



Weak signals: Ansoff today

Mari Holopainen^{a,*}, Marja Toivonen^{b,1}

^a Aalto University School of Science, BIT Research Center, Otaniementie 17, FIN-02015 Espoo, Finland

^b VTT Technical Research Centre of Finland, Organisations, Networks and Innovations Systems, P.O. Box 1000, 02044 VTT, Finland

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ABSTRACT

This paper examines the concept of weak signals: its basic idea presented by Igor Ansoff and its later developments. We argue that recent futures studies have essentially deepened the analysis of this concept, which originally lacked an accurate definition. Placing weak signals in the general context of futures research has provided the concept with a theoretical point of attachment and linked it with other futures concepts – such as strong signals and trends. Recent studies have also increased the applicability of the concept of weak signals, specifying ways in which signals can be identified, collected and interpreted. Consequently, a number of empirical examples of the analysis of weak signals are nowadays available. In the present paper, we summarize and evaluate both theoretical contributions and managerial implications of these new approaches. While emphasizing the advancements of research, we also want to point out that Ansoff not only was a pioneer in the field, but developed many ideas that are still applicable today. We conclude our paper by suggesting directions for the further development of weak signals research.

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1. Introduction

Ansoff started to develop his idea of weak signals as an alternative or supplement to strategic planning, which in the 1970s and 1980s was a dominating future-oriented approach in firms and organizations. He stated that strategic planning is reasonable in the case of incremental development of historical trends, but it is not successful when dealing with surprises. The reason is that strategic planning demands strong signals, i.e. information which is available early and is specific enough to allow adequate responses. In circumstances where the rate of change is continuously accelerating, a more reasonable approach is to increase strategic flexibility and determine which actions will be feasible when the detailed information becomes available. This kind of approach can be called *response to weak signals* [1–4].

Forecasting and scenario methods were a typical way to support strategic planning. Along with faster development cycles and the increasing number of uncertainty factors in society, these conventional methods proved insufficient for acquiring futures intelligence. A change of focus has taken place in futures studies since the late 1980s [5,6]. The approach, in which the primary object is not to identify the most probable state of affairs in the future but to understand the new processes initiated, has gained more and more ground. The central ideas of this approach are preparedness for many different futures and ‘making the future’ [7]. Despite the apparent similarity of Ansoff’s ideas with the new perspective of futures studies, the concept of weak signals has become an integral part of these studies only recently. One reason may be that Ansoff developed his ideas in the context of the strategic management of firms, whereas the main interest of futures studies has been – especially earlier – in

* Corresponding author. Tel.: +358 40 7620944; fax: +358 9 451 3665.

E-mail addresses: mari.holopainen@aalto.fi (M. Holopainen), marja.toivonen@vtt.fi (M. Toivonen).

¹ Tel.: +358 40 5334582.

broader societal issues. Today, when futures techniques have become increasingly popular also in firms, analyses of weak signals are emerging as a part of futures 'toolkits'. Hand in hand with these practical applications, theoretical analyses of weak signals are now accumulating. As the examination and evaluation of possible and probable futures are the core of futures studies [8], weak signals belong to this discipline as a natural element.

Thus, we consider Ansoff's work very topical, and in this paper we analyze it together with its later modifications and specifications. We try to bring clarity to Ansoff's ideas, whose complexity may be considered to be one reason for their late adoption [9,10]. After this introduction, the paper has been structured according to the following sequence. In the second section, we present Ansoff's original views regarding both his definitions of weak signals and his ideas about the management of weak signals. In the third section, we discuss later specifications of the concept, and in the fourth section, we describe how weak signals are positioned in the field of futures studies. Thereafter we move to more practical issues. In the fifth section, we examine the methods used in the identification and interpretation of weak signals, and in the sixth section, we provide practical examples of the analyses of weak signals. We conclude with a summary and some suggestions for further studies.

