Expectations and learning as principles of shaping the future

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> *"Stop visiting the past, visit the future. What a beautiful expression! Pereira said, visit the future, what a beautiful expression, I had never thought about that before"* Antonio Tabucchi, *Declares Pereira.*

1. Introduction.

We start by evoking a sentence from *Declares Pereira*, the novel by Antonio Tabucchi, because it expresses poetically the emerging fashion of today that encourages thinking about what the probable future may be as a principle for approaching life.

We have witnessed, in the last years, the growth in popularity of a new generation of planning tools, associated primarily to science and technology policy, but also to the management of innovation, that include among others, foresight, technology assessment, scenario analyses, etc. These tools aim to improve our information on the possible future states of the world (either as results of our own actions or others) with the objective to improve our decision making when confronting choices or selecting different courses of action. What these new approaches tell us (from normative and prescriptive views) is that when selecting a course of action or making a choice we must take into consideration the future. However, besides the normative side of the recommendations, what is true is that imaginations of the future, like imaginations of the past, are devices for living in the present (March, 1995); that is, constructing possible futures serves today's life.

More recently, some sociologists studying science and technology, whom generally consider social actions as being very much constrained, have started to call to our attention the relevance of some variables associated to future, such as *expectations* or *promises*. Associated to this increasing interest on the future, empirical cases recently published (e.g. van Lente and Rip, 1998) on the role expectations or promises play in the development of science and technology. However, although these empirical cases define limited ambitions in explanatory terms, there is an emerging tendency to establish generalisations based on these arguments. We would like to signal the risk of under theorised generalisations, especially in such that they conflict with some of the evidence based theories in social sciences.

The future and other associated concepts have been traditionally part of the underlying models of social sciences, especially in economics, hence we can draw from these experiences and learn from these studies. In fact, what is presently the dominant model of understanding, rational choice, includes in its basic postulates considerations on the future states of the world as critical elements in the decision making processes; there is a central concern on issues associated to the future and how the possible futures states of the world may influence our present choices.

Our intention in this paper is not to reject these new sociological approaches or the empirical relevance of the variables identified, but to bring some insights from behavioural decision theory and organisation theory to insist that there are other variables that should be considered in the process of decision making and action in addition to or besides expectations and futures. We agree that the future is important for the present, but to suggest that whether the views of the future become self-fulfilled is a different matter, this is consistent only with a very fundamentalist view of rational choice postulates.

What we will do here is to confront the arguments on the role of expectations in science and technological development with some of the established theories, especially organisational decision making. Our departure point is what theory tells us about individual and organisational decision making and how this causal model could contribute to enrich our empirical investigations.

The paper begins by briefly introducing the emergence of foresight as an information tool in which expectations on the developments of science and technology form a significant part. The next section discusses the recent sociological approaches to the future as a key factor in human behaviour. The following section covers how these approaches relate to rational choice decision making models and its limitations. Finally, we will present other models that include learning, experience, rules and identities which complement the role played by expectations in order to explain the behaviour of innovation actors.

2. Fads and fashion on the future and foresight.

The future is what matters in the present. Although this statement may seem somewhat simplistic or obvious, what is true is the fact that forecasting, foresight, prediction and other derivatives of the future have become recently the main focus and attention concerning social, economic, and political issues, but even more so in the areas of science and technology (see Irvine and Martin, 1984 or Martin and Irvine, 1989). In particular, concerns on the future developments of science and technology have led many actors, whether they be firms, organisations, or governments to engage in informal and formal foresight or future oriented processes to help determine, understand and even shape the future developments in scientific and technological areas.

As a result of the efforts of improving our decisions, particularly in very uncertain environments, new tools and forms of systematic collection of information have emerged in which foresight has extended in the last years all over Europe and abroad (see EC -Cameron, Loveridge, *et al*.,1996; IPTS -Gavigan and Cahill, 1997; OECD - Martin, 1994). In Europe, we have witnessed many national level technology foresight

exercises, for example in the UK, Germany, the Netherlands and France promoted by policy makers to aid in co-ordination of science, technology and innovation policies. These exercises are booming and other countries and regions also feel the need to promote and carry out foresight exercises.

