Strategic Scanning and innovative design: fuel the C/K method through Strategic Scanning information

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Abstract— **The aim of this article is to study the role of Strategic Scanning in innovation processes. We seek to answer the following question: how can Strategic Scanning feed an innovative design activity? We mobilized the C-K theory which models the logic of creation in companies and the method of the same name. Based on a case study of 65 participants, we conducted a Strategic Scanning study to feed an innovative C-K design approach. The results show that Strategic Scanning helps to provide knowledge in a C-K process. It helps either to build the knowledge base of novice participants, or to validate the existing knowledge of expert participants. The Strategic Scanning activity also makes it possible to start the first disjunction mechanism C→K from the C0 concept.**

Index Terms— **C-K theory, Innovative design, knowledge space, Strategic Scanning.**

I. Introduction

ORGANIZATIONS now live in a world of "projects" where changes, sources of income, creation of competitive advantages ... arise from processes based on project-based organizations. Innovation projects are an illustration of this. Numerous companies, large and small, have established innovation projects that are more or less transversal with the aim of increasing their capacity to develop new products and/or competitive services. Others, in parallel, have implemented Strategic Scanning (SScan) projects to understand and anticipate changes in their external environments in order to reduce uncertainties related to decision making [1] and identify new opportunities in the market. Some have also linked their SScan activity to their innovation process with the hope of feeding innovation them and their related decisions with richer, more relevant and more anticipative information.

SScan is not always clearly defined in literature, nor is it really homogeneous inside a company. In their study, [2] admit that for all authors, SScan is an informative process whose the changes in its external environment and to support decisions [3]. Depending on the authors and the contexts of the studies, SScan process can take very different forms (ie. [4]-[6]). It can be individual, informal and unstructured, or organized and centralized. For example, it could take shape in the form of a cell, a service or an observatory [7]. The position of technology to support this process can also be very contrasting. Thus, SScan process can be completely computerized and use a dedicated platform for it, but it can also be based on a combination of numerous tools that are not very specific to SScan and that are weakly integrated and urbanized (for example, using Google search engines or curatorship tools such as Scoop it! to collect information coupled to emails or tweets for their diffusion).

However, there is not a single definition of an innovation process. Innovation is a particularly complex concept to address due to its multifaceted nature. It can respond to the desire to "do better, do things differently, do something else, do things faster, do fewer things or do things together" [8]. In a study dedicated to identifying the success factors of industrial innovation, [9] highlighted 5 generations of innovation processes. Since then, a sixth generation emerged at the beginning of the 2000s: The Open Innovation model, as shown in Table I.

The 6th generation process is the most implemented process in companies today. However, it should be noted that a significant number of companies are using 3rd generation innovation processes, such as the well-known Cooper Stage-Gate process. But, in fact, companies are also adopting a hybrid innovation process that mixes the 3rd and 6 th generations. Therefore, a company can adopt the Stage-Gate process (3rd generation) and consequently register its innovative activity in a context of open innovation of the 6th generation. Organized in more or less linear and/or parallel stages, each of these innovation processes involves making decisions with strong

TABLE I
THE 6 GENERATIONS OF INNOVATION PROCESS. ADAPTED FROM [9]

Generation	Date	Type of innovation process
1st generation	1950 - 1965	Technology-Push
2nd generation	1965 – 1970	Market-Pull
3rd generation	1970 - 1980	Interactive Model
4th generation	1980 - 1990	Integrated Model
5th generation	1990 - 2000	Model System integration and Networking
6th generation	2000- …	Open innovation

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impacts on the progress of an innovation project.

The purpose of this article is to study the role of SScan in innovation processes. Its objective is to answer the following question: how can Strategic Scanning feed an innovative design activity? This research question forces us to direct our field of study to companies that carry out or have carried out SScan studies and that integrate these results into their innovative design activity. We use the C-K theory developed in the "École de Mines de Paris" by [10], which models the logic of expansion and creation in companies. We adopted a research approach of the type of case study by conducting an experiment in a school of creativity in the presence of professionals, academics and doctoral students. We used the CK method (declined of the theory of the same name), which is an innovative method for designing new products/services. The first results suggest that the use of previously directed and analyzed SScan information can help an innovative design process through the emergence of innovative concepts and new knowledge.

