the ideas come from the same three or four individuals”. Jonathan West, who studied innovation in semi-conductor firms, mentioned to us in conversation that in some of the groups he studied, each with more than 10,000 employees, innovation was completely managed by a group of at most forty people, implying that all innovative ideas came from a subset of this groups, admittedly a dismal percentage of the workforce where each individual has a tremendous importance for the firm.

We also find, at all levels of the hierarchy, baseline operators as well as middle managers and professionals who individually have innovative ideas and the will to try them out. Although apparently more modest in scope, these innovative ideas in daily life have recently been identified as crucial to firm’s success, for example in knowledge management and in the accumulation of marginal innovations initiated by Japanese firms.

Before coming to a close on innovative ideas generated by free willing individuals, it may be warranted to ask ourselves if there exist forces other than competence that lead them to develop a strong will to have innovative ideas and to develop them.

Individuals fighting against their own organization. Let us add to it that the innovator is often considered irrational by the people around him (Romelaer and Lambert, 2002).

The story is reported in Bernstein (1992). I owe this story to Pierre Batteau.

When dealing with the link between competence and innovation in paragraph 5.1, we mentioned that it is unclear whether individuals will have more innovative ideas if they have more competence. We saw that lack of competence of the innovator may be an advantage as its drawbacks can be palliated. Hence we shall not explore here the link between competence and the will individuals have to innovate.
Among many possibilities, such seems to be the case for people whose talents and contributions cannot be recognized in the organization or in the society. Upward mobility may leave people who have not acquired the “good degrees” in their twenties on the side of the road. People who are in this situation and have talent may be deprived of any chance of promotion in the firm or in society at large, and see investing themselves in innovation as a way of gaining recognition. Alter (1990) mentions this possibility about the “semi-clandestine innovators” he observed: most of them seem to have been people whose career was blocked for a variety of reasons.\textsuperscript{87}

As we saw above, the will to innovate may thus be extremely strong, or just be ordinary, concerning marginal innovations in daily work life. No research has been carried out, as far as we know, on the mechanisms through which an individual is led to develop such will\textsuperscript{88}, or on the processes through which people who want to innovate can survive in a given country at a given time, and likewise in an industry or in a firm. We shall simply call for more research on this topic and leave this aspect of the question.

**The constrained or influenced will to innovate**

Aside from free will to innovate, we find people who have the will to innovate because they are forced to do so, or because they are constrained to a degree which can go from strong to mild pressure. We find this in at least three settings:

1) the pragmatic inventions of necessity identified by March,
2) the social pressure to innovate exerted on the individual by social milieux to which they belong\textsuperscript{89},
3) the management constraints, indeed all constraints identified in paragraphs 1 to 5.

There is a degree of truth in the saying that people have innovative ideas when they meet a problem and have no known solution (“necessity is the mother of invention”). These are

\textsuperscript{87} In this line it may be interesting to know whether member of disadvantaged minorities, most recent migrants for example, have more innovative ideas and will than people in the population at large. From a more macro-perspective, it may also be of interest to know whether, all other things being equal, countries see more innovations when the proportion of disadvantaged minorities in their population is greater. It is however probably difficult to compare countries with the condition that “all other things are equal”.

\textsuperscript{88} Such will is probably linked to motivation structure, socialization, contextual incentives and personality.

\textsuperscript{89} The social pressure exerted on the individual by social milieux external to them will be seen later, when we deal with “confrontation with variety”.
March's "pragmatic inventions of necessity". Innovation and change may thus be triggered by declining performance, unexpected difficulties and unbearable situations.

In most cases however, conduct other than innovation may exist to deal with the problem. If his superior asks him to do the same work as before with 10% less budget or get fired, an individual will presumably feel a strong pressure to find new ways of getting the work done. But he can also try to get transferred to another department, find employment elsewhere, mobilize the union, and still other alternatives exist (some of which unethical or illegal).

Most pressure to innovate is not as strong as above. It is sometimes simply better if the individual has innovative ideas in some area: fixing a bug in a computer program or developing a package which is more agreeable to clients may just be two among dozens of elements that are recommended. And aside from such "pressure to innovate" the individual may have strong pressure to perform non innovative tasks: selling products to clients, processing orders in the plant, etc. In such circumstances, the pressure to have innovative ideas is unclear, and the amount of pressure felt will probably depend on the individual's subjective assessment.

