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Early detection, warnings, weak signals and seeds of change: A turbulent domain of futures studies

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ABSTRACT

This paper marks a milestone in a six year research cycle on weak signal analysis and early detection issues in futures studies. While providing a broad view and discussing a variety of contributions on this topic, the aim of this article is to offer a more constructivist approach to early detection studies than has been typically the case so far. The article starts by positioning the underlying problem of weak signals within the broader field of futures studies. The second section examines the Ansoffian tradition, first on the basis of Ansoff's own contributions, then through key enhancements offered by scholars working in the same perspective. The third section develops the arguments for a constructivist critique of the Ansoffian tradition as a way to renew and enrich scientific debate. The fourth and final section presents the main open issues where research, case studies, methods and applications still need to make significant progress in the vast domain of weak signal analysis and early detection.

"I have never doubted the truth of signs, Adso; they are the only thing man has with which to orient himself in the world. What I did not understand was the relation among signs."
William of Baskerville, in the Name of the Rose[1]

1. Early detection, warnings and weak signals as a particular domain of futures studies

The key centres of interest and methodologies of futures studies have developed dialectically along diverse lines. During and after World War II, a demanding context opened the way for a series of innovative "forecasting" attempts and, as the Cold War escalated, for an increasing need for studies aimed at reducing uncertainties and supporting strategic choices. These early future-looking explorations involved expert opinion, calculable inputs based upon time series and "what if" simulations, and in the 1960s enriched scenario planning and system-based methodologies. While the then dominant term "forecasting" could apply to a large array of situations and objectives, from next summer's seasonal trends to far-away questions 50 years ahead, most of the forward-looking targets of future studies were related to medium and longer-term issues.

In the 1970s and 1980s the focus of scholarly work shifted towards strategic corporate challenges. This led not only to a reorientation from the longer to the shorter-term but also to prioritizing the interests of organizations and political bodies in perceiving 'early warnings' of changes to come. Here it is important to recognize, from the outset, that "early" does not necessarily mean a temporal horizon since the emphasis can be on understanding the unfolding of a critical issue either

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[1] Taken from translation of Eco [90:549–550].

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before others (in the case of a competitive market struggle) or before it is too late in the case of a more general type of problem.

Igor Ansoff was a pioneering theorist of strategic planning. In particular, he was the first one to stress the fact that contrary to the Cold War configuration, which could be formalized as a stable equilibrium supporting reliable forecasting and game theory approaches, with specific and well identifiable threats, the environment of the firm was more often one of turbulence. For Ansoff this was a problem requiring appropriate managerial capabilities. For the first time, the idea of a need to be "early", or rather as early as possible in anticipating change, was expressed and translated into a complete methodological proposal.

Up until Ansoff this issue had only been treated as an embedded and even tacit dimension within a broader future-looking perspective. This is precisely the reason why Ansoff's contribution has been so seminal. Early perception of change is not an automatic or incidental consequence of either forecasting or a forward-looking exploration. Ansoff filled a gap in the theory and practice of foresight, providing the corporate arena with a toolbox specific to the business domain, an approach that addresses its constant uncertainties and changes, not just as a by-product of military strategic studies or macro-level socio-economic analysis.

This paper starts with an assessment of the strengths and weaknesses of Ansoff's original contribution and then moves on to consider more recent 'neo-Ansoffian' developments within the context of a broader epistemological debate. The contention of this paper is that despite the extensive literature already dedicated to the topic of weak signals there are still a number of issues that remain open to questioning and in need of further research. These challenges to the Ansoffian and neo-Ansoffian methodological approaches can be attributed, at least in part, to new developments in the field of futures studies over the last fifteen years. In particular the work in futures studies related to constructivist and reflexivity-minded concerns call for a substantial revisiting of weak signal theories. Such an evaluation, as discussed in the concluding section of this article, opens up on a new landscape, raising new stakes and issues in the domain of early detection and hence setting out new tasks for research.

2. The Ansoffian tradition under scrutiny

2.1. Ansoff and weak signals as main initial landmark

Igor Ansoff was an applied mathematician by training but with considerable interdisciplinary interests, in particular in the field of management. This was a domain that was a growing concern in the 1950s and 1960s not only academically but also in the public and the private sectors. Ansoff pioneered an innovative approach to management. He is renowned for key inputs to the field, many of which are still part of the MBA landscape today. Among his most famous contributions are "gap analysis" ("what is currently lacking as compared to where we want to be in the future?") and the "product/market expansion grid". This specific tool is a strategic positioning method, mapping basic business components and their status (products and markets, current or new) into four strategic options: market penetration, product development, market development, diversification. Each of these options then leads to a series of different possible configurations. All this work is implicitly and at times also explicitly "future-oriented" (after World War II, Ansoff worked for the Rand Corporation and Lockheed Aircraft), even if the focus of Ansoff's reflection remains the firm' short-term viability.

