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What makes a knowledge management system work: a case study

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ABSTRACT

Knowledge management relies – willingly or unwillingly – on three components: organizational structures, communities of practice, and material settings. In an organization, those three components are interdependent, that is, each of them enters into the composition of the others. They are also resistant to each other, which means that each of them marks the limits of the others' action. This relationship allows us to understand why a knowledge management system, if conceived strictly from the point of view of organizational structures, does not benefit from the support of communities of practice. It also suggests that emphasis should be put on the settings that reinforce both organizational control and the communities' autonomy. Finally, this allows us to understand that the appropriation of such a setting by communities of practice implies a slight modification of organizational structures.

Categories and Subject Descriptors

K.4.3 [Computer and Society]: Organizational Impacts – computer supported cooperative work

General Terms

Management, Documentation, Design

Keywords

Organization, community, practice, settings, participative, wiki, document

1. INTRODUCTION

In organizations, knowledge is generally seen from the organizational structures' point of view, which is the point of view of the hierarchical, functional and quality rules which define an organization and allow it to function [11]. Knowledge is thus conceived as elements which are or can be explicit, and which are possessed by the different elements that compose the organization (a service, an engineer, a product, a procedure) [3]. Doing knowledge management, then, consists in identifying the organizational elements where knowledge is located, and put in place specific settings for making explicit knowledge and facilitating the access to it. This insures the management of *knowledge formed*, what Zacklad [17] calls the “*known*”.

This form of knowledge management, though necessary, tends to neglect the spaces where knowledge emerges: communities of practice [15]. Those communities are groups of people who share

a common interest in something they do, and who learn to do it better by interacting regularly. The learning character of those communities has two important consequences. First, in order to solve the problems emerging in the course of their practices, those communities *de facto* dispose of some autonomy from organizational structures. Second, knowledge is not possessed by the entities that compose these communities (individuals, groups, objects), but results from the partially unforeseeable interactions between those elements. Those communities thus ensure the management of *knowledge in the making*, what Zacklad [17] calls “*knowing*”¹.

Far from ignoring each other, these two forms of knowledge management constantly interplay through the material settings, which are the diverse objects that can be used alone (e.g. a document) or combined in a more or less perennial fashion (e.g. the material agency of a meeting). Numerous authors (e.g. [5] [6] [7] [13] [14]) have shown indeed that objects function as markers containing the memory of the forms of action that have shaped them. Within an organization, objects thus reflect both the organizational structures' action and the one of the diverse communities of practice. In other words, objects function on the one hand as actors enabling to act from a distance so as to align numerous human and non human actors [8] [9]. On the other hand, they function as “boundary-objects” allowing sense-making and coordination within and between different communities of practice [2] [12].

What thus appears is a knowledge management model based on three components: organizational structures, communities of practice, and material settings. In the frame of an organization, those three components are both interdependent, that is, each of them enters into the composition of the two others, and resistant to each other, which means that the action of each of them marks the limits of the action of the two others. Organizational structures define the frames in which communities of practice develop, while, at the same time, they restrict the autonomy of the latter. The communities of practice both comply with and escape the organizational structures' constraints (including those communities who have the power to decide upon the forms of those structures). The material settings both enable and limit the alignment efforts of the organizational structures and the learning efforts of the communities.

The intention of this paper is to show that taking the interactions between these three components into account is essential for the success of any enterprise aiming at optimizing an organization's

¹ Zacklad borrows this distinction between the known and knowing from Dewey and Bentley [4].

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knowledge management. After presenting the method followed during this study, I will describe how organizational structures, communities of practice and material settings interact in the organization I have studied. Do to so, I will present the functioning of the documents and meetings that allow the coordination between the diverse communities of this organization. I will then look at the conclusions that can be drawn from those interactions in the frame of an effort aiming at improving knowledge management. I will thus present (a) the difficulties met during the deployment of a knowledge base conceived essentially from the organizational structures' point of view, (b) how a Participative Document Space enables to reinforce both organizational control and the autonomy of communities of practice, and (c) why the appropriation of such a setting by communities of practice implies a slight modification of organizational structures.

2. METHOD

The model presented here can be considered as the result of an effort which aimed to combine two perspectives on knowledge management: the organizations' traditional perspective which cares about efficiency and tends to focus on the *management of the known*; and the perspective, stemming from the social sciences, which cares about the details of everyday practices and tends to focus on the *management of the knowing*. The participating observation method that I have used during this study reflects this willingness to combine these two perspectives.