Foresight may be described normatively as a two dimensional activity: the production of information, in the form of reports, documents, etc. on future tendencies and the interaction process between actors to co-ordinate their research, development and innovation activities through a large scale consultation and mobilisation exercise. The more traditional vision is to consider foresight as an information support device for decision making , and in this sense it has the same effect as other information pieces have on the decision making process, which is primarily legitimation (Sanz-Menéndez, *et al*, 2000). Foresight has emerged as a part of the general dynamic of policy making of linking problems and solutions, and in most cases, the purpose is to provide information in order to improve the capability of policy makers of dealing with uncertainty, that exists especially in the areas of science and technology.

Based on the perception of technological innovation as an inter-organisational process, more recently technology foresight is being employed by policy makers with the aim to improve the competitive position of the innovation actors within systems of innovation. Foresight activities assume that strategies and future expectations on scientific and technological development can be merged by considering medium to long term time horizons. In an explicit way the purpose of foresight has been to align expectations of different organisations in innovation systems, to improve the co-ordination of S&T developments in the policy context.

Furthermore, these search processes of information on futures or foresight exercises are not only occurring at national or regional levels for co-ordination and policy making purposes, but also undertaken at the level of individual firms, research organisations and other institutions. It is undisputed that the future (and how people see the future, even in probabilistic terms) is relevant to understand actions of individual economic agents.

Innovation actors have expectations on the future developments that shape their behaviour, and these expectations could be modelled through interaction with other innovation actors. In general, we have been witnessing that participation in the foresight process have shown potential benefits in adjusting mutual expectations on technological development of the different actors. What has attracted attention of sociologists is that expectations matter in influencing behaviour and decision, however the key issue is to build up a coherent model of how they become relevant and how they relate with other variables explaining human action.

3. New sociological approaches to the future as a key factor in explaining human action for technological development.

The concern for decision makers has been focusing in how to encapsulate or incorporate the future into their present decisions. Policy makers have increased their demand of knowledge about future, more precisely forecasting and predictions about the evolution of complex systems, even at the risk of changing the traditional understanding of prediction in scientific work. The use of prediction emerges a means of legitimising policy and decision making in science policy (see, for example, Savewitz and Pielke

(1999) with illustrations from environmental policy). Even within the social sciences[3] academic circles, this focus on the future has been well recognised, and efforts have been made to find explanations about what role future may play especially in shaping developments in science and technology.

In recent years, in social studies of science and technology, a concern on the role of expectations has emerged and has been introduced into the explanatory models of science and technology development. Expectations (or other concepts related to the future) have become a central concept in arguments about the developments in science, technology and innovation.

The main sources of inspiration for these new sociological approaches are in debt with the social construction of science and technology views, more precisely the socio-technical network approach. Technological developments and changes, the adoption and diffusion of technology as well as general advancements in S&T are seen as the outcome of the activities of research, development and investigation processes. However these processes are embedded, constructed within, and supported by, social structures of knowledge production. In other words, technological change and evolution, with its varied rates and directions is a result of the interactions between heterogeneous actors within these social structures or networks. These interactions are governed by norms or "rules of the game" within these social structures. Our next step is to explore some of the concepts.

To account for the emerging technological developments, some underlying social structures have been identified: *techno economic networks* (TENs). The configuration and dynamic of these TENs depend on several factors which include: the set actors (the formality and durability of their relationships), the intermediaries (both human and non-human), the resource dependencies, the binding and decision rules throughout the network, the negotiation processes of issues at stake, and other processes such as the stability and irreversibility, or the dynamics of convergence and divergence of the TEN, etc. (Callon, 1986a, 1986b, 1991 and 1995).