One must remember that before Ansoff, management theories were still primarily linked to the applications of Taylor and Ford's principles. Along with such other legendary figures as Selznick, Chandler and Drucker, Ansoff constructed the basis for a more effective strategic view of the firm. He started with a rather planning-oriented strategic proposal that developed gradually into a more open-field perspective (hence the above-mentioned grid). Within that general evolution, he emphasized the fact that the firm had to cope with changes, some of them not necessarily expected and that one could characterize this changing environment as turbulent. Since Ansoff was interested not only in identifying difficulties but also of proposing solutions, he suggested concepts and tools to deal with the specific problem of turbulence. Weak signal analysis was born.

We can summarize Ansoff's approach along the following dimensions: (1) a core hypothesis, (2) some definitional aspects of weak signals, (3) two complementary lines of treatment regarding newness or change prospects, and (4) a series of possible outcomes or gradually stronger strategies.

First comes the starting hypothesis: for Ansoff [1,2], any change taking place is preceded by some form of "warning", which the analyst has the role of capturing and making good use of. This is what he called a signal, based on the Information Theory work of Shannon and Weaver [3] in the 1940s. Ansoff distinguished weak from strong signals as follows [1]: Weak signals are "features of incipient changes that can help managers avoid strategic surprises". While strong signals are sufficiently visible and concrete, weak signals are "imprecise early indications about impending impactful events". In order to move from an imprecise perception to a more substantial and usable indication (from weak to strong signal) Ansoff developed the idea of a series of different and successive filters. These filters were considered to interfere (hinder) with effective sense-making, but could also be analyzed and worked out to positively build a consistent corporate problem-processing framework. Such a reworked filtering system could then allow for the seamless integration of weak signals into strong ones, enhancing the learning curve and strategic responsiveness of the firm.

Ansoff's first and best known approach to moving a weak signal from a new but relatively unclear phenomenon to a perceptible and then operational input to the firms decision making requires passing through three different filters. The surveillance filter intervenes when collecting and selecting information from the environment of the firm (current market movements, with all relevant and useful data). This first filter helps give a substantial idea of how the environment of the

firm is evolving. The mentality filter, in a second step, consists of evaluating a signal's relevance, meaning and value, on the basis of experience but also hypotheses on the potential impact of novel phenomena. In the end, the power filter has the role of bringing this knowledge to the decision-making level, therefore involving some form of interpretation and translation fitting both the power structure and the strategic power needs of the firm. There are of course numerous ways that the process can be biased and far from relevant but also adapted and customized in ways that improve its effectiveness.

Ansoff's second line of methodological contributions, formulated in his later work [4], sets out a full panel of options on how weak signals might appear in the strategic environment of the firm, characterized in terms of "earliness", intensity and criticality. First, in line with his observations on the nature of firm and market environments, comes turbulence. At this stage it is still a rather vague situation for decision makers or analysts, inducing some worries, possibly involving difficult-to-predict, even surprising and most of the time difficult-to-cope with developments. Then, based on the basis of open questioning a clearer threat starts to emerge from the competitive environment. At some point, the source of challenge becomes concrete and the moment arrives for the threatened organization to generate responses. With time, the outcome of the response becomes "forecastable", implying in particular that the threat has become a commercial issue. For Ansoff, this sequence is a typical scenario of how an organization may try to gradually cope with weak signals. The last two stages (response and outcome), however, are already part of the strong signal range, corresponding to an internal learning process for the organization.

With respect to outcomes Ansoff emphasizes not only the firm's responses but also the related states of knowledge, whether the result of external or internal interactions. Better strategies fall into three main options: one that improves the firm's awareness and understanding, one that increases the firm's flexibility and one that allows the firm to directly tackling threats or opportunities.

2.2. Parallel or derivative approaches to Ansoff

Ansoff is not the only one to have considered weak signals of change as a key challenge for organizations. Between 1958 and 1965 a French school of futures studies established its own flavour of foresight (called "prospective" in French, suggesting a proactive look-ahead philosophy). For example as early as 1964 [5] Pierre Massé a "Commissaire au Plan (Commissioner to the Plan), in a then-famous foresight study targetting the 1985 horizon, formulated the concept of "faits porteurs d'avenir" (future-bearing facts").[2] This somewhat fuzzy[3] and partly paradoxical concept (since it can only verified in the future) is often referred to as one of the founding concepts in futures studies. In 1967, Massé himself [6] completed his idea by declaring that "Intuition and reasoning must be confirmed by facts. The idea is therefore to discover the sign, very small as far as its present dimensions are concerned, but immense as regarding its virtual consequences" [6:133]. It is not difficult to recognize an already familiar perspective, although Ansoff, who borrowed his weak signal idea from the cybernetic tradition (information theory), may be considered as having developed his own parallel approach. Let us stress, also, that while Ansoff was primarily concerned by the firm and the management of uncertainties, the French futurists of that time were dealing mainly with societal and public policy issues.

