Knowledge Management and Scientific Observation

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Abstract

In this article, we propose a method to optimise the interaction between the existing knowledge in an organisation and the system of scientific, technical or economic observation. The goal is to identify strategic axes of information gathering starting from a representation of the domain. This method is based on three phases: Projection (establishing connections between knowledge within the organisation and the environment) ; Information (from information gathering to the development of a corpus of information) and finally Creation of knowledge (development of a new knowledge by means of representation, placing in context and interpretation).

Keywords :
Scientific and technical observation, knowledge management, management, knowledge engineering, innovation, creativity.

1 Knowledge Management and Environment Scanning

Knowledge Management helps to spot, preserve, enhance and make more attractive the strategic knowledge of the firm [8][11].

It becomes essential for the firm to make its Knowledge Base evolve. If not, the lack of creativity will cause a great damage : the extinction of the firm [9] (see also [7] for ONERA context).

Information coming from the Environment is necessary for the enhancement of the Knowledge Base. By "Environment", we mean Scientific and Technical Environment but obviously, we must keep in mind that some economic and geopolitical aspects cannot be separated from the scientific and technical aspects.

When reading the literature, we can notice that the notion of Environment Scanning has considerably evolved since its beginnings and the approaches are multiple.

Generally speaking, Environment Scanning can be defined as "the setting of an organised and formalised Information System in order to collect, to treat and to share the company's Environment information in a dynamic way" [6]. Another interesting definition is : "the

Informational and voluntary process used by the company to scan weak signals of Environment in order to find opportunities and to reduce uncertainty risks" [15].

In a Schematic vision, a common way is to define Environment observation as an "interactive and organised link between a firm and its environment". This link can be seen in two different ways (Figure 1).

The first way consists into considering the firm as included in its environment (spatial vision). Beyond the spatial vision of this link, the firm and its Environment can be considered as two distinct subsystems with a strong interaction. The equivalent weighting of interactions going from the Environment to the firm and vice-versa is a fundamental factor of stability.

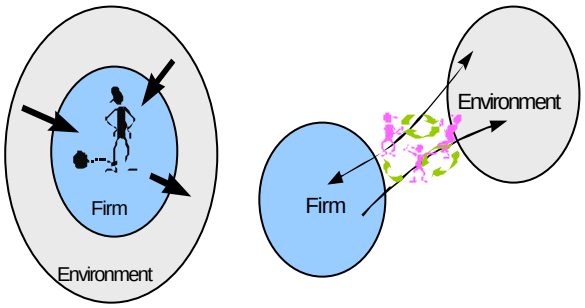

Figure 1 : two aspects of interaction between a firm and its environment

These are hypothesis supporting this idea :

- there are actors in the firm able to react, to understand and to control situations
- the firm have original resources for responding efficiently to environment interaction.

Among these resources, the Knowledge preserved, thanks to a "stock approach", contributes to the durability of competitive advantages. Intelligence is collectively thought and is supported by a "memory" called "Corporate Knowledge" of the company. This Knowledge cannot be restrained to existing systems as Information System, Human resources, etc. Corporate Knowledge should be seen as a specific system with its own functions determined by the company (to create, preserve, share Knowledge), its own structure and organisation.

We have to focus on two points :

- optimising Corporate Knowledge

- optimising interactions between Corporate Knowledge and other subsystems.

Actors of scientific and technical observation system analyse their environment and determine elements for decision, innovation, etc.

In a classical approach, information research is directed towards entities which form the domain where the scanning action take place. Here, requests are used to determine a typology of the domain's concepts. In this case, the structuring of the scanned domain is restrictive because requests are based in only one dimension : the domain experts master the most. Thus, the major risk with the classical approach is to restrain Knowledge creation. Replacing ourselves in a context of innovation help, we propose a new approach of Environment scanning titled "EP approach"(to say "Environnement/Patrimoine" in French) which is based on a formalisation of the domain.