Organization members obviously also have innovative ideas even when not explicitly asked for, to simplify the work for example. James Watt invented the automatic regulator for the steam engine because he found that keeping close to the machine and regulating it manually was tiring. Talent and genius set aside, it is doubtful that everyone placed in the same position would feel similarly induced to have innovative ideas. Apart from strong orders to innovate, the pressure to have innovative ideas is partly in the mind of the individual.

Since meeting problems and recognizing opportunities may be a source of innovative ideas, it may be useful to say a few words on the origin of these problems and opportunities. They can generally speaking be identified as unexpected or unavoidable "dissonances between systems", among which several classical categories have been identified:

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90 They may naturally also innovate by spontaneous will to innovate and creativity.
the unintended consequences of action, coming from insufficient knowledge of the laws of functioning of relevant contextual systems. These are seen as the one major organizational phenomenon by Crozier and Friedberg (1980).

- the inevitable existence of contradictions between different internal and/or external systems. For example we mentioned in paragraph 4 the existence of eleven "coordination systems" in each organization, and among them we detailed a number of regulated systems. The least that can be said is that all these systems are not compatible with each other all the time. Problems of compatibility may trigger innovative ideas.

- problems and opportunities naturally also appear with unexpected events: changing clients’ tastes, economic ups and downs, innovations made by competitors, etc.

Aside from the pragmatic inventions of necessity, the will to have innovative ideas and try them out may come to an individual because of the pressure of one or several of the social milieux he belongs to.

Some social pressures may be more “positive“ than the constraints examined in the preceding section: an individual will feel pressure to have ideas if he works in a marketing department of L'Oréal where everyone is trying new things all the time and those who don't "do not belong". Any type of organizational unit may likewise pressure its members into having innovative ideas, because of the combined effect of leadership, organizational structure and workforce composition.

The same may be true in informal groups and networks. Among Alter's observations on "semi-clandestine innovators", one finds some groups of friends intensely interacting to develop micro-computer applications through informal collaborations and “bricolage“ (trial and error), although these tasks were not among their formal assignments. Here

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91 See these systems in the part of paragraph 5.1 devoted to the framing and context constraint on innovation. The lack of knowledge may come from insufficient efforts and competence in gathering information about the contexts. It may also come from the complexity of the required knowledge, excessive compared to the cognitive capacities in the firm.

92 We saw above the importance of social connections and social milieux as information and knowledge sources important for the generation of innovative ideas by individuals. What we see here is the pressure to innovate (or not to innovate, or to innovate in specific directions) these social milieux exert on the individual.

93 The constraints on innovation coming from these social milieux should normally be treated with the management constraints coming from the coordination systems, specifically the coordination systems n°7 and n°8 in the list we presented at the beginning of paragraph 4. Lack of space has led us not to present them. What we shall do here is limited to a brief presentation of the “geography of relevant social systems", with some clues about the possible constraints they exert on the generation of innovative ideas.
again, individuals in the group may feel the pressure to have innovative ideas for fear of not belonging any more.

Besides organizational units and informal groups, many social and organizational milieux may exert pressure on their members to have innovative ideas:

- some are temporary or part-time formal groups of the firm: committees to improve information systems, task-forces to manage the reorganization following a merger,
- some are external to the firm: family, kinship and ethnic groups, technical leisure groups, religious groups,
- some may both include members of the firm and outside persons: alumni, professional communities, ethnic and religious groups again,
- some are large:
  - the atmosphere is innovative in the Silicon Valley and in the other innovative connected milieux we saw in section 6.1. Those organizational and social milieux are not only information and knowledge “baths” which facilitate individual creativity. They also exert a pressure on the people who live there, if only to permit the individual not to feel different from the people he meets everyday, at work as in his social life.
  - an executive in the cement industry may feel pressure to have innovative ideas if he is in an established firm and sees new firms which innovations may destabilize the industry (Dumez and Jeunemaître, 1996).
  - even larger size, we find ideologies which are widespread in some countries at some periods of their history. Change is a high prized value in most OECD countries, and an individual who lives in such a country where everyone asks “What's new?” probably will feel pressure to have innovative ideas and actions.\textsuperscript{94}

Although we only mentioned groups and networks which value members having innovative ideas, it should be mentioned that other groups may undermine and exclude people having innovative ideas in general (the label “conservative” applies to them), and still others may be selective in this respect, for example when religious groups socially punish members having ideas contrary to their principles. Galileo is a case in point.