The first part presents the justification for the field of study. The second part explains the theoretical framework by presenting the C-K theory. In the third part, we establish the link between the innovative design by means of the C-K theory and the SScan process. The fourth part presents the research methodology of the case study, the results of which are presented and discussed in the fifth part.

II. The role of the Strategic Scanning in innovation projects

Research on the contributions of SScan activities to innovation processes is, to our knowledge, limited. Some authors, however, have demonstrated the role and importance of SScan in the development of innovation.

[11] explains that entrepreneurs who wish to develop their creativity should proactively and frequently look for information from sources, especially when their environment is very turbulent. [12] explain that creativity is nourished by the internal and external environment of the company. As a result, SScan. by means of contribution of knowledge of the external environment, is likely to fuel creativity.

Other research has shown that scanning the environment to collect information is a critical activity for identifying opportunities to develop and invigorate the innovation process [14]. The role of "Champions", defined by [13] as "heroes of innovation", stands out as well. They are people who carry out SScan to promote innovation to interest groups, overcome resistance to innovation and obtain the essential resources for the development of innovation. These people can, according to [14], correlate technical problems with external scientific knowledge and technical developments with market demand by identifying innovations with potential. [15] have shown that "champions" can accelerate the product innovation process by collecting and applying external information to development activities.

[16] showed that monitoring the technological environment would facilitate the design and introduction of market innovations. They specify that the companies that introduce the best new products in the market are those that have flexible SScan process that are adapted to the environment.

Finally, [17] explains that anticipatory SScan oriented towards usages would reduce the risk of divergence between market needs and innovation. This type of SScan leads to "identifying future uses of emerging technologies. Its general principle is based on the observation of the dynamics of technological innovation, as well as on the dynamics of social innovation in order to anticipate their potential convergences" [17].

Several authors have shown that companies that follow up (including technology) are more likely to innovate. Thus, SScan seems to play a role in the innovation capabilities of organizations. However, these studies do not show or have not tried to understand how SScan could fuel an innovation process to make it more efficient.

In conclusion, we can say that SScan, as an activity of gathering and processing external information, can play a role in an innovation project.

III. Innovation Project and Innovative Design: The C/K Theory

Like [18], we suggest that "innovation is an (non-systematic) output of innovative design". In fact, a design activity implements reasoning, one or more models and associated performance criteria that allow the development of projects and, therefore, innovation.

Developed initially by Armand Hatchuel and Benoit Weil, and later by Pascal Le Masson, the C-K theory is a theory about the design of innovative products or services [19]. Developed in the years 2002 and 2003 [10], [20], this theory aims to present a unified approach of design in order to provide a theoretical framework that integrates all kind of design activities (regulated and innovative).

This theory distinguishes two fundamental notions: the notion of "knowledge" and the notion of "concept". The authors discuss a knowledge space called space-K and a concept space called space-C.

The knowledge space is defined as a set of propositions that have a logical state. This space describes all the objects and truths, in other words, established knowledge. The space K is expandable as new facts and truths become available.

The space-C is defined as a proposition without a logical state. A concept has an unknown or undefined part. The concepts are the starting points for an innovative design process. Without a concept, the design is reduced to optimizing the existing ones and solving problems.

In the C-K theory, the innovative design process is based on a back and forth between space C and space K, a transformation of concepts into knowledge and vice versa. There is, therefore, a gradual expansion of the two spaces by mutual enrichment. This back and forth between spaces is modeled by external and internal operators.

There are two external operators: (1) the K→C disjunction that makes it possible to convert knowledge into the formulation of a concept by the addition of new properties or attributes, and (2) the C→K conjunction, which transforms a

concept into knowledge and therefore corresponds to a validation of the concept, and in a practical form, to a "finished design".

There are two internal operators: the C→C operator that defines the partition process of the set of concepts, and the K→K operator, which defines the expansion of knowledge.