2. EP Approach : the CEA case

CEA ("Commissariat à l'Energie Atomique" in French) is a research centre and one of the biggest knowledge producer in France. It was wished to get a new program of Research and Development concerning the instrumentation of nuclear reactors (sensors are essentially concerned in nuclear reactors)[19].

So it was decided an Environment Scanning action . Objectives can be summarised in two points :

- determining a strategic direction for Research and Development programs (about nuclear reactors instrumentation)
- completing Knowledge about reactors instrumentation.

We apply in CEA case "EP approach" in order to list advantages and differences with a classical approach.

First, experts' Knowledge of the domain were modelled. Then with the modelled Knowledge, physical processes (to be instrumented, used or controlled) are collected. These processes are considered through the "professional" point of view and not through a technical or a scientific point of view. Therefore, a same physical phenomenon can be considered from multiple aspects by actors of different businesses.

Thus, using MKSM methodology [10], every phenomenon or process was modelled and this modelling helped to give a generic phenomenon model (Figure 2) and helped also to determine axes for information research :

- involved physical processes
- used technologies
- measurement objectives.

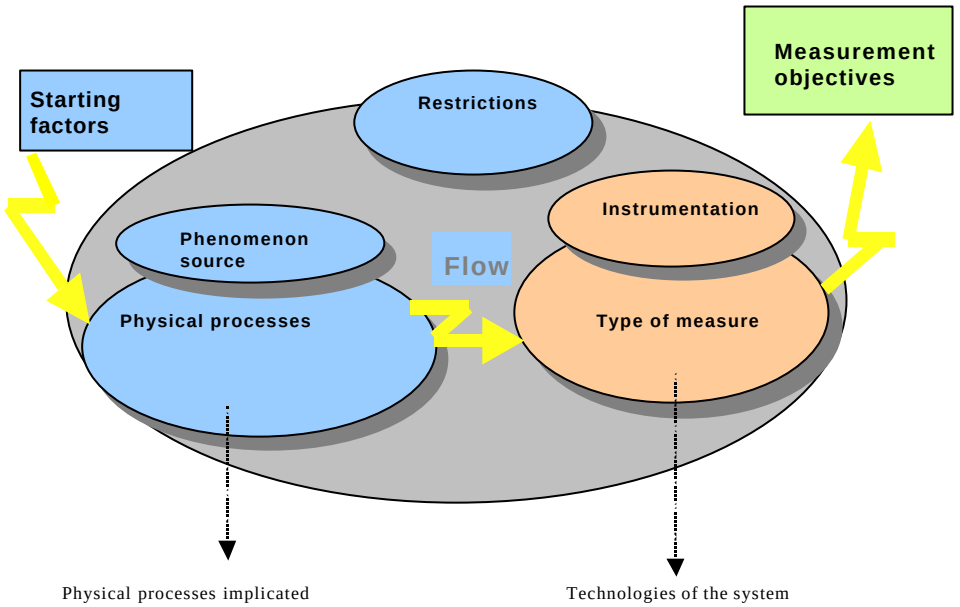

Figure 2 : A generic phenomenon model

Information sources (Tableau 1) and requests obtained from research axes gave a really different information corpus. So it could be possible to spot new technologies (in addition those found by the classical approach), new measurement processes and new understanding to physical phenomenon (Tableau 2).

Axes	**Example of information sources**
Determined Physical processes	Scientific publications and R&D documents
Used technologies	Technical information sources about sensors
Measurement objectives	Documents about reactors driving, reactors safety, breakdown diagnostics, etc.

Tableau 1 : example of information sources determined from strategic axes

Axes	Example of results
Determined Physical processes	New understanding of flow modelling in a "diphasic" environment
Used technologies	Use of optical fibres for measures in radiant environment
Measurement objectives	Necessity of having new sensors

Tableau 2 : example of results determined by using EP approach

3. Modelling of "EP Process"

First, let us remind the fundamental hypothesis of this study : "it exists an interaction process between the Corporate Knowledge of the firm and its Environment".