TENs are formed by heterogeneous elements and their composition is dynamic, that is they evolve over time. A TEN can thus be characterised in the degree of diversity of its composition as well as its degree of evolution. This idea encompasses concepts of innovation studies, which characterises innovation processes to be systemic in nature rather than linear from science to market , and these processes involve social as well as technical aspects although they are often path dependent. The overall process of building TENs is linked to "translation", characterised by four stages: problematisation, interessement, enrolment and mobilisation (Callon, 1986a). For example, the concept of enrolment defines the manner by which actors gain audiences and join others in a common process of knowledge and technology development and utilisation. Enrolment involves aligning strategies, and coalitions can be formed through co-operation mechanisms that are used within competitive environments. However, what is of our

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[3] We should also mention that in other research areas such as comparative policy or public policy we have also witnessed the emergence of *ideas* or *beliefs* (Hall, 1989, 1993; Golstein, 1993; Goldstein and Kehoane, 1993) and e*pistemic communities* (Hass, 1992) as independent variables explaining sharp policy turns in many policy domains; a revival of the traditional arguments from Max Weber that ideas (worldview, causal models, etc.) are a decisive variable –in association to interests- to understand human behaviour.

interest is to what extent, behind these coalitions mechanisms in the formation and mobilisations of social actors within a TEN, we find that promises, preferences or expectations on the future play a significant role. Many authors have attempted to use these or related concepts in their empirical studies to explain processes in innovation and scientific and technological development.

Akrich (1992a) made a clear presentation of the postulates of the approach when discussing the social construction of technology and stated that a technical artefact can be described as a scenario which represents the roles and directions governing the interactions between actors (both human and non-human) who in turn are supposed to assume those specific roles. The innovation process must cope with the ability to manage differing relations with users whose abilities and expectations can be extremely variable. The success or failure of an expectation varies according to whether it is simply an actor's projection (their future alone) or is integrated across all socio-technical dimensions of the case. In the end, the agenda may become what Akrich (1992b) has defined as a script, that is, a declaration of the motives, aspirations, and commitments, inscribed in the expectations of the new technology. Such scripts are deployed to predetermine a future world through socio-technical prescription and impose specific actions. Along the same vein, De Laat (1996) studies the case of ADEME a French agency involved in supporting technical research in the field of energy and environment. He discusses how future socio-technical environments are implicit in the actions, the programs or technical objects developed by the agency, which in turn shape the agency's future behaviour. His contribution relates to a procedure for making explicit actors' script-based scenarios. What is implicit in his analysis is that actors use expectations embedded in the emerging technologies to define their own positions and then strategies with respect to them.

De Laat and Laredo (1998), exploring the relationship between innovation studies and foresight, conclude that integrating lessons from innovation studies drives the focus of foresight from a predictive to a procedural conception. Here they argue that the foresight processes can be seen as an arena where future scenarios of different actors meet (policy makers and researchers), thus the effects are to promote as well as confront these scenarios. The authors use two meanings for scenarios, in one sense the formal scenarios used in foresight exercises, and in another, the trajectories actors envisage which represent the world they try to construct and inscribed in their actions as attempts to stabilise or modify the TEN that they form part of.

A special comment should be made on a significant empirical contribution by Van Lente and Rip (1998), because of its relation to future issues. It represents a practical attempt to converge two main streams in science and technology studies: sociology of scientific knowledge and political sociology of science. Van Lente and Rip (1998) present a case on the emergence of "membrane technology", partially based on van Lente (1993), as a new scientific and technological field under the context of strategic science policy. But what interests us is how they describe the process of interaction between actors through cognitive and structural variables, and how that contributes to the transformation of the rhetorical space of promises into a social reality.

The basic idea in the explanation of the process of socio-technical construction relates to the effects that the dynamics of expectations have on social actors' behaviour. First a specific label emerges as a direct result of the scientific entrepreneurs actions,

and around that label a set of expectations are formed. These expectations imply that the emergent technology brings promises, which then progresses as a generalised solution to problems. Expectations and promises become the tool used by research entrepreneurs and spokespersons to construct the audience, first in the policy makers world and then for firms and enterprises. Within the process, researchers, firms, and governments tend to legitimise claims of resource by promises on the development of technology. The result is a dynamic of expectations in which the rhetorical space, that is created through these claims and promises, gradually evolves in a reality that shapes the strategic actions of the actors.

Although the description is very attractive, there are some unexplained points, and while van Lente and Rip derive an interesting explanatory arrangement to account for the connection between cognitive aspects and actors behaviour, the solution taken is quite idealist, because they have forgotten almost completely the basic difference between what is "seen" and what is "desired", the distinction between expectations and preferences. In this model, in our opinion, there is a risk of neglecting some critical aspects. .