The C-K theory implements several steps:

- Transform an initial proposition into a concept C0. This concept is therefore derived from a K→C disjunction. This disjunction must respond to two principles: (1) that all the terms of this proposition belong to propositions of K, and (2) that this proposition has no logical status, otherwise it would be an acquaintance of K. Because it belongs to the domain of concepts, this proposition has no logical status. It is neutral, neither false nor true.
- Add attributes and properties from the K space to the C0 concept. The goal is to expand the concept domain by proposing new concepts.

At this stage, two options are possible:

- The designers may consider that they know how to design one of the new concepts, in which case this concept acquires a logical, true state and becomes known. Consequently, the design reasoning can be stopped.
- Or, these new concepts are "neutral", in which case it is necessary to prolong the reasoning by making a new partition with the help of knowledge.

The C-K theory allows the formalization of the appearance of new concepts as well as the development of new knowledge. It offers a structured framework for the increasingly advanced development of an initial concept of C0 and a developed knowledge space at the beginning of the innovative design process.

IV. Innovative design and Strategic Scanning

We have seen that SScan can play a role in innovation, foster creative approaches, identify opportunities for development and revitalization of the innovation process, help introduce new products into markets or even reduce the risk of divergence between market needs and the new products/services.

However, we cannot find any research detailing the role of SScan in innovation and even less research that links innovative design and SScan. However, when we read professional journals and interview innovation leaders, the link between SScan, innovation and innovative design is clear, almost as obvious as it is shown in the Table II.

SScan has several purposes: it can gather information to build a state-of-the-art of current knowledge of the field/topic on which you want to work. You can pretend to anticipate future changes that do not yet exist by collecting weak signals [21] that can identify new threats and opportunities.

Whether for the construction of a state-of-the-art of current knowledge or for the identification of future changes, SScan is based on increasingly sophisticated and accurate computer tools used in the collection and analysis of information. Developed by service companies and often paid but sometimes free, these tools can collect a lot of information from a wide variety of sources, analyze it automatically and then present it in the form of panels and/or graphics. This is the case, for example, of data mining tools such as Thomson Innovation patent database or Space Net (a free tool) that allow, thanks to a keyword search, to analyze existing patents. Tools like Ixxo, E-Perion or Izi'Nov allow one to track the web, visible and invisible, and provide information of all kinds that will be filtered according to the needs of the user. Digimind offers monitoring software that monitors social networks and allows the company to be attentive.

TABLE II
ANSWERS TO THE QUESTION OF THE LINK BETWEEN SSCAN AND INNOVATIVE DESIGN DURING INTERVIEWS WITH DIRECTORS OF LARGE GROUPS

Innovation Director (March 2017)
"If you want to put yourself in a correct C-K dialogue, you should navigate in C and look at the known and unknown K and do the iterations recommended by the method, so we are in the construction of the K tree in SScan before embarking on the prototype to make sure we have the right knowledge and that we will do well in the project in question".
Director of Technology and Innovation by Uses (March 2017)
"Then, SScan is K. Knowledge, full of observations, full of learning. We are smarter, so being smarter, we may have a little more C, a little more concept. "

The use of data mining tools for innovative design has already been proven. [22] compared the results of creativity sessions of students in a school of engineering. Some groups used data mining tools, others did not. The conclusion is clear: the teams that used data mining developed more sophisticated offers than those that did not explore the data. They were able to identify solutions they had not considered before and offered a more advanced product to potential users.

These tools allow creative teams to think beyond what already exists [23]. As information is growing in size and will not stop growing, it is difficult (not to say impossible) for businesses to capture it all. Data mining techniques capture a lot of information, including weak signals, and thus offer the possibility to explore new trends or interesting functionality for a team wishing to go beyond their acquired knowledge.

Therefore, we consider that computer tools for SScan and, in particular, data mining tools can support innovative design, either through the collection of information that allows us to develop the latest advances in knowledge or by identifying weak signals useful to detect new trends. Based on these research results, we created an experiment with the objective of using a computer SScan tool to feed an innovative design approach through the C-K theory. We developed this case study in the following section.

V. Research methodology and data collection

A. The case study method

The research method used in this research is case study. The work of [24] has contributed to its development and legitimacy

by highlighting its scientific interest. We define a case as a set of empirical data that is related to a reality and that fits a situation which constitutes a unit of analysis. The concept of context is very important: all the results obtained must be analyzed with respect to the specific context of the case study.