I have been embedded in an organization inside a unit that is responsible for the management of scientific and technical knowledge of a project. My role was to contribute to improve a knowledge management document setting. My main task was to work with the manager of this document setting to formalize users' feedback, and to identify and put in place functions that are likely to improve the performance of the setting. In doing so, I accepted a mission mainly oriented toward the *management of the known*. However, I have also sought to understand the functioning of the community I was part of and the communities it interacted with. In order to explore these issues, semi-structured interviews were carried out. I thus aimed to identify the diverse *managements of the knowing* within the organization. Far from opposing each other, these two strategies form the two poles of an iterative method. The observation of the functioning of the diverse kinds of *management of the knowing* can improve the *management of the known*, which in turn allows us to follow new aspects of the *managements of the knowing* etc. In this paper, the *Context Analysis* and the *Results* can be considered as frozen pictures of the dialectic between those two poles.

The main bias of this method has to do with its localized nature. The risk is (1) that I could adopt the point of view of the community I was working in, or the point of view of the communities it interacted with, and (2) that I could contribute to the evolution of the knowledge management system in accordance with the point of view of only one of those communities. However, two techniques exist to avoid these risks, techniques stemming from the social sciences and engineering respectively. I have firstly aimed at developing an *empirical-conceptual* analysis. This accounts for the diverse localized practices in terms of a global theory (e.g. communities of practice). The idea is (1) that the persons observed must feel that the description of their practice is both accurate and fair, and (2) that this description must be integrated into a model that can be transposable to other

situations. From this point of view, the *Context Analysis* and the *Results* must be given the same weighting. They are both empirical and conceptual descriptions. I have aimed secondly at developing an *experimental* process. This refers to modifying the state of a situation by following a certain protocol. The idea is to distinguish an initial state, a final state and the process leading from one to the other, in order to identify the reasons that make an action efficient or inefficient. From this point of view, the *Context Analysis* and the *Results* are quite different. The former describes the initial state while the latter describes a series of intermediate states and their associated processes².

3. CONTEXT ANALYSIS

This analysis aims at highlighting the relationship between the organization structures, the communities of practice and the material settings within the organization under study. It underlines the both necessary and limiting role that the organization structures play on communities of practice, and shows how this role interplays with the main material settings enabling the coordination between the communities.

3.1 The Project B, the organization, and the communities

The context of our study is a project that is both central and strategic for the responsible organization. This project (*Project B*) aims at conceiving a building that must be functional during a long time scale. It is structured in interdependent *Themes*. I will present four of them: (1) the *Safety Theme*, which aims to evaluate the safety of the building in normal functioning and in accidental functioning, in accordance with safety rules, (2) the *R&D Theme*, which describes the set of phenomena likely to affect the building and its environment, (3) the *Numerical Theme*, which aims to simulate the functioning of the building and its environment during the envisioned lifetime, (4) the *Engineering Theme*, which aims to conceive the building and define the construction and exploitation techniques. Those themes are themselves structured into Thematic Units each corresponding to a subset of tasks.

The *Project's* structure is important in understanding how the *Project's* communities form themselves, and foremost, what I will call here "*coordination communities*". A *Coordinator* manages each *Theme*. He works with the *Thematic Unit Leaders* notably to locate difficult points and a means to overcome them. He also works with the *Coordinators* of the other *Themes* to manage the interactions between each *Theme*. The *coordination communities* that form around each *Theme (Coordinator)* therefore overlap on one another. If this interweaving is in part formalized in the *Mid-Term Plan* of the *Project* and the *Coordination Meetings*, it is also the expression of the relative autonomy of those communities. According to the participants, their common history, and the questions they must address, this overlap will be deemed beneficial or detrimental, necessary or subsidiary, and will therefore be pushed further or, on the contrary, reduced to the strict minimum.

To fully understand how these communities interact, one should also consider the role played by the hierarchical structure of the

² Note that the experimental conditions that we are developing here cannot be reproduced. "Experimental process" is thus not to be understood in the sense of the experimental sciences (biology, chemistry, physics etc.).

organization. To simplify, I will say here that the organization studied is broken down into three main departments: an *R&D Department*, an *Engineering Department*, and a *Safety Department*. Each of those departments is divided into units. This division aims at constituting competence poles that can be mobilized in the different projects and missions of the organization, thus contributing to optimize the efficiency of the organization³. It translates particularly into grouping together in connate places people driven to regularly work together, and placing them under a single hierarchical authority. Those groupings thus tend both to reinforce the solidarities that have been built between communities, and to maintain the distance between other communities. By doing so, they also influence the building of future solidarities and distances, and may therefore constitute power stakes.

