Title: **From weak signals to anticipative information : learning from the implementation of an information selection method**

Authors: Sylvie BLANCO, Professor, CREDO / Grenoble Ecole de Management
                Nicolas LESCA, CERAG / Université de Grenoble 2

Postal Address: Grenoble Ecole de Management
                12, rue Pierre Sémard, BP 127
                38003 Grenoble Cedex 01
                France

E-mail: sylvie.blanco@esc-grenoble.fr
Tel. number: +33 4 76 70 64 29
Fax number: +33 4 76 70 60 99

Abstract

A major issue in strategic management is the ability of managers to anticipate opportunities and threats in their environment. They should be able to detect weak signals announcing future major changes and to specify forthcoming events, their potential impact, importance and urgency. This assertion, with which most authors agree, takes for granted the existence and the practicability of the concept of weak signals and also the possibility for managers to clearly identify and specify a future.

Field observations question these assertions. Many difficulties and ambiguities appear regarding the concept of weak signal and the anticipative capabilities of managers. Examples highlight that some of them are totally resistant to adopting a future orientation mainly because of a weak tolerance to ambiguity. Others may think they have detected a weak signal without being able to formulate any potential future change – thus being unable to consider delays and time variables. These weak signals detectors may make some of their colleagues aware of a kind of urgency and of an acceleration of change whereas other colleagues may ignore the identified weak signal as no future change is perceived. Observations show that the issue of time management triggers divergence, conflicts and cognitive dissonance between individuals. Finally, organizations are badly equipped to overcome turbulence.

In this context, a heuristic method aimed at transforming weak signals into anticipative information has been developed and implemented within four organizations and with fifty participants. Through a narration process, observations about how managers interpret information in a future-oriented manner give insights about their time perception and orientation, the way they formulate delays and the variables that may affect their judgements. Major learning from these experiences are presented in this paper with an emphasis on the major difficulties regarding time perceptions. Finally, a proposal about how to develop future-orientation of managers is formulated.

Introduction

By introducing the strategic management of discontinuities, Ansoff (1975) emphasizes the problem of anticipating and envisioning future within turbulent environments. Managers should be able to detect signals of future change thus preparing in advance to potential strategic surprises. Empirical observations show that most of them do acquire information

related to their environment, with the eventuality that some pieces of information might be useful and important in the near future (Mintzberg, 1973). Nevertheless, managers often suffer from information overload and time pressure forcing them to filter information (O'Reilly, 1982). Unfortunately, anticipative information is nearly systematically filtered out, eliminated, notably because of its ambiguity (March et al. 1981 ; Weick 1995). These empirical observations about the inability of managers to build representations of future situations may explain why firms are hardly proactive or even reactive enough in front of major external events.

The task of anticipating future events is largely presented as relying on intuition, interpretation and attention. The major sources of failure and difficulty identified in the literature are related to human cognitive capabilities and more precisely to their cognitive limitations and biases (Kiesler and Sproull, 1982). For instance, detecting future events and the delay before their occurrence may be difficult or erroneous because of phenomena such as selective perception (eliminating or overamplifying information) or erroneous interpretation. These explanations suggests that the implementation of appropriate methods may help overcome the lack of anticipative abilities of managers and firms.

So far, although anticipation of discontinuities is widely admitted as vital, no adequate device has been conceived and implemented to improve the situation (El Sawy et al., 1988 ; Lesca, 1994, Gibbons et al., 1996, Yasaï et Nyström, 1996). A better understanding of the process by which individuals may achieve the anticipation of surprising events is required to support both firms within turbulent environments and researchers willing to conceive appropriate methods and tools. This knowledge production is at the heart of this research. Nevertheless, producing "procedural" knowledge about such an unconscious and intellectual process requires to develop a specific access to raw empirical observations. In this context, the "management engineering research" methodology (Chanal and al., 1997) has been chosen and allows to produce both theoretical and practical knowledge.

This paper presents both content and methodological dimensions about how managers achieve anticipation of potential future events. First, the conceptual framework and the research problematic are described then, the methodological approach and the results are presented.