The authors almost overlook the effects of the structure (interest) on behaviour, the existence of conflicts of interests, or in terms of the rational choice models, they do not enter into the preferences of the actors. Consequently with the argument developed, a question arises: when do the actors sacrifice their preferences, what they like, because of what they expect or what they see? It is critical to take into consideration what actors like or prefer, because it is quite plausible to imagine a realistic situation in which besides an expectation over some technological development actors' preferences push their behaviour in opposite directions, in this situation the model proposed by van Lente and Rip will not work.

On the methodological grounds it should be stated that they have selected only a "successful case", in which the technology becomes a social reality. They attribute the success to the expectations that formed through "mutual positioning", however this mechanism appears decisive only if actors make sense of their interactions as games of strategy (Schelling, 1978). Taking some non successful cases of technological development, such as the electric car reported by Callon (1986b), how then can we explain that Renault did not want to participate in the agenda proposed by the electricity company, even if the expectations were extraordinary. The idea of "mutual positioning" may be a way of dealing with conflict of actors' interests opening a bargaining process over the coalition of the TEN. Also a more careful analysis of the success or failure conditions in coalition building could open the door for a "repositioning" of the role of expectations in the explanatory model. Overall, what emerges through these examples is how the future is incorporated into the present and how expectations may dictate the development of science and technology, but more specifically how expectations influence the behaviour of actors.

However, while sociologists attribute novelty to the arguments around expectations and promises, we have found that economists for some time have paid attention to these issues. As we have already mentioned, expectations over future states of the world were central in the traditional rational choice decision making approaches.

4. The role of future expectations or preferences and economic analysis: rational choice decision making models.

Economic theory, and somehow psychology, has attributed to expectations a quite significant role framed on schemes based on rational choice and methodological individualism (Arrow, 1974). Economic theory has traditionally defended that human behaviour can be understood as having a large rational component even beyond the more specialised sense of maximisation and that the dynamics of rationality largely influences choice and action. Economic analysis has even claimed that the concept of rationality has been the main "export commodity" in its trade with other social sciences (Simon, 1978).

Some of the developments in economics have confirmed the central role of the expectations in the economic models. The reason is clear, virtually all economic decisions, other than the trivial, involve the aspect of time. In this context any decision must make an estimation of future. Such estimates may be based upon the extrapolation of past trends or, alternatively, may be based upon different scenarios involving optimistic or pessimistic assumptions generating a range of possible outcomes with different probabilities applied to each.

As a reaction to traditional non-rational or naive expectations formation a complete line of research has been identified as "rational expectations" (Lucas, 1976; Shaw, 1984) where rather than forming expectations on the basis of limited information drawn from previous experiences, people take into account all available information. For example, when governments announce that they would do whatever necessary to promote innovation, people by taking into consideration this information on innovation policy, would adjust their expectations accordingly.

The idea of rational expectation in economics has two components: first, that each person's behaviour can be described as the outcome of maximising an objective function subject to perceived constraints; and second, that the constraints perceived by everybody in the system are mutually consistent. The first part restricts individual behaviour to be optimal according to some perceived constraints, while the second imposes consistency of those perceptions across people. In an economic system, the decision of one person form parts of the constraints upon others, so that consistency, at least implicit, requires people to be forming beliefs about others' decisions, about their decision processes, and even about their beliefs (Sargent, 1993).

In fact, these hypotheses are quite restrictive, however economists have embraced it, applying them especially to the study of financial markets, as a reaction to the non-rational of naive expectations. The reasoning is that if perceptions of the environment, including the perception about the behaviour of other people, were to be left unrestricted, then models of people's behaviour which depend on their perceptions could produce so many possible outcomes that they are useless as instruments for generating predictions, and thus formal models.

Even studies on the economics of technical change for sometime has recognised the important role played by expectations of future changes and its influence on economic agents' behaviour. For example, Nathan Rosenberg (1976) discussed the role of technological expectations and how these influenced the decisions, specifically in the

adoption and diffusion processes of innovations and new technologies. Technological expectations are an important determinant of entrepreneurial decisions with respect to the adoption of innovations. Since technological future is obscured with uncertainty, different economic agents will hold different expectations and their behaviour will further differ due to varying degrees of risk aversion on the part of decision makers. The point made by Rosenberg is that overall technological expectations play an important role in the decision making processes of innovation, not only in the adoption (which it may cause to delay) but also in determining the characteristics of the actual innovation chosen.