The notion of "future-bearing facts" will be taken up as a standard concept (and even as a synonym of "weak signal"),[4] by contemporary French futurists such as Godet [7] and de Jouvenel [8,9], as well as by French scholars active in environmental scanning (Castagnos and Lesca [10], Blanco and Lesca [11,12], Blanco and Lesca [13], Rouibah et al. [14], Blanco [15]). Lesca, with his ideas of "collective learning" (Blanco and Lesca [16]) and "puzzle" (Lesca [16]) and de Jouvenel, with his concept of "Vigie (or "look-out"[5]) have in addition experimented with ways of collecting and enriching weak signals through networks of contributors.[6] The link between this French tradition and the American weak signal approach has been thoroughly examined by a series of Finish scholars and by Mevel [17].

Closer to the Ansoffian tradition is the "early warning" concept (see the broad analysis by Nikander [18] and the related German tradition of early detection, in German: "Frührerkennung" or "Frühaufklärung"),[7] after the seminal work of Krystek and Müller-Stewens [19], Reinhardt [20] and Liebl [21]. These authors take an approach linked to the identification of risks and

[2] Durance (in Berger, Bourbon-Busset, Massé and Durance [91]), mentions that, before Massé, Bourbon-Busset, in 1962, had already presented to the "Centre international de prospective" in Paris, the ideas of "factors of futures" and "germs of futures". Already, with this preliminary concept, one can ask if anything can do, from the Yalta conference to the coming of age of mini-skirt fashion in the sixties or Microsoft translation of Windows in swahili.

[3] It is interesting to observe, however, that some of the criticism addressed to the notion of weak signal (see further) have also been expressed concerning the future-bearing facts (Gonod [92]), namely the idea that there is hardly any indication in Massé's work on how to identify them. Massé himself [34,93], admitted that finding future-bearing facts was a difficult quest as there is no necessary relation between the visible importance and the hidden meaning of these facts.

[4] http://www.futuribles.com/vigieaccueil.html.

[5] Deploying environmental scanning as a distributed intelligence scheme is a worldwide trend (see for instance Saul [94], but the originality of Lesca and his colleague is that they have turned this network-based weak signal capture into a consistent theoretical concept (roughly based upon the commonly shared idea that many can be more intelligent than one).

[6] For the possible differences between those concepts, see Romeike [95].

[7] It is to be noted that SEWS does not constitute a stabilized and consensual acronym (see also the critical approach by Schwarz [96]); to give examples, SEWS has also been used to designate all sorts of alerting systems regarding natural disaster reduction (Zschau and Küppers [97]) and "Shared early warning system" of more military orientation (https://www.fbo.gov/index?s=opportunity&mode=form&id=3d0f4d1d22a09a5af5c1ffbaa51dda66&tab=core&_cview=1&cck=1&au=&ck=) or "Standard Emergency Warning Signal", applied to disaster management in Australia (http://www.disaster.qld.gov.au/disasters/warning.asp), just to stay in our area of concern. Needless to insist on the fact that early warning (without the strategic connotation, however), is a very important notion in natural disaster management and epidemic management.

threats, as suggested by the notion of "warning" (Ortner et al. [22]), but also of opportunities (see Jansen [23] and Peduzzi et al. [24]). These latter contributions build on the idea that risks and opportunities are dialectically linked, offering a more interventionist approach that can play the role of helping to cause certain identified signals to come true. The relationship of the "early warning" tradition with weak signal analysis is often explicit in Simon [25], Steinle and Eggers [26], or may even take a slightly critical perspective, as for instance Konrad [27]), stressing the difficulty of interpreting weak signals. This "warning" tradition has led to a rather broader agenda, e.g., "Strategic environmental scanning systems" (SEWS), making use of warning as key concept but also including other diverse targets and methods, like environmental scanning for the business arena (see Lücken and Baisch [28], and their "FiFIFoFo" method, for "Find, Filter, Format and Focus", as well as the more recent work by Gilad [29]).[8]

A detailed examination of all of these different branches of the weak signals field would go beyond the scope of this paper. In summary form it is fair to remark that all of these derivatives of the "warning" concern expressed by Ansoff share a cross-cutting leitmotiv: warning > identification > action. Not all of the parallel or derivative work on weak signals offer substantial innovations or additions to Ansoff's initial contributions. Although there has been a more explicit linking of warning approaches with environmental scanning methods and a considerable broadening of the areas of application of the early warning work overall little new has been added to the basic Ansoff heritage.

2.3. The neo-ansoffian contributions

As Ansoff did most of his work on weak signals in the 1970s and 1980s, it is no surprise to observe forms of improvement proposed by more contemporary scholars. This evolution is both diverse and rich. We have identified six main types of additions to Ansoff. Although most of them go beyond the strategic needs of the firm, all of them refer in one way or another to Ansoff's original influence with respect to weak signal analysis.

- Classificatory maps making use of two-by-two matrices to pre-characterise weak signals and enrich the operational scope of weak signal analysis.