The case study is based on the two principles of internal validity and external validity. [25] define the internal validity of qualitative research as the existence "on the one hand, of "only", "authentic" and "plausible" results in relation to the field(s) of study, and on the other hand, of results related to a previous or emerging theory".

External validity refers to the generalization of results. This validity is often presented as an important limitation of the case study. However, it is still possible under certain conditions of representativeness and transferability of the results [25].

However, the recognition of the case study is mainly based on internal validity. That is the only topic that interests us in this article: the measure of this internal validity. We do not intend to generalize the results obtained during the experiment described below.

Finally, it should be noted that two of the three authors of this article had observer status. One of the researchers participated in the design and preparation phase of the experiment; the other researcher participated in the experiment.

B. Context

The experiment took place in the Winter School of Creativity in Grenoble organized by Promising. Coordinated by the University of Grenoble Alpes, Promising is a Future Investment Program IDEFI financed by the French State for 5 million euros for 7 years. Its objectives are, among other things, to develop the collective intelligence of innovation and to explore the relationships between understanding and acting in situations of innovation. The ambition to contribute to the development of a collective intelligence of innovation involves the exploration of new forms of experimentation regarding projects that involve doctoral students, professors and the socio-economic world.

The Winter School of Creativity is a training program in the form of workshops. It is aimed at managers, employees of the private and public sector, teacher, researchers and doctoral students. This is an active learning path with theoretical contributions, tools and methods, case studies, and concrete techniques, all taught through practice. The Grenoble Winter School of Creativity is part of an international network of School of Creativity under the auspices of MOSAIC - School of Creativity HEC Montreal. The network includes the cities of Lille, Bangkok, Strasbourg and Grenoble.

In 2016, the Grenoble Winter Creativity School welcomed 65 participants, including 25 companies, 12 public organizations and 27 teacher-researchers and doctoral students. One of the 17 workshops was dedicated to experiencing the relationship between SScan activity and creativity in relation to the C-K theory.

C. Conducting the experiment

The objective of the experiment was to practice the C-K method (derived from the C-K theory) in half a day by explicitly linking it with a SScan activity. The innovative aspect that we wanted to test was related to make participants use the results of a SScan activity by mobilizing an innovative design method in order to bring innovative concepts to light.

1) Preparatory phase

This experiment required a preparatory phase of work in two stages.

Preparatory step 1: First, the identification of concept 0. For this, four experts (a consultant specialized in the C-K method, an innovation consultant with good knowledge of the field and sports-related issues, a researcher from the Ecole des Mines, from which the C-K theory came from, and a researcher specializing in the field of SScan) conducted a two-hour brainstorming session to identify and establish a concept 0 as clearly as possible.

Concept 0: Make stadium fans enjoy in an innovative way

Preparatory step 2: The goal was to build an initial K knowledge space. To this, we worked with a company specialized in SScan that also offered consulting and services in research and analysis of data and information. It proposed, in particular, SScan studies, benchmarking studies, thematic states-of-the-art, patent mappings, and networks of actors, partners, and clients.

During a one-hour meeting, we worked with an employee of the company and a specialist in the use of SScan tools to identify keywords related to the concept 0. Both the consultants and the innovation researcher tried to verbalize what they wanted to say by "making stadium goers enjoy in an innovative way". Based on this very informal discussion, the SScan expert identified keywords. Then he looked for intelligence information related to concept 0. His research approach is shown schematically in Fig. 1. However, the first results obtained, which were already satisfactory, were refined by a new research work based on new keywords.

Thus, following two iterations of information search via monitoring tools, we obtained the information detailed in Table III.

Then, an information analysis tool structured this large amount of information. In this way, the analysis of the information allowed extracting 44 documents to feed the K knowledge space. These 34 documents were structured as shown in Table IV.

These 34 documents, which can be either patents, excerpts from scientific publications or web sources, were gathered in a 39-page document for distribution to the participants of the Grenoble Winter School of Creativity. Fig. 2 is an excerpt from this document.

