1

Knowledge Transfer and Knowledge Sharing

1.1. Articulation of Chapter 1

The purpose of this chapter is to explore conceptually and practically the third step in the virtuous cycle of knowledge management. described in Volume 1, Chapter 1, which is dedicated to the transfer and sharing of the organization's knowledge.

In section 1.2, we recall the main concepts of transfer and sharing operations that are sufficient to fully understand the case studies.

The practical exploration of knowledge transfer and sharing will then be done through case studies, respectively of a banking company (section 1.3), Sonatrach (section 1.4), Hydro-Québec (section 1.5), analysis of the choice of a knowledge transfer method (section 1.6) and an agricultural field (section 1.7).

Section 1.8 summarizes the lessons learned from these five case studies on knowledge transfer and sharing.

1.2. Introduction to knowledge transfer and sharing

This paragraph is based on the study written by Thierno Tounkara [TOU 13] (sections 1.2.1 to 1.2.5) and that written by Jean-Louis Ermine [ERM 10].

1.2.1. *Introduction*

The concept of knowledge transfer was introduced by [TEE 77] in the classic case of technology transfer. It can be defined as the process by which an organization regenerates and maintains a complex, causal and ambiguous set of routines in a new context [SZU 96]. This process is a key element of the knowledge management cycle and allows organizations to absorb and make optimal use of critical knowledge. We are interested here in this process as an *intra-organizational* transfer of knowledge.

Knowledge transfer (or sharing) is an exchange process based on a binary relationship that depends on the contexts in which the actors operate. A knowledge transfer action is therefore characterized by the target audience (receivers), by the source that provides the content and participates in the transfer, by the characteristics of the knowledge that is transferred and by description of the environment (technical, social, organizational, cultural, etc.) in which this transfer takes place. A transfer process is easily described by a model (Figure 1.1) and thus provides the reference model for transfer or sharing operations (see Volume 1, Chapter 1). It is not *a priori* a unidirectional model from the holders to the receivers, because many cross-influences and retro-adjustments are implemented in its implementation.

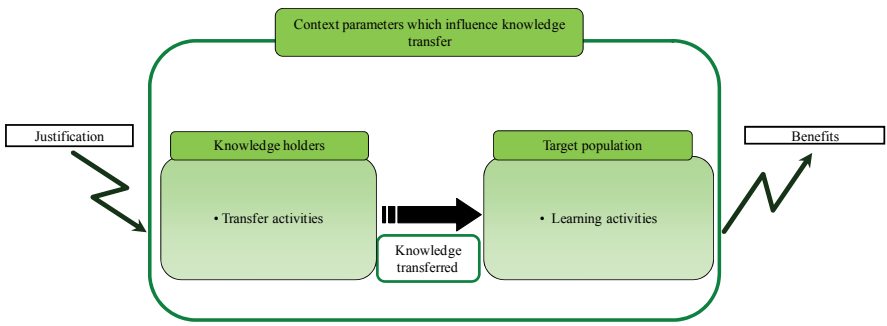

Figure 1.1. *Model of the knowledge transfer process*

This model makes it possible, for any transfer action, to specify in detail which elements are to be taken into account in the implementation. It is extremely useful for the success of the transfer. A large number of criteria can be established that can be used to characterize these processes. This is the purpose of this paragraph.

Research on knowledge transfer in general focuses on three themes [HAR 12, DAL 11, GUP 00, ZAC 99, SIM 99, SZU 96, ZAN 95]:

– factors that affect knowledge transfer: these are parameters to measure the degree to which knowledge can be easily communicated, understood and transferred;

– knowledge transfer modes or processes that address the respective transformation between tacit and explicit knowledge;

– evaluation and measurement of the performance of knowledge transfer, with the aim of developing indicators to measure the effectiveness of knowledge transfer.

We deal here with the first two themes. We focus here on knowledge transfer where knowledge codification is a possible step in knowledge sharing and transfer, including the use of knowledge engineering techniques for knowledge codification and the development of organizational memories. We can thus observe the effects of codification on the factors that affect knowledge transfer. We then propose an approach that provides optimal continuity between knowledge capture using knowledge engineering methods and knowledge transfer at the individual and organizational levels.

1.2.2. *Factors influencing knowledge transfer*

We can group the factors influencing knowledge transfer into four dimensions:

– characteristics of knowledge;

– knowledge transfer mechanisms;

– the absorption capacity of the receptors;

– cultural and organizational contexts.

1.2.2.1. *Characteristics of knowledge*

With the characteristics of knowledge, we can measure different aspects that can be facilitators or barriers to knowledge transfer.

The work of [ZAN 95] and [SIM 99] highlights three characteristics that affect knowledge transfer: their tacit nature, the complexity and specificity (or degree of contextualization) of knowledge.

Tacit knowledge versus explicit knowledge

Polanyi described tacit knowledge as "things we know, but cannot express" [POL 67] and can therefore only be transferred through interaction. Tacit knowledge is not easily expressed or formalized and is difficult to translate into words, texts, drawings or other symbolic forms. In fact, tacit knowledge is the property of those who possess it: it can be easily expressed by one person, but another may find it very difficult to explain.

Tacit knowledge is generally considered to be more valuable than explicit knowledge and requires more cognitive effort on the part of transmitter and receiver [DAL 11], [HAR 12].