2. The nature and importance of weak signals according to Ansoff

In his analysis of weak signals and feasible responses to them, Ansoff first introduced the concepts of *turbulent environment*, *strategic discontinuity* and *strategic surprise*. Strategic discontinuity means that a future development shows a significant departure from the past or from the smooth extrapolation based on the past. In principle, such discontinuities can be anticipated by forecasting techniques. In practice, however, anticipation often fails and firms confront an unfamiliar and often threatening event. Such events are strategic surprises: sudden and urgent changes in the firm's perspective which threaten either a major profit reversal or the loss of a major opportunity [1]. Weak signals are first symptoms of strategic discontinuities, i.e. symptoms of possible change in the future, acting as warning signs or signs of new possibilities [3].

When a weak signal first appears, the information included is very vague; there is only a sense of a threat or opportunity. Progressively the information increases and describes the source of the threat or opportunity, its characteristics, the responses needed, and finally the outcomes that can be expected. These *different states of knowledge require different futures techniques*, starting from the use of expert opinion (e.g. Delphi) in the vaguest state and ending with quantitative modeling and forecasting in the highest state of knowledge. In addition, conventional impact analysis techniques should be used in order to examine the consequences of each threat or opportunity from the viewpoint of different parts of the firm in question [1,3].

Also the firm's responses should be adapted according to the state of knowledge. Ansoff divides the responses needed into two main groups: responses that change the firm's relationship with the environment and responses that change the internal dynamics and structure of the firm. For both of them, there are *three progressively stronger strategies*: one that enhances the firm's awareness and understanding, one that increases the firm's flexibility and one that directly attacks the threat or opportunity. Ansoff emphasizes that much can be done before the threat or opportunity becomes so tangible and concrete that direct responses come into the picture. A sense of a threat or opportunity is enough to make feasible the strategy of awareness raising. Awareness measures may include environmental monitoring and technological/sociopolitical forecasting, for instance. Environmental monitoring, in particular, should be a continuous process in firms. For flexibility strategies, the knowledge of the sources of the threat or opportunity is usually sufficient. These strategies include positioning the firm in the environment and configuring its resources and capabilities so that quick and efficient repositioning is permitted when needed. Even direct responses need not await detailed information but can be based on risk taking, typical of forerunner firms [1–4].

The main advantage of the strategy based on preparedness, i.e. proceeding from awareness raising via flexibility building to practical operations, is that the firm needs less time for completing the response when the anticipated phenomenon actualizes. Ansoff [1] also mentions *ad hoc crash responses* as a means to achieve time savings when strategic surprises occur – a view that has later aroused interest among researchers of organizational improvisation [11]. All in all, striving for a *balance between creative thinking and systematic management* is clearly observable in Ansoff's ideas of weak signals. According to him, creativity is required particularly in the detection of weak signals [3,4]. Thus, the issue of the abilities needed in the identification of weak signals, which has been touched upon in some recent writings, was present already in Ansoff's considerations.

Ansoff [3] also took into account the fact that the acceptance and use of his suggestions for a new managerial approach are by no means self-evident. He considered gaining the acceptance of senior managers as one of the greatest challenges and judged that strategic and creative managers more probably have 'a weak signal mentality'. The latter group often detects early warnings, but does not necessarily see the importance of their systematic management. Thus, the idea of weak signals must be 'sold' to senior managers, whereas strategic and creative managers have to be persuaded to see the value of the management of weak signals.

According to Ansoff [3] weak signals act as still immature warning signs. In order to affect the future, the signal has to traverse three filters: *the surveillance filter*, *the mentality filter* and *the power filter*. This 'filter model' is one of the most well-known insights created by Ansoff. The surveillance filter refers to observation of the signal: in order to pass this first filter, an actor or several actors have to discover the emerging signal. The mentality filter refers to the fact that when the environment is undergoing a discontinuous change, the historical success model becomes invalid, and acts to block the newly relevant

data. Thus, several individuals or organizations notice weak signals around them, but do not understand the importance of the signals because they rely on what has been learned in the past. The power filter relates to decision making: although a weak signal would be perceived and understood, it may be intentionally or unintentionally ignored and not taken advantage of.