Contributions of this type constitute the richest category. Several authors have proposed innovative directions to mapping and understanding of weak signals. In particular Morrison and Wilson's [30] approach of cross-referencing the dimensions of low/high certainty/uncertainty (or low vs. high probability) with low/high impact is an idea which others have taken up Mannermaa [31]. Kuosa [32] has proposed a slight variation that calls for referencing novel signals connected to trends (known or unknown) with events which range from partly to completely expected. In 2008, he linked this idea with other notions such as drivers and disruptors as well as other sources of causally relevant information.

Gustafsson and Ahola [33], in much the same perspective as Ilmola [34], suggested comparing first the relevant level of weak signals with the variation of viewpoints associated with them, and second how some filtering options apply to broader issues but with little depth of content, while others may provide a deeper understanding but for narrower concerns or perspectives. This last trade-off between broad-shallow and narrow-deep is valid for futures studies in general not just for weak signal analysis. Most recently the evaluation of ex-ante weak signals as more or less certain has led to the use and debate within the field of future studies of the category: "plausible"(see for this Wilkinson and Ramirez [35]).

- Multi-criteria and multidisciplinary analysis.

This is a less explored but rather stimulating track towards an explicitly designed multi-criteria methodology, mainly promoted by Könnölä et al. [36]. Their claim is not to be confused with teamwork, often perceived as leading to an equivalent result (in particular when the team involves several specialists and disciplines) and now considered standard professional practise in weak signal and filter analysis. As a matter of fact the multi-criteria perspective implies a more systematic account of various influential domains. Similar recommendations for multi-criteria approaches can be found in the Foresight Handbook elaborated by Georghiou et al. [37:104].

- Systemic perspectives that continuously stimulate different angles of early detection.

Ansoff borrowed his weak signal metaphor from information theory so it is no surprise if some consultants and scholars have pushed this linkage to the point of viewing all weak signal analysis as an expression of information theory and systems' analysis. These authors pay particular attention to information processing, the relationships between information and weak signals, and of course to the notion of noise. In the consultancy-oriented Anglo-Saxon work inspiration along these lines has come from Coffman [38] and to a lesser extent by Smethurst [39], both tied to the McTaylor Group. In the French speaking arena Mevel [17] has been influential through his comprehensive overview. Both currents offer sophisticated system-minded treatment of how to select and make sense of weak signals in specific organizational contexts.

[8] Just to get an idea of the complexity involved in the categorization of uncertainties, see Gonod [92].

• Knowledge life cycle sequencing of the value associated with different stages of weak-to-strong signal integration.

This group of authors also builds directly on Ansoff's contribution by focusing on the strengthening of weak signals into strong signals through graduated stages in a firms' options to respond. This approach adds to the original by focusing on the relationship between information access and the knowledge life cycle of management, either for absorption and adaptation or for learning. Several authors have contributed to this current, in particular Wygant and Markley [40], Gustafsson and Ahola [33], Choo [41], Veljgaard [42]. Others have linked weak signal uptake to the Nonaka and Takeuchi approach to knowledge management [43], like Ilmola and Kotsalo-Mustonen [44], for instance. Finally, the above mentioned systemic perspective, which is attached to defining a virtuous circle from weak signals to usable information, can also be associated with the group of knowledge-sensitive approaches; the same can be said to a lesser extent of more specific approaches, such as Nikander [18] within the project management perspective and Debackere and Rappa [45], who take a new technology adoption approach that distinguishes between so called bootlegging activity of champions responsive to weak signals of an emerging technological paradigm (against a general lack of enthusiasm) and bandwagoning when the minority perspective is gradually assimilated into the mainstream.

• Peripheral attention.

This approach focuses on what is "different", arguing that an effective way to perceive early forms of change is to look to the fringes, margins or periphery. This can be done by cultivating one's own vision or, if that is too difficult, to seek out individuals or groups with an affinity for fringe perception. Each one in their own terms, Day and Schoemaker [46], Steinmueller [47,48] and Hiltunen [49,50] have emphasized stimulating aspects of this delegated detection capacity. Let us make clear here that the notion of "peripheral vision" is a metaphor and contrary to what Haeckel [51] suggests, it does not constitute, per se, a sense-making perspective (Schoemaker and Day, as discussed below, have enhanced this approach to make it more "realistic", by examining how biases are introduced by analysts and what is the impact of such intervention). However, this "enlarged perspective", lacking systematic reflexivity with respect to their own procedures, is still subject to the same weaknesses as the Ansoffian tradition.

• Semiotics.

This is an old new idea that extracts "future" knowledge from distinctions arising from how and what is being communicated. The most interesting reference here is the article by Elina Hiltunen "The Future Sign and its Three Dimensions" [52], which is analyzed and discussed in detail in Rossel [53]. Hiltunen proposes the thinking of Pierce, a nineteenth century linguist, as a means to establish a scientifically grounded method to detect early signals of things to come. However on careful reading what she asserts is her belief in the capability to perceive objective signals. This is in opposition to the idealist point-of-view which considers such signals as being in our heads only. Hiltunen takes a daring but controversial standpoint while at the same time shedding light on the largely inaccessible but highly relevant Finnish debates on detecting and making sense of weak signals.