\textsuperscript{94} Ideologies like the Enlightenment in the 18th century and the ideology of Progress in the 19th probably exerted pressure to have innovative ideas on their contemporaries.
6.3) “Confrontation with variety“ as an origin of innovative ideas

Innovative ideas do not come only from individual creativity, be it spontaneous or constrained. They also come from what we shall name “confrontation with variety“, i.e. encounter with people and organizations which have different views, objectives and/or knowledge. We shall give some examples below, concerning sources of variety which are first outside the firm, and then inside it.

Confrontation with external variety

Beyond innovative ideas produced by its members, a firm may find or buy ready-made innovative ideas in its numerous environments. The sources they may come from are the same as seen above: suppliers, consultants, professional press, ethnic groups or alumni, etc. Several examples are presented below:

1) time spent with professional associations, clients, foreign firms and unusual organizations may give innovative ideas. Thus, as Leonard-Barton (1992) observed in Chapparal Steel, organizing visits of workers on clients' sites to see how they use the firm's products may help them to have improvement ideas more in line with clients' needs. Likewise, Gouesmel (1996) observed that R&D team members continue to exchange with the colleagues and researchers they met in the lab where they did their doctoral research, and we mentioned in paragraph 3.2 that researchers in biotechnology discuss freely with friends in their professional community, even when they work for competitors.

2) partnerships and alliances (Blanchot, 1997; Doz and Hamel, 1999), co-development with clients or suppliers (Nonaka, 1990; Von Hippel, 1977, 1986),

3) buying innovative firms also provides a means for innovative ideas, as well as buying products or services which are new to the acquiring firm, or simply adopting free of charge modes of functioning which are in use in other companies.

It is of course not by chance that the production of “something new“ by the confrontation of “two different things“ is close to Aristotle’s dialectical method.

Namely those we mentioned in paragraph 6.1 when dealing with the origin of the innovator's knowledge, and the groups we listed in 6.2 on the social pressures on innovation.

Keeping informed with relevant outside people and organizations was already seen as crucial by Lawrence and Lorsch (1967). The importance of outside connections is linked to the social embeddedness of members of the firms (notably executives and managers, but not only them) in Granovetter's theory (Granovetter and McGuire, 1998), and in the importance of “encounters” in Giddens (on this see Giddens, 1986; Autissier and Wacheux, 2000, Romelaer, 2000). As an example of this importance, the largest acquisition General Electric
Buying innovative firms is sometimes a practice of large established groups which think that their internal organization cannot compete with the creativity of small entrepreneurial structures. They even consider such acquisitions as being rather secure since the acquired targets have proven viability. The origin of innovative ideas is then in the market of small innovative businesses potentially for sale.

As an example of imitation of a mode of functioning, we can mention the Italian automobile parts producer Magneti-Marelli, which after several unsuccessful attempts to find an organization to its taste, decided to directly copy Motorola's structure (Cenciarini, 1997).

In fact, such acquisitions of outside firms, products, services or mode of organization may be done in many different ways. The purchase may be done for the sole purpose of patents, products or concepts contained in the acquired firm. But the acquisition may also be done with the purpose of total integration in the group, with the objective of using the new organizational unit to dynamize the innovative spirit of the whole group. Such acquisitions are not devoid of risk: key personnel may leave rapidly, taking with them the explicit and tacit knowledge without which the newly acquired unit is left with scant value. And even if no one leaves, there is no guarantee that the regular organization of the group will not reject the transplant.

Similarly, an innovative product or technique may be bought “off the shelf”; i.e. as it is, according to directions given by the supplier, with no modification. In this first case, the innovative idea is just picked on the market. But the acquired product or technique may also be used after (maybe substantial) modifications performed to adapt it to the buyer’s needs and to integrate it to the organization. This latter case is labeled “Not Reinvented Here“ by Leonard Barton (1991). In such a case, the firm’s needs and organization may even be modified by the arrival of the outside innovative idea. The origin of the innovative idea is a joint product of the market and of the firm.

When a product, a technique or a mode of organization is gradually bought or adopted by an increasing number of firms, we say it is diffused. We saw such diffusion processes in the strategic mimetism in the cement industry (Dumez and Jeunemaître, 1996). The existence of diffusion processes has also been established in various settings such as divisionalized structures or machine-tools (Ventakraman and Koh, 1994; Burns and Wholey, 1993).

made when Reg Jones was CEO consisted in buying a firm whose CEO was a member of GE's board, hence a person regularly met by GE management (Mintzberg, 1994).
In what precedes, the origin of innovative ideas lies in the market, as well as in the social networks linking firm's members to the market (it also partly is in the firm when the outside idea is subsequently transformed by the firm).