1. Conceptual framework

The strategic management of discontinuities

Throughout the literature in strategy, authors argue that one of the major roles of top executives is to build a vision of the future that can be used for action. This vision should encompass the firm within its whole environment to allow a clear view of: (1) potential competitive advantages for the firm (Porter, 1985);(2) decisions to be made to overcome major problems (Simon, 1977); (3) innovations that may create economic value for the firm (Argyris, 1976); (4) major events to react and to adapt to (Lawrence and Lorsch, 1967).

By further analysing these four objectives, major differences appear regarding the issues of future, time and anticipation (Table 1). For instance, when searching for a competitive advantage by identifying a specific fit between strengths and opportunities, Porter takes for granted the stability of the situation within and outside the firm. Opportunities can be identified in the environment relying on past events and durable economic principles – "schemes are to happen again the same way". In this approach, anticipation relies on stable reasoning and rules which may evolve slightly and slowly.

On the contrary, when innovation is a major stake within a specific environment, one has no idea about what the future may be like. The representation of the future should be a totally new configuration, and more than only one unique configuration can and should be figured out. For instance, a firm may wish to introduce a new innovative product. Identifying whether customers will adopt this product, to what extent, at what rate and speed, whether and how existing or new competitors may react and the impact of their reaction is difficult. In this latter case, past events can not support a vision of the future and of the time required to reach objectives.

Table 1. Strategic management and anticipation

| Schools	Strategic planning			Strategic management (of discontinuities)	
Hypothesis about the future	Stable	Progressive	Changing	Discontinuous	Surprising
Ability to envision future	Strong		Medium	Low	Near nil
Anticipation approach	Recurrence and iteration		Extrapolation	Foresight	Amplification of weak signals
Time perspective	Long range	Long range	Medium range	Long range	Short term

Inspired from N. Lesca (2003)

The expression *"Strategic Management"* introduced by Ansoff (1965), highlights the necessity to focus on organizations' ability to anticipate threats and opportunities, in order to cope with turbulence. Empirical studies confirm that successful organizations are those which are able: to detect major events through *"alert sensors"* (Hedberg et al., 1976); to gather more information, with more diversity and more frequently (Daft et al., 1988).

Nowadays, most organizations recognize that their environment is turbulent. Surprises and discontinuities are more and more frequent making future less predictable (Huber and Daft, 1987; Weick, 1995). Hence, it is essential for managers to be able to anticipate within discontinuous environments. This research is completely integrated in this view of the future and in the field of strategic management of discontinuities. By this hypothesis, we assume that representations of the future can not be built relying upon past events and extrapolative approaches.
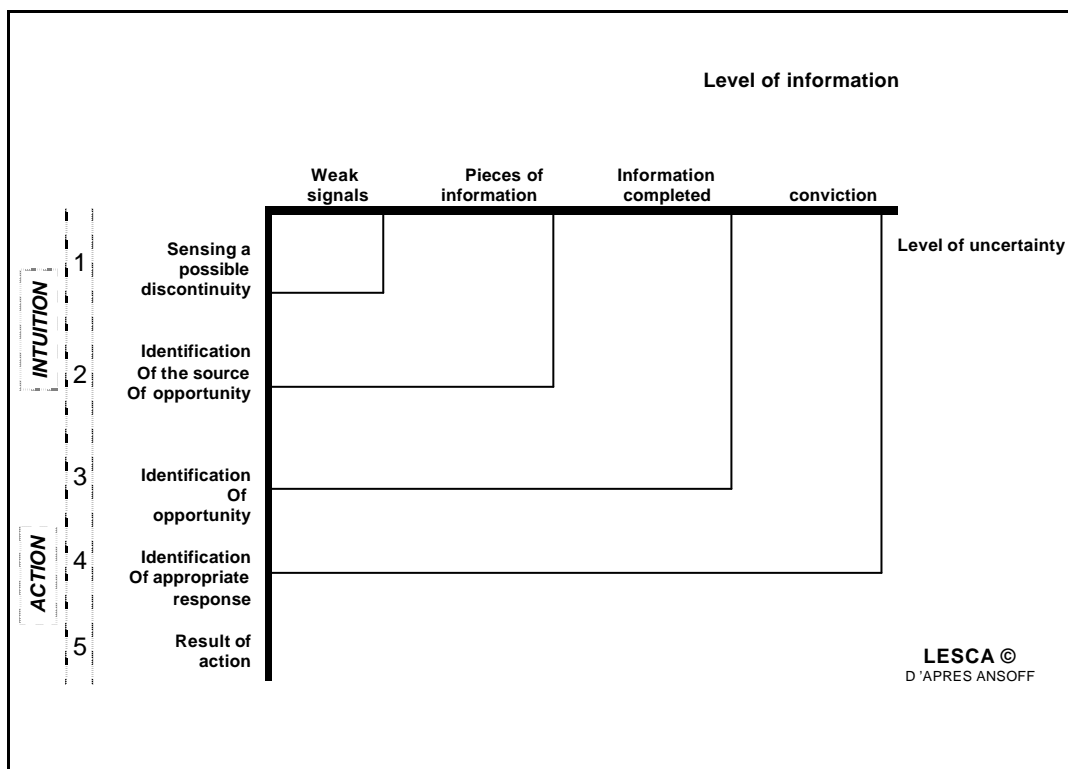
The amplification of weak signals