Explicit knowledge is associated with declarative knowledge, consisting of descriptive elements [GAR 97]. Explicit knowledge is a set of elements collected in tangible form, such as texts, sound recordings or graphic representations.

Complexity

Knowledge complexity can be defined as the number of tools and operations used in the knowledge transfer procedure [PTR 90]. Operations are actions based on implicit conventions from past experience that can embody knowledge translation within an organization [SZU 96].

Therefore, the greater the number of operations required to interpret and appropriate knowledge, the more difficult it can be to transfer this knowledge [ARG 00].

Specificity or degree of contextualization

Specificity describes the degree to which knowledge (and the operations in which it is integrated) can satisfy the beneficiary of the knowledge transfer (the receiver). In other words, "specificity" represents the degree to which knowledge is dependent on many different contexts of use [ZAN 95]. The more knowledge is adapted to the receiver's context, absorbed and understood by him, the more valuable it is.

For example, knowledge that is closely linked to local experiences and culture can be a barrier to transfer and difficult to transplant to another environment.

Key transfer elements (ECT) [ERM 10]

In a knowledge transfer action, it is important to characterize the difficulties specific to the flow of knowledge from transmitter to receiver. This characterization consists of identifying the difficult points in the transmission of knowledge in the field. This identification is mainly done in cooperation with experts in the field, who de facto always have experience of transmission to less experienced people and who are familiar with the difficult points that are generally a problem for novices. To assist in this identification, a grid is used to classify what are called "key transfer elements", an example of which is given in Figure 1.2. These elements are classified according to whether they involve theory, technique or practice, and in general in two classes: the key points to know and the classical errors to avoid [CAS 04]. Identification of these characteristics is a valuable aid for any transfer device.

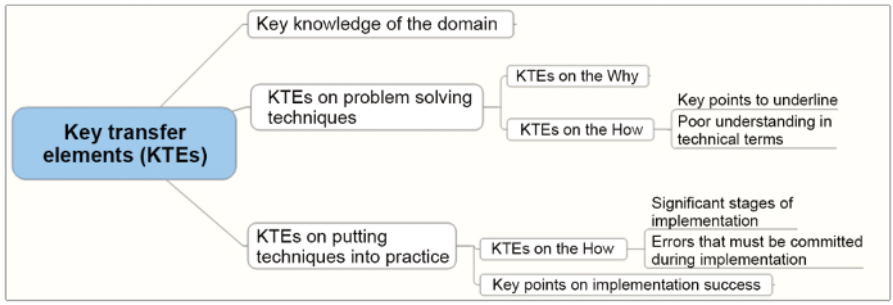

Figure 1.2. *Key transfer elements*

1.2.2.2. *Knowledge transfer mechanisms*

Transfer channels

Communication mechanisms and information flows stimulate knowledge transfer in organizations. The existence and richness of transmission channels are success factors for knowledge transfer [GUP 00].

Knowledge transfer channels can be informal or formal, personal or impersonal [HOL 98].

Informal mechanisms (such as informal seminars or coffee break conversations) are part of socialization and are more effective in small

organizations [FAH 98]. However, such mechanisms may involve some loss of knowledge due to the absence of a formal coding of knowledge.

Formal transfer mechanisms (such as training sessions) can ensure a wider dissemination of knowledge, but they can inhibit creativity.

Personal channels (such as learning) can be more effective in disseminating highly contextual knowledge, while impersonal channels (such as knowledge repositories) can be more effective in providing knowledge that can be easily codified and generalized to other contexts.

Information technology can be beneficial for all four types of knowledge transfer channels.

Transfer devices [ERM 10]

The transfer of knowledge is a rich issue that has many tools [ROS 08]. There are many methods of knowledge transfer (Companionship, Twinning, Tutoring/Mentoring, Community of Practice, Training, etc.) supported by many technologies (CMS [Content Management System], Weblog (or blog), SPIP (Publishing System for the Shared Internet), e-learning platforms (e-training), portals or knowledge servers etc.). Unfortunately, the process, method and technology of transfer are often confused.

We are interested here in transfer processes that use, as initial support, a body of codified knowledge (obtained, for example, through the capitalization of knowledge using knowledge engineering techniques [see below]).

This raises the question of how to design a sociotechnical system, modeled by the process described in Figure 1.1 and based on a body of codified knowledge, resulting for example from an operation capitalizing on one more expert (see Volume 1, Chapter 3). It is a question of adapting often classic devices to this context. Among the tracks currently being followed, here are three significant examples:

The transfer process based on the socialization of a body of codified knowledge

Two distinct processes can be put in place for this purpose:

– expert/novice co-modeling: this involves putting an expert and one or more novices together (with a knowledge engineer as facilitator), with the objective of using the knowledge modeling technique to capitalize on the expert's knowledge. The know-how is thus represented on a common basis, which allows novices to learn;

– direct transfer of the corpus of capitalized knowledge: the knowledge models created during capitalization provide a structured, intense and rich "digest" of the corpus of knowledge to be transmitted. It is a formulation of the expert's knowledge that allows him to explain it in a structured and logical way. From this representation, the expert can, easily and quickly, explain to novices, during training sessions, the essential part of his know-how. This can be done with the help of a knowledge engineer. It has even happened that the knowledge engineer who produced the knowledge book alone performs a direct transfer session to the target audience, without the presence of the expert.