The boundaries of a unit may tend to match those of a *coordination community*, and reinforce the preferential links this community maintains with other *coordination communities*. For instance, the chief of the *Impacts Evaluation* unit is also the *Coordinator* of the *Numerical Theme*, and groups into his unit half of the *Unit Leaders* of this *Theme*, and the whole set of computer engineers responsible for the computation codes used in this *Theme*. This centralizing configuration results from the decision to reinforce the “integration” role played by the *Numerical Theme*: the latter uses the results of the *R&D Theme* to produce results that are directly usable by the *Engineer* and *Safety Themes*. The idea, in other words, is to allow the *Impacts Evaluation* unit centralizing knowledge from *R&D* in the same way as *Engineer* and *Safety* units centralize knowledge that matters to them, so as to reinforce the interactions between those three *Themes*. This is what figures 1 and 2 illustrate.

However, this investment is necessarily achieved at the expense of other possible investments. Importantly, some members of the *R&D Theme* regret that they are not sufficiently involved in relations between the *Numerical*, *Engineer* and *Safety Themes*. This is what an engineer explains during an interview: “So here, this is all the relationships of the *Numerical Theme* with the coordination of the *Project* and the link between the other [*R&D*] units with the *Project*. Is the *Numerical Theme* the interface with the *Project*, with the *Safety*? And do the other [*R&D*] units have to put themselves behind the *Numerical Theme*? Or do the units have a direct interface with the *Project* and the *Safety*? These are things that remain largely unsaid in our organization”.

These cases illustrate how the organization structures – especially when they combine a hierarchical structure with a project structure – have the effect of favoring some interactions between communities to the expense of other interactions. This restriction of the communities’ autonomy certainly catalyses the communities’ work in a common direction, achieving efficiency gains. It may also restrict the input of some communities, depriving the organization of a part of its innovation potential. The aim is then to address the means to retain the organizations structures’ positive effects while seeking to minimize their potentially negative effects. In this perspective, it is useful to shed

³ The superposition of projects with a hierarchical structure allows dissociating objective management, entrusted to *Themes Coordinators*, from (material, human, financial) resource management, entrusted to unit chiefs. This dissociation facilitates sharing resources between several projects, therefore achieving efficiency gains.

light on the role played by the material settings in the interactions between the organizational structures and the communities of practice, and foremost, the *boundary-settings*, which are the settings enabling the coordination of several communities. In the case of the *Project B*, those settings are the boundary-documents and the boundary-meetings.

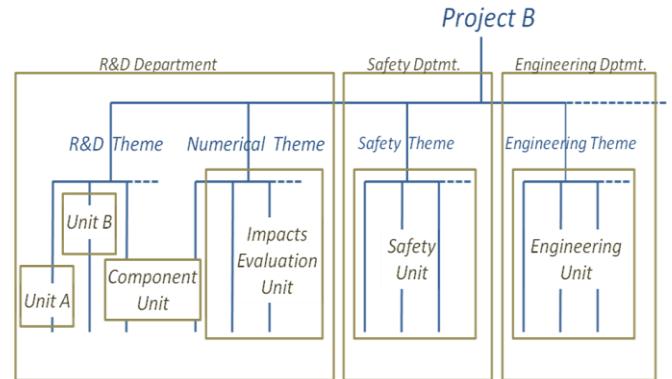


Figure 1. The organizational structures constraining the communities’ space

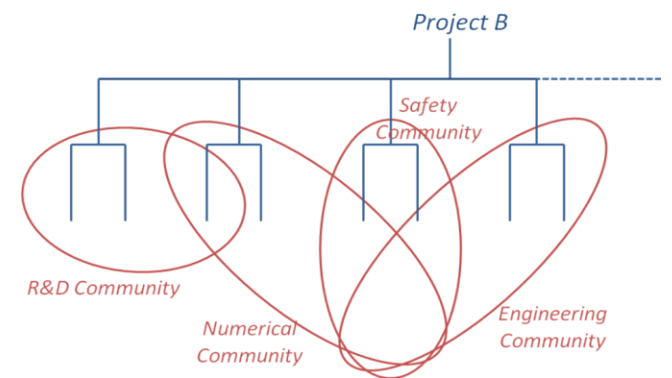


Figure 2. The relations between the coordination communities of Project B.