From the perspective of this article, however, Hiltunen seems to overlook the constructivist approach to weak signals. This does not deny the possible existence of phenomena and the signalling virtues associated with them, but rather emphasizes the fact that perception and sense-making are organized in our minds and socio-cultural practises through specific paradigmatic lenses, learning pathways, social perspectives and choices, typically confronted and/or agreed upon with other stakeholders. As a matter of fact, as other authors have made clear (see below), even objective reality in the making can trigger a variety of equally legitimate representations, profiling a diversity of possible futures. In this sense, weak signals are "boundary objects", as defined by Star and Griesemer [54], and supportive of the idea that some interpretative flexibility is involved. Only a "Mode 2" type of knowledge, defined by Nowotny et al. [55] as socially robust, meaning that it is the result of social interaction, thus conveying strong validation and legitimization attributes, can emerge as stable or consensual, and therefore potentially influential for certain futures.

Having now pointed out the key original features of early detection formulated by Ansoff and his contemporaries, as well as more recent contributions, it is now time to evaluate the Ansoffian tradition as a collective contribution to the understanding of early perception of changes to come. It would seem reasonable after several dozen papers, reports, chapters and books involving almost as many researchers and consultants worldwide over a period of 40 years that the weak signals field would by now have reached a maturity. My contention is that this not the case and that on the contrary key claims remain highly disputable.

2.4. The main problem with the Ansoffian tradition

In recalling the contributions of French scholars attention has already been drawn to concerns about the ease with which weak signals (or their semantic equivalents) could be identified and interpreted. Further reservations along these lines have been expressed with respect to the metaphor of 'weak signal. Webb [56] and Coffman [38] or Castagnos and Lesca [10] point out that that no one is really sending messages from the future. Within the Ansoffian and neo-Ansoffian tradition, this is as far as one dared to go in questioning the founding concept of early detection.

The problem can be summarized by pointing out that new and odd expressions of human behaviour can be easily spotted, but that their possible relation with further changes, with their contribution or even causative meaning and impact, is in general far less obvious. Seen the other way around, and before detailing a constructivist approach to weak signal analysis and early detection, the question remains for any weak signal, – what is its relationship to change? What change does a weak signal represent or carry? And how can any claim of weak signal identification be verified? To use more recent terminology, the whole of the Ansoffian tradition fails to take account of reflexivity. Even the most sophisticated revisited approaches fail in this regard, including Gustafsson and Ahola [33] with their depth and scope transaction approach, Coffman and the systems approach [38], Fountain Park consultants and the knowledge management integration, Könnölä et al. and the idea of a multi-criteria perspective [36] or the team as multidisciplinary framework, as optimistically emphasized Pina e Cunha and Chia [57] in their paper "Using teams to avoid peripheral blindness".

In the whole of the Ansoffian and neo-ansoffian tradition it is hard to find any serious grasp of reflexivity. Consider, for instance, the following the neo-ansoffian contributions.

(1) Mapping weak signals in terms of greater or lesser impact based on the analyst's rough appraisal and experience of what is deemed likely to happen. Like in the Ansoffian perspective, the analyst is the one to make the selection of features from the perception of his own reality and on that basis is expected to spot particular features as weak signals (we still do not know of what change).[9]
(2) The life cycle approach is very linear and provides little room for disruptive, serendipitous or complexity issues.
(3) The systems approach appears very serious but fails to even envisage signals that cannot be encapsulated upfront in the systemic net of the analyst. This blind spot arises in part because the systems approach defines information as the equivalent of knowledge, a problem that is also typical of those that conflate weak signal analysis with environmental scanning.
(4) Multi-criteria and "peripheral" approaches are less intrinsically bias-producing but do not tackle the core problem of the absence of reflexivity.

In fact so far the peculiarities of the knowledge process that lie at the root of early detection of signals, warnings or any similar expressions of realities to come, have not really been a research issue. The aim of this paper is to shed new light on the various knowledge processes involved in early detection, even tacit aspects and claims that weak signals have been found. The failure to take into account reflexivity in most approaches to weak signal analysis does not make such efforts useless, only it is important to recognize that this is no way of determining if a weak signal is indeed, on the basis of the dominant definition, a weak signal. The confirmation that a weak signal is indeed a weak signal must wait for the hypothesis to become a demonstrable pattern or trend; which still does not rule out false positives (discovering later that the evidence was deceptive) and false negative guesses (being right but for the wrong reason).

This general problem with the Ansoffian tradition and the weak signals literature in general is powerfully demonstrated in the next section by the remarkable contributions of one of the most active scholars on the early detection scene.

