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BUSINESS INTELLIGENCE
A PROCESSING HEURISTIC FOR WEAK SIGNAL

ROUIBAH Kamel : Ph.D. Student in industrial Engineering CERAG/ IPI / Grenoble
LESCA Humbert : Professor in Organizational Information System at ESA School
MALEK Siham : Ph.D. Student in industrial Engineering CERAG/ IPI / Grenoble

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Summary

In this paper, the authors present an exploratory study that proposes a cognitive approach for creating useful meaning from weak signals. We begin by explaining the nature of the problem that requires processing. We deplore the absence of methods for processing this type of information, and emphasize the need for using a cognitive approach to do so. A description of the approach we propose in order to produce meaning from weak signals follows. Before implementing it, in the form of a computer tool, we study some existing software to show that currently no efficient and simple tool exists for processing weak signals. Then, we describe the environment we have chosen to implement our approach. In our conclusion, we develop perspectives for the validation of this approach.

INTRODUCTION

Currently, most enterprises are encountering major changes and are under strong pressure because of the internationalization of markets, the evolution of technologies and the demand of clients. Many studies have shown that proactive corporations have to scan and interpret their external environment to adapt to these changes (Lesca 1986). The business intelligence concept highlights this fact and states that corporations have to scan the external environment in order to survive. This environment is composed of actors who may affect the enterprise. We designate them as competitors, suppliers, clients, public authorities, and pressures groups, etc. The basis information of business intelligence is anticipatory information called weak signal (Ansoff 1975). This refers to information « that allows to anticipate an event as soon as possible before its completely realized». The analysis and the processing of this information are of crucial importance. Nevertheless some difficulties persist. Our current research focuses on one of these.

THE BUSINESS INTELLIGENCE PROCESS

The business intelligence concept has emerged from publications on strategic management. According to Lesca (1994), it designates" the process by which a company keeps informed in an anticipatory way about opportunities and threats which occur in its socio-economic environment, by collecting anticipatory information instead of calculating statistical forecasts Fahey (1981). This process involves five main stages (Lesca 94, see figure 1) : the selecting of actors to scan, the tracking of targeted information, the routing and diffusion of collected information, the processing of information in the form of useful meaning to the action of managers, and finally the integration of processed information in the decision-making process.

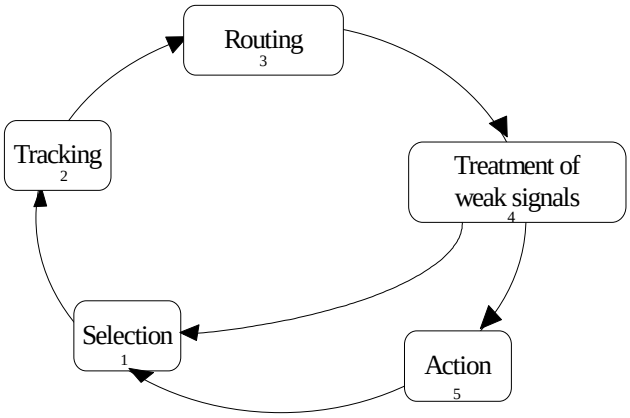


Figure 1 : Phases of the business intelligence process

This process has many facets covering technological, commercial, and competitive business, etc. Nevertheless, this study focuses only on the processing phase of commercial and competitive businesses. The goal of the processing phase consists in providing useful meaning to the action of managers and in reducing the reaction time of the corporation to external environmental changes. For that purpose the corporation can adopt two different policies :

- a political offensive via a proactive attitude, that consists in seizing opportunities in focusing on events which have not yet taken place and that are announced by weak signals.
- a political defensive strategy that consists in alerting corporate managers early enough about threats can emerge in the enterprise environment.

The creation of meaning allows corporate managers to develop their creativity through anticipation and imagination of the future.

Unfortunately, the nature of information does not facilitate the creation of this meaning. Indeed, according to El Sawy (1985) and Lesca (1986), a weak signal is :

- anticipatory because it must inform management about the changes which have begun to occur in the external environment,
- qualitative because in most cases, it does not consist of numbers which record or extrapolate from the past,
- fragmentary because each piece of information taken apart is insignificant,
- uncertain because it concerns an event not yet realized,
- fragmentary because these data come from various sources, in a fragmentary and often hazardous manner.