More generally, a knowledge capitalization, built with experts from a knowledge community, can be entrusted to that community, which must ensure its dissemination, maintenance and sharing. Knowledge is then fully socialized.

The transfer process based on a knowledge server

A knowledge server is a website that provides a knowledge community with a body of knowledge and provides access to all knowledge resources related to the corpus, as part of a professional activity (URL links, documentation, work groups, databases, software, collaborative spaces, etc.). We also talk about a knowledge portal or a professional activity portal.

Designing a knowledge server raises particular problems, compared to designing a traditional website. These are essentially problems of cognitive ergonomics, where the progression within the site must follow mental diagrams that correspond to professional activities logic. The design methods currently used proceed in two stages: creation of a knowledge directory, where all resources are encapsulated, in the sense of object languages, in "knowledge capsules", then the structuring that distributes the knowledge capsules according to a professional activity logic (or several, if sites are to be obtained for distinct uses). It is only during the creation of the site that "use" elements are integrated, which cannot be encapsulated in knowledge elements.

The transfer process based on a learning system

A body of knowledge, resulting from capitalization, is organized in such a way as to represent know-how in a specific field. This is practical knowledge, acquired from problem-solving experiences. This corpus is generally not sufficient in itself to ensure the transfer of the knowledge it capitalizes on. As is often the case, the transfer can be carried out traditionally through an associated training system. The way in which the corpus has been designed greatly facilitates the educational engineering required to design a learning device. In particular, it allows you to:

– design the pedagogical path to be followed by the learner(s), according to their level of learning, the evolution of their learning, etc.;

– produce teaching materials based on a knowledge book, in the form of quizzes, level tests, evaluation tests, etc.;

– specify teaching tools that can be integrated into learning materials, such as e-learning.

1.2.2.3. *The absorption capacity of the receptors*

According to [GUP 00], absorptive capacity can be interpreted as a key element of the knowledge transfer mechanism.

Absorption capacity can be defined as "the ability of a company to recognize the value of new external information, to assimilate this information and to apply it" [COH 90].

It seems very difficult to control absorption capacity, because knowledge must go through a recombination mechanism in the mind of the knowledge receiver. This recombination depends on the cognitive ability of the recipient to process incoming stimuli [VAN 98].

1.2.2.4. *Cultural and organizational contexts*

Cultural and organizational factors

Inter-organizational knowledge transfer (across organizational boundaries) seems more complex than knowledge transfer within the organization. There are several reasons for this:

– cultural distance can hinder partners' understanding and the transferability of knowledge;

– organizational distance (centralized vs. decentralized, innovators versus followers, entrepreneurial vs. bureaucratic) can increase the difficulty of transferring knowledge through inter-organizational relationships [SIM 99].

We limit ourselves here to the case of the knowledge transfer context within an organization.

Intergenerational transfer: the generational profile of an organization

The *Club Gestion des Connaissances*, in France, has worked on the generational characteristics of the source and target groups of a transfer, which can determine successes and failures depending on the method used and the modalities of the intergenerational transfer (Figure 1.3).

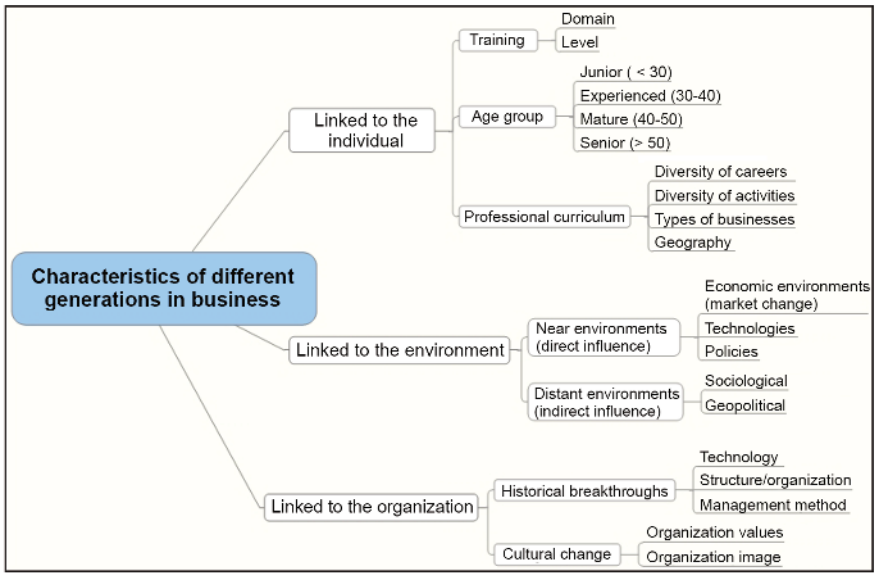

Figure 1.3. *Generational characteristics ([ERM 10])*

It is remarkable to see that, contrary to a long-held idea, characterizing a generation amounts to far more than referring only to age. According to the former idea, a generation would be a set of people born at approximately the same time. As generations follow one another at specific intervals, each generation would be characterized by a major innovation that would destroy

the old heritage of innovation brought by the previous generation. The criteria for characterizing a generation would then be the year of birth and the "technical contribution". But this vision, called positivist, has long been contested (see [MAN 28]). A qualitative, non-measurable approach can define a generation as a set of people with the same structuring tendencies. For there to be a generation, there must be unity of generation, with socialization based on structuring principles. This definition of generation has an economic aspect, and is a factor of social dynamics, as well as having a significant sociospiritual aspect.