2) Mobilization phase of the C-K method

During the half day of the workshop, the 65 participants at the Grenoble Winter School of Creativity were divided into 11 groups. For 45 minutes they were informed about the work expected of them (presentation of the purpose of the session, the C-K method, the concept 0 and the information constituting the initial K space (the 34 documents selected)). Each participant received a document that contained the SScan information. Then, they worked independently (with the help of 2 specialists of the C-K method if necessary).

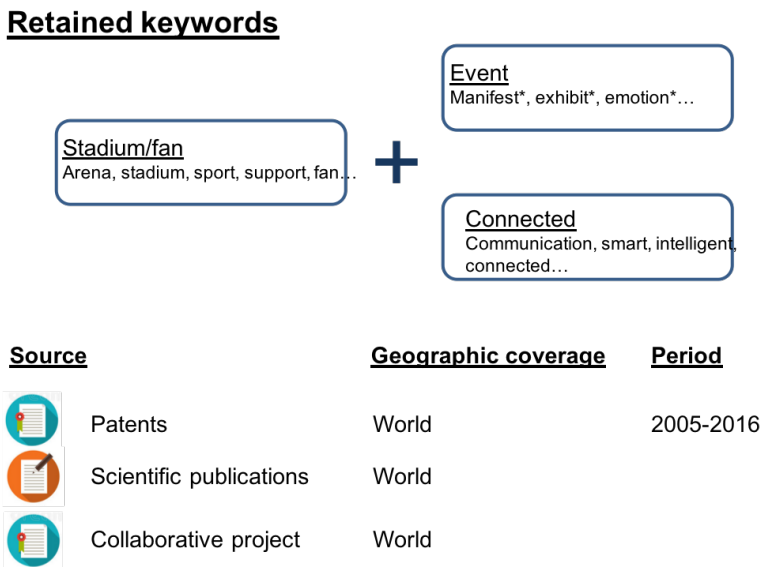

Fig. 1. Information search process.

Using the documents of concept 0 and the other 34 documents, they tried to propose a concept 1 and a concept 2. Each time it was necessary, and on the basis of concepts 1, 2, 3, etc., they could contribute to space K using the 34 documents but also their own knowledge, since some of the participants were sports professionals or members of sports companies, and others were passionate about sports. The iterations between the concepts C-space and K-knowledge space were completed when each group considered that the identified concept was sufficiently new and had a non-neutral logical state. Then, each group presented its concept to the other groups. It should be noted that all the groups were able to propose a new concept. Finally, one of the specialists of the C-K method presented his own reasoning on the basis of the concept 0 and the 34 documents of the space K (Fig. 3).

VI. Results and Conclusion

The purpose of this article is to begin a reflection on the link between SScan and innovative design. The experiment executed with 65 people shows that SScan can be integrated into an innovative design approach of type C-K. In half a day, each group, based on an initial K-space, succeeded in identifying one or more innovative concepts. Although these concepts are still underdeveloped and should be elaborated upon to produce real tradable innovations.

The research question was to understand how SScan activity can fuel an innovative design activity. The first results give some answers.

A. Expansion of space K and space C

The experiment showed that the participants were able to increase the knowledge space K (knowledge) as well as the space C (concepts).

1) The knowledge space K

Without any difficulty, the participants seized the document that contained the SScan information. They saw it as a starting point, as the initial knowledge space that they could mobilize. The monitoring document has thus replaced the K knowledge space. Therefore, SScan has come to fuel the knowledge space.

SScan served as a catalyst for the innovative design work of the C0 concept. All participants were curious to discover what this document might contain. All used it as an initial knowledge base, that is, initial K space. However, there are two types of behavior. The first was that of the beginners, who had little or no knowledge related to the C0 concept. These beginners used the reservation information as support for ideation and divergence reasoning. On the basis of certain information, they did not hesitate to diverge on ideas of original concepts, which were sometimes very original and disconnected from any realistic consideration. The latter, sports experts or sports enthusiasts, used the SScan information as validation for the knowledge they already had. They also managed to draw concepts. It is important to bear in mind that they generated many more concepts than the novices. However, some of these concepts were very originals and strongly anchored in themselves in pragmatism and feasible concepts. These experts also played the role of moderators against the concepts of beginners. They mobilized their own knowledge, their own K space to modify (and sometimes judge) novice concepts.