METHOD OF INFORMATION PROCESSING

There is little theoretical research on weak signal processing. We distinguish the following methods.

Scenario Method

This is used to imagine the future, it is carried out by a group of experts from inside or outside the corporation. This is the case of the LEAP technique (Preble 1982) and the QUEST technique (Nanus 1982). In the case of these two techniques, expected events are estimated, and the most plausible ones are analyzed during discussion.

Drawing Up a Chart

According to Calori (1989), this method consists in organizing consultations with experts. At the end of consultations, a chart is drawn up. It includes a list of variables to scan, a classification of these variables, and a list of information sources.

Method of 3 B

According to Hunt (1990), this method consists in creating the meaning by formulating goals, by defining needs, and by elaborating a data base to store the collected information.

Brainstorming

According to El Sawy (1988), this method consists in creating the meaning by generating ideas during a collective discussion. The K. J. Method of Kawakita, Jico (1975) is another brainstorming method that consists in producing the meaning by using "blind arrangement ". During a session, participants generate ideas on a sheet of paper. Then, papers are gathered, mixed and given back to participants in a random order. Each individual then tries to create new meaning based on the ideas of the others.
An analysis of the above methods lead us to identify the following disadvantages:
- the authors give only advice, often just common sense remarks, but no real guide or method for creating the meaning from a jumble of widespread weak signals,
- the influence tasks of scanning the external environment is continuous. This tasks looks like a ship's radar.
- those methods are organized to anticipate changes, according to predetermined goals, in the medium term. Therefore they do not take into account signals of alert that can appear from the opposite direction.
- those methods do not furnish a methodology that can be passed directly on to corporate managers.

Puzzle Method

According to Valette (1993) creating meaning from weak signals can be done by bringing weak signals together in order to construct meaningful representations. These representations are used to conduct all types of inferences including :
Induction : provides significant representations about environmental changes which pose several questions (or interrogations).
Deduction : infers inaccessible information from the available data. The inferred information is used as a hypothesis which needs to be validated.
Abduction : provides verification of the coherence of reassembled information.
Nevertheless, this method does not specify the mechanisms for constructing meaningful representations. This method will be used as a support to develop our approach.

PROPOSED APPROACH

Necessity of a Cognitive Approach

As there is no simple and efficient method to create meaning from weak signals, we consider this problem as an ill-structured problem (El Sherif 1988), which means a "a problem that has no available procedure resolution" (Toda 1990). The recourse to a cognitive approach is a necessity justified by the following quotations :
- according to Keen (1978) " decision support system have to take into account the structure of cognitive users, their perceptions, intuition and judgments".
- Ford (1984) concludes in a study on the cognitive map of managers that "contemporary organizations, confronted with an environment in continuous change, have to take frequent decisions of adaptation. These decisions have to result largely from cause/effects maps used by managers as a support of evaluation choice".

- according to Yadav (1991) " to assist managers, it is necessary to develop a cognitive approach through decision support systems".
- to argue that the comprehension of an ill-structured problem is related to the cognitive orientation of individuals, Pound (1969, p.5) asserts
"because the world of managers is complex ..., the comprehensiveness problem, can be possibly reduced to the comprehensiveness model used by the manager.

A Summary of the Proposed Approach

In (Rouibah and Lesca 1996), we have proposed a conceptual framework to create meaningful meaning from weak signals. Here is a summary of that approach
1- Categorizing information in order to facilitate its use.
2- Elaborating various associations such as graphical representations by using different kinds of links : logical implication, support, contradiction, presupposition, etc.
3- Elaborating multiple arrangements of the information in order to generate other new links between the existing data. According to Kanter in Couger et al. (1993) « kaleidoscopic thinking » allows us to take existing data : « twist them, shake them, look at them upside down or from another angle or from a new direction ».
4- Visualization of both the information and the graphical representation because individuals are more attracted by visual images.
Therefore, these representations must be dynamic in order to incorporate in newly collected information. The arrangement of the information must be easy to change. It requires an appropriate computer tool which enables the creation of dynamic links between fragmentary information. When this is done, it allows one to go from atomized and insignificant information to intelligible representations. In order to generate meaningful representations (maps), it is necessary to build a prototype that implements the previous four stages.