Other economists have addressed the issue of how expectations in their influence on firm decision making mechanisms. For example, Hall (1994) identifies three types of expectations. *Adaptive* expectations are those that decision makers in firms make when they revise single forecasts by correcting previous errors. *Static* expectations are those that forecast by considering that the exogenous variables will remain at their current levels, while *rational* expectations are when firms form expectations according to the stochastic processes presumed in generating the exogenous variables.

Underlying the basic model of understanding human behaviour in terms of rational choices there is a set of basic postulates (more or less modified). Rational choice is based on three assertions: universality, context representation and rationality. What this means is that every significant action is a result of choice, that to choose what course of action to take depends on the context in terms of the choice situation, e.g. the set of available acts and their consequences, and that finally the action chosen or selected is based on a calculation of the value (Lane *et al*. 1994).

Human action is the result of human choice, and decision making is viewed as intentional and consequential. In the most familiar form of the model, it is assumed that all alternatives, the probability distribution of consequences is conditioned by each alternative, and the subject value of each possible consequence are known; it even is assumed that the choices are made by selecting the alternative with the highest expected value. This emphasis on the expected value may be moderated by a risk preference (i.e. some value associated with the variability of the outcome distribution).

These underlying theories of rational choice presume two guesses about the future, the first guess is about the future consequences of current actions and the second is on the decision maker's future preferences for possible future outcomes. In the first case, choice or decision depends on the uncertain future consequences of possible current action, and that although it is well recognised the human limitations may restrict the precision of the estimates, that the estimates may be biased and that the information on which the estimates are based may be costly, the information about probable consequences is assumed to be decisive for the choice. In the second case, choice depends on the preferences of individuals which are assumed to be stable, unambiguous and consistent.

Within this rational choice frame a distinction can be made between beliefs about what a person *sees* and what a person *desires*, thus linking these ideas to the distinction between expectations and preferences. Desires include the ways in which actions and outcomes are defined, theories about the world are given credence, and the interpretations of those theories are elaborated. The beliefs about what a persons desires

or likes include affective sentiments, values, and tastes. However, the process that is postulated for coming to believe that something exists is not fundamentally different from the process for coming to believe that something is desirable, because individuals construct meaning in the context of becoming committed to the chosen action by organising arguments and information according to their beliefs (March & Olsen, 1989).

In this model, partially assumed by the new sociological approaches, we can observe the important role that information plays. The sources of information, its availability, the context in which it is provided, etc. are factors which may directly influence the nature of the expectations formulated. Under this rational choice frame expectations are subject of changes by new information acquisition, and can influence choices, but in summary, rational choice sees decisions as based on an evaluation of alternatives in terms of their consequences for the actor preferences'. That is, any improvement on the expectations of a technology would not imply that actors prefer it to some other alternative in which they have interest.

However, we find that there are limitations to the simple use of this model, and its sociological derivatives. To build up our criticism to the expectations as a central concept in the explanation of behaviour we will insist on two lines of argument: a) the first one states that rational choice provides an inadequate foundation for action, in particular for understanding the innovation process in organisations. From a cognitive view economic agents are not the kind of entities that conceptualise their world in the ways required by rational choice. From a structural side economic agents interact in networks of relationships which induce processes that constrain the set of possible actions but also provide opportunities. These generative relationships are incompatible with the idea of prospective comparative evaluation of future prospects as defended by rational choice models (Lane *et al*, 1994). b) The second line of argument defends that more often organisations and individuals fulfil identities and thus they follow rules or procedures that they see as appropriate to the situation in which they find themselves. The logic of consequences (based on rationality) can be contrasted with the logic of appropriateness, in which actions are matched to situations by means of rules organised into identities, and neither preferences nor expectations of future consequences enter directly into the decision making process (March, 1994). This relates to the fact that individuals are not the same as organisations, especially since organisations may have conflicting objectives.