3. Later specifications of the concept of weak signals

After 'finding' the relevance of Ansoff's argumentation for futures studies, several researchers have specified and further developed his ideas, and also questioned them in some parts. We have identified four main directions in this discussion. Firstly, a more accurate and detailed definition of weak signals has been pursued. Secondly and partially linked to the first aim, the sign of an emerging phenomenon has been separated from the phenomenon itself. Thirdly, the significance of the phenomenon that the weak signal indicates has been debated: some researchers have argued that the concept of weak signals should be restricted to signs of broadly influential phenomena, whereas others do not want to make such a restriction. Fourthly, managerial implications of weak signals – the topic to which Ansoff paid most attention – have been examined both generally and in some specific contexts.

Ansoff's quite simple *definition of weak signals* as 'symptoms of possible change in the future' has been discussed at a more detailed level by Coffman [12] and Kamppinen et al. [13]. According to Coffman, a weak signal is: (i) an idea or trend that will affect the business or the business environment; (ii) new and surprising from the signal receiver's vantage point although others may also perceive it; (iii) sometimes difficult to track down amid other noise and signals; (iv) a threat or opportunity to an organization; (v) often scoffed at by people who 'know'; (vi) usually has a substantial lag time before it will mature and become mainstream; and (vii) therefore represents an opportunity to learn, grow and evolve. This definition quite faithfully follows Ansoff's original ideas, just specifying them and making them more concrete (e.g. by pointing out that people who 'know' often scoff at weak signals). Also Kamppinen et al. [13, p. 894] have formulated their definition in the same spirit: a weak signal is an individual event or a group of interrelated events, which may not seem essential or extensive at the time of occurring, but which has an important or even crucial meaning for the emergence of the future. The connection of the weak signal with the upcoming event is not necessarily possible to explain credibly by statistical investigation, such as a historical time series.

There are other terms used as synonyms for the concept of weak signal. One of the most well-known is the term 'germ' introduced by Godet [14], and another is the notion of 'seed' explored in the COST A22 project [15]. The concept of a 'wild card' [16] has also been applied synonymously with a weak signal, but there are researchers who highlight the difference between them. These researchers want to *discriminate between the sign of a phenomenon and the phenomenon itself*: a weak signal is a sign of a future wild card [16]. Hiltunen [17] also distinguishes these two concepts; in her terminology weak signals may, however, pre-indicate many types of changes – not only wild cards but gradual changes as well. In a later article [18], Hiltunen suggests a new term; instead of a weak signal she prefers the term 'future sign'. In addition, she goes deeper into semiotics and applies a triadic model which consists, not only of the form that the sign takes (representamen) and the emerging issue that it indicates (object), but also of the sense made of the future potentiality of the sign (interpretant).

Grounds for the discrimination between weak signals and wild cards can be found even in Ansoff's original texts. His description of strategic discontinuities and strategic surprises corresponds quite well to the idea of wild cards, about which weak signals provide early information [17]. On the other hand, some researchers have justifiably remarked that even though the difference between a phenomenon and its sign is clear in theory, it is often difficult to make in practice [19]. Making this difference is quite complicated even in some theoretical contexts, e.g. in analyses that concern the relation of weak signals to trends and other futures phenomena. Here researchers often interpret a weak signal as a futures phenomenon, as we will see in the following paragraph and following section.

The nature of phenomena that weak signals indicate is another issue of dispute. Researchers are unanimous that weak signals (wild cards) are characterized by a sense of improbability, but there are differing opinions as regards *the importance of the phenomenon if it eventually occurs*. Mendonça et al. [16] describe wild cards as phenomena that will have large and immediate consequences for organizational stakeholders if they take place. Also Mannermaa [20] links a weak signal with a big impact – either catastrophic or positive – in the case that it becomes true. According to him, weak signals differ clearly from meaningless noise, on the one hand, and from trends to megatrends on the other. Future phenomena with a low probability and a minor impact are meaningless noise. When the probability rises significantly, phenomena with a minor impact can be called trends. Phenomena with major impacts are either weak signals or megatrends; weak signals have a low probability and megatrends have a high probability of realization.