This prototype requires
- functions to construct a data base in order to store collected weak signals,
- functions to retrieve the stored weak signals by multi-criteria research,
- and functions to construct graphical representations "puzzles".

STUDY AND CRITICISM OF SOME SOFTWARE

Which software tools allow the above approach to be implemented ?

RDSS

The Research Decision Support System RDSS (Toda 1990) is a software tool designed to assist the research in the area of R&D. RDSS provides functions to construct a structured database, functions to generate the research of themes, and functions to select the optimal strategy research path.
Database : it contains information and their attributes. All R&D projects comprise needs (motivations) and intermediate results. RDSS data are stored in the form of needs, intermediate results and relationships between needs and intermediate results. Attributes concern sources of information that connect needs to intermediate results as well as themes of research.
Retrieval information : RDSS offers many functions designed to retrieve the stored information.
Drawing graph : RDSS includes functions to generate R&D graphs, a zoom function, as well as the possibility to write comments on graphs. A graph is an R&D model of composed of needs, intermediate results and relationship between needs and results that contribute to reach the same objective. Moreover, RDSS allows one to find the optimal research path in R&D and this allows to solve others problems and to reach a maximum of intermediate result.
However, information is seized in the database in the form of abbreviations and not as phrases. Also, RDSS does not allow the creation of specific and free themes for each user. In addition, the RDSS does not allow each user to construct a personal graphic because information cannot be easy to move inside the screen, and links between the information on a graph are only specified during the storage of the information.
Conclusion : the RDSS cannot be used as a support to implement our approach.

CLSS

The Cognitive Lens Support System (CLSS) (Yadav 1991) is a software tool destined to assist corporate managers to structure information of an ill-structured problem. It provides of cognitive origin functions , that allow a user to look for solutions to a problem via his or her own vision as well as that of others.

Database : Through a didactic module, a user introduces concepts, and necessary relationships for the construction of lentils, relationships and weight signs allocated to relationships. Once clarified, these elements are stored in the database in the form of graphs.
Retrieval information : It is possible to access to the different components of lentils.
Drawing graphs : CLSS allows to display constructed cognitive lentils, to modify them or/and to destroy them, to write comments and to zoom in on them. In addition, it allows the analysis and the evaluation of cognitive lentils, for both the individual or a group, and enables to work out a consensus.
However, according to our research characteristics, CLSS can not implement the proposed approach because it does not allow the creation of specific themes by each user; it manipulates concepts instead of phrases, it cannot store information in the form of key sentences, references, etc.), it cannot manipulate a list of links because the relationship between the nodes of lentils are created during the storage of information.
Conclusion : the CLSS cannot be used as a support to implement our approach.

Leximappe

According to Courtial (1994), Leximappe is a software tool used to analyze technical and scientific information existing on data bases and data banks. Leximappe allows to answer the following questions : what are the themes characteristic of a technological area or a scientific branch ? What are the parameters (important terms) that describe a scientific branch ? What are the emerging themes that present potential future development ?
From information given from the data bank, the software makes a statistical analysis via the "co-word method", and creates clusters. A cluster is a graph whose nodes are key words or normalized titles of information, and relationships are statistical links between these words (superior or equal to a fixed threshold). In addition, it allows one to draw a map of a scientific branch , more specially it allows one to highlight the main themes being treated, the relationships that exist between these themes and the position of each of them within a scientific branch. This map shows the emerging themes, that are considered as the most important.
However, according to our approach, Leximappe presents the following disadvantages : it has no database to store information. The information coming from the data banks are reliable and in great quantity. Consequently, Leximappe has no retrieval of information functions. Also the links between the information of a graph are statistical. Finally, elaborate graphs can only be interpreted by experts.
Conclusion : Leximappe cannot be used as a support to implement our approach.

RlDoc

This is designed to model the flow of strategic information both on the external and internal environment of the enterprise. RlDoc creates and manages a model of the functioning of information in the form of a network. The elaborate model allows a user to reply to the following questions : concerning a given research theme, who works on
this theme in my service ? What patents are deposited ?Which organization has deposited those patents? What research that organization involved in ?Do the scientists researchers participate in current research projects ?
Database : the tool allows to store information and their attributes.
Retrieval information : RlDoc offer automatic, semi-automatic and manual modes of retrieval of information.
Drawing graph : RlDoc displays information on a network where a user can navigate.
However according to our approach, RlDoc manipulates only technical and scientific information that is very reliable and not weak signals. In the displayed graph network, these information are not mobile. In addition, links are created only during the storage of information. In addition, these links are activity links, membership links, participation links. Consequently, these links do not allow graphs to be constructed according to our approach.
Conclusion : RlDoc cannot be used as a support to implement our approach.