3.2 Occasionally produced boundary-documents

There are two main sets of boundary-documents within the *Project*: the documents detailing the results of the *Project* – the *Syntheses* – which are composed notably with a *Scientific Analysis*, a *Safety Analysis* and an *Engineering Dossier*, and the *Project’s* organization documents, i.e. notably the *Mid-Term Plan* and the *Themes*. These two sets of documents give structure and keep the results of hundreds of studies in numerous domains consistent, and coordinate the planning of many new tasks. This capacity to keep consistency comes from the perennial nature of documents, and the information they contain. They consequently function as coherent reminders of information of a diverse nature that no oral conversation could articulate in totality. Of course, most of those boundary-documents don’t “talk” directly to all the communities. For instance, documents as scientific analyses mainly “talk” to the different scientific communities who have worked together to produce them. Conversely, engineering communities who mainly rely on safety analyses use them less. However, the interdependency between the different *Themes* documents is such that producing them triggers mutual learning

effects within all the *Project* communities, including those that are usually not in contact. The disadvantage of those boundary-documents may come from the fact that they are only occasionally produced. Indeed, the results of each study must first be put into documents and “digested” at the level of each *specialized communities* before being articulated in the different documents of the *Syntheses*. As a consequence, some communities whose works are interdependent are rarely in contact and therefore not well acquainted with their respective work logics and the way they interact.

This lack of mutual knowledge appears, for example, during two interviews conducted respectively with an engineer of the *R&D Department* and an engineer of the *Safety Department*. These two engineers express opposite points of view on the order in which synthesis documents should be produced. During the first interview, the engineer from the *R&D Department* explains: “the logical process of knowledge acquisition (...) it is univocal process that is to say you go from a knowledge state A toward a state B, the state B being an extremely digested state”. In this perspective, he then adds: “the classical building progression is this one, the *Safety Analysis* must be done before the *Scientific Analysis* (...) if you like, it is the building game, you can always make bypasses but that’s the logic”. This opinion is the exact opposite of the engineer of the *Safety Department*’s, who explains: “I don’t see how the Safety gives data for the Scientific Analysis... Because for us, the *Scientific Analysis* is an input in our analyses”. He adds, “The *Scientific Analysis* normally, if everything was an ideal world, is an input of our analyses, except that regularly, well, what we can see [these days], is that it is arriving almost in parallel”. Those two opinions, if they disagree about the documents production order, must agree about the existence of a “logical” or “ideal” order in which the documents should be produced. Those two engineers are however, totally aware of the limits of this strictly linear approach of the relations between documents (and communities). The engineer of the *R&D Department* expressed an interest for a “process” that would allow managing the “retroactions” between documents in a “continuous” way, “rather than having steps where there can be breakdowns”⁴.

The hesitations of these two engineers concerning the relations between documents, and their wishes to see those relations managed in a more “continuous” way, indicate the limits of a document production setting in which the interdependencies between some communities appear to those communities only occasionally. These limits also allow a better understanding of the necessity of strong organizational structures. Without material means enabling the communities to manage together their interdependencies, organizational structures enable dispatching – and thus reducing – the management of those interdependencies. This is the reason why one department only, and sometimes one particular unit, manages each of the synthesis documents of the *Project*. However, organizational structures, because they compensate for the material limits of the boundary-documents’

⁴ In the same way, the safety engineer corrects what he has stated: “On second thought (...) in the frame of the *Safety Analysis*, we define a set of altered situations which make the system deviate from its [normal] evolution, so, in fact, there is a cycle (...) where the *Scientific Analysis* first gives the system’s normal evolution, and at a given point, the safety will ask the *Scientific Analysis* to somehow do the analysis again for the cases of altered or accidental situations (...) In fact, there are feedbacks.

production, also tend to make those limits persistent. The allocation of each document to each department and unit may therefore institutionalize the distance between some communities whose works are interdependent.

3.3 Boundary-meetings where the participation is limited

The other settings supporting the boundary-practices of the *Project* are the boundary-meetings. Compared to the boundary-documents, these meetings have the advantage of allowing a rapid evaluation of how the different communities’ works impact upon each other. The participants of these meetings generally detail three required elements to maximize the efficiency of a meeting: (1) a limited number of participants (5 to 15), so the opinions of each participant can be taken into account during the limited duration of the meeting, (2) a precisely defined meeting theme, allowing identification of the most relevant participants, and (3) the participants having proven ability to understand and explain the issues of their own communities and those of the other communities involved. However, those three aspects all have the (unintentional) consequence of limiting the participation in those meetings, thus excluding possible contributors. The difficulty is that from the excluded person’s point of view, his exclusion is always contestable, and this for several reasons: (1) it is difficult to determine at which number of participants a meeting starts losing its efficiency. (2) The theme of a meeting can evolve so that a person not concerned initially becomes pertinent. It is therefore difficult to know *a priori* an exhaustive list of the relevant participants for a meeting. (3) A person has little chance to improve his participation ability or simply to prove his ability, if the opportunity to contribute is not provided.

