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ABOUT DIVERSITY IN ORGANISATIONAL TRAJECTORIES

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ABSTRACT

The fact of organisational diversity leads us to put forward the paradox of « dynamic fit ». This serves as the basis for an alternative view of Lamarckism as applied to social sciences, which can provide a more efficient explanation of regular evolution in firms and populations. However, when a firm is trapped in a lock-in situation, Darwinian selection best explains how the system will behave. Thus we propose a continuum from alternative Lamarckism at one end, through Lamarckism, to Darwinism at the other end, in order to understand what evolutionary principles are appropriate to specific situations.

INTRODUCTION

A few sentences sometimes throw up more questions than hundreds of pages in a book. This indeed can be said of the following extract from Allen (1994) in which the issue of organisational evolution is discussed:

“Evolution selects [...] for populations with the ability to learn rather than for populations with optimal, but fixed behavior. This corresponds to the selection of “diversity creating” mechanisms in the behavior of populations, initially involving genetics, and later cognitive processes” (Allen 1994, 11).

There are at least four highly important issues here which provide a framework for discussing the origin of organisational diversity.

First, it is advanced that one criterion of selection among populations is the ability to learn. This implies that a population should be able to conduct and direct its own evolution. In the context of organisational theory, this stands in contrast to the neo-Darwinian ecological perspective (Hannan and Freeman 1977,1984, Aldrich 1979) in which populations are not supposed to be adaptive. In the latter view, when the environment modifies its requirements, the least fit are replaced by new entrants, thus freeing resources for the development of the fitter. Those firms which are the least fit and which are engaged in a process of evolution will be selected out of the market in as much as they will absorb a huge amount of resources and increase uncertainty in the quality of products and services, even though it is highly unlikely that their evolution will be completed.

Clearly, this pessimistic view does not recognise the role of organisational learning and willingness. A firm is continuously subjected to variations in the environment that can be converted into administrative innovations leading to evolution. Rather than accepting a deterministic law as an explanation for inertia, we postulate that if a firm is trapped in such a situation then this is the outcome of a specific social process and not the result of an

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insuperable evolutionary process, at least not in the early stages. Consequently, it is necessary to understand the internal process of variation-selection-retention in order to manage it.

The question is to know what role learning plays in evolution and why a specific learning process will be institutionalised (or not, as the case may be).

The second point considers that optimal behaviour in the short term will not be effective in the mid to long term. This is consistent with Von Foerster's conjecture that the more effectively the various parts are determined by the state of the whole system the less able they will be to influence the whole behaviour of the system. As regards our discussion, the closer an organisation is to the requirements of its environment in the short term, the more difficult it will be to evolve when that environment changes. Thus, this represents a theoretical inversion vis-à-vis the ecology of population theory. Here, it is the focus on short-term performance which is responsible for inertia, not the opposite.

To assume that the environment selects firms which do not evolve somehow does not make sense. Such a phenomenon could possibly be appreciated in the short term, but selection processes and evolution have nothing to do with short term views. In a long term view, conditions evolve by definition. If a firm does not evolve, it will be sanctioned anyway.

Thus, the problem is to understand how to remain flexible while looking for fit, i.e. how to be sufficiently sub-optimal in the short term in order to be more successful in the mid to long term. We call this problem the paradox of the dynamic fit.

Thirdly, Allen explains that a multitude of sub-optimal behaviours combined with different learning processes can create a multitude of evolutionary paths leading to diversity. This throws up a bridge between different levels of analysis. Diversity at the population level can be the outcome of different types internal evolution at the firm level. But the link between internal and external evolution is seldom analysed, and following Madsen et al. (1997), we consider that “[...]few studies consider intrafirm selection and retention in conjunction with intrafirm variation, and connect intrafirm evolutionary processes to firm outcomes and competitive dynamics” (Madsen et al 1997, 3)

It is also in a sense an appeal to recognise that the “external” process of selection is partly defined by the “internal” transformation of firms (Romme, 1990). Firms create their environment and the criteria for selection as much as they are determined by it (Weick 1979, Giddens 1984). These two propositions suggest that a firm has the possibility to orient the environment so that the latter may evolve in accordance with its path dependency, so long as it is willing to accept a certain amount of disequilibrium in the short term. Thus, the aim is to understand what conditions are most likely to allow such disequilibrium to produce effective administrative innovations.

Fourthly and last of all, Allen suggests that internal evolution initially involves genetics and later cognitive processes. We want to lay stress on the order of that sequence. A recombination of existing routines (considered as genetic assets) can produce an innovative procedure (Usher, 1954) in the same way as grammar can combine words differently in order to give a different meaning to a sentence (Pentland and Rueter, 1994). Therefore, the process is also cognitive. A routine cannot always be perfectly duplicated, even in the firm where it was invented.

“The idea of flexible schemes entails that the actor is not a passive entity, acting according to a scheme of unambiguous instructions as if he is dummy and the scheme is his ventriloquist” (Khalil, 1998, 37). There are at least three important implications in this.

First, people can either be affected by the ambiguity of routines and make errors, or they can take advantage of that ambiguity if they have asymmetrical control over the information. *Second*, people tend to modify the existing system not only because it has become objectively worse, but also because their expectations or their appreciation of the state of the world have

changed. As a result, the incentive to evolve can be endogenous and not exclusively exogenous.

Third, if innovation is always a disruptive event of one kind or another, a new item must be compliant with the “deep structure” of the firm (Gemmil and Smith, 1985), that is to say, the shared understanding of the values of the firm. This is a condition for innovations to be institutionalised at the organisational level.

So, these four themes which we have inferred from Allen lead us to question what organisational change is at the level of the population of firms and how it depends on their internal evolution.

We shall seek to clarify this point by representing organisational evolution through a model of self-organising dissipative structures which is adapted to the social sciences. This model contests the Darwinian Ecology of Population theory but is also an alternative to the Lamarckian Evolutionary theory of economic change

THEORETICAL FRAMEWORK

TOWARD AN ALTERNATIVE VIEW OF LAMARCKISM.

Evolutionary theories of economic change (Nelson and Winter, 1982, Dosi et al., 1990) have integrated Schumpeterian evolutionary theory in a meaningful cognitive paradigm for a major reconsideration of the nature of the firm and the way in which it evolves.