The significance of weak signals comes out most clearly in cases where the signals indicate the rise of a new trend or influence the breakdown or slowdown of an existing trend [cf. 21]. Even in the latter cases, a weak signal itself is a novel phenomenon, which has no recognizable past; the phenomenon is just linked to some trend. In addition to weak signals linked to trends, there are apparently signs that refer to unimportant or passing phenomena. Deviating from the views of Mannermaa [20] and Kamppinen et al. [13, p. 894], other researchers have argued that these signs too should be included in the definition of weak signals. Here we can identify two questions that are often confused. The first question is whether the concept of weak signals covers all types of futures phenomena that are realized at some point of time, irrespective of their importance. The second question is whether the concept of weak signals may also refer to phenomena that never take place. Answering affirmatively the latter question seems easier, and several researchers – starting from Ansoff himself – have given reasons for this. Even an important weak signal may not develop into an actual and influential phenomenon, because it is

never perceived [3], or the external environment may change at such a rapid pace that the signal loses its connections to it [22]. There are also proponents of the first view [12] and some researchers have applied it, examining all kinds of indications of future developments in a certain context [22].

As Ansoff's main interests were in the field of strategic management, he put much emphasis on encouraging companies to use weak signals in order to react proactively to change. Among later researchers, Coffman [12] and Mendonça et al. [16] have discussed *weak signals from the viewpoint of managerial implications*. Coffman states that if a company interprets weak signals in their early phase, and executes its actions based on them, the strategy includes both more risks and more opportunities. He also points out that the identification and understanding of one weak signal often leads to perceiving a whole host of other signals. Mendonça et al. analyze the nature of activities based on the detection of weak signals, highlighting organizational improvisation and the management system for wild cards, in particular. Organizational improvisation can be developed by the use of futures methods such as alternative scenarios. The development of a wild card management system increases the probability of advanced perception of those events with a significant and possibly highly negative impact.

Emphasizing possible negative impacts, i.e. pointing out the threat aspect of weak signals, is clearly visible in Ansoff's own writings, too. Consequently, the term 'early warnings' has been used as a synonym for weak signals in some studies. A study by Nikander [23] is an example of the application of early warnings in a quite specific managerial context; in project management. (See also Nikander and Eloranta [24])

4. Weak signals in relation to other futures phenomena

According to Ansoff [1,3,4] past experience – such as forecasting based upon trend extrapolation – was a reliable guideline to the future only until the 1950s, whereas after that flexibility, in the form of preparedness for multiple actions, was required. Ansoff's theory on weak signal management is in line with foresight [7,25,26] as both emphasize an active approach towards the future. In this section, we discuss more comprehensively the relationship between weak signals and neighbouring concepts: strong signals, trends, megatrends and drivers. As weak signals are hardly identifiable events with no recognizable past, we think that a deeper understanding of them can be gained by placing them in the context with other futures phenomena.

The evolution from a weak signal to a strong signal, and further to a trend or even a megatrend has been presented using an information life cycle model by Wygant and Markley [27] and Choo [28], the model being cited and developed by several authors [29–31]. Here the axes are time and awareness of the event: by reaching a wider audience a weak signal develops in strength – from a hint to even a mainstream. In the beginning, the idea may exist without anyone being aware of its relevance. As it becomes more general, transforming into a strong signal, the event can be spotted, for instance in the research reports of analysts, in 'think tanks' or business incubators and in special purpose magazines. In the course of time, the weak signal starts to appear in several contexts and transforms into a 'minitrend' of a certain niche group [29–31]. Here a weak signal is interpreted as the event itself instead of sign of the phenomenon.

A detailed discussion of *strong signals* was started by Ansoff himself [3]. As in the case of the concept of strategic surprise, we can again perceive that Ansoff makes a separation between a sign and the phenomenon that the sign indicates. He speaks about 'strong signal issues' that refer to easily visible and computable issues on which a firm can make specific plans. In Ansoff's terms [1–4], strategic planning responds to strong signals whereas weak signals require a different type of approach, which Ansoff calls 'the strategic issue analysis'. A strong signal differs from a weak signal by its greater probability of realization [1,3] (Table 1).