Topic

Topic is a documentary research software tool in full text. It is designed to respond to the problem of the overabundance of information (information that is external and internal to the enterprise). Topic allows to research and access both documents and the knowledge that they contain via the oriented technology object. Although Topic allows all types information (text and image) in various formats (Word, Excel, Word Perfect, Acrobat, Pdf, Html, etc.) to be retrieved. It cannot store information nor construct meaningful representations such as graphs because it cannot manipulate a list of reasoning links.
Conclusion : Topic cannot be used as a support to implement our approach. Nevertheless, with the emergence of on-line newspapers, Topic can be useful for information retrieval, and for the communications on profile in the area of business intelligence.

IMPLEMENTATION

We choose to represent collected weak signals as visual graphs and meaningful representations. A graph is made of nodes and edges, where nodes are small phrases corresponding to collected weak signals, and edges are reasoning links which connect different nodes (logical implication, support, contradiction, presupposition, etc.).

The Software Criteria Choice

This prototype is composed of a data base and a drawing graph. The chosen data base is the Groupware Lotus Notes, and the drawing graph is Cope. We will now explain the reasons for our choice.

For Lotus Notes

Three raisons lead us to choose Lotus Notes. It allows :
1. to store, categorize, retrieve, and visualize the collected weak signals in a protected data base,
2. to deal collectively with weak signals in a synchronous (asynchronous) mode,
3. to route (circulate) weak signals inside the enterprise. Those weak signals are stored in a data base protected by a user password. In addition, it can be used as an electronic mail to deliver and visualize the processing information related to all users. In addition, Lotus Notes presents other characteristics : it is very user-friendly because it allows one to store text and images, and it is possible to connect Lotus Notes to a scanner in order to digitalize textual information.

For Cope

Cope is a drawing graph developed by the Ackermann team (1992). It is used to draw the cognitive maps. However, we use this software in order to construct graphical representations. Graphs handled by Cope are composed of nodes and edges, where nodes are small phrases and edges are reasoning links. The functions offered by Cope to draw cognitive maps are the same as those which are needed to draw our graphs.
The pieces of information on a graph can be easily moved which allows one to construct several graphs,
Cope offers a typology of link because our conceptual framework requires different kinds of links (logical implication, support, contradiction, presupposition, etc.).
Those links are dynamic, i.e. when information moves, its links also move, and when this information is deleted, its links are also deleted. This condition is required both to delete obsolete information (because each weak signal has a limited life cycle), and to change the structure of graphs.
The prototype issued (result) from Lotus Notes and Cope software, allows both the storage of information and their representation in a global and
synthetic form.

Prototype Description

The prototype developed is made of a data base and a graphical tool

The data base of the prototype

The data base developed on Lotus Notes is made up of five modules.

Memorization. This is used to store collected weak signals. Each piece of information has a descriptive file according to customers, suppliers, competitors, lobbies, etc. This descriptive file contains : the actor's name, the title of the weak signal which is a small anticipatory piece of information picked up from raw data, the edited dates, the expired dates, the collector' name, the source attributes.

Visualization. When weak signals are stored in the data base, they appear in this module ranged by editing date from the old one to the recent one. Users can accede to this information and analyze its content. A simple click of the mouse on a piece of information allow to go from that information to the descriptive file. At this stage, a user can assess the content of a weak signal. This task requires to assess the following :
the foreseen event (what event do we expected to happen ?), the hypothesis made (why have we collected this information ?); and the action taken (What can we do on the basis of this information ?),
the importance of the weak signal, ranked in three categories : important, average and irrelevant,
the reliability of the weak signal, ranked in two categories : high and low.
Thus different maps can be generated according to their importance and reliability.

Selection. This module allows a user to select information related to a particular subject. This selection is organized according to several keywords related to : the information source, the actors' name, the collector of information, the editing date, etc. It is also possible to combine those criteria using boolean operators "and, or, ≥, ≤, different", proximity operators, etc.