It is advanced that the legitimacy of the firm as a social organisation is rooted primarily in human nature and not in the inadequacies of the market. Human nature is characterised first of all by bounded rationality and limited cognitive abilities. Each human being has to rely on procedural devices —conveniently labelled routines— in order to maintain his or her performance above a psychological satisfaction threshold (Cyert and March 1963). According to the problemistic search principle suggested by Herbert Simon, new learning is developed in contact with the environment if performance is below this threshold. When a solution is discovered it constitutes a new routine which replaces the former. Thus there is a creative-destructive process inside the firm which serves as a basis for Lamarckian Transformism. Obviously, we are here in the field of exosomatic organs of human beings, i.e. tools, technology, routines organisations, etc., i.e. artefacts they have built. What is generally considered as true for the endosomatic evolution of these individuals can be prove wrong when we study their exosomatic organs [Georgescu Roegen, 1978].

Organisations are then considered as being made up of interconnected routines which are assimilated to genetic assets and represent the sum total of organisational learning (Nelson, 1994). This definition of an organisation is different from that given by the ecology of population approach and is becoming that which is the most widely accepted in the relevant literature. By way of an example, Amburgey and al. [1993] propose following Hannan and Freeman in defining organisations as structured systems of routines embedded in a network of interactions with the environment, but they insist that they go beyond this model and integrate theories of learning and innovation.

Members of a firm can inherit the knowledge previously developed by others and are able to produce new learning from this base. But that limits the array of opportunities for organisational evolution. The ability of a firm to distance itself from current routines depends on its "absorptive capacity", which in turn depends on previously acquired organisational competencies. As a consequence, routines and knowledge are linked together in a dynamic relationship according to a structuration perspective (Giddens, 1984). This social process is an

unbroken productive loop where outputs have an impact on those who produced them (Morin 1991). Such local mobility is very different in nature from the inhibiting inertia exposed by the ecology of populations theory. On the contrary, such relative inertia is a condition for the movement to be sustained in as much as it shields the firm from inconsistent variations that could create a chaotic trend (Heiner 1983, 1988).

Differentiation becomes a cumulative and irreversible process which increases the divergence of trajectories and thus the organisational diversity at the population level.

Therefore Nelson and Winter tend to consider that the orientation of trajectories is objectively driven by the searching process. Routines are replaced thanks to a second level of routines (double loop learning) which represent the way the firm has learned to learn at a third level ("deutero learning") (Bateson 1977) but there is no mention of the social process that yields the routines.

The authors recognise that a dominant coalition is able to inhibit any new solution promoted by an entrepreneur, as already stressed by Schumpeter, but nothing is said either about the social conditions which allow routines to develop or about the process of institutionalisation. Routines seem to resemble social truces and nothing is suggested in order to explain what precedes and what follows the elaboration of these peaceful rules. Following Coriat and Weinstein (1995) we may wonder if it is "...possible to define the closely related concepts of organisational competencies and the firm without taking into account the conflicts of which (these routines) are the expression, the stakes and the outcome" (Coriat and Weinstein, *ibid.*, 142, our translation)

In this context, we should like to reconsider the work of Jean Baptiste Pierre Antoine de Monet, Chevalier de Lamarck (1744-1829) in the social sciences on the basis of two major points: first, the capacity of a system to be creative and not solely adaptive, and, second, the role of willingness. We believe that this is the basis for an alternative model of social Lamarckism which goes much further on the subject of endogenous evolution.

Firstly, Lamarck assumes in his major work, *Zoological Philosophy*, that all species derive their energy from heat and electricity. But he proposes distinguishing between the primitive and the higher animals. The former rely on their environment to obtain that energy and their behaviour is therefore mechanically determined. On the other hand, the higher animals are supposed to be able to generate their own heat and electricity, and therefore to achieve a measure of self-determination.

Proposition 1: As far as economic and organisational evolution is concerned, we consider that Lamarckism as alluded to by the Evolutionary theory of economic change is consistent with the proposition concerning the adaptive primitive animals. Therefore, we can assume that an alternative view of Lamarckism, which is consistent with the supposed evolution of the higher animals, can also be proposed for organisations.

This position can be seen as related to recent models of self-organising dissipative structures (Allen 1988, 1994; Gemmil and Smith 1985; Smith and Comer 1994).

In both situations, the role of energy in the natural world is played by resources in the context of the firm. Thus, in the first proposition the firm is completely dependent on its environment for obtaining the essential resources to produce and to evolve in accordance with that environment. In the second, the environment is not considered as exogenous. Thus, the firm constructs its surroundings as well as being determined by them. This means that a group of people in a firm can also find resources inside the organisation to produce new solutions (technologies, routines, etc.) which can affect the environment.

We believe that this distinction is consistent with the second and third categories of the typology that Jantsch (1980) proposes for dynamic systems. These include:

- the deterministic Newtonian dynamics,
- the equilibrium dynamics of an adaptive open system,
- the “out-of-equilibrium” dynamic of self-organising dissipative structures.

We do not wish to argue that in the third case a firm is solely innovative, but there is a balance between innovation and adaptive exploitation (March 1991). The problem is to determine the conditions for the sustainability of this balance, which we do not consider as a given.

The second difference between Lamarckism and evolutionary economics concerns the role of willingness. In this respect, we need to come back to a misinterpretation of the driver of evolution suggested by Lamarck himself. In the first third of the 19th century, scientists criticised Lamarckian analysis for claiming that desire and intent were the main drivers of evolution. In fact, Lamarck was talking about need as driver of evolution, and it is this correct interpretation that is to be taken into account in evolutionary economics.

Therefore, in order to explain, from a Lamarckian perspective, how innovation emerges from the deep parts of the firm and why and how it may or may not be routinised, we propose to come back to this initial misinterpretation. We shall consider that the drivers of evolution are a combination of need, intent and desire, and that these drivers can be in conflict with each other. For example, an organisation may need to evolve in order to fit the environment better, but the desire or intent of members or groups within the firm can impede this evolution.

We assume that organisational learning is better understood when combined with the notions of power and bargaining. First, learning occurs among people but also among people and events, thus providing a situated learning context (Lant 1998). This means first that established artefacts such as routines do influence the learning process. Second, learning does not only take place in the minds of individuals but also in their interactions. If we consider learning as a product of interactions, and if we admit that power doesn't exist by itself but in interactions among people (Crozier and Friedberg, 1977) then we can posit that learning can be affected by social matters.