A *trend* is a phenomenon that is already broadly known and can be recognized by several persons [13,32]. As mentioned earlier, a weak signal can be identified as a potential trend in its early phase, the point when only a few indicators of the signal have been identified by certain forerunners (e.g. [29]). The interrelation of weak signals and trends can also be understood in the way that weak signals point towards trends instead of being part of trends (e.g. [19]).

Trends can also be perceived as being part of broader types of dynamics called *megatrends*. The term megatrend was created by Naisbitt [33] and refers to the same type of process as the 'heavy trend' used for instance in the French futures studies' tradition. Megatrends refer to development lines changing slowly over time: they can be influenced only to a certain degree, or not at all. A megatrend is significant, complete and recognizable entity comprising phenomena with a history and a course of development of their own. A megatrend contains several and even contradictory sub-events and series of events. The relation of weak signals and megatrends can be investigated by means of the transitional periods, a period when one trend is changing considerably [13,33].

Driving forces refer to the phenomena affecting a whole society or societies [13, p. 891]. They are forces of change which direct the decision making and choices of individuals and groups. Driving forces underlie the choices at either the conscious or unconscious level, and they are often related to attitudes and values. Although driving forces have similar characteristics with trends, clearly distinctive elements can also be found. Driving forces have an influence on the present whereas trends or weak signals can give directions for the future development. Also, they are forces which affect or give impetus to other phenomena, whereas if the phenomenon is studied as a trend, the direction of its own development is the focus of interest [34].

In addition to futures studies, there are examples of studying weak signals in the context of communications research, especially in business journalism. As their sources of information, business journalists use analysts and investors, who themselves attempt to foresee future events. However, events that have changed the world radically, such as major collapses

Table 1

Summary of weak signal studies – Ansoff's original thoughts and contributions of futures researchers.

	Ansoff's analyses	Contributions of futures studies
Definition of weak signal	Weak signals are first symptoms of strategic discontinuities; they are symptoms of possible change in the future	More detailed definitions, e.g. by Kamppinen et al. [13, p. 894]: an event which may not seem important when it occurs, but may be crucial for the emergence of the future
Differentiating sign and phenomenon	No explicit discussion, but the concepts of strategic discontinuities and strategic surprises refer to a difference between a weak signal and the phenomenon that it indicates	Some authors argue that weak signals should be separated from 'wild cards', i.e. from phenomena that they indicate [16,17]
Nature of knowledge of weak signals	First a sense of a threat/opportunity, then gradually increasing knowledge of its source, characteristics, necessary responses, and outcomes	Adopting from semiotics the term 'interpretant' to refer to the sense made of the future potentiality of the sign [18]
Importance of phenomena that weak signals indicate	The concept of <i>strategic</i> surprises restricts the phenomena to the important ones; however, Ansoff states that a weak signal may not be realized because it is never perceived	Some researchers restrict weak signals to important phenomena [13,20], others not [17,22]
Managerial implications	Ansoff's main focus, including e.g. analysis of three progressive strategies: enhancing awareness, increasing flexibility, and directly attacking the threat or opportunity	Additional notions: identification of one signal often leads to perceiving others [12]; emphasis on the management system for wild cards [16]
Weak signals in relation to other futures phenomena	Discussion of differences between weak and strong signals	Positioning weak signals in the context of futures studies, analyzing their relation to strong signals, trends, megatrends etc. [13,15,19,20,29]
Sources of weak signals	Ansoff named experts outside the firm and personnel with broad contacts inside the firm as relevant sources of weak signals, but did not discuss this topic in detail	Moving outside one's own context, eliciting opinions from people of different backgrounds, unofficial discussions, Internet and other media, 'expert amateurs' [20,38,41]
Methods and tools for identifying weak signals	Ansoff developed a systematic framework for identification of weak signals, but did not discuss in detail the methods and tools to be used in identification	Systematic environmental scanning, expert opinions, Internet-based tools that facilitate the choice of information, visual images 'in the futures window' [40,47,49–51]
Skills needed in the mapping of weak signals	Sensitivity, creativity, genuine interest and expertise are all needed	Creativity and daring are essential. But expertise is also needed [29,40]
Factors hindering the perception of weak signals	The idea of 'filters': surveillance, mentality and power filters	Discussion and application of the 'filter theory' [49]; 'paradigm blindness' as a new concept [20]
Empirical studies of weak signals	Ansoff created a network of contacts to major corporations over the years to validate his research. He consulted with Philips, General Electric and IBM to name a view [55]	Applications in many contexts, ranging from broad societal issues to the management of organizations and projects [23,46]