To detect strategic surprises, Ansoff recommends to focus on weak signals, that is to say actions by a competitor that provide direct or indirect indications about its intentions, its motivation, its objectives or its internal situation (Porter, 1982). They can concern the technological, political, economical or social environments (Bright, 1970). The figure 1 illustrates the concept of weak signal.
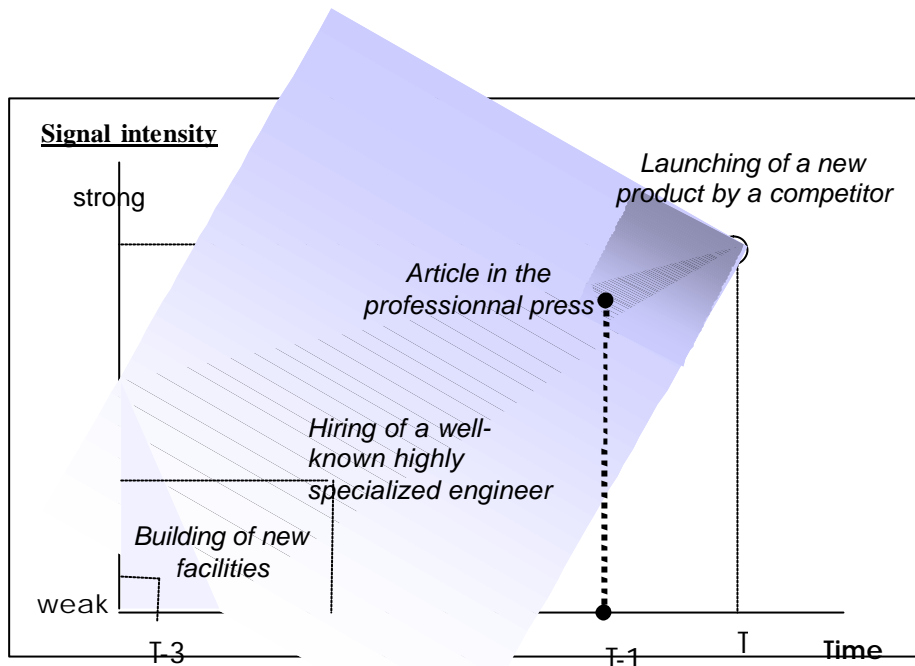
Figure 1. The co _ _ of weak signal

No clear definition of this concept has been formulated, but only comments about its nature: "*A development about which only partial information is available at the moment when response must be launched, if it is to be completed before the development impacts on the firm.*" (Ansoff et al., 1990, p. 490). Hence, the identification of a weak signal should allow the identification of a future event, its nature (opportunity or threat), its potential impact on the firm, its probability and the delay before its occurrence (urgency). This information completion process is described by Ansoff as a "graduated response through amplification and response to weak signals". Lesca and Blanco (2002) proposed a schematic illustration (figure 2).