That meeting participation is limited presents two disadvantages. (1) *Meetings tend to multiply*. Every time the evolution of a meeting’s theme shows that a person (or community) who is not attending is relevant, a new meeting must be organized. (2) *Meetings sometimes generate frustration*. When a person (or a community) deems that he is regularly excluded for the wrong reasons, a feeling of marginalization emerges which may damage the quality of boundary-practices. The person (or community) excluded may, for instance, react in two ways. (A) He may retreat into himself, and participate as little as possible in the boundary-meetings where he is invited, e.g. by remaining silent most of the time during those meetings. (B) He can be tempted to exclude from some boundary-meetings the people he deems responsible for his own exclusion, e.g. by omitting to invite them to some meetings. Inside the *R&D Department*, one can mention again the relationship between the *coordination community* responsible for the *R&D Theme* and the one responsible for the *Numerical Theme*. The former sometimes has the feeling that *Numerical* keeps *R&D* from the boundary-meetings with communities of *Engineering* and *Safety*. This situation seems unfair to *R&D* people because (1) the results used by the *Numerical Theme* have been assembled by members of *R&D* communities, whom deem themselves competent to discuss them, and (2) many of them are engineers used to managing interactions between different specialties working together within the *Project*. During an interview, an engineer involved in the *R&D Theme* explains: “we sometimes get the impression that we dump knowledge without knowing what they become in their exploitation. What does the *Numerical Theme* do with that? If the feedback that the *Numerical Theme* gives, it’s a feedback during the *Unit Chief Meetings*, then is it sufficient? Wouldn’t there be another way to do that?”

Beyond the particular case described here, the feeling that decisions have been made without consultation to oneself is regularly expressed in the organization. This opinion is mainly caused by resorting to meetings with limited participation to increase efficiency. This material limit (which is obviously not specific to the case studied here) highlights again the necessity of strong organizational structures. Without a means of enabling the communities to efficiently discuss collectively, organizational structures enable to determine who the relevant participants are. This is why the responsibility of the organization of some meetings comes back only to some *Coordinators, chiefs*, or more generally, to certain *Departments or units*. However, the organizational structures, precisely because they compensate the material limits of the boundary-meetings, tend also to keep these limits persistent. The (necessary) allocation of meetings organization to certain *Departments* or units, tend to institutionalize the difficulty for some communities to participate in meetings.

The relationships between the organizational structures, the communities of practice, and the material settings are therefore complex. The organizational structures restrict the communities' autonomy so as to ensure a level of coordination that the material settings do not enable the communities to ensure themselves. However, the organizational structures tend to keep the material settings on which they are based, also retaining the material limits of the communities' autonomy. All in all, these three components are thus both interdependent, each of them entering into the composition of the two others, and resistant to each other, each of them marking the limits of the action of the two others. As the next section will show, these relations have important consequences when one tries to improve the knowledge management of an organization.

4. RESULTS

This section underlines (1) the difficulties that a knowledge management system meets when it is conceived without sufficiently taking into account the point of view of the communities of practice, (2) how a Participative Document Space can enable to grow a system reinforcing both the communities' autonomy and organizational control, (3) that to allow such a system to grow one must slightly modify the organization structures.

4.1 The limits of the organizational approach: the case of the *Base K*

The relations described in the previous section allow understanding of why putting in place an efficient knowledge management setting is difficult when it is conceived from the point of view of the organizational structure (i.e. *management of the known*). By searching to improve the *management of the known*, such a setting leads to unilaterally regulate the space where the communities' autonomy expresses itself most strongly, namely the management of knowledge *in the making*, and may meet the communities' resistance. This is what I would like to illustrate here with the case of a *Knowledge Base (Base K)* put in place in the frame of *Project B*.

An improvement pathway of the Project's syntheses regularly identified is knowledge tracking. Audits have sometimes highlighted the absence of documental elements justifying few decisions (which doesn't mean those decisions were not warranted). To solve this problem, a knowledge base has begun to

be put in place. The idea is to group together the tasks' results relating to the *Project* into standardized synthesis forms, and make the different *Leaders* involved write and update those forms. A person is specifically in charge of ensuring the forms' quality and the regular updating of the database. This solution, if it succeeds, presents real advantages for the "strategic submit"⁵: (1) it reinforces the centralized control of (scientific and technical) knowledge production, thus reducing the risk that documental elements are not referenced in the *Syntheses*; (2) it provides an overview of the evolution of the whole set of *Project's Themes*, thus functioning as an aid for "managing action consistency", "taking decisions", and "capitalizing knowledge". All in all, the problem has been defined from an organizational point of view: a "fabrication defect" of the syntheses is located, the settings regulating the production are improved, and the agents, complying with those new settings (the *Base K*), fabricate a better quality object.