Thus, the generational characteristics of the grid in Figure 1.3 include quantitative and qualitative criteria, linked to the individual (age, of course, but also professional and training background), linked to the social environment and linked to the ruptures or changes that people may have experienced in the company. In some projects, this grid has made it possible to draw up a company's "generational profile" and to determine the success or failure factors for knowledge transfer between various generations (as defined in the analysis grid) in this company. The establishment of a generational profile of a company is still a little explored and yet very promising avenue (for knowledge transfer, but also for internal communication, human resources management, etc.).

1.2.3. *Knowledge transfer methods*

To better understand knowledge transfer, it is important to explore two complementary approaches to knowledge: socialization exchange and codification.

1.2.3.1. *Knowledge transfer by socialization versus codification*

We can share and transfer knowledge through socialization exchange, which is a mechanism for personal communication and interaction. It is a socialization mechanism (based on tacit knowledge) as described by [NON 95] in the SECI knowledge management model.

Knowledge coding is the process of transforming knowledge into a tangible and explicit medium, such as a document, so that knowledge can then be disseminated much more widely and at a lower cost.

1.2.3.2. *Knowledge transfer models*

We present here two theoretical models with different perspectives. These models provide a conceptual framework for many knowledge transfer processes. They have been discussed and validated by academics and professionals [DAL 11, HAR 12].

These two models allow us to better understand the role of knowledge coding in the knowledge transfer mechanism.

The SECI model

Nonaka and Takeuchi's SECI model has proven to be one of the most robust in the field of knowledge management. This model focuses on the conversion of knowledge between tacit and explicit knowledge. It describes how knowledge is accumulated and transferred in organizations in four modes: socialization, externalization, combination and internalization.

Socialization is the sharing of tacit knowledge through social interactions such as face-to-face interaction. Externalization is the process of converting tacit knowledge into explicit knowledge. It is a way for organizations to make knowledge tangible and store it in manuals and databases to share it easily. In this mode, knowledge engineering methods are useful. Combination is the process by which discrete elements of explicit knowledge are recombined to form a new element of knowledge. Internalization is the last conversion process (from explicit to tacit knowledge) where knowledge is converted into individual mental models that can then be used optimally to accomplish tasks.

The BOISOT KM model

The BOISOT KM model is a conceptual framework that integrates a theoretical basis for social learning. [BOI 98] suggested that knowledge is structured, understood and transferred through three dimensions: codification, abstraction and diffusion.

Codification refers to the degree of knowledge coding (even if the receiver does not have the ability to understand it) while abstraction refers to a low level knowledge contextualization (meaning it is easy to generalize the knowledge to other contexts).

The hypothesis is that well codified and abstract knowledge is much easier to understand than highly contextual knowledge. Therefore, for tacit knowledge with a high contextual level (high degree of specificity), there is a risk of loss of context due to coding as an obstacle to knowledge transfer. This is one of the limitations of the knowledge transfer process based on organizational memories built with knowledge codified mainly using knowledge engineering techniques.

Highly contextual knowledge needs a shared context for its interpretation, which implies face-to-face interaction and, in general, a socialization approach as in the SECI model of [NON 95].

In this model, coding and abstraction work together and facilitate the dissemination and transfer of knowledge.

1.2.4. *Codification by knowledge engineering methods and knowledge transfer*

The ability to understand and disseminate knowledge codified with knowledge engineering techniques depends on several factors:

– the accessibility and readability of the formalisms used for knowledge receivers [DAL 11];

– profiles of knowledge recipients (context, context of knowledge use, preferences for logical structuring and understanding profiles) [CAS 04];

– the level of description of complex and specific knowledge;

– the channels of exchange between sources of knowledge (experts or specialists) and potential future users.

1.2.4.1. *Multiplicity of formalisms*

Knowledge engineering methods lead to a set of models and each of them corresponds to a specific type of knowledge. Examples include Common KADS [DIE 00], KOD [VOG 90], MASK [ERM 13]. Thus, expertise is codified through formalisms (which are often diagrams) according to the type of knowledge.

We can highlight many difficulties associated with the multiplicity of models: accessibility, readability and intelligibility. The profile of

knowledge receptors can accentuate these obstacles: are they familiar with the use of models? What about their cognitive learning preferences: are they more textual than visual?

Knowledge engineering methods focus only on codifying the tacit knowledge of experts or specialists, but they do not take into account the appropriation and organizational learning capacities of readers (potential future users).

1.2.4.2. *Heterogeneity of reader profiles*

In an organization, readers do not have the same level of knowledge and their profiles may be heterogeneous (background of knowledge, contexts of knowledge use, preferences for logical structuring, understanding of the profile, familiarity with models, etc.)

However, the logical structuring and presentation of codified tacit knowledge is not guided by the learning levels of future readers, but only by the concepts addressed when interviewing experts/specialists and by the structure of the models.

1.2.4.3. *Knowledge background*

A knowledge receptor with significant prior knowledge (related to the knowledge domain) and being trained in the use of models may have a greater capacity for absorption. It may be easier for such a receiver to decode and assimilate knowledge with a high level of complexity.