The EP approach we experiment at CEA broadens the classical approach. It functions on a modelling of the domain and on a generalisation of the different modelling.

We have made in evidence three stages in this approach :

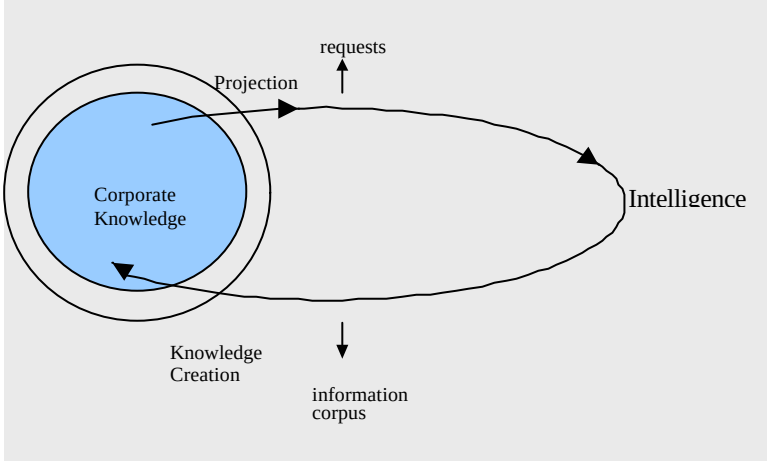

Figure 3 : The "EP process"

3.1 Projection

It's a confrontation of the structuring of the firm's Knowledge (tacit or formalised knowledge) with its Environment.

3.2 Intelligence

This stage goes from requests formulated through the projection stage to the elaboration of information corpus. Three steps are determined :

- Distortion

it's a perception (via actors) of a differences between the image of the projection and information coming from the Environment. These differences result from the fact that the knowledge structuring of the firm does not fit with information collected.

- identification

It's a clarification of fundamental distortion factors (identification of weak signals or singular points). This step can be well or not argued ; it can directly lead to a decision process.

- retro-adjustment

It's an elimination of non relevant singular points. When the information corpus is significant, using information tools to analyse results can be necessary.

3.3 Knowledge creation

Knowledge Creation is the result of the interaction process between internal Knowledge and the environment information. This creation should be more significant with our approach. There are two complementary steps :

- representation

It must be noticed that, with the "EP approach", analysis of information needs the use of treatment and representation tools in order to give a simple and understandable cartography.

However, we must keep in mind that the use of these tools has limits.

- Creation of sense

It consists into setting an interpretation process, an "actionable" Knowledge Creation [3] , by using individual or collective cognitive processes.

The representation and the creation of sense are individual or collective cognitive processes which are not well known.

As we can notice it, the projection and knowledge creation stages are directly linked to the cognitive abilities of the firm.
Projection uses the Corporate Knowledge because that is the internal vision of the firm which is projected. Knowledge creation, which is the most mysterious stage, has also a direct link with the corporate knowledge.

How is created Knowledge ? how can we represent and integrate Knowledge in the firm's memory ?

4. Actions for "EP Process"

EP process must be examined in detail to develop concrete actions concerning the three stages and particularly for projection and knowledge creation stages.
We choose as domain of study "Environment Observation". Our choice is stimulated by the fact that Creation of Knowledge for decision help (development of new strategies for the firm) and for innovation was also one of Environment Observation' aims.
Here, EP process has two objectives :

- getting a better modelling of interaction processes between Corporate Knowledge of the firm and its environment
- getting a new vision of Environment Scanning by integrating new concepts of Knowledge Management.

For our study, we use three models of Environment Scanning : JAKOBIAK [14], MARTINET and RIBAULT [17], LESCA [16] models.
These models are exhaustive and the authors are acknowledged. We use these models to make an inventory of actions that could be integrated in EP process.