With a management technique like benchmarking\(^98\), the origin of the innovative idea resembles the above when the firm compares itself with competitors. But benchmarking may also be practiced internally. For example a sales region may compare its sales performance and methods with that of the other sales regions in the firm\(^99\).

As in the buying of outside innovations seen above, the information gathered through benchmarking may be used for imitation purposes (choose the best and implement it) or as a source of inspiration (consider all solutions implemented and results obtained elsewhere, and build your own best solution from these “elementary bricks”). In benchmarking, the origin of the innovative idea is in the “comparison set”, i.e. the set of inside and/or outside situations on which dependable data could be obtained. The origin is also partly in the firm if the gathering of data is followed by an internal invention of the final solution.

To finish on the origin of innovative ideas coming at least partly from outside sources, we shall mention “reverse engineering”, a method whereby a new product just issued by a competitor is bought, and a team is asked to dismantle it, and to reconstitute the design and the production process from the observation of what the competitor has produced. Here again the origin of the innovative ideas comes from outside and inside the firm. Reverse engineering is currently practiced by automobile producers.

**Confrontation with internal variety**

Confrontation with variety is also a source of innovative ideas, when contacts within the firm produce the dissonance and surprise leading to new ideas. There exist numerous methods and behavior which have that effect, even if that is not necessarily their objective:

\(^98\) Benchmarking consists in comparing something done in a unit of the firm with what is done and achieved elsewhere. Benchmarking may be done for any product, product part or process. The comparison is systematic in terms of result (performance of the product part made by competitors or by other plants) and process (how do the others attain such performance). To be more precise, the comparison is as systematic as possible within the limits imposed by the time and resources allocated, the sources of possible comparison known to the firm's members, and the quality of the data gathered. In each of these domains the limitations may be quite severe.
- brainstorming, participative decision-making and problem-solving (see Romelaer [1997] on the last point).
- relations between formal and informal groups in the organization\textsuperscript{100}, informal collaboration between groups, conflicts in the power system, pluri-functional project groups, strategic conversations, technology fairs\textsuperscript{101}, solution generation through work-groups whose members are chosen from different countries, functions, hierarchical levels, etc\textsuperscript{102}.
- some management tools and regulated systems induce innovative ideas as seen in paragraph 4. There we gave examples such as interactive control systems and ambitious productivity objectives.
- maintaining organizational variety. It was seen above that incompatibilities between pairs of organization units and systems produce problems, and that problems may be the source of innovative ideas. Hence maintaining sufficient organizational variety (albeit not too much of course) is a potential origin of innovative ideas. As an example we can mention the (possibly conscious) maintenance of competition between divisions in a group.
- knowledge bases and expert-systems play a double role in terms of variety. First they provide each agent using them with knowledge produced by colleagues who have styles and knowledge different from theirs and work in different situations. Second, when they are created and updated by “knowledge suppliers” who discuss with each other, they are then a source of confrontation of variety\textsuperscript{103}.

\textsuperscript{99} Benchmarking may also use a mixed approach where both internal and external comparisons are done. 
\textsuperscript{100} See in Romelaer (2002a, b) a list or these groups with some examples. Since the relation between groups is a potential locus of innovative ideas, the result is that people belonging at the same time to several groups potentially play an important role in the generation of innovative ideas. To our knowledge, Jamous (1969) was the first to identify their existence. He named them the “marginal-secants“. Crozier and Friedberg (1980) fully take into account the existence of marginal-secants in their organization theory. 
\textsuperscript{101} We saw in paragraph 3.2 those organized by Bell & Howell. 
\textsuperscript{102} Concerning this latter point, a partial confirmation comes from the strong correlation (.35) empirically established by Dean and Sharfman (1996) between the performance of strategic decisions and the “complete character“ of the decision processes. Among the indicators used to measure the latter dimension, one has the number of functions, hierarchical levels and more generally of people involved. In fact, Dean and Sharfman call this variable “the degree of procedural rationality“, although no procedure or heuristic is present. See our definition of procedural rationality, obviously linked to Simon’s, in Romelaer and Lambert (2002). 
\textsuperscript{103} Knowledge bases also often contain syntheses of outside knowledge. Using them thus economizes on search costs for outside knowledge. This advantage does not come without cost however. The better the bases are, the less firm’s members are induced to continue developing personal links and ties with precious informants. A comparable drawback comes with the use of expert-systems: (1) their objective is to permit the firm to use less educated (hence less expensive) people; (2) but moderately educated people using expert-systems have a tendency to use them rather “blindly“, without thinking any more of possible improvements, and due to the expert system the number of experts in the firm decreases dramatically; (3) the result is that using expert-systems may in the long run seriously decimate progress and innovation capacity.
- many processes linked to human resource management may also provide the firm with increased variety and hence innovative ideas: the arrival of new managers and executives, recruitments\textsuperscript{104}, the maintenance or increase of variety in workforce composition\textsuperscript{105}, mobility and transfers\textsuperscript{106}, developing a critical mass of professionals. The new recruit or transferee will induce innovative ideas directly or indirectly, through his actions, through others' reactions or through collaboration. The effect will exist only if there is sufficient welcome by the organization.