TABLE III
Information related to Concept 0 after search

2000 patents
40 collaborative projects
500 scientific publications
3000 other information from the web
2000 patents
40 collaborative projects

TABLE IV
Information related to Concept 0 after Analysis

11 documents related to connected stadiums	2000 pate
9 documents related to connected textiles	40 collabo
7 documents related to intra-stadiums	500 scient
7 documents related to visual displays in sports enclosures	40 collabo

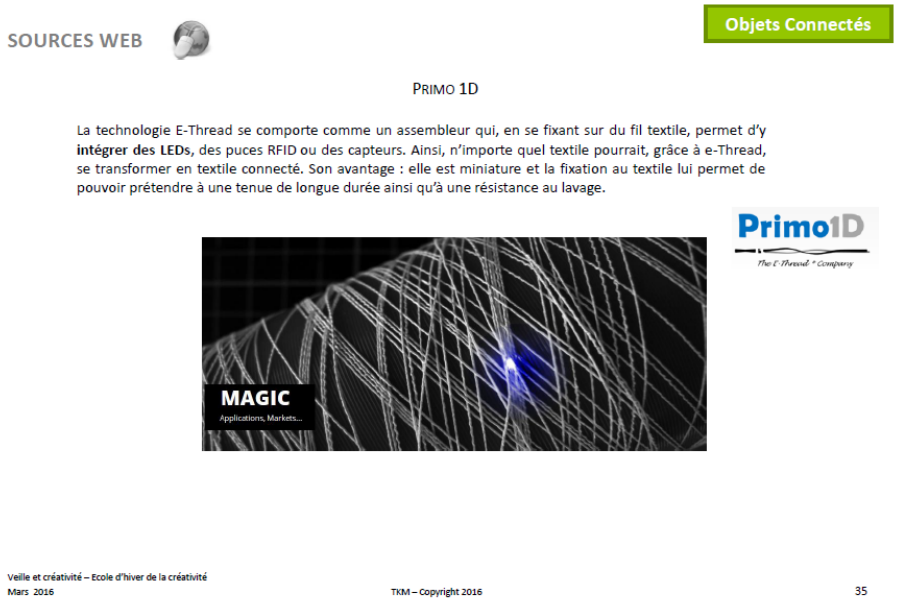

Fig. 2. Extract of web-based information about connected objects

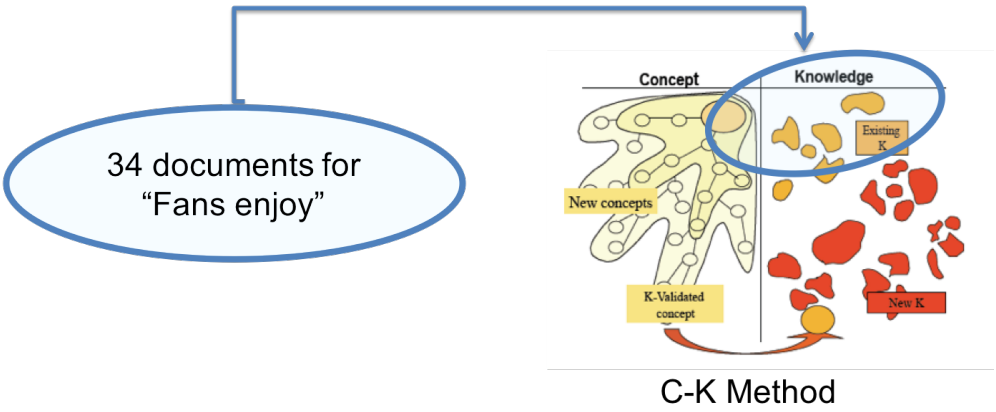

Fig. 3. Iteration between space C and space K according to the documents of the concept 0 and the 34 documents of the SScan work.

Therefore, we can say that the groups have used a disjunction mechanism K→C that allows movement from a set of knowledge to the formulation of one or more concepts by adding innovative properties or attributes. In addition, the initial knowledge space has been increased through informal exchanges of information between participants or through the creation of new knowledge. Finally, and especially among beginners, the internal operator K→K has allowed an expansion of knowledge.