4.1 Projection

Projection can be divided in two aspects :

4.1.1 Strategic projection

It results from the "Martinet and Ribault" model of Environment Observation. They develop in this model the notion of strategic objectives.
As for HUNT and ZARTARIAN [13], they defend the idea that "*information is not an identical objective for all, but a construction anyone makes in accordance with his needs*".

They recommend to structure Environment into strategic axes. These axes will give the main information necessary to reach objectives of the firm. The structuring of Environment into strategic axes will allow a more efficient capture of needed information for the firm.
That is what we call the "strategic projection". In CEA example, MKSM modelling makes it possible to structure the scanned domain in three axes (physical processes, used technologies, measurement objectives).

4.1.2 Tactical projection

Tactical projection is characterised by means used to delimit information research in strategic axes.
We can identify two actions:

- Determination of information sources

The first action needs help of observers (experts, etc.) who know industrial information sources and who are well informed about evolution of technologies concerning the observed domain.
It can be seen as a delimitation of the firm' environment. Considering Environment as "all actors able to influence the firm", we can complete this action by an "analysis of actors". This means that we'll consider two types of environment :

- Close environment which is concerned by actors directly linked with the firm (suppliers, customers, etc.)
- Distant environment which is concerned by actors not directly linked with the firm but with an influence in the firm activity (universities, research centres, etc.).

Then, in each type of environment, the firm will spot actors who get useful knowledge for its activity. So, it will be possible for the company to optimise knowledge transfer from environment (via actors) towards corporate knowledge.
"Analysis of actors" should be done in each strategic axe.

- Gathering of information

There are many ways for gathering information :

- *gathering information resulting from documentary research*

  This action is usually done by information officers. They make projection of their knowledge about the firm activity by means of requests in documentaries database.

- *periodic gathering of information*

  It deals with data concerning rival firms (annual reports, etc.). It's a projection of Knowledge about rival firms.

- *constant gathering of information*

  it's the most difficult action to be defined and organised. It concerns information brought by observers called "go-between". They are used to work outside of the firm (mission, conferences, etc.) and they usually get very interesting information.

4.2 Intelligence

The models studied for Environment Observation show an individual step (a single expert is involved in the intelligence stage) followed by a collective step (a group of experts is involved). Let us precise that we are supposed to be in a collective "Environment Observation" process.

These two steps have repercussions stages of intelligence phase.

Individual distortion and identification

The manager of each experts' group receives gathered information and makes a first analyse. He lists differences between his knowledge' structuring and the gathered information. Then, he eliminates non interesting information.

Collective distortion and identification

Here, it's a global and well argued analysis of all individual distortions.

4.3 Knowledge Creation

We define knowledge as "*an information interpreted in given situation*" [8]. This definition shows, as said by WEICK [22] and HUFF [12], that sense creation is essential in Knowledge creation.

What is the "creative" process that gives sense to information ? LESCA [16] studies about sense creation are a good reflection base. He sets two interesting phases in sense construction :

The grouping of gathered information

It's a grouping of information using criteria of analogy, proximity or similarity. Another alternative would be the use of cognitive preferences but it seems less efficient.

Creation of links between information

The aim, here, is to replace many "literal" information by a synthetic and visual information. Studies showed that human treat visual information with more precision [4].

The links can be created by using criteria of causality, influence or opposition. It can also be used cognitive links to get cognitive maps. But cognitive maps are difficult to use for collective sense creation.

5. Research issues

This new approach of Environment scanning will become really interesting when taken into account by an innovation approach. It would be also interesting to integrate TRIZ methodology [1][2]in the EP approach. TRIZ helps to get information by using analogy, association and junction methods in a base of physical, mechanical or chemical effects coming from listed inventions.

The first experience at CEA [18][19][20] makes it possible to formalise the EP methodology (Figure 4). This methodology described in details in [5][21] is experimented at ONERA in the PHD preparation of Thierno TOUNKARA, a PHD student of LAMSADE (Paris 9 Dauphine).

Our aim is to go deeper concerning the stages of EP interaction Processes. We will focus on Knowledge representation and creation aspects.