**Technology transfers**

Technology transfer is also a possible origin of innovative ideas. We shall mention it separately because of its multi-faceted character:
- it can be done between firms, but also inside the firm between different plants, commercial regions or other units.
- as in the case of innovations bought from outside, technology transfer may be seen as pure replication or as an opportunity to learn.
- some empirical studies show that technology transfer may be very complex (Galbraith, 1990). Although "replication" is far from being simply the mere "repeated application of a simple recipe", careful experimentation and strategic framing allow to perform it (Winter and Szulanski, 1999, 2001). Marcus (1988) has established that the absorption of outside innovation is more effectively done by rather decentralized organizations.
- technology transfer includes large-scale phenomena like civilian use of military research and links between business firms and universities. It is not by chance that the Silicon Valley developed in an area where there are defense industries and universities like Stanford and Berkeley. It is not by chance that a wealth of innovation followed the Second World War as well as the Gulf War. Diffusion of technologies may be helped by organized programs initiated and funded by various authorities (Brussels, regional governments, industry associations). But diffusion of technologies may also be a quite spontaneous phenomenon.

\textsuperscript{104} Especially for the recruitment of creative or high level people, or simply of people who in a sense “do not fit”, like the recruitment of a management control specialist in a simple structure.

\textsuperscript{105} Baron and Krep (1999) discuss the importance of this factor at length. The generic term “workforce composition” includes important special cases like variety in the top management group. Much research has been done on this latter case.
The expression “technology transfer” should be taken with precaution. It surely does not mean in general that a technology is “transported from one place to another without change”. What frequently happens is that the technology developed by “the sender” (1) is in part impossible to transmit because the knowledge is too tacit or “sticky” (Von Hippel, 1994); (2) is in part used faithfully by “the receiver”; (3) is in part bent by “the receiver” to his own needs and as a function of his previous knowledge and practices. Hence what we have is often a “transfer with transformation”\textsuperscript{107}.

The existence of such circulation of innovative ideas with transformations has an importance for several reasons. One of them goes as follows: through successive transformations, one can witness the apparition of one innovative idea which is much more the compound product of the successive transformations than the original product of the last person who expressed the idea. Such a representation induces us to think that “intellectual property” of innovative ideas should be much less individual than it is in most national laws: much of any discovery comes from the community and should benefit the community.

\textit{6.4) Innovative ideas which have a collective origin}

The origin of innovative ideas does not come solely from individual will to innovate, let it be spontaneous or constrained.

As seen above, even for individual innovative ideas, the origin cannot really be said to reside only in the individual:

- knowledge the individual has when the idea comes depends partly on social networks and sources, and the same is true concerning knowledge searched for and help enlisted before and after the initial idea arrives.

- in innovative milieux, the innovative idea, even if expressed by an individual, is more than anything else a collective idea (since the probability is high that, had the individual in question not found it, the idea would have been found by someone else).

\textsuperscript{106} Mobility and transfers are specially effective to create variety when they result in transferring people between divisions, countries, regions, product groups or functional groups which have different cultures, traditions and organization.
Innovative ideas also come from the deliberate use of organizational and managerial tools we saw in paragraphs 1 to 5. We also mentioned in sections 6.1 to 6.3 above many other management tools and techniques which can encourage innovative ideas: brainstorming and reverse engineering, benchmarking and productivity objectives, buying outside innovations with or without modifications, internal and external technology transfers, etc. In almost all cases, management tools produce partly collective ideas since many people from different inside and outside units are called on to contribute to parts of the “final idea”.

Beside what precedes, all natural phenomena identified in sections 6.1 to 6.3 above, may serve as inspiration sources for the management of innovation, and thus enlarge the set of possible sources of innovative ideas. As a first example, we may mention the study by Ancona and Caldwell (1992) on the roles of project managers. Since the research has identified the roles most often present in successful innovation projects, a firm may consciously try to reinforce these roles and try to limit the roles which the research proved to be associated with failure.