of the stock exchange, have often occurred as complete surprises and were not foreseen in advance [35]. Uskali [35] divides weak signals into four categories that can appear in the business news: (i) feeling signals, (ii) uncertain signals, (iii) almost certain signals and (iv) exact signals. The first two, the feeling signal and the uncertain signal are based on the journalist's own feeling or rumours about something important. The almost certain signal and the exact signal have some reliable sources and some details about the phenomenon are known. Uskali's angle of approach differs from Ansoff's: Uskali seems to create an ex post classification of weak signals on the basis of their uncertainty.

5. Identification and interpretation of weak signals

Ansoff's [1–4] model of weak signal management included some general guidelines on the sources of weak signals. He emphasized that their detection requires sensitivity and expertise: advisory groups with broad knowledge on social, economic, political and technological issues are good sources for *external weak signals*. Also individuals working in the interface functions such as marketing, purchasing and R&D are good sources for external weak signals. Employees with broad contacts inside the firm, including developers and planners, are sources for *internal weak signals* [3]. Thus, Ansoff [3] described the types of positions that individuals should have in order to detect new phenomena.

Ansoff's followers have made some contributions to our knowledge on the identification and interpretation of weak signals. Certain common elements have been highlighted, although not all of them are anything particularly new. Collective approach and networks have been emphasized in the gathering of weak signals – simply because a greater variety of novel views will more likely be included in this way [36–38]. Several articles repeat that the detection of weak signals should focus on somehow unusual areas (e.g. [20,38,39, p. 196]). Day and Schoemaker [38] launched the term *peripheral vision* to point out that organizations should not focus too much on what they are currently doing but open their eyes to the outside world. As a metaphor for over-concentration on safe and familiar circumstances, the authors use the expression 'the lack of peripheral

vision'. Mannermaa [20, pp. 22–23] calls the acceptance of society's predominant way of thinking *paradigm blindness*. The influence of these tendencies can be reduced by involving people with various backgrounds in the detection of weak signals (e.g. [20]).

Paradigm blindness can be a challenge for an expert, whether he is established or self-taught; however, in the latter case the problem is not linked with the professional position. In the context of expert panels such as Delphi studies, it has been argued that a high level of expertise is important for the identification of weak signals [40]. On the contrary, more informal channels such as family and friends are suggested to be useful sources for weak signals [41]. Thus, the discussion concerns the position or the depth of expertise suitable for the detection of weak signals: the professionals vs. 'the amateurs'. In certain cases, the experts may recognize the discontinuities more easily than lay people as they have thorough knowledge in their own field [22]. Nowadays it seems that, as professionalism is widely distributed, weak signals can often be spotted by 'expert amateur groups' who acquire or even create the latest knowledge around their interest. Expert amateur groups are deeply involved in their interest area, often being determined to find the latest development and inventions associated with their topic and able to share information in real time, for instance through blogs. Ansoff [3] himself considered that persons with broad knowledge working at the boundaries have the ability to make interpretations of novel phenomena and they are most likely to be exposed to weak signals: Formal expertise is not required.

Researchers have also examined this question from other viewpoints. For instance, the evolution of weak signals based on the information life cycle model [27–31] suggests that 'radical persons' can be sources of weak signals, in addition to art, academic theses and patent applications, Internet sites, chat forums and blogs. In a study by Hiltunen [41] unofficial inter-organizational sources, such as discussions around the coffee table, have been considered important for the detection of weak signals. Similarly, unofficial discussions and non-traditional thinking were the most prominent sources for extra-organizational weak signals. The most important sources in her study included the following: the Internet, business and technical journals, discussion with family and friends, customers, competitors, subcontractors, science fiction, employees in research centers, consultants, and travelling [41].