Categorization. This module allows users to categorize stored weak signals. This categorization can be done by keywords, synonymies, or ideas (such an investment in R&D, opportunities about foreign markets, etc.). This categorization is flexible because it allows the user to: place a piece of information in more than one category; rearrange the information when it is ranked; manage the new collected information. When this information is stored, it can be ranked under an existing category if it shares common characteristics with of that information in the category. Otherwise, it constitutes an isolated group. When an information is stored in the data base, each user can assess its content. This information and its contents appear in the categorization module. Thus each user can consult both his and other users' analyses. This option, leads to collective treatment in order to achieve a consensus about the foreseen event, the hypothesis to be made, and action to make.

Module of management. This module allows the management of the various pieces of information in the data base. It is possible to update, modify, and delete information from the data base.

Graphical software Cope

After screening, the pieces of information are removed (translated) from Lotus Notes to graphical Cope. Thus Cope allows the construction of meaningful representations. A meaningful representation is a graph where nodes are small phrases corresponding to collected weak signals, and edges are reasoning links which connect different nodes. Weak signals are not all similar, they might come from different sources. Thus they can support or contradict each other. One signal may be the cause, the consequence or the result of another weak signal. Therefore links used to connect weak signals might be logical implication, support, contradiction, etc. When atomized weak signals are connected with those links, they become an intelligible representation. Graph construction is a real act of creativity. The user may either update a pre-constructed graph or create a new one. In the case of a new construction, the user can work as follows.
When weak signals, related to an interest theme (category), are selected, then the end user makes a mental effort so that these pieces of information become connected. After reading those pieces of information, the end user finds the main central information which becomes the starting point of his
reasoning. After that, he compares it to the other pieces of information, and tries to identify possible links existing between them. He then draws the graph according to the following functions offered by the Cope software : addition and deletion of nodes and edges, relocation of nodes and edges, selection of color and shape of nodes, selection of types of lines for edges, modification of sentences of nodes, writing comments, storing edited maps in a file, editing hypotheses and actions with different colors, editing maps on a display and storing them.

Analysis and Interpretation of the Graph

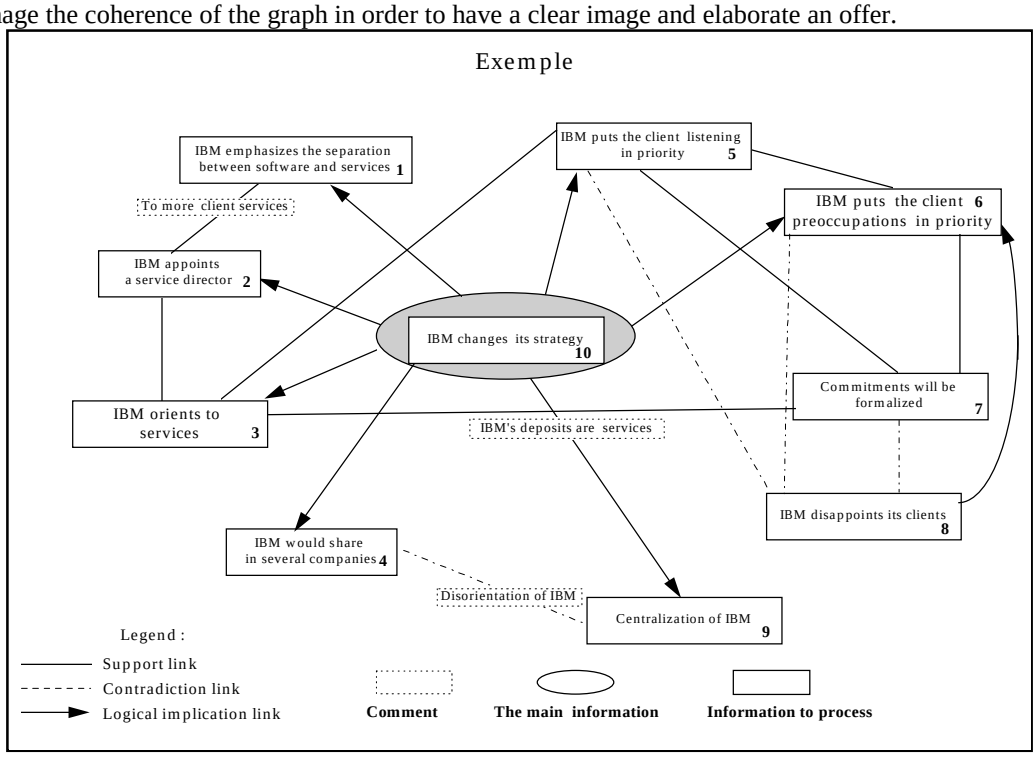
Going from atomized weak signals to an intelligible and graphical representation allows the end user to engage the following reasoning process : identifying an objective, maintaining alternative hypotheses, arguing his objective, and proposing action.
Objective : it consists in checking whether the constructed graphic concerns an opportunity to be seized or a threat to be avoided.