Figure 2. Weak signals amplification process (inspired from Ansoff)

Despite these conceptual elements, no empirical validation has been proposed concerning "weak signals" and the "amplification process". This statement is all the more challenging as Ansoff (1975) and March *et al.* (1981) show that dealing with this kind of information is difficult because of its anticipatory thus ambiguous nature. This leads us to question the validity of these concepts and to try to better understand the way managers anticipate through weak signals.

2. Anticipation through the amplification of weak signals – overview

Many authors state that dealing with anticipatory information to detect opportunities and threats is essential but difficult (Wilensky, 1967 ; Smircich et Stubbart, 1985). Beyond these theoretical assumptions, we attempted to validate the empirical reality of the problem. A first survey revealed the high level of perception of the problem (Table 2) and at least three levels of managerial awareness regarding anticipation :

(1) A few managers are hardly aware of the problem – it is not important or intuition suffices;
(2) most managers are aware of their lack of anticipative capabilities and relate this problem to three phenomenon: turbulence, information overload and time pressure;
(3) a few managers are conscious of their limits but do not have any idea about how to improve their weaknesses.

Tableau 2. Level of generalization of the perceived problem of anticipation

	firms		R&D centers	
	OK	not OK	OK	Not OK
Using anticipatory information is perceived as highly useful but very difficult	67%	22%	62%	38%

A first conclusion from this preliminary study is that anticipation is not such an innate way of thinking and it is perceived by most practitioners as important but difficult. Three types of explanatory factors have been identified: individual cognitive processes and behaviors; organizational characteristics; information and communication technologies in use.

Individuals cognitive mechanisms appear to be the most determinant explanatory factor as regarding the processing of ambiguous information. Kiesler and Sproull (1982) proposed a very illustrative and detailed study of the limited cognitive capabilities of managers when facing time pressure, environmental uncertainty and information overload. They highlight the negative effects of cognitive biases such as selective perception or lack of tolerance to ambiguity on the ability of managers to process ambiguous information – thus explaining their difficulties to process anticipative information such as weak signals.

To go further into the improvement of the situation, a few authors suggest to develop heuristics, based on managers' cognitive processes to deal with anticipative information. Some of them suggest specific criteria to filter, select and interpret future-oriented information. These numerous criteria (more than thirty have been listed – see Blanco, 1998) should be part of a specific heuristic method. Nevertheless, this proposal supposes to be knowledgeable about these processes which is hardly the case and to make sure that criteria are understandable, practicable and useful. In this context, a better understanding of the cognitive processes at stake within activities of anticipation is required which implies to collect empirical observations.

3. Research question and methodology

The objective of this research is to better understand the managerial processes leading to the anticipation of strategic surprises and discontinuities. Hence, the primary objective of this research is to get a better understanding of a complex process, not easily observable, on which little knowledge is available. Notably, the aim is to produce new insights regarding the possible future-oriented postures of managers, the kind of heuristics (interpretative, iterative, etc.) they rely on, the criteria that guide their judgments and the major difficulties and obstacles to the development of anticipative abilities.

In this context, action research is an interesting way of collecting empirical data. Nevertheless, observations may be difficult to gather because activities to observe are essentially intellectual, not formalized and can take place at anytime, anywhere. So we have completed our action research approach by an engineering approach – thus relying on a methodological approach named "engineering action research in management" (Chanal et al., 1997). It consists in designing and implementing a framework (an heuristic method) for the processing of weak signals. This methodological approach is rather constructivist. Methods and tools that conceived and implemented are considered as supports for observations and reflection (Avenier, 1989). The implementation took place within four organizations during about 18 months which allowed us to be in situation of observing managers' anticipating activities both during an initial training phase and in the course of their daily work. Finally, we have achieved a one-year follow-up of the effects of this intervention. The research material we have gathered includes direct observations (participatory observation during the training and the follow-up), narrations by persons implied into the process and formalized documents resulting from training and follow-up.

This exploratory research has been lead within four organizations among which three high technology firms, trough research partnerships. They lasted between one and one year and a half. Organizations' objective was to improve their ability to cope with turbulent environments, both regarding technologies and competitors. They felt they suffer from both information overload and lack of strategic information. The groups of participants where constituted of fifteen persons from various functions and hierarchical levels.