The identification and interpretation of weak signals can be seen belonging to methods of foresight, such as environmental scanning [16] or the Delphi method [40], and it can also be understood as part of futures thinking. Futures thinking influences the present by creating goals and motivations for our current activities [8,42]. As personal interests guide the scanning of the environment, the demographic and cognitive diversity of the persons involved influences what kinds of weak signals are spotted. Individuals place signals in the context where they live and operate [43]. They may recognize patterns of weak signals but cannot directly articulate the meaning of signals. In organizational contexts, leaders call these feelings of weak signals 'intuitive' and describe them as 'soft skills' [35]. Therefore, we propose that focusing on these 'soft skills', i.e. how to continuously trigger employees' futures thinking, may open up new horizons for the management and theory of weak signals. Futures thinking can be seen as a learning process which can be trained [44,45].

Events that we observe do not always transfer into concrete ideas or actions. Ansoff [3] relied on the framework of filters, explained earlier in this article, when specifying how the early information passes through the human mind into an organizational practice. Later research has only rarely included discussion about the decision-making aspect, or the power filter in Ansoff's terms [3]. However, involving various employees in the detection of weak signals may not be relevant unless attention is paid to the power relations involved in decision-making. Hamel and Prahalad [37] discussed the topic by following Ansoff's view. According to them, senior executives are not the only possible actors of industry foresight. On the contrary, they should capture and take advantage of the foresight capacity that exists throughout the organization. An interesting issue is also the degree to which the identification of weak signals should be in line with current strategies, taking into account that the aim is to find something outside the existing paradigm.

6. Empirical examples of weak signal analyses

The empirical examples of the application of weak signal analyses cover a wide range of approaches, including academic research and more consulting-like approaches. Many of the studies aiming to find out the futures perspectives of a specific branch with the help of weak signals apply interview techniques [34,41,46]. In addition, to facilitate the observation of weak signals, strategic and concrete tools have been developed.

Decker et al. [47] studied the use of an Internet based tool for environmental scanning in marketing planning, which aims to reduce obstacles hindering the observation of weak signals. The tool facilitates the choice of information sources and saves the user's time for work on the more demanded tasks. The main benefit of the research was the integration of weak signals into the information search process of the strategic planning and marketing.

For the purposes of the participatory strategic work, a company called Fountain Park offers Internet-based tools for environmental scanning, including scanning of weak signals [48]. The two-phase method is based on the creation of the signals through techniques aiming to encourage the participants to cross and overcome different filters which limit creative thinking and observation. (It is notable here that Fountain Park interprets Ansoff filters as obstacles inhibiting an organization's analytical potential.) In the second phase, the participants evaluate some of the collected ideas in relation with the given theme [48,49].

Könnölä et al. [50] introduced a collaborative foresight method called RPM Screening for the analyses of weak signals in the context of prospective innovations. The seemingly heavy process consists of phases for the generation, revision, multi-criteria evaluation, and portfolio analysis of innovation ideas.

The types of methods described above aim to collect and formulate information so that it can be more easily processed. However, one of the simplest ways to crystallize information is to represent it visually. Hiltunen [51] has developed the concept of collecting weak signals in visual images in 'the futures window'. The futures window aims to be a monitor of images of weak signals for organizations in order to provoke ideas. It may include for instance photos appearing on a screen in a company's lobby where employees are able to see them easily.

The previous examples of exploration of weak signals are still in their early development phase. The Delphi method, which has been developed further, is also applicable for collecting weak signals. The Delphi studies bring together experts' views, which can differ from the main stream of forecasts, and they can be instrumental in bringing out weak signals [40].

The challenges in identifying weak signals in the empirical studies are numerous. Many of the attempts to locate emerging issues do it by asking the opinions of recognized experts (e.g. interviews and the Delphi method). However, this does not correspond with the earlier claims of the importance of looking outside the existing paradigms. The so-called 'radical persons' rarely have a chance to express their opinion in the official discourse.