Hypotheses : the identified objective is not sure, because it is based on ambiguous and vague information. In this case, it will be necessary to supply hypotheses that necessitate rapid validation.

Arguments : In order to admit and accept conclusions, requires arguments. These arguments can be the use of links such us support and causality links, or inferred information, or identified lack of information.

Action : after identified an objective, formulated a hypothesis, and clarified arguments, it is useful to propose suggestions for action in order :
- to verify the feasibility of the identified objective (realization, means and time),
- to verify the hypotheses advanced so as to evaluate the impact of the objective on the enterprise,
- to identify intentions (can we suspect an intentional misinformation or contamination by an actor such as a competitor, or is-it a wrong interpretation ?),

- to verify the enterprise's reaction capacity in the face of the identified objective,
- to track other information in order to complete identified defects,
- to manage the coherence of the graph in order to have a clear image and elaborate an offer.



File of synthesis

Objective identified

• IBM a potential partner for us (an opportunity),

• IBM maintains its distance in services (a threat)

Hypothesis

IBM has problems with services, it orients its strategy to more services rendered to its clients.

Arguments

• 6 logical implication links confirm that IBM changes its strategy,

• 6 support links prove that it changes its strategy to services rendered to its clients.

Actions

• verification of information coherence (4 - 9) and (6-8),

• track of new information in order to restrain the space of alternatives (service for client, service for SME, collaboration software, service on Internet, etc.).

• verification of the hypothesis credibility,

• imagination and elaboration of possible responses.

Figure 2 : example of the approach

Perspectives

The following perspectives concern only the drawing graph. When the size of a graph (number of nodes >= 12), and the number of crossing links is raised, the overall impression is not user-friendly. To overcome this problem, we propose to modify the graph's structure. This modification requires some functions that are currently being developed.

1. functions to display a part of the graph without losing the global view of the graph,

2. functions to display a group view (replace one or more node in the initial graph G by a new complex node), a view in expansion (initial graph G with successive grouping), and a developed view (graph formed by the graph G, by a view on G, and by all complex nodes)
3. function to represent a graph with a minimum of crossing numbers between links.

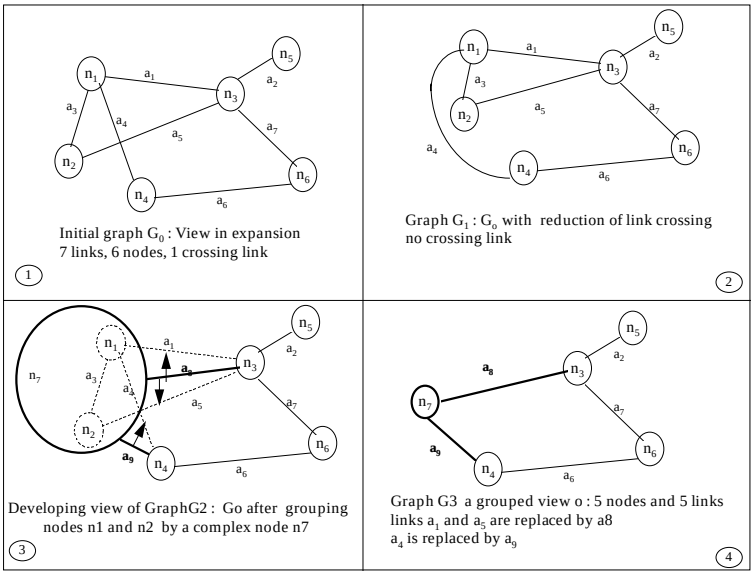


Figure 3 : ideal drawing graph

CONCLUSION

We have presented an approach to create useful meaning from weak signals of business intelligence. To implement this approach in the form of a computer tool, we have studied some available software. Nevertheless, from this study we have shown that existing software does not allow to implement our approach because of weak signal characteristics, the nature of the decision-making, and the need intelligence reasoning for high activity level .