4. Field observations

We have structured our field observations according to the three main period of our intervention: after conceptual training, after practical training, during the daily work within the months after intervention. For each phase, we have observed the following elements: future-oriented attitude, heuristics, judgments and interpretation criteria, satisfaction, difficulties, potential improvements. We will focus on the two first phases within this article.

The main observations we gathered are presented in the table 2.

Table 2. Data collected from field observations

Phases	Elements to be observed	Observations)
After conceptual training	Future-oriented behavior and overall heuristics	"I am absolutely not aware that the potential existence of anticipative information". "Anticipative information is not available within the firm." "For instance, in the competitors database, there are only monographies and states of the art which are rarely updated and often too long." "The concept of weak signal with the examples you mention allow to understand what you are talking about". "So far, I think we were not aware of the existence of this kind of information and we sure mixed them with other information". "We have to acquire a kind of anticipative reflex." "Filtering only anticipative information may not be possible for us as researchers. We are used to memorizing information related to the overall knowledge of a field or a technology and we try not to miss any piece of information". "It is anticipative because the reason why our competitor engage in this partnership is to better know our own customers. You'll never guess why ! " "It is easy – you read the document, if nothing triggers a reaction, even a slight one, you just through it away". "It does not consist just in summarizing but rather in interpreting things". "This concept of weak signal remind me a recent event that I do not know what to do with except diffusing it to others."
	Criteria of judgment and interpretation	"The problem is that between the time when you gather information and the one when it was created, a long time can have been spent. One can not calculate this to have any idea about the obsolescence of information and the time before something may happen." "This is surely recent !" "We already know this since a long time ! it's surely too late to react !" "Having a few criteria such as the anticipative nature of information and the anticipated potential event helps us in formulating good questions."
	Satisfaction	"The use of anticipation seems very useful to me." "I think that the awareness the training provokes will prevent people from sending me every day the prices of all our competitors regarding all their products just hoping that I'll be able to formulate a magic plan." "Thanks to this training we become aware of our potential role in anticipating surprising events. It's a collective role within the firm !".
	Difficulties	"The problem with many internal pieces of information is that it is never updated". "As a researcher, it is very difficult for me to focus on anticipative events and information. I am more used to states of the art, exhaustive and detailed presentation of past and present events". "It is not useful to think too much about reliability of what we anticipate. We will only know that afterwards". "I am unable to say if something that triggered my attention is anticipative. Sometimes, it is too new for us to be able to interpret anything."
	Potential improvements	"It would be really enriching if we could rapidly share our impressions regarding future events.

Phases	Elements to be observed	Observations)
After practical training	Future-oriented behaviour and Heuristics	"It reminds me a piece of information which in fact is a weak signal – I was not aware of its anticipative potential". "Finally, I do think it is not within magazines that we will have a future-oriented behaviour but rather in the field, everyday". "It is mandatory that now we gather information about this kind initiatives because if their innovation succeeds, we should anticipate it seriously." "When I think anticipation, I just feel like I lack too much knowledge to be able to formulate any anticipative vision." "I think that anticipative abilities also rely on curiosity – there is a stage where we detect something but we are unable to find any meanings, to say whether it is important or not, etc." "My opinion on anticipation : it reveals so many questions I have no answer to give to that it is quite uncomfortable."
	Criteria of judgment and interpretation	"I never know how to assess urgency or give clues about the delay before it is too late to react. It's because things are too complex and diffuse." "Actually, we are never able to anticipate what to look at". "Information, ideas and intuition are neither good nor bad. It is a difficult situation."
	Satisfaction	"Thinking in an anticipative way will allow me to overcome information overload. I'll be more selective regarding information sources I use." "This debate about our future potential situation is very enriching thanks to the multi-disciplinary approach"
	Difficulties	"Arguing the anticipative nature of a comment requires a very good expertise – or experts will formulate destructive comments." "It is not so easy to say if a patent is anticipative. For instance, let's consider the ADSL which was emitted more than 20 years ago. Noone could say whether it would be integrated within a future major innovation. It is thanks to another innovative technology that it could be used. How to anticipate this kind of innovation." "Everything is too vague and uncertain." "Anticipations are never clear nor reliable." "To assess urgency, one should really be very knowledgeable of the issue he deals with."
	Potential improvements	"This culture of anticipation should be extended to all the teams implied in innovation processes." "After this training, we were so astonished by our own lack of anticipation that we ask colleagues about their vision and anticipative capabilities. The conclusion is that they are not richer than us which is quite a critical situation."