1.2.4.4. *Context of knowledge use*

The greater the distance between the receiver's context of use and the one described, the greater the cognitive effort required on the part of the knowledge receiver to adapt the knowledge. This case occurs when the codified knowledge is very specific to the context of the knowledge source.

1.2.4.5. *Logical structuring preferences and understanding profile*

Preferences for logical structuring depend on the learning level of the knowledge receiver. For a novice, understanding concepts before procedural tasks could be more logical. On the other hand, an expert might prefer a structure guided by problem-solving.

Understanding of the profile can be assimilated to the cognitive preferences of the reader during learning: textual and/or visual preferences. When the knowledge domain is codified taking into account the logical structure and cognitive preferences of the reader, knowledge transfer can be accelerated because the knowledge receiver makes less cognitive effort.

1.2.4.6. *Level of description of complex knowledge*

The more complex the knowledge is, the more difficult it can be to transfer. To reduce complexity, we propose complementary actions to enrich the repository of codified knowledge:

– identify complex sets of knowledge that have already been codified;

– describe and illustrate operational mechanisms in which identified complex knowledge is integrated;

– organize exchanges (with appropriate knowledge transfer channels: informal or formal) between experts and users to help them create a shared interpretation context.

1.2.4.7. *Level of description of the specific knowledge*

It may be difficult for experts to explain certain sets of knowledge without a close link to the situations they have experienced. For these sets of knowledge with a high degree of specificity, the knowledge receiver must make a significant cognitive effort to generalize (abstract) the knowledge and put it into context for personal use.

We propose three actions to facilitate this abstraction step:

– identify specific knowledge sets already codified;

– promote with experts the general principles that guide the use of the specific knowledge identified;

– identify and illustrate with experts other possible contexts of use.

1.2.4.8. *Exchanging channels to increase diffusion and transfer*

Communication and transmission channels are necessary to accelerate the transfer of knowledge. They are an important basis for:

– the development of a shared context for interpretation;

– legitimation, as best practices, of the knowledge captured;

– the evolution of codified knowledge through social interactions.

In the grid below, we summarize the key points to be analyzed for the effectiveness of the transfer of codified knowledge.

	Actions for effective transfer codified knowledge
Codified knowledge	**Complex knowledge** – Identify highly complex knowledge sets – Explain and illustrate the associated routines – Create a shared context for interpretation (develop interactions between experts and knowledge receptors)
	Specific knowledge – Identify knowledge sets that are highly dependent on the context in which the knowledge source is used – Explain the general principles related to specific knowledge – Identify and illustrate other possible contexts of use
Player profiles	**Technical background** – Professional background – Level of knowledge of the reader in the field concerned – Degree of familiarity with knowledge engineering models
	Contexts of use – Identify situations where codified knowledge would be useful to the reader
	Define preferences for logical structuring
	Define preferences for your understanding profile – Visual representation? – Text representation? – Audio support? – Illustration with concrete cases?
Exchange channels	– Identify existing communication and transmission channels – Stimulate social interactions between experts (sources of knowledge) and readers

Table 1.1. *Analysis grid for knowledge transfer coded according to [HAR 12]*

1.2.5. *Methodology for effective knowledge transfer*

We propose here an empirical methodology for the transfer and appropriation of codified knowledge repositories at the individual and

organizational levels. It is a two-step approach (rewriting and sharing), guided by the previous analysis grid and supported by a set of methodological tools tested in several companies and in different contexts with the *Club Gestion des Connaissances*, mainly in France, but also in other countries.

Execution of the two steps of this transfer methodology presupposes, first of all, that the identification and codification of tacit knowledge is properly carried out.

1.2.5.1. *From knowledge mapping to codification of tacit knowledge*

We identify the tacit knowledge to be captured using a cartographic approach to analyze the knowledge domains in the company. Then, with knowledge engineering techniques, we capture and codify tacit knowledge.

Mapping and evaluation of knowledge areas

The reader is referred to Volume 1, Chapter 2 (Strategic Analysis of the Organization's Knowledge Capital) for a presentation of the mapping and evaluation of knowledge domains.

Once the knowledge domains have been assessed, it is possible to draw up a table of the knowledge domains most particularly concerned by specificities that could be interesting to highlight by considering the points of view of the operational actors: very knowledge-intensive domains, domains to be valued, very vulnerable domains or domains requiring improvement / adaptation for training and knowledge transfer. This table provides a basis for further analysis and the identification of appropriate knowledge management actions:

– "codification-transfer" in the case of acquisition, preservation or transfer;

– "organization" when it comes to managerial actions;

– "training-recruitment" when actions deal with learning systems, recruitment for new skills;

– "innovation" when the actions focus on creativity, surveillance of the environment, etc.

Capturing and codifying domains of tacit knowledge

We refer the reader to Volume 1, Chapter 3 (Knowledge Capitalization), for a presentation of the capture and coding of tacit knowledge domains.

The result is a codified knowledge repository, reflecting the field of knowledge and tacit experience of one or more experts, structured into chapters corresponding to tacit sets of critical knowledge identified with experts.

1.2.5.2. *Adaptation of knowledge repositories to readers (rewriting approach)*

This approach is based on two steps:

– characterization of readers: this is an important step in defining reader profiles (knowledge background, context of use, preferences for logical structuring);

– the development of specifications for rewriting.