The arguments against rational choice do not pretend to imply that organisations and individuals do not make rational calculations, but rather they suggest an alternative form understanding complex processes such as innovation. Our point is to insist on the danger in generalising the role of expectations as the main explanation for scientific and technological development. We believe that the arguments made by critics of rational choice shed some light along the same lines in understanding human behaviour and the role the future plays in the strategies adopted by policy makers, researchers and firms in science and technology.

From cognitive psychology and organisational theory many criticisms have emerged on the factual foundations of the rational choice model, insisting on the fact that we can observe significant bias in the choice of decision makers. For example, March and Shapira (1987) have emphasised the role of illusion of control of the situation as a bias of highly optimistic judgements of risks and opportunities. Kahneman and Lovallo

(1994) have insisted on the adoption of "inside views" which leads to anchoring plans on the most available scenarios. However it is interesting that these bias in the choices, that usually are identified as sources of failures, may be mechanisms by which the actors involved in socio-technical networks could reinforce their commitment with emerging technological expectations.

Actors (individuals and organisations) make their guesses about and use expectations as information devices within situations to determine what to do. But the process of choosing and acting (even accepting the basic model of rational choice) depends on many other variables. The available literature has brought us to question not these relationships but rather if there are some other or additional factors that need to be taken into consideration.

While in the specific case of membrane technology the explanation could be empirically adequate to account for the process, the generalisation of the argument on expectations as main source of dynamics in technological development is another question. Expectations are intervening variables, but cannot be considered as the main independent variable of behaviour. In logical terms, our point is that we accept that expectations are a necessary condition to explain the developments in science and technology, *but not a sufficient condition*.

5. Additional elements to explain human and organisational behaviour.

We have witnessed that the use expectations as a central concept in explaining human behaviour has a strong association with approaches based on rational choice models. And we have analysed some of the criticisms made to the plausibility and adequacy of those models to the real behaviour of actors. This section will develop a better understanding, built from alternative models of human choice, on how the future influences the actions of actors.

In addition to rational calculation, actors follow very often a logic that can be described in quite different terms. Instead of thinking of decisions as intended rational choices, we focus on recent studies of organisations which indicate that decisions often stem from the *logic of appropriateness* rather than the logic of consequentially, and that decision-making processes may often are better understood in terms of other consequences rather than their outcomes. It has been said that "decisions happen" (March, 1994) instead of decisions "are made" to suggest that the organisational process that produces decisions may be poorly understood by a simple conception of intentional future-oriented choices.

This alternative to rational, anticipatory, calculated and consequential action is based in an alternative decision logic, the logic of appropriateness, obligation, duty and rules. In fact, much of the decisions we observe reflect the routine way in which people do what they are supposed to do, and much of the behaviour in organisations is determined by standard operating procedures, professional standards, cultural norms, and institutional structures.

In this model of decision making the future is not necessarily important and the logic of human behaviour responds to norms, rules and identities that draw from past

experiences or *learning processes*. Decisions are based on how well they "fit" into the environment. There is no assessment of the future (no expectation formulated) and action does not necessarily form part of a choice process. While in the traditional consequential models it is implicit that choice generates action, where an expectation can be defined as something that is considered likely or certain and is used in calculations for choices. As it has been said, attributing such a central role to the expectations responds to the traditional model of decision making process.

The logic of appropriateness sees decision making based on rules and identities where there is a question of recognition (what kind of situation), a question of identity (what kind of person or organisation) and a question of rules (what does a person/organisation do in such a situation). Rule based decision making proceeds differently from rational decision making because its establishes identities and matches rules to recognised situations (March 1994). Rather than evaluating alternatives in terms of the values of their consequences or adjusting to the emerging expectations, rules of appropriateness match situations and identities. For example: *Situation* (How do I define what kind of a situation I am confronting? For instance, a situation in which the research actors has discovered some property or feature in the laboratory). *Identity* (What kind of a person am I? I am a researcher). *Matching* (What is appropriate for a person like me in a situation such as this? In this case, before strategic science emerged one would probably have been only concerned with the publication of the results, but in the last two decades new rules have emerged that increasingly define that the research (even academic) should try to disseminate, mobilise, etc. If we were to look back on the case of "membrane technology", even though expectations are relevant in the explanation of the behaviour of researchers, we also could consider the changes in identities of researchers and especially the emergence of new rules as a result of the new strategic science.