We will compare our approach with existing tools and methods in order to make it more efficient and more operational and adapted to ONERA needs concerning Environment Scanning and innovation.

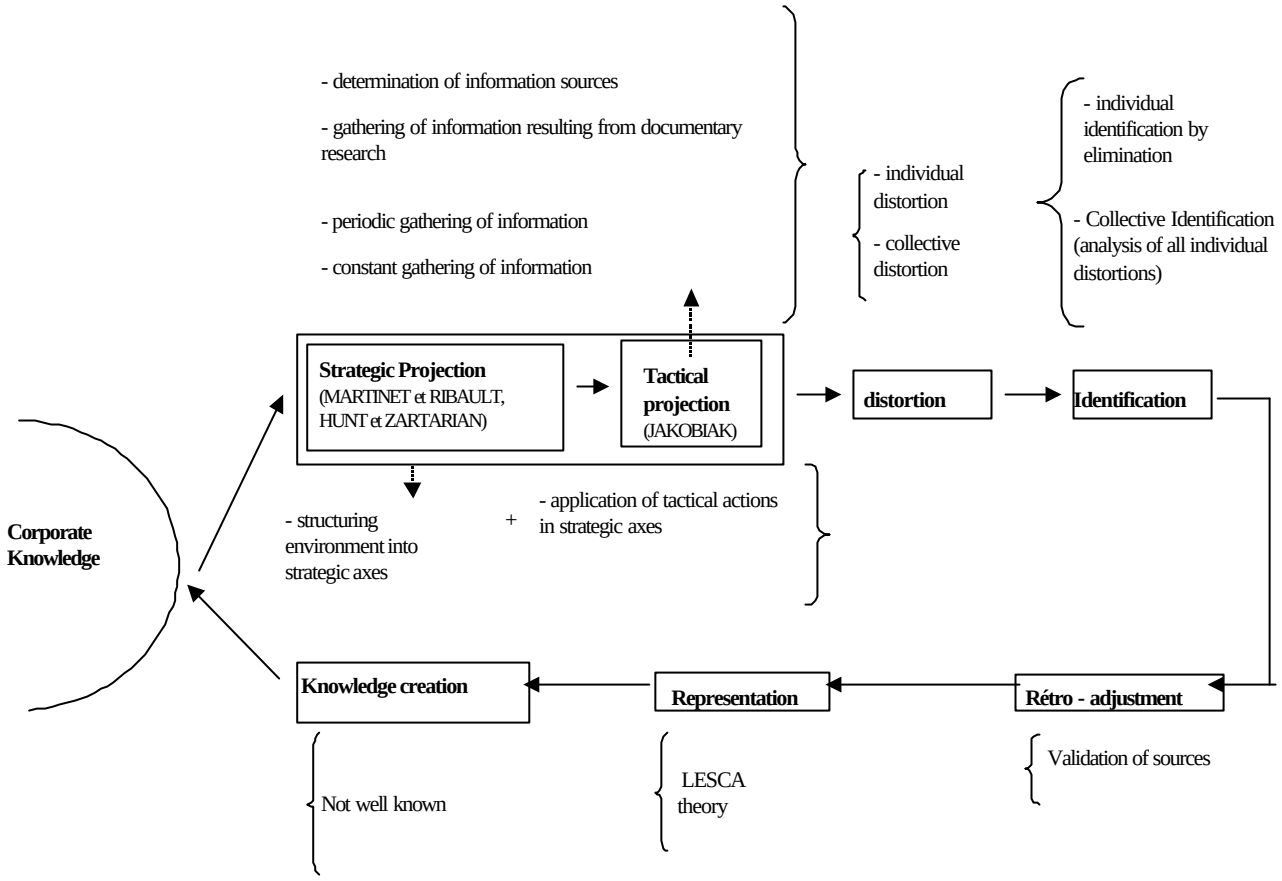

Figure 4 : Actions in EP process

6. Thanks

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