The goal here is to define:

– additional content for the description of very complex and specific knowledge;

– additional illustrations (case studies, videos) to be developed;

– a logical structuring of the codified knowledge repository;

– rewriting and validation of the new knowledge repository.

1.2.5.3. *Sharing of the knowledge repository*

The main objective of sharing is to create a shared context for knowledge interpretation to facilitate and accelerate organizational learning.

It is based on three principles:

A clear vision of the actors involved in the transfer process

There are three groups of key players:

– knowledge sources that are experts or specialists interviewed to capture their tacit knowledge. They are the authors of the repository of codified knowledge;

– readers are knowledge receivers selected to contribute to adapting the codified knowledge repository. These are the reviewers;

– other potential recipients/receivers who are future potential users (other team members, new employees, etc.).

Adequate structuring of exchanges between groups of actors

The objective is to formalize exchange situations that will lead to a good collective appropriation and legitimization of the knowledge captured. Clear and precise objectives must be defined for each formalized situation.

Use appropriate channels with regard to the purpose of knowledge transfer

For each exchange situation, it is necessary to select the most appropriate transmission channel (informal or formal, personal or impersonal) to increase ownership and transferability (Table 1.2).

Exchange situation	Objectives of the project	Transmission channel
Presentation of the codified knowledge repository to reviewers	The aim is for reviewers to fully understand the objectives, scope and content of the knowledge captured. Knowledge-bearing sources (experts, specialists) present and comment on the repository, clarify complex and/or specific knowledge sets by providing illustrative examples of different contexts of use. The presentation initializes the mechanism for developing a "shared context for knowledge interpretation" and is important for its success. It may be useful to consider many sessions to arrive at a collective understanding of the codified knowledge repository.	– Formal seminars
Exchanges between reviewers for the adaptation of the codified knowledge repository	Reviewers are involved in collaborative work that will lead to the adaptation of the repository. Here they identify complex and/or specific knowledge sets and try to make them more explicit by: – collectively building case studies; – illustrating other application cases from their own experience; – evolving the logical structure of certain chapters; – …	– Formal seminars

Sharing the updated repository with potential future users	The goal is to share the revised and stabilized version of the repository with other readers who are potential future users. The group of reviewers should define learning objectives and define the appropriate scope of knowledge sets on which to focus. Exchange sessions with potential future users can be useful.	– Training sessions – Online sessions
Sharing lessons learned through the use of the codified knowledge repository	The aim is to facilitate future developments of the repository by capitalizing on the lessons learned from the actors who use it. Exchanges (even informal) between the different groups of actors must be organized periodically in order to identify: – more effective ways of doing things; – new applications and new contexts of use; – the difficulties encountered; – …	– Informal seminars – Conversations during coffee breaks – Online forums – Formal seminars

Table 1.2. *Formalization of exchanges in order to develop a shared context for the interpretation of knowledge according to [HAR 12]*

1.3. The case of a banking company

This paragraph is based on the study written by Thierry Isckia and Jean-Louis Ermine [ISC 07].

1.3.1. *Introduction*

In the banking sector, as in many other sectors, staff training is a priority. A company's performance cannot be conceived independently of the training of the men and women who work there. Banks are aware of this and are investing heavily in training. The banking sector is the third largest private employer in France, with 500,000 employees at the end of 2006, representing about 1.7% of the employed working population. In addition, the bank generates around 200,000 indirect jobs. Banks are one of the leading recruitment sectors in France: they employ 30,000 to 40,000 people per year, more than two-thirds of whom are under 30 years of age. The main aim is to support the dynamism of the activity (700 new bank branches created in 2005) and to anticipate the many retirements, with more than a third of employees aged 50 or over.

Today, more and more banks are diversifying their hiring profiles and thus offering opportunities to people of various origins and backgrounds. In 2006, 13% of recruitments were for people with a baccalaureate or below. Favoring internal promotion, banks often offer these people continuous training so that they can occupy positions at the bac + 2 level. At the end of 2005, 7,800 people were on rotation in the banking sector, representing nearly 2% of the workforce. As part of a professionalization or apprenticeship contract, they prepare diplomas at all levels, such as the BTS Banque or Masters. Continuous training makes it possible to complete these measures.

Every year, banks spend 4 to 6% of their payroll on continuing training, which puts them, in all sectors of activity combined, in the top ranks, with the legal minimum being 1.6%. According to CEREQ, banks spend an average of €1,700 per employee per year on continuing training, compared with €800 for other sectors.

1.3.2. *Project context*

As is often the case, the starting point of the project was linked to the observation made by the group's HR department and validated by the various business units (BU) in the field: within two to three years, the bank would be confronted with massive departures of retired and early-retired staff – mainly in the back office – and therefore with a net loss of know-how in the associated professions (operators). In this context, it was necessary to take stock of the situation, identify and analyze this business know-how and reflect on the skills transfer mechanisms that could be implemented to capitalize on and bring to life all this "business" experience.