The rule following behaviour is not wilful in the normal sense. It does not stem from the simple pursuit of interest and the future calculation of future consequences of current choices. That is nor preferences or expectations play the key roles, rather, it comes from matching a changing (and often ambiguous) set of contingent rules to a changing (and often ambiguous) set of situations. Rule following can be viewed as an implicit agreement to act appropriately. The existence and persistence, the development and transformation of the rules is then the basic issue for the explanation. The understanding of what is appropriate evolves over time, and current rules store information generated by previous experiences, thus roles may be seen as coded information.

However, looking at decision and action we can not forget in the analysis the environments of organisations and individuals, as a basic element that creates the conditions for adaptive reactions, because many specific changes in organisations have resulted because they seek to survive and are selected by their competitive environments.

Rules and their environments adapt to each other by means of several intertwined processes. These processes by which identities and rules come to anticipate the future or reflect the past include two main aspects according to March, (1994): *Analysis*, that involves anticipation and evaluation of the future consequences by intentional decision makers, –a forward looking process; theories based on analysis as the primary

mechanism of adaptation presume that rules reflect expectations of the future. *Bargaining* which is a process of negotiation, conflict and compromise among decision makers with inconsistent preferences and identities –that can be either forward or backward looking process or both.

Furthermore, there are three major processes by which rules develop: *Imitation* that involves the copying of rules, practices and forms used by others, which is either a forward or backward looking process or both. Imitation, is a common feature of organisational adaptation, and decision making can be seen as reflecting rules that spread through a group of organisations like fads or fashions. *Selection* considers the differential birth and survival rates of unchanging rules and decision making units that use them, it presumes that rules reflect history. Selection, is a process that could be identified if the individual rules are invariant, but the population of rules changes over time through differential survival. Finally, *learning* comes from experience based changes of routines and of the ways routines are used and it also presumes that rules reflect history. Learning is a process by which actors or organisations modify the rules for action incrementally as a result of feedback from the environment and such experiential learning is often adaptively rational.

Theories of rational action in decision making processes presume that expectations and wilful actions of human beings enact the future in the present. Rational actor models explain adaptation in organisational rules and forms as a result of the preferences of actors and their calculations of future consequences. In contrast, theories of identities, rules and institutions tend to emphasise history dependent adaptation for the decision making process. The past is seen as imposing itself on the present through retention of experience in routines. Historical processes by which the present encapsulates the past are the mechanisms of theories of change, including theories of learning, culture and natural selection[4] (March, 1995).

However the adaptiveness of organisations to their environment and uncertainty involves both the *exploitation* of what is known and *exploration* of what may become to be known (Levinthal and March, 1993; March, 1991). Exploitation refers to short term improvement, refinement, routinising and elaboration of existing ideas, paradigms, technologies, strategies and knowledge. It emphasises improvement of existing capabilities, competencies and technologies. Meanwhile, exploration involves risk taking and refers to experimentation with new ideas, paradigms, technologies, strategies and knowledge in hope of finding alternatives that improve old ones.

Exploitation and exploration are both necessary for organisations, because exploration produces variety in experience (experimentation, variation, diversity) while exploitations produces reliability in experience (selection, consistency, unity) (March 1994, 1995). Then the problem is finding the balance between the two because survival depends on both. Rational choice theories represent that balance as a problem of balancing search and action; institutional change models the problem of balancing change and stability; and theories of evolution see it as the problem of balancing variation and selection.

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[4] We should state that there is convergence of our organisational arguments with some of the new economic arguments that convey relevance of the trajectories of developments and irreversibility of some dynamics and processes, such those stated by Brian Arthur (1989; 1990) and Paul David (1985).

But the dynamics of learning tends to destroy the balance, because the returns of exploitation of existing knowledge are systematically closer in time and space than are the returns of the exploitations of possible new knowledge emerging from exploration. This situation produces two "traps" of adaptive systems: the "failure" trap and the "success" trap (Levinthal and March, 1993; March, 1991). In this context, the imagination of possible futures is a mechanism used by organisations in helping them in their process of exploration and experimentation because the proposed futures insulate exploratory ideas from the hostile environment. Inventing the future, either from past or from imagination, serves to stabilise organisational understanding and expectations. However, while imagination of futures serve the process of exploration, the consequences of insisting on the future and forgetting the present (that is capabilities and competencies) could be disastrous for individual organisations.