Consequently, we suggest substituting the learning approach developed by Argyris and Schön (1978) for that used by Nelson and Winter, which still relies on mechanistic principles. In the former approach, a firm is not able to collectivise all the competencies the members have learned. The issue is not only about how the search process is activated but what form the internal process of selection takes when more than one type of experimentation challenges the same routine. What conditions are required for an innovation to replace a previous routine and, conversely, what can explain the preservation of the status quo?

SELF-ORGANISATION AND SOCIAL INSTITUTIONALISATION

Self-organisation has become a commonplace for the social sciences, and the literature on this theme has been increasing since the late 1980's, but we believe that the work of Woodward (1965) is consistent with a particular kind of dynamic equilibrium of self-organisation.

A self-organising system is able to go beyond its physical or mental limits without the need for any external driver (Jantsch, 1981). The core process is creation and not adaptation. When a variation occurs, there is a break with the self-referential values of the system. This variation can be the result of “order by fluctuation” (new solutions tend to contest the established system easily) or “order by noise” (mistakes made in an ambiguous situation lead to sense-making and organisation). There is a continuous conflict between the forces of self-

organisation and self-reference. A stable system does not mean that such forces are not in conflict within the system but that the self-referential backloops are strong enough to inhibit the contesting fluctuations.

The operational characteristics of a self-organising system can be considered as follows (as adapted from the work of Nonaka et al., 1988):

- widely defined goals, which reinforce the cohesion of members (Lindblom, 1965, Quinn 1980);
- ambiguity of interpretations are considered as a regular characteristic because they favour the diversity and complementarity of mental frameworks (holographic memory, Morgan and Ramirez, 1983);
- direct and shared information among members of the group, (no uncertainty absorber as proposed for the M form by Thompson 1967);
- the deliberate delaying of a decision is accepted when the relevant information has not been found by the group itself and is thus not considered as credible (Heiner 1988);
- an avoidance of excessive specification of tasks and routines in order to favour innovative behaviours (Allen 1994);
- shared responsibility for success or failure as a basis for commitment (Miles et al. 1997).

Therefore the role and importance given to self-organising systems are substantial in the field of social sciences. By way of an example, Miles et al. (1997) state that self-organisation belongs to a new organisational design—the cellular form—adopted by firms preparing their entry into the 21st century. This new design is characterised by self-organisation, entrepreneurship and joint-member ownership of assets and resources. It is the outcome of a progressive evolution of the previous major organisational designs, i.e. the functional, multidivisional, matrix and, more recently, the network organisations.

If this trend can't be contested, we can object that a given design does not automatically replace a previous one or at least not so quickly.

We can cite numerous examples of firms combining two or more of these features. The French Post Office combines heavy hierarchical structures with small autonomous groups, while Aerospatiale combines the M form (one branch for each aeronautical speciality), the matrix form (functional departments and project teams), and the cellular form (in order to develop new technologies or conduct a crash programme), while some groups can even be considered as small business units.

Thus, the issue of endogenous change has to take into account the following two points:

First, we suggest that it is not only a question of understanding how an innovation is produced (variation), but why (selection), and how this innovation is or is not institutionalised (retention). What we are considering here is precisely the transfer of an administrative innovation from one organisational design structure to another situated on a different hierarchical level. This does not mean that we suppose the firm to be ambidextrous (Duncan 1976), since we will see that there is a place for innovation at each stage of the model, from variation to retention. The retention process is not pure assimilation and, in the words of Piaget (1979), does necessitate accommodation,.

Secondly, a group can find resources both “outside” the organisation and in the internal environment. Thus, evolution as a transformation of energy (resources) is consistent with the second law of thermodynamics and can be considered endogenous. Each level tends to look for resources situated at the next level. An organisation doesn't evolve as a whole, but is confronted with internal and local variations which may or may not be institutionalised. Institutionalisation is defined here as a common acknowledgement that a new administrative

device is efficient and legitimate, and can thus become a routine. This process of institutionalisation, which will be developed in the fourth part of the model, is considered as means of allowing organisational learning.

In order to respond to this particular issue, we aim to develop a multi-level model concerning people, groups, networks and finally the organisation as a whole. This is why we stress the institutional forces in action between these different levels to explain endogenous evolution as a fluctuating, unpredictable and non-deterministic process.

THE EFFECTS OF AMBIGUITY ON INTERACTION

Before developing the model, it is important to define which paradigm applies to interactions in the firm. In order to explain this, we can consider Meyerson and Martin's classification (1987) of three paradigms differentiated according to the amount of ambiguity they are able to tolerate. The first paradigm is called "integration" and assumes that ambiguity should not exist because of its negative impact on organisational cohesion (OD, cultural management, etc.). The normative consequence is that managers should eliminate ambiguity.

The second, which is called "differentiation" assumes that ambiguity does exist between the different decentralised and differentiated parts of the firm but not inside the groups where the first paradigm can be retained (contingency models, new institutional economics, etc.). Managers have to channel the ambiguity in interdepartmental relations in order to control it.

Finally, the third paradigm, called "ambiguity", assumes that ambiguity is produced by the social relationships in the firm and cannot be eliminated (Scott, 1978). In addition, ambiguity should not be eliminated because it explains a great deal of emergent evolution. Organisational evolution has its roots in that complexity. This implies that the predictability inherent in the previous models is not applicable here. Fluctuation and unpredictability are mainly caused by ambiguity in social interactions, and the evolutionary vision that we are developing is consistent with the third paradigm.

A SOCIAL MODEL OF DISSIPATIVE STRUCTURES

THE MOTORS OF CHANGE

We consider that intra-organisational evolution follows an internal variation-selection-retention process which is not necessary self-sustaining. We shall seek to develop a self-organisation model of dissipative structures (Nicolis and Prigogine 1977, Prigogine 1981) in the same spirit as Gemmill and Smith (1985) where the creation of variety comes both from natural selection and dissipative (endogenous) change.