3. Signs and signals: towards a constructivist critique to the Ansoffian tradition

A systematic deconstructive approach to weak signals can be seen as emerging (see for instance Rossel [53,58–60] and COST A22, in particular Working group 1 on "Seeds of change"). Beyond the initial suggestion by Adams [61] that assumptions need to be explicit, defining a starting point for a reflexive epistemology, this emergent strand constructivist strand for thinking about weak signals offers the conceptual couple "Framing"/Meta-framing as a way to lay out the main problems linked with the Ansoffian and neo-Ansoffian traditions. A first stimulating attempt in this direction has been made by Seidl [62], who criticises the Ansoffian approach for ignoring the fact that we cannot "know reality" without the mediation of our cognitive faculties. Seidl considers direct perception and filtering as illusions. To substantiate his claim, he analyzes the case of the Oil crisis in the 70s, presented as an example by Ansoff. In Seidl's view, it emphazises the kind of mistaken outcome one may produce by not taking into account the fact that weak signals are constructs that we generate within our broader representational process. Taking this as a point of departure, the aim here is to develop a more generic framework for early detection issues. Hence, the framing starting point.

Initially, the "frame" idea came from Bateson (mentioned in 1955, but published in 1972 [63]). Gofmann explored this notion extensively before it was taken up and analyzed by a variety of scholars and disciplines (from artificial intelligence and political science to neuro-linguistic programming). For Gofmann [64], a frame is a "schemata" of interpretation of experience, allowing individuals to recognize events and build meaningful perception of what they capture. Framing allows for the activities of locating, perceiving, relating events, scenes or processes to known patterns of meaning, and therefore labelling them. It always involves some level of organization (as a particular viewpoint, but also as the basis for a structured activity): "Framing (...) organizes more than meaning, it also organizes involvement" [64:345].[10]

In this perspective, calling "weak signal" a certain event, message, behaviour or process corresponds to a certain framing of reality; filters, warning, noise or periphery are also framing forms. The way we do this framing (which is also something

[9] We have analyzed the framing and meta-framing notions in detail in Rossel [60].
[10] The same comment also applies to wild cards ("why are we surprised?").

we do naturally, all the time), however, can be deconstructed as a means: (1) to take into account our own biases and influences on the interpretation we make, and (2) elaborate methodologies hopefully less biased (or at least more resilient to various types of biases), introducing non-converging principles and actors point's of view into the knowledge process. Such an epistemological activity can be called "meta-framing" (Rossel [58,60]). This reflexive methodology allows in particular for the examination of such framing constituents as: assumptions, boundaries, context-linked features, attractors or paradigms, as embedded and structuring forms of influence. Intention, volition, desirability are also factors that introduce particular forms of framing, including those of power. This of necessity creates a multiplicity of viewpoints and types of uncertainty.

The introduction of biases in the interpretation of weak signals is certainly a common theme in the literature and one which can be addressed through meta-framing. Indeed many authors, even in the neo-Ansoffian tradition, have suggested that biases and blind sports are not infrequent in weak signal analysis (Lesca, Ilmola and Kostalo-Mustonen, Mevel, Gilad, Day and Shoemaker). Others have taken this problem as their main focus, for instance Levinthal and March [65] and the cross-cutting idea of myopia, Kirschkamp [66] six attitudes influencing organizational design, that explore the relationships between early warning and levels of strategic uncertainty. Work that is not too far from Freeman and Pattinson's analysis of six main patterns in the way that senior managers influence corporate foresight activity [67]. Fuller and de Smedt [68] also emphasize the need for more reflexivity in order to escape the interference of "more of me" filters in anticipatory activities.[11]

Biases can come from various factors: blind spots (Gilad [29]), volition, tacit knowledge, power shortcuts (Rossel [59,60]), influence of normative intention (Georghiou at al, [37:129]), mechanisms that miss or ignore vital information (Wissema [69]), etc. The possible influence of mental models capable of masking the unexpected to the observer (and therefore likely to mislead decision-making) is even accepted by such Ansoff loyalists as Ilmola and Kuusi [70]), after Chermack [71], as well as Harris and Zeisler [72]: "Weak signals are weak because they are easily obfuscated by other factors, including current mind-sets, attitudes, and biases of those involved in the search for the future". A typology of biases, including ways of circumventing them, has been initiated by Schoemaker and Day [73]. Every factor that plays a role in framing phenomena such as weak signals can be analyzed with the same depth as the production of biases. For instance when it comes to social dynamics and changes in social dynamics the detection of weak signals is influenced by factors like the social status of interpreters, the multiplicity of points of view or power relations that often reflect hidden or tacit paradigmatic attractors.

To sum up, a constructivist approach postulates that the interpretation of weak signals is not merely a problem of deciphering a future that already partly pre-exists in the expert's awareness (nothing is already decided or written yet). It is rather to be thought of as a substantial sense-making activity, whose relevance is to be confirmed by facts and knowledge process integration, which under certain conditions may play a role in its own fulfilment ("future making", a dimension which we will examine in the end section). In this sense, the goal is not to obtain perfect or complete information about the present[12] even less so regarding the future, but to define how we use the information which we collect from our environment or from our own experience within open knowledge building processes that are always influenced by our socio-cultural, paradigmatic or communicational perspective (see Renn [74]). This view of weak signals can be seen as opposing one of Ansoff's early definition of weak signals in which he sees them as "warnings (external or internal), events and developments that are still too incomplete to permit an accurate estimation of their impact and/or determine their full-fledged responses" [75:12].