2) Concept space C

The concept space has been enriched. Therefore, each group was able to present an innovative concept related to the C0 concept. Some groups were able to draw several concepts. Other groups had more difficulties and sometimes stopped at the appearance of a concept. However, and probably due to lack of time, the concepts presented were not successful concepts. Several participants regretted that they did not have more time to continue the experiment. Therefore, the conjunction mechanism C→K was not mobilized due to lack of time and support for the mobilization of the C-K method. The mobilization of operator C→C was neither observed.

B. A real help but limited for fueling C0 concepts

The definition of the concept C0 is the catalyst step of C-K. SScan carried out in the experimentation had a limited role in helping to define this initial concept.

1) Definition of concept 0

This is the primordial stage of the C-K theory. However, it is used very little in the C-K method and, sometimes, it is difficult to put into practice [26]. In the context of experimentation, the construction of the C0 concept was carried out with the help of specialists in innovation and the C-K method. It was based on their personal knowledge, whether in the field of sports and innovation, or the C-K method. SScan and the collection of information that could help identify the C0 concept, was not mobilized. However, we can question here the role that SScan could play. The collection of very general information about sports and its automatic analysis could have provided knowledge that would have helped in the development of the C0 concept. This knowledge could have played the role of K0 and could represent a state-of-the-art form in the treated field.

Therefore, it would be interesting to respond to the dissatisfactions of the C-K method on the elaboration of the C0 concept, to study the contribution of SScan, in particular, in very general information about the field studied. Therefore, a research track could study the role of SScan in the development of the C0 concept.

2) Fueling the C0 concept by identifying the information needs

The implementation of the document delivered to the participants as an initial knowledge space implies some conditions. First, the SScan expert's ability to listen and reformulate in order to identify keywords representative of the C0 concept is vital. Round trips are also needed to refine and validate the final document. Similarly, it also assumes the ability of the initiators of the C0 concept to verbalize their ideas in a clear and unambiguous manner. Knowing that a concept is defined as a proposition without a logical state, this task is not easy. The identification of the need for SScan information depends on the capacities of the different actors to verbalize, exchange, understand and reformulate the C0 concept. In a traditional SScan activity, the identification of needs is also a prerequisite for the collection of information because no organization has the resources to scan all of its environment [27]. It corresponds to the identification of strategic objectives and priorities in terms of information collection to optimize the allocation of resources necessary for the observation activity, obtaining useful results and avoiding the failure of the SScan project [28],[29]. Detailed and instrumented by [3] and [21], the identification of SScan information needs to identify the part of the environment that needs to be monitored as a priority. [21] implemented this step by constructing a method called Target®. It helps to identify the actors (competitors, customers, partners, etc.) and the issues (e.g., regulatory, technological, etc.) that will be prioritized under SScan. It would be interesting to study to what extent this scanning tool that targets the environment to be monitored could be used in the definition of the C0 concept. Is it relevant to use the notions of actors and themes to define the C0 concept? Could the actors and issues identified thus be used as keywords for the search for information?

3) Analysis and restitution of information

Fueling the C0 concept in information means being able to construct a readable and usable document: A document that presents the information in an easily understandable text and visual form. Therefore, it is about having a SScan tool with analysis and advanced graphic functions. Today, monitoring tools of data mining style have all these characteristics. Therefore, this step is not a problem as long as you have been able to gather potentially interesting information.

The experiment carried out during the Winter Creativity School shows the role of SScan in an innovative design activity. It suggests that SScan is an activity that contributes to the expansion of the knowledge space K and the concept space K. It also suggests that SScan can fuel specific information to the C-K method and more specifically to the C0 concept. However, this role is subject to a number of conditions, including the ability to fuel relevant information into the initial idea of the C0 concept. Its results make it possible to provide a beginning of answer to our research question. The internal validity criterion is thus satisfied. However, these results should be considered only in relation to the context of the experiment and not to claim any generalization.

Some lines of research have emerged. Experimentation shows that SScan cannot be limited to collecting information and producing a document. It would be interesting to use information identification methods to better support the construction phase of the C0 concept. In fact, after this first experiment, other experiments were carried out. They are being analyzed, but the first results show that professionals find great interest in coupling SScan and the C-K method during their innovative design activities.

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