This point of view, however, doesn't sufficiently take into account the problem's complexity relating to the existence of communities of practice within the organization. The organizational approach works well for the production of documents coming out at a predetermined date. The communities may find the disturbances that the production of syntheses induces in their practices difficult (e.g. the reduction of a several years work into few paragraphs). But the product needs to be delivered on time, and everyone must resign himself to work to the deadline. However, this organizational approach is probably not sufficient as soon as one must deal with the document production following the variable and partly unforeseeable calendars of the communities of practice. The knowledge production rhythm may considerably vary from one community to the other or within one community. The "right time" to put into a document the knowledge of reference therefore depends greatly on the evaluation of each community (except when they are forced to do so by the *Project's* planning). Intensifying the organizational constraints in matters of document production by fixing of regular dates for the production of standardized synthesis forms risks unsettling the communities' work and provokes resistance on their part (e.g. by systematically re-negotiating the moment of document production). In this case, one should (as much as possible) take into account, beside the needs of the "strategic submit", the functioning of the different communities, their specific needs, and therefore their interest in participating in such a system. In the case studied, these aspects have probably not been sufficiently taken into account. The *Base's* objectives and its overall structure have certainly been discussed during several meetings with representatives of the *Project's* main *Themes*. However the needs' details that the base should satisfy have, in practice, been discussed within a single community. There is one main reason for this: the identification of those needs have officially been allocated to the *R&D Department* unit responsible for *Impact Evaluation*⁶. It was therefore normal for

⁵ According to Mintzberg (1979), the "strategic submit" is composed of the organization executives and their advisers. Its function is to ensure that the organization fulfils its mission in an efficient way.

⁶ The *Organization Manual* states that the *Impact Evaluation* unit's objective is to "manage the whole set of R&D data necessary to execute the performance studies through the knowledge base while making sure of the consistency of the data, and this, in relation with the other units involved".

this unit (which groups specialists of most of the *Project's R&D Thematic Units*) that it deals alone with expressing the needs' details. In other words, the communities excluded were neither sufficiently competent (because they were too specialized), nor sufficiently legitimate (because knowledge management was not part of their status). Those reasons, though perfectly understandable, do not prevent reactions of resistance from the communities supposed to contribute to the base content. Those communities feel that additional constraints are being imposed on them and do not see any real benefit for themselves (or the *Project*) in those constraints. They are globally prone to contributing as little as possible. In fact, after one year of existence, the base should have contained a larger number of forms to reach the objectives given. To justify this weak participation, most of the engineers highlight lack of time, which implies they do not see the base as enabling them to gain time, or the difficulty in writing certain forms, suggesting these forms are not adapted to their specific purpose. Some directly question the way the base was conceived.

This example illustrates the necessity of taking into account the interactions between the organizational structures, the communities of practice and the material settings to conceive an efficient knowledge management system. In this case, the role of the communities of practice has been underestimated, leading to a system where the *management of the known* is achieved in the expense of the *management of the knowing*.

4.2 A Participative Document Space based on “wiki” functions

The analysis of the difficulties met by the *Base K* suggests that a knowledge management system, to be efficient, must reinforce both the communities' autonomy and the organizational control. One of my first actions has thus been to identify the material elements most likely to both integrate and modify the main two material settings of the *Project B* – the boundary-documents and the boundary-meetings – so as to achieve this double empowerment. A tool category that Zacklad (2006) names Participative Document Spaces (PDS) seems interesting. PDS (e.g. blogs, wikis, forums) can all enable a potentially important number of people to both (1) modify a set of documents in a continuous way [18], and (2) discuss and organize these discussions in writing [18]. As a result these tools seem capable of overcoming the limits of both boundary-meetings and boundary-documents without replacing them. Among the different types of PDS available today, we searched for the one that the functions are the most likely to enable (1) those who cannot participate in a boundary-meetings, to participate in the discussions unfolding in those meetings, and (2) those whose work is impacted by boundary-documents written occasionally, to participate in the elaboration of the latter in a continuous way.

The functions that best satisfy those criteria are generally associated with “wikis”. Those functions enable a set of documents to be embedded in the context of their collective production and reception. On top of the classical functions of content management system (editor, control panel), those “wiki” functions can also:

- Automatically archive each document modification with the author's logging, the date and the hour of the amendment.

- Compare the different versions of a document so as to quickly see what has been added and deleted between two versions.
- Link to each document a discussion page, whose modifications are also archived, allowing version comparisons.
- Present in an ante-chronological way a listing of documents and discussion pages that have recently been modified within the whole platform.
- Create a personalized list of documents and discussion pages whose modifications you can monitor.