After examining some available software, we have justified the choice of the Lotus environment Note on which we have built a database to structure and classify weak signals. Currently, this database is operational on the version 3.0 and 4.5. To generate meaningful representations, we have coupled Lotus Note with graphical Cope. However Cope offers limited functions especially when the graph seize becomes big. We have offered some suggestions to overcome this problem. This improvement is on development. Later on, this prototype will be validated in some french campanies from perceived usefulness viewpoint and perceived facility.

BIBLIOGRAPHY

Ackermann, F. Cropper S. and Eden C. (1992) : « COPE user guide ».

Ansoff I. (1975) : Managing strategic surprise by response to weak signals. *California Management Review*, vol. xviii, n°2, p.21-33

Calori R., Johnson G. and Sarnin P. (1994) : CEOs' cognitive maps and the scope of the organization. *Strategic Management journal*, vol. 15, p. 437-457

Couger J. D., Higgins L. F., and McIntyre S. C, (1993) : (Un)structured creativity in information systems organizations. *MIS Quarterly*, December, p. 375-397

Courtial J. P. (1994) : A coword analysis of scientometrics. *Scientometrics* n°.31, p.251-260

El Sawy Omar (1985) : Personal information systems for strategic scanning in turbulent environments : can the CEO go on-line ? *MIS Quarterly*, Marsh 1985, pp. 53-60

El Sawy**,** Omar and Pauchant Thierry (1988): Triggers, templates and twitches in the tracking of emerging strategic issues. *Strategic Management Journal*, vol. 9, p. 455-473

El Sherif Hishem and El Sawy Omar (1988) : Issue based decision support systems for the Egyptian cabinet. MIS Quarterly, December, p. 551-550

Fahey L. King, R. W. and Narayanan V. K. (1981) : Environmental scanning and forecasting in strategic planning : The state of the art. *Long Range Planning*, February, vol. 14, pp. 32-39

Ford J. D. and Hegarty W. H. (1984) : Decision maker's beliefs about the cause & effects of structure : an exploratory study. *Academy of Management Journal* 27, n°3, p.271-291
Hunt C. et Zartarian V. (1990) : *Le renseignement stratégique au service de votre entreprise*. First, 245 p
Kawakita, Jico (1975) : The K. J. Method. *Kawakita Research Institute*, Tokyo, 12 p.
Keen and Scott Morton, (1978) : *DSS : An organizationnel perspective*. 1978
Lesca H. (1994) Veille stratégique pour le management stratégique état de la question et axes de recherche. In *Economies et societés*, série science de gestion, n°20, p.31-50
Lesca H. (1986) : Système d'information pour le management stratégique. Paris, McGraw Hill, 146 p.
Lotus (1996) : Documentation of Lotus Notes
Nanus B. (1982) : Quest : quick environmental scanning technique. *Long Range Planning*, vol. 15, n'2, pp. 39-45.
Pound W. F. (1969) : The process of problem finding. *Industrial Management Review* 11, n°1, ,p.1-19
Preble, J. F. (1982) : Future forecasting with LEAP. *Long Range Planning*, vol. 15, n' 4, pp. 64-69
RlDoc (1995) : Documentation of Resoudre
Rouibah Kamel and Lesca Humbert (1996) : A proposal approach for Strategic Probe : A support structured scanning information. Ithurs Prcoccedings, Léon, Spain, July 5-7, vol. II, p. 197-203
Valette F. (1993) : *Le concept de Puzzle : coeur du processus d'écoute prospective de l'environnement de l'entreprise*. Conceptualisation, opérationalisation, enseignements nouveaux. Th. de Doct., Ecole Superieure des Affaires, Grenoble 2, 378 p
Verity (1993) : Topic documentation of Verity
Toda M., Shintani T. and Katayama Y. (1991) : Information structuring and its implementation on a rechearch decision support system. *Decision support systems* 7, p. 169-184
Yadav S. B. and Khazanchi D. (1992) : Subjective understanding in strategic decision making : an information systems perspective. *Decision support systems* 8, p. 55-71