"Dissipative self-organisation implies a system change that takes shape within turbulent conditions through the breakdown and rebuilding of a structural arrangement. When a system is operating far from its equilibrium parameters and when certain key processes are present and reinforced such a change can occur" Smith (1986, 204)

We are therefore less confident in the "natural" aspect of the selection process and we shall consider this point while seeking to identify the drivers for evolution. Following the typology elaborated by Van de Ven and Poole (1995) we should like to identify the different "motors" which operate in this composite model.

In order to epitomise these four ideal-type theories of social change we shall adopt the key metaphor and logic approach put forward by the authors :

- Life cycle. *Key metaphor*: Organic growth; *Logic* : Immanent programming, prefigured sequences, compliant adaptation;
- Evolution. *Key metaphor*: Competitive survival; *Logic* : Natural selection among competitors in a population;
- Dialectic. *Key metaphor*: Opposition, Conflict; *Logic* : Contradictory forces, thesis, antithesis, synthesis;
- Teleology. *Key metaphor*: Purposeful co-operation; *Logic* : Envisioned end state, social construction, equifinality.

These four motors operate at different levels and are associated differently during each stage of the self-organising process.

Together they explain evolution as the outcome of human actions and intents, which are just as responsible for its fragility as for its endurance. In other words, the process is social and subjective and not natural and objective.

Finally, the effective evolution of any trajectory is a function of the retention process. This depends on which among the new competing solutions the system is able to institutionalise. On a regular basis, the system will probably accept options which are in resonance with the "absorptive capacity" of the firm (Cohen and Levinthal, 1990), therefore the organisation can be trapped in a position where no new solution can be institutionalised. This failure of internal innovation is supposed to be a function of the intensity of the previous organisational fit achieved by the firm before the environment changed.

STRUCTURAL ASSUMPTIONS

Consistent with the theoretical framework we posit the following structural assumptions:

Assumption 1 : For each of the stages of the model we posit that a specific sociological system will drive the interactions between people. These systems are wrongly considered to be incompatible (Alter, 1996).

Assumption 2 : Each stage can be more specifically characterised by a particular form of ambiguity which plays a specific role in the innovation process.

Assumption 3 : Three levels of learning are comprised in that model, i.e. individual learning (1st step) collective learning in groups (3rd step) and, at the higher level of the system, organisational learning (4th step).

Assumption 4 : The four motors of change identified by Van de Ven and Pool (1995) operate in the process. They act at different levels and are associated differently according to each step¹.

A STAGED PROCESS

The model consists of four stages which, in the literature on dissipative structures, are usually named "disequilibrium", "symmetry breaking", "system experimentation" and "boundary repairing". The first two are associated with dissolution and the latter two more closely associated with creation. Steps one and two can partially overlap as can steps three and four.

The staged model goes through these four steps according to a life-cycle structure. That is to say that an innovation imagined from a variation at the first step tends irrepressibly to go to

¹ Note : We will note LC for life cycle, T for teleological, D for dialectical and E for evolutionary. We will indicate 1 when the motor operates at the individual level, 2 at the group or network level, 3 at the organisational level.

the next step. This is consistent with the Schumpeterian view that an entrepreneur is always motivated to institutionalise his or her innovation or his or her project.

This does not mean that each period of the four steps will be completed or that an innovation will be institutionalised. Innovation can progress toward institutionalisation at each step or can end in deadlock because of the nature of the social forces.

Assumption 5 : The common motors for the whole process are LC3 and E3

This means that a second motor is deeply related to the first one and can contradict the forces in action i.e. the evolutionary motor. The latter can prevent the life cycle from progressing or, on the contrary, it can favour its passing on to the next stage.

Step 1: Disequilibrium

By disequilibrium we mean an unstable state where a gap exists between specified procedures and practices, thus creating uncertainty.

In that sense, a variation (the gap between procedures and practices) in itself is not sufficient to create disequilibrium. The variation should give members of the group the opportunity to act in a way which is not expected by the whole organisation, and this produces uncertainty about the quality of the outcome and about the co-ordination of the modified procedure with others. In an express delivery company a group of sellers found themselves with sudden and aggressive competition on prices while the management stuck to its opinion that prices were not to be decreased in order to signal the constant quality of the service offered. In order to maintain the number of new contracts (taken into account for the determination of salaries), the sellers established an unofficial system encouraging the customers to announce higher levels of delivery than they could ever achieve in order to obtain officially better rates. The proportion of forecast over effective deliveries was increasing and the sellers cited the high uncertainty of the economic climate of the time as an explanation. Although far from convinced by this explanation, top managers nevertheless considered the situation to have become irrevocable. Members gained a degree of freedom even within the context of highly specified routines.

This illustrates the dilemma existing between organisation and innovation, order and disorder. The organisation tends to reduce uncertainty by progressive routinisation (Perrow 1970), but innovation is the art of taking advantage of this uncertainty. We shall call innovation this association of variation and intent.

In this step, all four motors are engaged in producing change in the organisation from two kinds of variations, one created by an entrepreneur and the other by an actor.

First of all, firms are used to accumulating more knowledge than their current operations require (Miles et al, 1997). We call this surplus "joint knowledge" in order to stress that it is produced out of daily practices. Entrepreneurs, therefore, are those people who can transform this knowledge into an innovation.

By way of an example, R&D engineers are used to devoting a significant part of their time to verifying whether different hypotheses satisfy their current and specific problem(s) or not.

"In order to find a solution we need to open dozens of doors only to verify that what is behind them is not appropriate to our problem" reports a chief engineer in a French aerospace company.

The rooms whose doors are opened and closed contain this kind of joint knowledge. Obviously, there is a potential disequilibrium only if someone takes an interest in reopening one of these doors and making sense of that knowledge.

This source of innovation is driven by an LC1 motor in as much as this joint knowledge is produced during the life cycle of technologies, products and also administrative routines.

Secondly, this modification of internal conditions can also be produced by members considered as actors. These actors are motivated by their personal strategies and are able to deviate from official prescriptions even in controlled systems such as bureaucracies (Crozier 1963). There is a life-cycle motor which explains that the more used to a routine people are, the better they control it. And the better they control it, the more likely they are able to develop an idiosyncratic behaviour, different from that which is specified. An LC1 motor, not very different in nature from the previous one, is also at work here.

The more information people control, which is not shared by their immediate superiors, the more power they have. This power gives them the opportunity to develop a gap between official and effective practices.