These functions allow envisioning a PDS overcoming the limits of the boundary-meetings and the boundary-documents without replacing them. Firstly, because the “wiki” functions enable you to monitor the documents *in the making*, it becomes possible to produce the boundary-documents in a continuous way. The latter can thus be considered not only as deliverables, updated every five years, but also as the structure of an ongoing common work, integrating the results of the studies as they are produced. Secondly, because the “wiki” functions can document discussions, it becomes possible to enlarge the participation in boundary-meetings. The latter can thus be considered not only as decision spaces restricted to a few specialists, but also as highlights in a process in which every community can speak. The meetings simply need to be prepared and extended on the PDS.

These modifications of the material settings through which the communities interact should have the effect of reinforcing both the communities' autonomy and the organizational control. The “wiki” functions would allow each community to more easily inform itself about or participate in the elaboration of a technical point in a boundary-document, or the understanding of a difficult point in a boundary-meeting. The gain for each community would be that each of them has more effect on the different elements likely to affect its own work. From the point of view of the organizational control, the “wiki” functions would enable the different managers to monitor more easily the priority documents and meetings, and ensure the latter remain priorities. However, these are theoretical benefits, and articulation alone is not sufficient to see them taking effect in practice.

4.3 A Participative Document Space structured around boundary-meetings

Once the PDS type (theoretically) best adapted to the situation was identified, my colleagues and I proceeded with a test. A wiki type platform was put in place to support the preparation work of the *Scientific Analysis*. This document aims at describing the set of phenomena affecting the future building all along its life. The choice of this document to test the “wiki” functions can be explained by two reasons. Firstly, this document's production is managed by the *Impact Evaluation* unit (of *R&D Department*), which I belong to. It seemed, for this reason, easier to set up the test with this document than with any other document managed by another unit. Secondly, this document's preparation involves boundary-discussions with *Safety, Engineering, and R&D*. This preparation requires evaluation of the phenomenological impacts of new conception options while taking into account new R&D results, and also, ensuring that the phenomena described will respond to the needs of safety studies. The idea was to use the wiki as a way to gather in one place, both preparatory document production and discussions between all stakeholders. The

discussions that would unfold on the wiki should serve to better meeting preparation, consequently reducing the number of them. In this perspective, a wiki page was created for each of the issues where questions were asked, as well as a manual page for the wiki. After completion, an announcement was placed on the organization intranet's main page, and the wiki was individually presented to the persons most relevant for the questions asked.

Despite those precautions, the *Scientific Analysis* preparation on the wiki was a failure. During the seven weeks when the preparation phase officially unfolds, exchanges occurred on the wiki only during the week that followed its official launching. Retrospectively, the cause of this failure is that one didn't anticipate (a) that the *Scientific Analysis* preparation couldn't be dissociated from the preparation of the other main documents it interacts with, namely, the *Engineering Dossier* and the *Safety Analysis*, and (b) that building a wiki specifically for the *Scientific Analysis* led precisely to dissociating this document's preparation from the one of those other documents. It is significant indeed, that all the questions asked on the wiki was (1) written before the launching of the wiki by the person responsible for the *Scientific Analysis* management, (2) placed in a page set designated as the *Scientific Analysis*' input data, and (3) integrated in tables so that each of the persons they were asked to had to write their answer into a box. This functioning left little room for the different stakeholders to reformulate the questions and use the wiki for their own needs⁷. In this respect, it was quite different from the one for the boundary-meetings in which the questions asked on the wiki finally got addressed and solved. Those meetings are regularly organized by an engineer responsible for the *Project*'s coordination and gather representatives of the *Engineering*, *Safety* and *Numerical Themes*. There, the questions are loosely designated as "difficult points" without specific reference to the documents they may impact upon. The participants are thus free to reformulate them according to their own various points of view.

The present analysis allows clear understanding of the engineers' reactions who are not responsible for the *Scientific Analysis*, to whom the wiki was presented. Each of them stated that they disposed of very little time to participate, adding that he already had to attend to an important number of boundary-meetings. These reactions suggest that the wiki was considered as additional to the boundary-meetings, not as enabling the engineers to reduce the number of those meetings. They signal the inability of a wiki to articulate itself to boundary-meetings when it is structured around the needs of only one of the stakeholders. This first test thus highlights that for a Participative Document Space (PDS) to be useful, it needs to be co-built by the whole set of communities driven to interact on it, that is, to be built as a true boundary-setting. In this case, during the preparation of the different documents of the *Syntheses*, the main boundary-settings are the boundary-meetings (and the reports that come along with them).

This is therefore around those meetings (and reports) that a PDS should be structured.