The group's HRD also wanted to benefit from the knock-on effect of implementing the new "Dynamics 2010" strategic plan to carry out a criticality skills analysis. At this level, the idea was to identify critical knowledge with regard to the strategic orientations set out in the "Dynamics 2010" plan and their application to back office activities. Indeed, following a merger with another national banking institution a few years earlier, the bank in question had mobilized around an ambitious business project aimed at building a single banking model, highly differentiated from its national competitors. In this context, the new strategic plan provided for a redesign of operational processes in order to improve the quality of service for the

bank's various customers. Operating under its own brand, the bank now wanted to focus more particularly on retail banking activities in the corporate and professional market and thus become a leader in this field.

1.3.3. *Objectives and methodology*

The project began in the second quarter of 2006 after a kick-off meeting held at the bank's head office, in the presence of several top managers including the Group's HR department, the Director of the Customer Services Division (CSD) and the head of credit processes, the Director of the Corporate Markets Division and his counterpart, the Director of the Professional Markets Division. These different people formed the project steering committee.

Examination of the data from the business lines observatory and the various exchanges with the members of the steering committee made it possible to define the pilot unit for the project. Thus, a business unit (BU) located in the Paris region was selected as a pilot site and the "Contracts" area specific to the management was chosen as the field of investigation. This business unit was particularly interesting because it represented, at the national level, the staff, skills, professional backgrounds and work organization methods of the various BUs. The "Contracts" area proved to be the most relevant to study, as it corresponded to the core business of the various BUs and directly contributed to the creation of value and the development of commercial performance: the preparation of credit applications and the management of associated guarantees over the entire life of the operation. The objectives of the study therefore mainly covered:

– identification of the business know-how affected by the "Dynamic 2010" strategic plan and by the organization in process;

– criticality analysis of the various business skills;

– the elaboration of recommendations on the implementation of mechanisms for the transfer of competence within the BU.

The method used to carry out this project is the MASK method (see Volume 1, Chapter 2).

1.3.4. *Knowledge management analyses and actions*

1.3.4.1. *Strategic analysis*

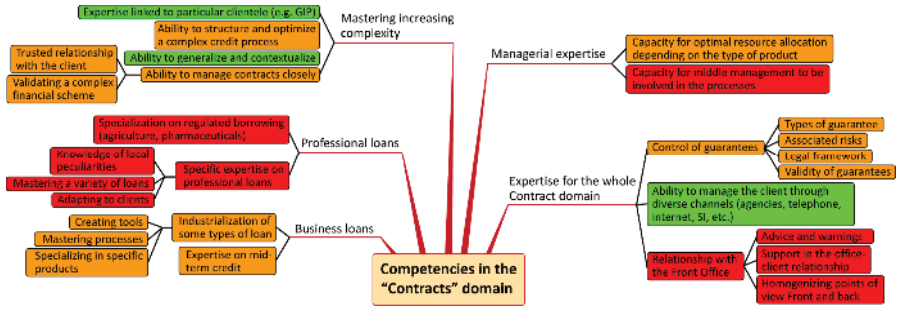

Figure 1.4. *Map of strategic competencies in the "Contracts" domain. For a color version of this figure, see www.iste.co.uk/saulais/knowledge2.zip*

The strategic skills map in the "Contracts" domain shows five main areas of knowledge presented in a color code (red, green, orange) that reflects their degree of criticality.

In the table below, we present some strategic skills that are considered very critical with a synthesis of the analytical elements.

Highly critical strategic skills	Overview
Relationship with the Front Office **– Advice & Alert** **– Support of the Front-Client relationship** **– Homogenization of Back and Front processes**	These skills are generic – at least for standard files – simple and easy to acquire and are not very rare, however, there is a need for intervention before the relationship with the client. Also: what is the interest of setting up one or more expert cells? It is difficult to imagine having experts scattered throughout the country on the front office, hence the need for a grouping in order to constitute one or more cross-functional centers of expertise. On the substance, the use of certain expert opinions is made through informal contacts between the front office and the back office. This would be the way to institutionalize this type of relationship. The front office is globalizing, stimulated by the client. The back office is analytical, stimulated by the internal. There is a need to bring together the subjects' points of view and approach. In this sense, the development of this know-how in the relationship is strategically very critical

Ability of middle management to be involved in processes	The renewal of managerial know-how must be achieved through better communication and leadership of middle management. It seems necessary to also take into account the sociological evolution of their profile, and, taking into account the new social and economic conditions, to attract these managers by messages based in particular on "self-fulfillment". It is necessary to imagine and allow a return to the "clan", to the "tribe": only intermediate managers will be able to directly control the network of their collaborators involved in the key processes, and to affirm their leadership. This is a critical development for the future
Specific know-how of the professional segment **– Knowledge of local particularities** **– Mastery of the variety of credits** **– Adaptation to the customer**	It is a very "geographical" know-how, but this field requires "acting globally, and thinking locally". Local know-how will be "delocalized" in centers following the regrouping of the BU, which poses the problem of exchanges and transfers to other BUs

Table 1.3. *Overview of highly critical strategic skills*

1.3.4.2. *Business analysis*

A business unit (BU) located in the Paris region and specialized in the Corporate segment was chosen after a proposal by the steering committee. The business know-how map (Figure 1.5) was drawn up with representatives of the various business lines – on a voluntary basis – to analyze the "Contracts" area.

Analysis of the recordings made it possible, as above, to summarize the arguments that were put forward to justify the degree of criticality of the business know-how analyzed. For example, we will briefly present the results obtained in the areas "Internal / External Environment" and "Economic Aspects for the Company". We will then provide an extract from the summary table (Table 1.4) of the criticality analysis for all the areas studied in order to identify the highlights of the analysis.