The concept of routine, consistent with this proposition, is closer to that proposed by Argyris and Schön (1978) than by Nelson and Winter. For the former a divorce is possible between "espoused theories" and "theories in practice".

Actors take advantage of ambiguity and create or maintain a state of disequilibrium (March and Olsen 1976). Ambiguity is assimilated with instability and is necessary for people to innovate. People have a margin of power and can negotiate their operating methods with their hierarchy, and this can be a source of new behaviours which afford them greater facility in reaching their goals (Crozier and Friedberg, 1977). A D1 motor is at work here.

Finally, E1 and T1 motors are also included in this step. People have to select which of the variations they are experimenting with is worth being pursued (selection) and established (retention).

It is not because extra knowledge has been produced that it will be transformed into an innovation. From a Lamarckian point of view, we consider that this variation has to be activated by an intent.

Members move away from equilibrium if they do not achieve their goals or if they reconstruct their expectations. This developmental and unpredictable path is characteristic of the teleological motor (Van de Ven and Pool, *ibid.*)

Assumption 6 : The LC1 and D1 motors are closely interrelated in disequilibrium. Owing to the information and knowledge produced by LC1, a specific dialectical action is possible (D1), and because members have their specific goals they are motivated to practice their routines in such a way as to control more information and knowledge (LC1). E1 and T1 are intermediary motors between LC1 and D1 and allow members to select the more interesting variation (E1) and make sense with the knowledge or information they control (T1)

This kind of disequilibrium can be revealed and managed if top managers allow people to talk openly of their dissent. This does not necessarily mean that the process is under control, as Burgelman showed in the case of Intel (1994).

Step 2: Symmetry breaking

Symmetry breaking can be provoked by the evolution of coalitions which modify the system of power. The modification of coalitions is necessary for the system to be unblocked and for the challenging innovation then to have a chance of being shared by others (Friedberg, 1993).

Social actors are not just individuals. Members join and create coalitions (Thompson 1967).

People and groups reconsider the way of attaining their objective when their actions during the most recent period have not been effective. This provides an opportunity to contradict the previous dominant coalition. T1 and T2 motors are at work here, depending on the level on which this search is considered

This suggests that people do not have a clear idea of their preferences, that they are not directly affected by the subject at hand. They can contribute to contesting or reinforcing routines out of political considerations and join the coalition only because it will be useful in the future when they look for members to join their own coalition. These variations can occur for various reasons, and at many different moments, and are difficult to forecast, even to explain afterwards (March and Olsen, 1976).

If an entrepreneur possessing surplus knowledge or an actor trying to modify a procedure are regarded as opportunities to reinforce a coalition even for a while, they can be supported. Slack and rare resources such as attention or money can be oriented to them. There is a kind of selection in operation here—an E2 motor—and there is no guarantee that this selection is objective according to any criteria of efficiency.

Assumption 7: the E2 motor is closely related to the T1 and T2 motors in symmetry breaking. The evolutionary process which will provide resources for a specific innovation is coherent with the need of people or of groups to find a new solution in order to attain their own goals. Ambiguity as regards goals favours complex strategic attitudes and explains why a dominant coalition can be deposed. If everything were clear and rational, it would be more difficult to modify the positions in the field.

This gives a good idea of what an upheaval zone of punctuated dynamics can be in the social sciences and why it does or does not appear.

When symmetry breaking does not occur, this means that the system is not socially prepared for change even if there are plenty of good and rational reasons to change. In such a case there is no window for change.

Step 3: System experimentation

People can mobilise themselves for an idea or a project without calculating their personal interest. This enables sociologists to explain how certain people, for example, can join a strike. They have no personal interest in doing so in as much they could lose credit with their superiors, and if the strike is a success, each employee, whether on strike or not, will benefit from the results. They join the group on strike because of the usual pressures, or they may fear sanction from the group. It might also be because they want to participate in the stories their parents told them about the « glorious » strikes of the past.

This is an alternative to the strategic approach of the actor considered in the first steps, but these two conceptions of actors should not be considered as incompatible (Alter 1996).

In the case of our discussion, the group resulting from this mobilisation can be physically constituted—in particular, thanks to the resources obtained during the symmetry breaking stage—or otherwise it can be a network of members interacting on the subject. This second perspective is more appropriate for understanding informal experimentation.

Experimental innovation in a group is the first stage in creating a common competency, but it is still a collectively shared competency and does not yet represent organisational knowledge. The group tends to develop a new regulation system "in the making" which opposes the established regulation system. This new self-regulation system concerns methods, the sharing of tasks, the way of introducing a new product or new technology. For this reason, the main motor is T2, since the creativity of the self-organising group is devoted to attaining its own goals.

It is important to understand how the self-regulation of a group comes into conflict with the regulation system of the firm (Reynaud and Reynaud 1994). This opposition between two modes of regulation will favour or inhibit collective innovation.

A control system tends to channel the actions undertaken by the group, and the latter will try to promote the new procedures at the system level.

The system can totally inhibit self-regulation or, on the contrary, leave the groups free to experiment at the system level. There is also a third solution, called "joint regulation" by Reynaud and Reynaud, which can emerge out of negotiation between the two levels. D2/D3 motors are at work here in as much as this opposition can force one of the two parties to evolve or force both parties to find a new compromise

As proposed by March (1991), the system should be able to show a balanced situation between exploitation and exploration. Too much exploration can lead the firm to meaninglessness, as can be seen from Heiner's model of decision-making.

Gradual evolution shields members from inconsistent exploration when uncertainty overwhelms their understanding (Heiner 1983, 1988).

An important point in Heiner's model is that uncertainty creates a gap between imperfect information about the state of the world and the ability to take decision. This is a justification for pursuing credible routines of the past for a while in what seem to be similar circumstances. Credibility is defined as a past ability to meet a requisite level of performance. It is more intelligent than trying to innovate at any cost, because cumulative errors can be made.

These routines maintain the credibility expected by members of the inter-organisational network in spite of increasing uncertainty.

Above a certain level of C-D gap, inertia is more efficient than innovation. That means that inertia is part of the whole process of evolution and it can preserve the firm from being eliminated. "Problemistic search" and "satisficing" are presented by Heiner as current rules. Maximisation becomes a rare and extreme case where the C-D gap doesn't exist.