As a second example, we shall take the probably most elusive source of innovative ideas, i.e. the social networks where potential innovators may find knowledge and help. The link between social networks and innovation, once recognized by research, may be used as a management tool. In fact it was used more than hundred years ago at the birth of the electricity industry in the US: infiltrating journals, professional associations and decision committees, operating through cohesive informal groups, trying to influence technical standards, getting alliances with political leaders, elected officials and regional authorities, all these methods were apparently very consciously and effectively used at the time of Edison, with such non-obvious effects as seeing “the market” finally adopt technical solutions pushed for by a group, although the solution is not the most economical (Granovetter and McGuire, 1998).

The collective nature of innovative ideas also appears when a firm, informally or conciously, tries to use the complementarity between people.

\[\textit{Callon (1988) has tried to capture this idea by using the term “translation”. This appellation is equally misleading: the translator of a text normally tries to be faithful to the meaning of the author, while in the circulation of innovative ideas the receiver is opportunistic.}\]
This complementarity was observed at least thirty years ago in R&D project groups. New ideas come from the collaboration between people who spontaneously “specialize” in different roles: those who have ideas, those who can test the feasibility of ideas, those who have an extended knowledge of specific areas of the professional literature, those who are experts on equipment.

The technique used some years ago by Asahi Chemical is obviously linked to the same phenomenon: top management of the company first assembled a group of young high-potential managers, and asked them to produce collectively a list of innovative ideas, with the additional demand that they behave as freely and imaginatively as possible, not limiting themselves in any way to check whether their ideas were technically feasible or potentially interesting from a business point of view. After this first group had completed their work, top management then assembled a group of more seasoned executives to produce a selection of reasonably feasible and promising ideas, selecting from the first list and beginning to identify parts of them and modifications of them which may warrant more attention. Several years after this operation took place, top management indicated that 80% of the innovations launched by the firm could be traced back to this initial starting point (see this, and other participative innovation and change management techniques, in Romelaer, 1997).

Individual and collective creativity are profoundly intertwined questions, whose mutual links are still unclear for management research.

On the one hand, it may be said that collective creativity and innovativeness is greater if more innovative ideas come to the mind of more numerous members of the firm, if the organizational structure and atmosphere allow these ideas to circulate, be confronted, combined, improved, and implemented. It looks certain that much innovation can be traced to collective work in R&D departments and in multi-functional project-teams, to decentralized management initiatives and worker participation, to the opening up of the firm to numerous and varied outside contacts. We mentioned above numerous such examples from empirical management research. Even researchers like Jelinek and Schonhooven (1993), while they emphasize strong-willed management of innovation based on hierarchy and constant planning, also mention the crucial importance of communication flexibility and access to resources and information through personal networks. In this first view, innovation is at least partially collective.
But on the other hand, it may be also said that the creativity and innovativeness of the firm is greater if very few innovative ideas are selected, and their development pursued with determination under strong centralized guidance enlightened by efficient formal information and control systems. Examples abound of major innovations whose development may be credited to a single person: the Polaroid™ camera by Edwin Land, the worldwide global parcel delivery system by UPS™, Bic™ by Marcel Bich, BusinessObjects™ by Bernard Liautaud and Denis Payre, to name but a few\textsuperscript{108}. Present management research results hence lead us to admit both individual and collective innovations exist and may be effective.

We end here our presentation on the possible sources of innovative ideas. In our view, it is sufficient to show that ideas do not come in a completely “random” way. Many processes influence and constrain the nature and volume of innovative ideas which may appear in a firm or in a unit.

Our presentation on the sources of innovative ideas is not complete. For example we do not present the role of the “organizational places where ideas can be expressed and circulate”. Confrontation of ideas, of knowledge, solutions and problems happen in these places, which often lead to innovative ideas through transformation, selection, variation and retention processes.

7) The usefulness of management constraints

The word “constraint“ has a negative connotation in our culture. It sounds like “restricting freedom“, and freedom is a very positively prized value. The connotation is even worse when restrictions apply to innovation because innovation is a highly valued activity in OECD countries, and because new products and new technologies are an important fuel for the growth of the firm and for economic development.