Again we have to remember that choice and action are not interchangeable terms. In complex foresight horizons (Lane and Maxfield, 1995) characterised by rapid change, uncertainty and ambiguity, firms strategies in order to survive should consist of an on-going set of practices that interpret and construct the relationships that comprise the world in which firms act. Interpretation means making sense of what is happening and to act on the basis of the understanding. In this sense, we find that the most important actions that agents can take are those that enhance the generative potential of the relationships into which they enter with others. As a result, they must learn to set aside prior expectations and plans and follow where the relationships lead. Interaction is a mechanism providing vital information (either by transforming expectations or learning from others) and thus influences the behaviour of actors in context of mutual dependence.

Nevertheless, although individuals and organisations follow rules and identities it is not to say that their behaviour is always predictable. Rule based behaviour contains uncertainty, while situations, identities and rules are often ambiguous. Decisions (and actions) depend processes of recognition to classify situations, processes of self-awareness to clarify identities, processes of search and recall to match appropriate rules to situations and identities. All these processes are reasoned action but they are different from the processes of rational analysis (March, 1994).

6. Final remarks

Recently, studies have brought to our attention the relevance of some variables associated to future, such as expectations or promises. We find that expectations on the development of science and technology are emerging and constructed within socio-technical networks known as TENs. The concept of TENs is based on the idea that innovation processes are non-linear and systemic and involve social as well as technical aspects, although they are often found to be path dependent. This has been promoted especially through the widespread foresight and future oriented co-ordination exercises occurring at all levels (national, regional, organisational). Consequently, increasing importance has been given to expectations in influencing decision making processes of the innovation actors.

This paper has attempted to question the relationship between expectations and decision making processes. In particular we must remember that decisions in organisations,

involve a complex ecology of factors: 1) trying to act rationally with limited knowledge (and expectations) and preferences coherence; 2) trying to discover and execute proper behaviour in ambiguous situations; and 3) trying to discover, construct, and communicate interpretations of a confusing world. However, in this complex situation, to build up a description of the action process of actors only in terms of expectations could create misunderstanding of the real world.

Expectations may be considered a mechanism of relevance when talking about individual actions and its consequences. Though when we address the problem of organisations (firms, organisations, etc.) and their expectations, what we confront is a complex problem of the construction of social expectation. It is risky to apply simple explanatory models developed for individual behaviour to account for behaviour of organisations and collective actors.

Expectations have played a relevant empirical role in the description of what happened in some of the described empirical cases, but the general foundations of the behaviour of the actors and the outcomes of the process of technological development stay underdeveloped. Only within rational choice models we find a coherent theory of expectations. However expectations, as future images, incorporate only part of the elements to be considered in action or choice for the decision making. Learning, rules and identities also play a central role.

Finally, we have to distinguish between what expectations are about. There is a difference between expectations on the future technological development and expectations of how other actors will behave. From our view the central point is not the formation of expectations on the paths, timing or developments of a new technology, since once they are recognised they may just become parameterised. What is important are the expectations of the behaviour of other actors, because it is with respect to that behaviour the decision maker should respond or react to. In many cases the factor is not how technology will evolve, uncertainties are well known, because of path dependencies, lock-in, etc. but rather how other actors will respond to this given or even shared expectation. Also there may be a dominant expectation within a TEN caused by a leadership coalition or social power relationship among the actors. In these contexts what counts is the interaction between actors where generative relationships emerge.

A complete description of the overall process is probably elusive, the limitations are evident, although we have tried to point out the necessity to locate expectations and future images into a broader context for understanding the dynamics of actors and organisation decision making and technological development.

We cannot reject the significant role futures and expectations play in human and organisational behaviour. Expectations and images of the future help life to be less trying. As Eva Luna, from Isabel Allende, recalled in the imagination of her mother, Consuelo.

> "*She manufactured the substance of her own dreams, and from those materials constructed a world for me (...) to make our journey through life less trying*" Isabel Allende, *Eva Luna*.

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