Assumption 8 : Two motors are at work in system experimentation. First, the T2 motor which explains the adaptive behaviour of the self-organising group looking for ad hoc solutions. Second, the D2/D3 motors which guide the opposition between the two levels. Obviously these motors are closely related. The more innovative and powerful the ideas the group develops, the stronger the opposition will be. Conversely, the more powerful the system is, the less motivated the group will be to produce major innovations.

Step 4: Boundary repairing

So far, a number of actors have developed a questioning attitude to a particular behaviour (disequilibrium), then some of the members have had to notice this in order to allocate some slack resources (symmetry breaking) which are necessary for the group to turn this idea into a practical innovation. This innovation can contest established routines (system experimentation). But now innovators have to convince most members that their solution is legitimate and they have to convince top managers in order to have their innovation transformed into an institutionalised routine.

Sociologists concerned by innovation suggest that the best way to legitimise a new routine and to unite people around it is to "translate" the problem gradually in order to obtain agreement on it (Callon 1986). This will help promote the solution, as happened in one of the main public transportation companies in France. A new set of project management practices designed to orient relations between the functional teams and the project team were gradually elaborated within an experimental group. The diffusion of these practices was possible only after a long period of discussion (6 months in this case) during which several translations of the problems solved by the new practices were carried out. During the process these practices

were accommodated in order to be adopted by each new organisational level. This means that this phase is not only a question of assimilation but also of accommodation.

This translation process is critical because entrepreneurs and actors have to prove that the innovation is consonant with the accumulated learning and experience of the system (Cohen and Levinthal 1990). Obviously, an E3 motor is at work here owing to this variation (accommodation) in the selection and retention process.

In order to be institutionalised the innovation has to fit the "deep structure" of the firm i.e. its self-referential framework: "Self-reference implies some form of reflection within which the group arrives at a shared understanding of its values, its purpose, and desired future" (Smith and Comer, 1994).

There will be conflict and a trade-off between the internal fit (self-referential framework) of an innovation and its external fit (with the environment). The former should not be sacrificed to the latter. This is a condition of preserving dynamic flexibility. If the internal fit is affected by the search for external fit, the cumulative learning process could be interrupted and subsequent evolution made impossible. This is a structural explanation for the dynamic fit which could lead to an irrevocable position (Khalil, 1997). According to Goergecu-Roegen, Khalil dissociates "the irreversible change where objects can return to any previously attained phase but not by following the same course phase by phase in the reverse order [to the] irrevocable change [which] involve processes that cannot pass through a given state more than once" Khalil (1997) quoting Goergecu-Roegen (1971). Dissipative structures are responsible for irrevocable evolution while Lamarckism in evolutionary economics is concerned by irreversible change.

Proposition 2 : When the internal fit is sacrificed for the external one, the evolution process is not only affected in its ability to institutionalise new solutions but also in the quality of new variations. If the process of continuity can explain a gradual attraction toward a specific position, such renunciation of the self-referential framework can explain the lock-in phenomenon.

This idea of translation can be found in the field of politics. It relates to the political attitude conceptualised by Lindblom (1959) where it is crucial for politicians to give the widest meaning to their project in order to attract a greater number of sympathisers. They must refine this project with these people while trying to obtain a consensus in order to create a new powerful coalition.

This "unavoidable" ambiguity of strategies is precious in negotiations between people who can evolve in their preferences during the process itself (Baier, March and Saetren, 1968). If ambiguity is seen as being incompatible with innovation for the rational decision-making paradigm it appears here as a strength for the institutionalisation of innovation. In fact, strategic change is clearer in retrospect than during the period when it is taking place (Burgelman, 1994). A certain amount of ambiguity serves the institutionalisation of innovation.

Translation represents a kind of boundary repairing (Smith and Comer, 1994) designed to form a new community sharing the same values (Lant 1998). This process refers to a T3 motor.

Assumption 9: The E3 and T3 motors are in operation at the translation level. This step is a critical element in institutionalisation i.e. the retention of innovation, and the success of this retention will depend on the ability of the group to define new convenient boundaries around the community.

DISCUSSION

THE RECONCILIATION OF PUNCTUATED AND GRADUAL EVOLUTION

This model provides new insights into an old discussion about the rhythm of change. Some defend an incremental approach (Quinn, 1980) while others consider that change occurs because of disruptive events. Greiner (1972) associates these two features in a cyclical movement during the growth of a firm whereas others regard it as a Kuhnian process (Sheldon, 1980, Miller 1981) where the need to change is found in the coming of a new organisational paradigm. Most researchers consider that radical change is more effective than the gradual way and suppose that it represents the only opportunity to break through the cohesive organisational assets established during the inertia period (Miller and Friesen, 1980). By the same token, Hannan and Freeman (1977, 1984), and Aldrich (1979), in a less radical view, explain that, because of the cohesion of these organisational assets and because the market expects a constant level of quality, an effective organisational change cannot be a success. Firms should never undertake such transformations. New designs will be established by new entering firms.

Finally, from a Darwinian perspective, Singh et al (1986) state that evolution and revolution are not experienced alternatively, but simultaneously, in different places of the firm. The core follows drastic modifications but the periphery experiences a gradual adaptation. Darwin suggested a model where the phenotypes evolved gradually, but not the genotypes. The modern synthesis of the Darwinian perspective has suggested that genotypes underwent radical and hazardous change.

Proposition 3: An alternative approach where both gradual and punctuated transformations can be experienced at different levels of the system is possible. Going further still, we can assume that the one can explain the other.

The gradual evolution of an organisational species can be understood as produced by a punctuated transformation of populations which themselves are explained by a long maturation of firms considered as individuals (Nelson and Winter 1982). We propose the same relation at the micro level in as much as our model presents the gradual evolution of a firm as the outcome of the punctuated dynamics of groups which try to challenge the dominant routines.

Finally, we consider that this punctuated transformation can take its source from the gradual modification of the practices or mental maps of individuals who, when the time comes, decide to contest the dominant rules.