\textsuperscript{108} It should be noted that the last two innovations were not actually invented, but simply developed, by the people commonly credited for them. In each case they bought the invention from someone else. Hence invention (an innovative idea, with some possibly modest implementation like a tested prototype which has the required functionalities) should carefully be distinguished from innovation (an innovative idea whose implementation is much more complete, for example a product which has been sold for several months on the market, way beyond mere market testing). Transforming an invention into an innovation is the core task of innovation management, with all the management techniques and constraints we mentioned in the present paper. On the important distinction between invention and innovation, see also Alter (2000). Alter, maybe because he is a sociologist, would not accept the definition of innovation proposed above. He recognizes an innovation only when a product or a technique is widely adopted by the market.
With this, any “management constraint on innovation” may easily sound undesirable by nature. The objective of this short section is to show that such is not the case: some management constraints are useful, and for a great proportion of them the question need not even be asked because they are simply unavoidable (we may regret that gravitation and air resistance are constraints when we want to make a plane fly, but we have to live with them).

The management constraints we identified do not only impair innovation. They are also means through which individual actions may converge toward a collective realization. Most of them are the manifestation of the partial autonomy of various very useful “systems“. We have seen many such systems in paragraphs 1 to 6. Under general abstract headings such as “types of organization“, “coordination systems“, “regulated systems“, and “innovation processes“, we examined various empirical realities such as centralized small firms, professional large firms, professional milieux and their stars, planning and control system, productivity objectives, step-by-step innovation management, progressive fluid innovation management and intrapreneurs, benchmarking, individual and collective creativity, and many more. Some of the constraints thus identified actually push for more innovation, some others modify the type of innovation a firm is led to develop. Still others of course play against some or all innovation. But even these latter should not be considered as “pure nuisance“: if one manages to diminish them, it may facilitate innovation, but create problems elsewhere in the firm. It would be unwise for example to alter management control procedures and human resource mechanisms only because they create difficulties for innovation:
- they are also very useful support for the decisions executives and managers have to make.
- they provide comparison bases which allow us to choose which product to push or to terminate, which employee or manager to promote.
- they contribute to external information crucial for relevant outside parties (bankers, the financial community, industry associates).

Hence management constraints have positive effects on collective coherence. Any relaxing of a constraint is an arbitrage between its effects on innovation and its effects on the rest of the organization.
We also examined the management constraints on people involved in innovation, executives as well as other actors. The constraints experienced by these individuals should be taken into account by any person who want to mobilize them. Thinking about them may help predict and understand difficulties experienced by firms who want more innovation. No organizational action can be done without some thought given to the actors, and this is especially true for innovation activities, which are much more dependent than others on the free implication of individuals, which is relatively difficult to control.

To summarize, there is a dangerous temptation concerning how to use what we presented in paragraphs 1 to 6, that is to take each identified constraint, try to see what is its intensity in a firm we are interested in, and act to diminish it if we see that it is present. Such behavior would have disastrous effects because it would destabilize many extremely useful and vital organization processes. A much better behavior consists in taking these constraints into account when managing innovation, and to measure the indirect effects produced by actions undertaken to alleviate them.

It should be added that innovation is not a good thing in itself. For example, research by Capon et al. (1993) on American manufacturing industries, has shown that “non innovators” have the highest financial return. More interesting still, they have shown that the type of innovation depends on the firm's strategy: “prospectors“ are high on product innovations, “defenders “ are high on process innovations.

In another area, Zirger and Maidique (1988) have observed an electronic firm whose “innovation track-record“ brings us a profound lesson. This firm had first developed a maritime navigation equipment for medium size boats which was extremely successful because it was ten times smaller than competitors' products, a characteristic very much appreciated by clients. Management then decided that it wanted to repeat the success by developing the next generation product line, again dividing size by a factor of three. They succeeded technically, but the product was a complete flop: clients were quite satisfied with their first generation products (and with the comparable products later offered by competition), and they did not want to pay an additional price to decrease the size of equipment even more.

A very simple lesson can be drawn from these two examples: innovation is not good by itself, it should be in line with the strategy, the organization, the clients, the market. Some of the “framing and context constraints“, as we named them in section 5.1, have simply to
be accepted and taken into account in the management of innovation. It remains true of course that many constraints may be bent or avoided. Hence knowing the management constraints on innovation is useful to choose more efficiently the actions that will have to be taken and to predict better the difficulties which may be met.

**Conclusion**

Eight conclusions can be drawn from the above developments on the management constraints on innovation.

1) First, executives, managers and other actors in the firm have, in the area of innovation, at the same time constraints and possibilities of expressing themselves and of influencing things. These possibilities depend on the type of organization and on the type of innovation process. The most modern versions of the innovation process (Burgelman model, “platform organization”, emerging innovation, learning organization, concurrent engineering) all go in the direction of increased expression possibilities of actors of all hierarchical levels. If such is the main trend, this move will have to be accompanied by a strengthening of management constraints, in order to coordinate each individual action with the others and ensure their convergence toward a collective realization.