5. Analysis and synthesis

We will conduct the analysis at both the practical and the theoretical levels trying to highlight reinforcement, moderation and differences between research results and initial knowledge.

On the practical side, the research confirms the lack of awareness of managers regarding the need for anticipative thinking and capabilities. Nevertheless, for most of the persons we worked with, it is a very useful approach they plan to implement on a continual basis. A question remains to be explored: who should be sensitised to the anticipative culture. The use of analogies and examples illustrating concepts such as "weak signal" and "graduated amplification" are perceived as very helpful. Finally, the existence of many individual

cognitive biases has been confirmed – but a first step consisting in becoming aware of these biases is very useful to develop managers' ability and motivation for anticipation.

Practically, the criteria related to anticipation is not problematic in most cases. The following analysis consisting in formulating the future event, its potential impact, nature and time of occurrence is unrealistic out of a collective and iterative process that has not been described yet. Hence, managerial anticipation needs to be collective and iterative to be effective and satisfactory for managers and action. This collective dimension also allows to reduce the potential negative consequences of individual cognitive biases and limited cognitive capabilities. The major practical difficulty lies in the appreciation of time before a potential event may occur. Too much perceived complexity is perceived so that managers feel this work not useful and not credible. Regarding the heuristics, observations clearly show it as a process of attention and interpretation within a sense-making approach. To improve ways of doing, people need to reproduce the exercise within a collective approach. It entails a change of behaviour that can be assimilated to a collective learning process.

On the conceptual side, the main feedback lies in the nature of the managerial anticipation process:

- a graduated response in the form of prototypic categorization (Rosch, 1978) rather than a linear process relying on a list of judgmental criteria; the anticipation process supposes a kind of refinement of an initial sensation as presented in figure 2. Nevertheless, at any moment in the reasoning, one can go backward;
- an attention and interpretation process which success depends on the added-value managers can bring into the anticipation process. One should be able to assess whether a piece of information, an event or any observation is worth looking at and to argue or to question it in a future-oriented manner. Nevertheless, it is more a process which result is the emergence of questions rather than a process leading to the formulation of answers. Two major steps have been identified in this process: attention to anticipative elements which consists essentially in an individual perceptual process – attention is triggered by something different, new, dissonant; interpretation in the form of questions and actions to be implemented to challenge intuition.
- an individual and collective process: limiting the anticipation process to an individual approach is very dangerous as individual may not be able to apprehend the complexity and the dynamics of certain situations; this implies to wonder about the organization of the process;
- a collective learning process within which interaction allow managers to improve their anticipative behaviour and their representations of the future while limiting their individual cognitive biases. How to implement such a collective learning process remains a point to be studied.

Another major difficulty which requires a deeper and focused research is the unability of managers to integrate delay and time perspective within their interpretation. The proposal of Ansoff regarding the way to formulate and analyse a weak signal has been heavily challenged. None of the following criteria could be implemented and was used in the anticipations that emerged: probability of event, impact of event, urgency of event. Often, managers are not able to distinguish the nature of the potential event in terms of opportunities or threats.

5. Conclusions

This research allows us to give insights on a badly known process which we call the managerial anticipation process. We have deliberately chosen to achieve our field experiences within particularly turbulent environments where anticipation is perceived as very problematic, both by practitioners and researchers. This choice was done in accordance with Ansoff's recommendations. Although his proposal is very useful to seed actions to enhance an anticipative culture, we had to face major difficulties with the concepts and the terminology. For instance, weak signals is subject to ambiguity and non fertile discussion on "weak" or "strong", on "signals" or "signs". The suggested criteria such as reliability or

urgency could not be implemented. As a consequence, we do think that there might be different levels of turbulence as suggested by Lesca (2003), and that we should try to relate managerial anticipation process with environmental conditions. One major perspective of this research is its duplication within different environments to better understand what can be generalized and what might be specific to some contextual conditions. This could contribute to the operationalization of the concept of turbulence and the associated notion of time.

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