THE PARADOX OF THE DYNAMIC FIT

In the 1970's, contingency theory proposed different context-structure-performance relationships as good predictors of a firm's performance (Pugh et al. 1969, Child 1972). Following this, we can assume that the firm that will be the most successful in the mid to long term is the one that has been the closest to the evolving requirements of its environment. This is not a trivial point when compared with the following dilemma: the greater the fit between a firm and its environment at a specific moment, the harder it will be for the firm to give up its ingrained routines when the environment begins to change. This dilemma is considered as the "paradox of the dynamic fit".

We suggest that this is consistent in the social context with one of the laws proposed by Lamarck to explain change in animal life. He suggested that organs develop in proportion to their use. In respect of our discussion, exosomatic organs such as routines and sub-systems of routines operate in order to accomplish a specific function and are reinforced by their success. What is different between the animal and social contexts is the reason why an organ is used (and then developed). For animals, it is because this organ is used to satisfy a need. If the need disappears, the organ will regress.

Thus, use and need are closely related, and this is the adaptive perspective adopted by Nelson and Winter as we previously suggested in the theoretical framework.

On the other hand, in the context of social systems we consider that use and need are more ambiguously related. There is a remnant effect in the minds of members. A social system tends to persist with routines not only because they satisfy a present need, but also because they have been used to satisfy past needs. There are thus two interesting implications: first of all, the fact that past legitimacy can make up for a present lack of efficiency; and secondly, the fact that there is a great deal of ambiguity in the retrospective appreciation of the real reasons for success (Levitt and March, 1988).

According to the law stated above, the system is reinforced. The routine is used because it is developed, and it develops because it is more widely used.

The model shows a scenario where variation can be rejected at each stage of the evolutionary process. This internal failure of innovation makes the trajectory sensitive to the phenomenon of lock-in.

A routine can be preserved because of a continuity process and remnant legitimacy.

First, Simon proposes a mechanism of continuity [Simon, 1958] where attention and behaviour, once orientated toward a particular issue, tend to persist in the same manner for a long time. He adds that this is true even if the initial choice was of no particular strategic import, and this is particularly important for dissipative structures. Simon proposes three explanations for this tendency :

- sunk costs
- attention attracted toward continuity and achievement
- restarting costs

Secondly, the concept of remnant legitimacy explains the lock-in phenomenon by itself. As Burgelman (1994) reports, Intel's Geslach, vice-president of sales, complained that the board agreed to stay in DRAMS despite his argument that it wasn't profitable. For a whole year the board refused to change its mind while losses piled up. Of course, Burgelman argues emotional attachment to previous product success and bounded rationality in the face of a highly rapidly changing environment. However, like him, we should like to stress that the previous option had maintained widespread legitimacy. The more often routines are used, the more often other members adopt them within the firm in order to legitimise their actions, as Wesphal et al. (1997) explained concerning the adoption of TQM at the meso level. We consider that it is possible to replicate this analysis at the micro level. The initial adopters used the routine because it was efficient. Then the following adopters did so, even if there was no particular gain in efficiency, simply in order to be assimilated to the norms. This is consistent with the "social traps" analysis (Platt, 1973). The consequences are therefore different according to whether they are considered in the context of a micro or a meso/macro innovation. At the meso level innovating firms fear imitators. The former have developed a competitive advantage and try to diffuse this throughout the firm; the latter hope to benefit

from these efforts and try to erase this competitive advantage. Such pressure does reduce the life cycle of innovation [Mezias and Eisner, 1997]. As far as the institutionalisation of internal routines is concerned things do not function in the same way. If an innovator wants an innovation to be institutionalised (and then receive recognition and reputation as a payoff), he or she must do everything possible to encourage other members to use this solution. His or her efforts will be successful only if there is imitation. We are here in the presence of a competitive effort to impose a standard on a system of users. The more people who adopt the routine, the more legitimate it will become, and the more legitimate it is, the more people who will adopt it. In contrast to meso innovation, imitation does prolong the life of what becomes a standard procedure. The arrangement is stable i.e. able to absorb the shocks provoked by new solutions. The firm is on the point of being sanctioned by the external process of selection.

The continuity process and the effects of previous legitimacy seem to be subjected to the reinforcement phenomenon when attention is not reoriented toward a new stage of “boundary repairing”.

One can find at least three motives for reinforcement. The first is the easy access to previously chosen routines, the second is based on the previous efficiency of routines, and the third is linked to the sacrifice of internal fit to external fit, which thus tends to reinforce the self-referential backloops.

First, a routine can be reinforced because of the number of its previous adopters. Members tend to use this routine because it has been rooted in the context and is now highly familiar within the organisation as a whole. This enables the routine to be adopted more easily. Here, the percolation image and Polya urns model is helpful in understanding how the system goes its own way without taking effective performance into consideration.

Secondly, evolution can be attracted to a specific situation because of increasing income returns related to adoption, as shown with competency traps (Levitt and March, 1988). The payoff is based on the cumulative learning-by-doing that members carry out with established routines, which are then reinforced (Asquin 1995).

The more familiar people are with routines, the faster these routines overcome other solutions when a new problem occurs. This learning orients the choices made in a zone of upheaval.

No objective reason for the beginning of such a reinforcement process can be found other than what Schelling (1979) identifies as the “tyranny of small decisions”. Owing to an array of favourable circumstances an organisation will accumulate more experience with one specific routine among many, and this will orient its subsequent trajectory.

Thirdly, according to proposition 1, if the internal stretch required to achieve external fit has affected internal fit then members will propose more and more exotic alternatives which are no longer in accordance with the self-referential perspective of the firm. Then this chaotic tendency (Heiner 1983) will lead to inertia as a response and a lock-in phenomenon as a consequence. The system reproduces itself and there is less and less chance of its renewing itself since people are still convinced that the dominant practices are the best. This reinforces the legitimacy phenomenon, and so on.

As pointed out in the field of organisational learning, it is necessary to unlearn in order to undertake new learning (Nystrom and Starbuck, 1984). This process is impeded by the lock-in phenomenon and this prevents the system from experiencing any creative destruction of routines.

DESIGN OR TRAJECTORY: WHICH IS SUBJECT TO SELECTION ?

Firms located in the same industry and functioning with similar resources (engineers from the same schools, an equivalent level of technology in the means of production, comparable organisational structures, similar legal status) can experience contrasted organisational and technological trajectories.