Thus the question of the relation between innovation and management constraints is not that of the arbitrage between power at the top and power of bottom line people: both are needed. Nor is the question of the relation between innovation and management constraints that of the arbitrage between more participation and more constraints: here again both are necessary.

2) The second conclusion is that management constraints are not just impediments to innovation. Some of them push for more innovation than some actors would like, others push innovation in selective directions.
3) Third, management constraints on innovation should not only be searched for at the level of direct effects of formalized management tools: a number of them come from informal behavior and indirect influences. Some are perceived by the actors involved, but others may influence innovation without the actors being aware of their existence.

4) The effect of management constraints on innovation appears to be strongly present at the level of collective entities and “ecologies of actions”, rather than at the level of individuals. We saw here collectivities such as the type of organization and the type of innovation process. Many others should be studied in detail, although we could only mention them in the present paper: professional communities, action systems, networks, twelve types of organization, eleven coordination systems, six types or decision-making processes, etc.

5) Over the years, management research has produced a wealth of results which has enabled us to identify management constraints on innovation, as well as tools and methods which may be used to identify them and alleviate them.

6) But management constraints on innovation cannot disappear. First because they help the convergence of individual actions into collective realizations. Also because each organization is composed of a great many partly autonomous “systems” which are constraints on each other. For example each executive partly depends on the people and units which have information and competence, as well as on many organizational mechanisms whose sole objective is not innovation.

The executive must thus remain realistic and forego all hopes of innovating without constraints. Of course, other actors must likewise remain realistic.

Our identification of management constraints hence leads us to put actors in their proper place. The innovating entrepreneur, the project manager, the executive and the intrapreneur are important, but should never be considered as the sole force pushing for innovation, the sole people whose preferences will be reflected in the innovations developed in the firm. Likewise our study places to their proper position formal management tools such as the business plan and the project management software, which are considered by some as the alpha and omega of innovation management.
7) The production of innovative ideas does not come only from unmanageable spontaneous creativity. It also depends on the social and organizational milieu, on the incentives to have ideas coming from problems and opportunities. We saw that the density and type of innovative ideas appearing in a particular place at a particular time depends on social pressures, on groups and encounters, on successive transformations as an idea circulates between groups and individuals. In many cases the innovative idea which appears is much less the individual product of the person who expresses it than the product of the social and organizational milieu. Nowhere is this effect more obvious than in densely connected collectivities such as the Silicon Valley. This effect of social connections and encounters on the intensity of innovative ideas leads us to advise firms to increase the participation of all actors, even of those who have a modest hierarchical and professional level.

8) To summarize, innovation is managed through organization and processes, through competence and relations. For executives, this means that the best conduct does not consist only in trying to develop a strong control of each innovation. It may be better to develop organizations and processes which are conducive to innovation, with means such as competence groups, collective language and representations, and a culture of intensive contacts and cooperation. Through such means, innovation is indirectly managed: management may give free rein to individual initiative since it knows that it will go in directions compatible with the firm's objectives, and that actors will spontaneously do what is necessary to converge toward useful collective realizations.
Annex: Management constraints on innovation not treated here

Some management constraints on innovation are not developed here because they are at least partially presented elsewhere:
- the external relations of the project-group and of the firm (Romelaer, 1999)
- the roles of managers and executives (Romelaer, 1996)
- the roles of project managers and of functional managers (Allen et al., 1978; Ancona and Caldwell, 1992; Midler, 1993)

Many elements concerning the relation between innovation and management constraints could not be presented because of space limitation. We limited ourselves to presenting two of the twelve types of organization, two of the eleven coordination systems, and among the decision-making processes two of the six types. Numerous other elements which could be useful but have not been presented are listed below:
- management methods specific to functional domains such as marketing, production, finance, R&D management, etc.
- legal structures and contracts (national as well as international)
- technology in general and information technology in particular: internet, intranet, automatization of marketing tests, reporting, normalized technical languages, formalization of experience, automatization of molecule testing in the pharmaceutical industry
- the development of project managers, through initial and continuing education as well as through “learning by doing“ across successive assignments
- partnerships, alliances, joint-ventures, subcontracting and other outside relations
- the effect of “the mode of existence of management tools“ (Moisdon, 1997), with the numerous organizational aspects which have to be added to this perspective (Romelaer, 1997b)
- the management constraints which can be identified in Foray and Mairesse (1999).

As well as, undoubtedly, many others…
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