Furthermore, the concept of weak signal is sometimes used very loosely, even in a confusing way. In recent years, the significance of futures thinking has been emphasized in regional policies (e.g. European Commission Community Research [52]), and a number of future-oriented reports have been published. These types of reports (e.g. [53]) usually apply weak signal analyses in order to identify upcoming trends in a certain sector or region. Solid criteria of a weak signal are rarely used here; almost every phenomenon that is perceived as something new can be included. Many of the studies do not reach the level of weak signals but focus on trends. In Ansoff's terms, the states of knowledge included in these analyses concern threats and opportunities which are fairly well known. However, in order to keep clear the meaning of the weakness of the signal, foresight practices should focus on revealing upcoming phenomena at the stage when there is just a *sense* of threat or opportunity, i.e. the information is very vague.

In academic studies the criteria chosen for weak signals are usually explained but vary according to the study. Toivonen [34] chose the following guidelines to identify weak signals from research material: (i) weak signals have to be rarely-expressed, deviant opinions of future prospects, (ii) a weak signal is not a mere random opinion and (iii) small symptoms have to be associated with important impacts in the future in order to be weak signals. Thus, Toivonen takes a positive stand on the dispute as to whether future impacts are a criterion of a weak signal. Hiltunen [54] has made a more practically-oriented suggestion, according to which a signal really is a weak signal if it fulfils the following conditions: (i) it makes your colleagues laugh, (ii) your colleagues are strongly opposed to it, (iii) it raises one's eyebrows, (iv) no one has heard about the issue before, and (v) it is considered a taboo which no one likes to talk about. The criteria presented by Hiltunen are highly subjective in their nature and they rely on the explicit expression of feelings.

7. Concluding discussion

In this paper, we have examined the idea of weak signals, which Igor Ansoff introduced in the 1970s and developed further in the 1980s [1–4]. Recently this concept has gained an increasing foothold in futures studies, and futures researchers are now specifying it further and developing tools for the mapping of weak signals. Actually, it is surprising how long it took before the concept was adopted in futures studies – taking into account that the nature of weak signals as the first symptoms of change is deeply future-oriented. We have suggested in this paper that one reason for the late adoption of the concept may be the differing interests between Ansoff and the mainstream of futures studies: Ansoff focused on strategic management, whereas futures studies concentrated on broader societal issues. Nowadays when futures methods and tools are increasingly applied also in firms and organizations, it is high time to consider weak signals as an integral part of futures studies.

Based on our analysis, we can argue that Ansoff actually had something to say on most issues that nowadays are under discussion in the context of futures studies. The sources of weak signals as well as the methods and tools for their identification are the area where Ansoff was least explicit and where new contributions have been needed. Recent studies have also analyzed some theoretical issues at a clearly deeper level compared to Ansoff, one example being the discussion of whether a sign and the phenomenon that it indicates should be separated. This discussion has stimulated futures studies to become even more interdisciplinary than it has been, i.e. to 'find' disciplines – like semiotics – whose insights have not been extensively utilized before but which can enrich futures studies and be combined with its ideas.

On the other hand, there exist several open and disputable topics in the field. Even the above mentioned issue of a sign and its object is by no means clear. Many weak signals are actually *a part of the phenomenon that they indicate*. As a result they can be interpreted as signs on one hand, but also as the phenomenon in its early form on the other. Further studies are thus welcome here, just as they are welcome concerning the 'coverage' of the concept of weak signal. From the viewpoint of practical applications, it seems that the inclusion of all kinds of futures phenomena in the weak signal concept is not useful because it does not lead to the identification of the really relevant and strategic changes. Saying this means, however, that we commit ourselves to a more demanding interpretation of weak signals and believe that the relevance of signals is possible to evaluate beforehand, at least to some extent. In addition to these mainly conceptual issues, the development of user-friendly and plausible tools and techniques for the mapping and interpretation of weak signals is still in its infancy and thus an important challenge for further studies.

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