Such diversity in organisation (static) and trajectories (dynamic) seems not to be a judicious issue for management sciences. The literature on strategy, for instance, takes diversity as a given, since without this diversity no specific strategy could occur. The research agenda is devoted to elaborating the tools capable of discovering new niches for firms and not to understanding where such diversity comes from.

On the other hand, since the late 1960's the contingency approach has considered that such dissimilarities reveal the fact that some firms are mistaken as to what they should be doing. The specific environment of a given industry implies certain requisite conditions and, as a consequence, all the firms within this industry should adopt the optimal arrangement of resources in order to respond to these requirements. There is perhaps no one best way, but there is always a better way to respond to the peculiar circumstances of this specific industry. The literature concentrates on discovering the right designs rather than seeking to explain such diversity, which need not be understood but simply corrected.

Is "Why are there so many different organisational forms" such a trivial question? We consider this to be a highly relevant issue especially for evolutionary analysis, but few research programmes actually have it on their agenda (Davis 1996).

The paradox of the dynamic fit supposes that diversity at a specific moment can not be subject to selection because the environment is looking for an ability to evolve in the mid to long term. This does not affect the contingency theory by itself if we admit that it is a static approach or, in other words, a theory about diagnosis and not about change (Lawrence and Lorsh, 1967). The consequences are much more interesting when we consider the ecology of population theory as an extension of the contingency theory, situated in a dynamic perspective.

According to natural selection of the fittest, the ecology of population theory explains that a population tends to be homogenous. Owing to the "struggle for life" the least fit are pushed out of the industry. It can affect firms' strategic portfolios or lead them to file for bankruptcy. If diversity exists, it is mainly in a sequential form renewed by the entry of new firms, since organisational evolution in the "living" population is supposed virtually impossible or too risky. Diversity is essential in order to regenerate the evolution process but it is still exogenous. There is no precise explanation of the mechanisms of variation. Selection is what the literature focuses on, and diversity is firmly in the background.

But if we look at the general rather than the partial evolution of all the populations of all species, and if it is virtually impossible for an individual to create a new variation, then two questions have to be answered: first, where does original diversity comes from, and second, why does overall diversity not decline over time? At the population level selection operates only between existing variations but doesn't explain variation itself.

Spontaneous change in the blueprint of a particular firm is generally cited as an explanation of variation. This specific Darwinian mechanism allows the most appropriate changes to be selected and to be diffused among the population. Obviously, the problem is to understand what is spontaneous in the social sciences, and why these changes, rather than adaptive modifications, can occur.

A major consequence is that the orientation of evolution, as in organic evolution, can hardly be anticipated (Low, 1995). There is clearly suspicion of the effective role of human

consciousness and ability of people to drive their evolution, a position denounced in her own time by Penrose (1952).

Two kinds of flexibility are in conflict here. The ecology of population theory deals with a static flexibility in which the firm makes choices which represent a renunciation of other alternatives and thus progressively diminishes its degree of freedom. For our part, we propose that the firm has an ability to create, select and institutionalise new alternatives. This dynamic flexibility is only affected if the firm is trapped by the mechanism of continuity which leads it constantly to seek the best fit. The arguments of the ecology of population theory concerning inertia are thus admissible at the extreme pole of a wide continuum of possibilities. However, these are not considered as the sole nor the main possibilities.

As a consequence of this paradox, different designs can underpin equally successful trajectories while the same design can underpin both viable or defaulting trajectories at the same time. Selection operates between trajectories and not between designs. The principle of selection considered by the ecology of population theory is questioned.

Proposition 4: The principle of selection put forward by the ecology of population theory is called into question by the paradox of dynamic fit. Thus we can consider that selection operates between trajectories and not between designs.

CONCLUSION

We have shown that endogenous variation can be understood within a model of self-organising dissipative structures where an intricate network of “motors” is influenced by social groups. As a consequence, evolution is not necessarily self-sustaining, and the orientation of the trajectory will depend on social interactions. Members are responsible for variation but also for selection or retention.

Hannan and Freeman’s conception of inertia is an extreme situation within a wide array of possibilities. It explains a situation in which the firm remains far removed from any zone of upheaval. This distance is analysed with social parameters i.e. inertia is not inevitable and can be managed..

Proposition 5 : Darwinian principles of evolution are considered as an extreme case of Lamarckian evolution. These two approaches should not be opposed but considered specific to particular circumstances. We only wish to suggest that an alternative Lamarckian approach explains regular evolution and that Darwinian theory is appropriate in explaining trapped evolution. Between these two positions we have the adaptive behaviour proposed by evolutionary economics.

Proposition 6 : The dynamics of the situation are sustained if managers understand their role as institutionalising agents whose duty it is to increase the likelihood that the best processes and routines may thrive (Miner 1994). We can define such a role through the following three points:

- First, top managers should accept that, within the present environment, disequilibrium can exist in the firm, and that this is essential in order to enable the firm to remain innovative as far as its response to the future environment is concerned (Smith and Gemmil, 1991);
- second, managers have to get people and groups to be prepared to give up their innovative intents if the latter are not consistent with the self-referential vision of the firm;

- Third, the firm as a collective should not be trapped by few well-established routines which incarnate all the learning, the attention, the resources and legitimacy of the past. Managers must develop new criteria of legitimacy and should orient the translation process in order to help people to understand the potential of new solutions for their current problems.

Managers should not drive a specific change in order to obtain optimal fit for their organisation but should seek to pilot a trajectory which shows the best average proximity to the environment. This is a challenge for a new kind of management which, on the one hand, has to avoid allowing certain administrative innovations to become institutionalised as routines (even if top managers are considered as reactionary) and, on the other hand, develop a critical stance vis-à-vis the established system of legitimacy. This type of management consists in channelling organisational trajectories.

Since organisational evolution is embedded in a specific trajectory (specific assets, cumulative learning, absorptive capacity) and moves like molasses according to the now famous remark by Herbert Simon, this discussion justifies the view that a firm tends to bring the environment closer to its possible zone of evolution in order to benefit from a better fit without weakening its dynamic flexibility. It is an ultimate variation on classical Lamarckism where individuals only adapt to environmental pressure. From our perspective, firms are supposed to be able to modify and to orient the nature of the constraints. Maybe that is the main difference between adaptive and innovative firms.

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