However, positioning these boundary-meetings in the center of a PDS would not be without consequence on the organization structures. As said previously, the boundary-meetings in question here, regularly gather representatives of the *Safety*, *Engineering*, and *Numerical Themes*. Those meetings are of course totally legitimate, especially because they occur at the initiative of the unit responsible for the *Project*'s coordination. Those meetings, however, are not written in the *Project*'s structure as, for instance, the *Coordination Meetings*, which gather all the *Coordinators* of each *Theme* (there are approximately ten *Themes*). Placing in the center of a PDS the meetings between the *Safety*, *Engineering* and *Numerical Themes* would therefore have the effect of both: (1) Making the favoring links which exist between the *coordination communities* of these three *Themes* more official, and (2) giving to the peripherally positioned communities (e.g. the *R&D Theme*) the means to more easily monitor and participate in the discussions between these three communities. This is what figures 3 and 4 illustrate.

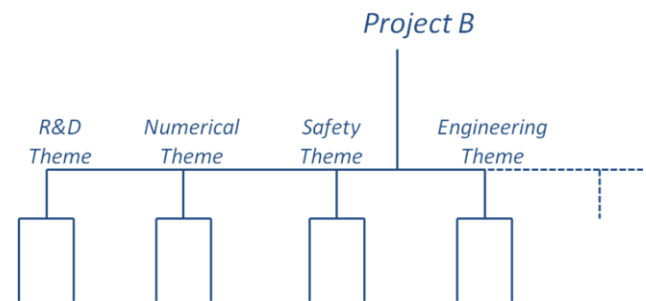


Figure 3. Current structure of Project B

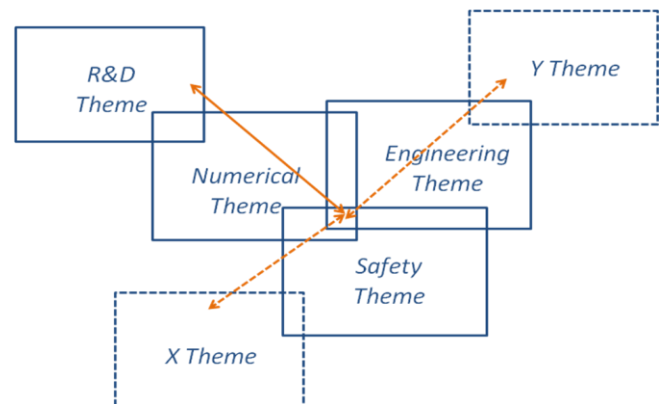


Figure 4. Project B's Structure integrating an PDS

⁷ It is interesting to note that the *Scientific Analysis*' writing phase which is currently unfolding on the wiki, doesn't meet these problems. There are mainly two reasons for this: (1) the writing of the *Scientific Analysis* mobilizes engineers who belong mainly to the same coordination community (the one of the *Numerical Theme*) and the same unit (the *Impact Evaluation* unit), and (2) the wiki is entirely structured around each of the forms and chapters which every stakeholder has to write. It can thus function as a true boundary setting for each of the specialized communities involved.

5. CONCLUSION

Firstly, this study enables a better understanding of the complex interactions between the organizational structures (i.e. the *management of the known*), the communities of practice (i.e. the *management of the knowing*), and the material settings. The organizational structures, especially when they combine a hierarchical structure with a project structure, restrict the autonomy of the communities of practice, notably by reinforcing the interactions between some communities at the expense of others. The organizational structures thus compensate for the limits inherent in the material settings that enable the interactions between communities. For instance, a meeting can gather only a limited number of participants. However, by doing so, they also support the limits of those material settings: it is unnecessary to enlarge the meeting participation if the organization structure designates the few legitimate participants.

Second, this study enables progress towards establishing a more efficient knowledge management. (1) It shows that a knowledge management system conceived from the point of view of the organizational structures, leads to reducing the communities' autonomy, which, in turn, is met with resistance by the latter. (2) It suggests that a knowledge management system must modify the material settings to reinforce both the autonomy of communities, and the control of the organization. This is what Participative Document Spaces may enable; by facilitating access to the *in vivo* working of different communities of practice. (3) It finally shows that one must also slightly adapt the organizational structures so that the communities can integrate those new material settings.

Our conclusion can be summarized as follows. Knowledge management can neither be entirely controlled by organizational structures, nor can it be entirely left to the diverse communities of practice. In other words, it can neither be isolated in a uniform centralized setting, nor dissolute in an infinity of particular settings. Improving knowledge management thus implies to work on the articulation of those diverse settings, and to extend awareness of the kind of interactions described here on the part of every stakeholder. In this perspective, the dual position that I have been trying to articulate here, both an engineer of *the known* and an ethnographer of *the knowing*, is a promising way to extend awareness of how organizational structures, communities of practice and material settings constantly interact within an organization's knowledge management.

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