3.1. Back to definitions issues

Having analyzed the rather significant epistemological territory staked out by weak signal analysts, we now have enough material to return to a basic question: what is a weak signal? Let us un-blackbox the concept while also moving beyond the idea that weak signals are merely (still) "unidentified future objects". Using constructivist principles, we can distinguish two contrasting views of weak signals, both with important implications for the significance and use of this fundamental concept.

The first category is concerned with defining "what" are weak signals (for instance "first symptoms of changes in the environment", according to Åberg [76]). Do weak signals involve paradoxes (future-bearing facts, warnings of changes that we cannot know about until they really unfold) and oxymorons ("faint evidence but big in virtual consequences")?

The second category is concerned with "how" we know what we think we know and can we track our hypotheses about possible futures through actual change process monitoring?

Of course, as already discussed, Ansoff himself provided several definitions. There may even be grounds, based on the evolution of the weak signals literature, to argue that perhaps despite himself, Ansoff has entered the constructivist perspective. After all he did envisage a weak signal as "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 and McDonnel [77:490]). So maybe even Ansoff would accept that it is not just a question of putting on weak signal glasses in

[11] Some authors linked to traditional information theory, stochastic calculation or even bounded rationality typically convey with this kind of objective (see for instance Mevel [17], Decker, Wagner and Scholz [97], or Schermann and Krcmar [78].

[12] Quite in the same type of dedication, let's also mention the activity of Happy spotting (http://www.happyspotting.com/). This form of swarm intelligence is likely to proliferate quite quickly, however, as the possibility to go for quick creativity and opinion build-ups seems to be rather appealing.

order to be able to act or react on time. Instead a weak signal is a tentative relationship between phenomena that claim attention and the impact of such phenomena on the survival of the firm. We can envisage this as a sort of methodological scenario-making scheme with several possible entry points and outcomes.

The first, rather deterministic category considers that as reality changes it leaves in its wake enough evidence of changes to come to serve as resources for to be picked-up and introduced into specific decision-making processes. This is the classical approach to weak signal analysis. As we have seen, this approach to the future raises several significant problems. One of which is the paradoxical idea of "early" detection. The "early" mindset, as a way to focus attention on changes to come, creates a "knowledge tension", already expressed and elegantly "solved" by Ansoff with his graduated response perspective (see Section 2). Schermann and Krcmar [78] have also dealt with this paradox in a much more acute manner, defining a weak signal as being "a certain set of data, which can be interpreted ambiguously only; as time continues, the data, from an evolving situation, becomes clearer, but a possibly needed response time gets shorter".

The second category is more constructivist as it postulates a conditional relationship to weak signals, envisaged as the starting point of an open-ended, actor-based knowledge dynamic. An intermediate form of this approach takes the view that weak signals alone cannot deliver enough information into complex transformation. The exception is a closed situation in which weak signals function as signatures or symptoms of initial change (e.g. for well known developments like natural transformations linked with the seasonal sequence or curves on a road). For not-so-well identified processes or more complex types of change, however, other complementary "signals" are necessary to produce the conditions for a interpretation. This is for instance implicitly present in Découlfé [79] who sees in future-bearing facts the elementary particles of heavy trends, suggesting that several such particles will ultimately be needed to make a heavy trend. Similarly, Schoemaker and Day [73:86], see a weak signal as "a seemingly random or disconnected piece of information that at first appears to be background noise but can be recognized as part of a significant pattern by viewing it through a different frame or connecting it with other pieces of information".

At this stage, we can come up with our own proposal: weak signals are perceptions of possible changes that are essentially "candidates" (or hypotheses) within a socially relevant and resonant knowledge building process, that in all cases need to be: (1) conjugated with other weak or strong signal candidates and iteratively matched against change models (a scenario-minded step), (2) confronted to one's own bias-producing capabilities, (3) interacted upon with others stakeholders, hopefully involving a diversity of viewpoints, and (4) followed-up and evaluated in light of actual developments, with constant "early" sensitivity regarding strategic options.

4. Conclusion: early detection as an open avenue for research

Weak signals are more than just "faint evidence of changes to come", ready to be deciphered by experts with glasses good enough to see them. Weak signals are starting hypotheses for a variety of future-looking knowledge processes. But, as should be clear from the preceding discussion, there are numerous challenging research topics lying in between the determinist conviction that weak signals are easy to discern and the constructivist posture that sees weak signals as part of a complex and difficult epistemic journey. Here is a tentative list of six fields for further weak signal research.

1. *Pre-qualification or post-qualification of the weakness dimension*: Choo [41], for instance, proposes several distinctions. Weak signals, for him, can be weak in the sense of (1) being difficult to detect, (2) appearing as confusing (difficult to analyze), or (3) finally rather spurious (i.e., not indicative of a true change), while others (4) only reveal the incompleteness of the available information. Similarly, several authors have tried to break down the components of "weakness" that could help make progress in the understanding and tracking of weak signals. The most complete attempt of the kind, at the moment, is the one of Lesca and Blanco [80]. However, there is still room for referencing change types and relation with more elaborate forms of "earliness".
2. *Types of change dynamics*: Change is a multi-dimensional process and the use of that concept is associated with a large variety of transitions. When it comes to relating weak signals with something like changes in the making or even more so, with changes still to come, it makes a huge difference whether we are dealing with merely minor and local changes or on the contrary with more substantial and global transformations. This relationship between weak signals and forms, scale and depth of changes can be better understood on the basis of a clearer characterization of changes. From this perspective, contrary to those who have constructed two-by-two matrices mapping weak signal types with levels of uncertainty and impact, thus suggesting that these dimensions can be known and defined a priori, change is envisaged as a complex and heterogeneous research topic. There are already many theories, linked with specific disciplines or schools of thought, that provide an abundance of models of change. However, the effect of particular linkages or mis-linkages between candidate weak signals and types of change models remains, for the most part, to still be assessed. Such a differentiated sense-making repertoire could become a quite promising field of study (see further, for instance the Cynefin approach, conceived by Snowden and his team [81]).
3. *Weak signals as conversational proposals and explorations*: A number of authors, as already reviewed, open up scope for further research into weak signals as conversational explorations with a variety of social actors: Hiltunen in her own creative style [52,82] and also on her website (http://www.whatsnext.fi/blog/). Similarly Cahen is in this vein in his periodic "Lettre des signaux faibles" (Weak signal letter within Les Cahiers de la prospective http://www.signaux-faibles.fr/), and a recent book [83], oriented towards strategic economic, cultural or political shifts. Research in this area

focuses on processes for massive scanning of potential weak signals taking into account diversity and collective intelligence. A lot remains to be done to make the various interpretative steps of this type of rich identification process more robust.

4. *Swarm intelligence vs. peer-certified expertise?*: Research in this area may be a weak signal, the beginning of a trend towards generating weak signals as massive collective expression. This approach not only couple weak signal analysis and environmental scanning, but also builds upon the so-called Web2.0 type of Internet dynamics, bringing to life broad communities or swarm like forms of expression. The research of Ahlqvist et al. [84] points at the potential of social media for future-looking conversations. Michael Jackson and Dave Snowden, in a dedicated joint webinar on "Futures planning using horizon scanning and social computing", (June 3, 2009), have made this type of suggestion, which seems rather obvious in 2010, but without specifying the keys of how to exactly do it (crowds are not always wise!). Hiltunen also hints at a role for swarm intelligence through her work on a web platform to capture weak signals and trend suggestions by the dozens (http://www.trendwiki.fi/).[13] iKNOW (http://wiwe.iknowfutures.eu/iknow-team/), a project led by the Institute of Innovation Research of the University of Manchester uses a methodology that involves only scientists, a medium-size quantity of weak signals and wild cards linked with the European Union's list of Grand Challenges. There are elements of crowd-sourcing, tapping into diverse opinions and then processing the mass of inputs into a reportable form is done by experts. Clearly much research remains to be done in this area of intelligence gathering and filtering.
5. *Weak signals and wild cards*: Weak signals can be indicators of upcoming wild cards as explained by Mendonça, Cunha, Karvo-oja and Ruff [85]. Efforts to make this connection Many others have tackled this problem but for the moment still inconclusively. Indeed one of the most impressive efforts along these lines is the iKNOW project mentioned just above. iKNOW's explicit aim is to clarify and document both theoretically and experimentally the relationship between weak signals and wild cards. Postulating a particular wild card makes it rather natural to envisage possible weak signals. On the contrary, considering anything as a weak signal, without a scenario, context, perspective or criss-crossing factor substantiating some sense-making claim, is only a temporarily valid exercise that does not necessarily induce associated wild cards. iKNOW points the research agenda towards the continued collection of expressive material, not to suggest predictions, but to feed European strategic thinking.
6. *System's approach*: In recent years, some authors have re-enforced the relationship of weak signal with system analysis, looking in particular for: (1) tipping points (Coffman [38]), (2) transitional/transactional areas from specific states of organization to others (for example Snowden [86,87] Kurtz and Snowden [88]), and (3) promising or on the contrary dangerous outcomes, respectively opportunities and risks (Snowden). Another research trend worth mentioning is being explored by the FuMee network (http://http://fumee.co.cc/), also a spin off of the COST A22 Action. This strand of research is exploring the relationship between a number of futures studies issues (e.g., weak signals, wild cards, reflexivity of futures literacy) and the concept of anticipatory system as originally defined by Rosen [89]. One of the issues being addressed by FuMee network is latency: how to understand the link between systemic change (modeling) of what is emergent and phenomena that can be defined as "latently" pre-existing?

Certainly the overall research agenda includes much more, but as this indicative list shows the concept of weak signal has now gone well beyond its original starting point in communication theory. Indeed some of the research areas touched upon in this article may be weak signals of changes to come.

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[13] Let's mention here that a contrary perspective is assumed by Hiltunen [82, slide 7], who suggests that some weak signals are typically becoming wild cards.

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