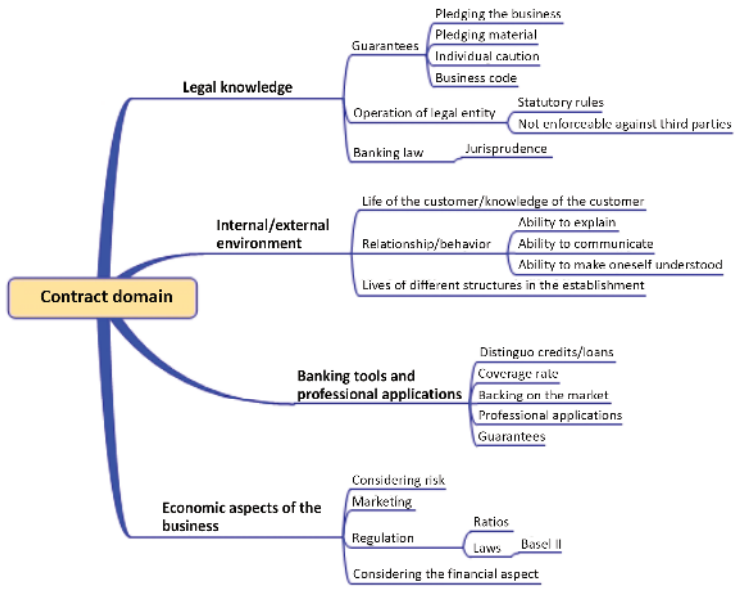

Figure 1.5. *Map of the business know-how of the "Contracts" Domain*

Area of knowledge	Highlights of the event
Legal knowledge	– High technicality of the field of knowledge – Training system to be reconsidered – Lack of recognition of operators and/or technicians – Importance of the relational network
Internal / external environment	– Training system to be reconsidered – Need to stabilize the IS and available tools – Need for a knowledge sharing tool
Banking Tools & Business Applications	– Low complexity knowledge area – Strong contribution to process optimization – Need to update existing documentation – Need to adapt existing training – Almost no mechanism for capitalizing on knowledge exists
Economic aspects for the company	– High specificity of the knowledge area – Work organization methods to be reconsidered – Productivity logic that increases financial risk – Training system to be improved – Lack of a mechanism for capitalizing on knowledge

Table 1.4. *Summary table of "business" knowledge areas*

1.3.4.3. *Strategic business lines*

Table 1.4. (extract) represents a synthesis, in terms of knowledge management actions, of the analysis that has been carried out on the critical knowledge areas related to the activity "Contracts" for companies. Each domain, identified in the map of business know-how of the "Contracts" activity for companies, drawn up by the BU, is positioned on two rankings:

– its importance rank, as perceived by BU interviewees (business importance rank). This ranking was obtained by using the overall score in the criticality analysis, which is an average of the scores that were given for all the criteria in the analysis grid. This score has been weighted to take into account other considerations;

– its importance rank obtained by weighting by what was perceived by respondents on the strategy (strategic importance rank). This ranking has been obtained by using the influence score Strategy>Business, in the synthesis that combines strategic and business analysis.

Each domain was associated with the knowledge management actions that were mentioned in the BU interviews, as they appear in the criticality study summary sheets.

These knowledge management actions have been grouped into three classes:

– organization, when it comes to managerial actions;

– training, when they concern learning devices;

– capitalization-transfer when they concern preservation actions, collection, sharing, documentation, etc.

Area of knowledge	**Business Significance Rank (out of 5)**	**Rank of strategic importance (out of 5)**	**Working axes**
Legal knowledge	5th	4th	Organization – Visibility and use of legal knowledge in the field of contracts and guarantees

			Training – Targeted and specific legal training for newcomers – Strengthen tutoring in the legal field Capitalization - transfer – Participation of staff who have left (in agencies, on retirement) in a group for exchanges on legal knowledge – Sharing of contact networks by business knowledge holders – Follow-up of updates according to the evolution of case law

Table 1.5. *Examples of knowledge management actions for a knowledge domain*

1.3.4.4. *Strategic skills*

A synthesis was made, in terms of knowledge management actions, of the analysis that was carried out on the strategic skills related to the "Contracts" activity for companies. It is summarized in a table, an example of which is given below (Table 1.6).

Each skill, useful in the "Contracts" activity for companies, identified in the skills map of the "Contracts" activity established with actors of the CSD strategy, is positioned on two rankings:

– its importance, as perceived by CSD interviewees (strategic importance). This criterion describes the criticality of the competence as stated in the interviews, as well as the need to either bring out this competence if it is new to the CSD or to maintain it if it already exists;

– its importance rank was obtained by weighting by what was perceived by respondents on the activity "Contracts" for companies in the BU (business importance rank). This ranking was obtained by using the influence score Business>Strategy, in the synthesis that combines strategic and business analysis.

Each competency was associated with the knowledge management actions that were mentioned in the interviews at the CSD, as they appear in the summary document of the strategic analysis.

These knowledge management actions have been grouped into three classes as in the case of business know-how.

Strategic competence	Business Significance Rank (out of 7)	Strategic importance	Working axes
Relations with the front office	1st	Very critical to bring out	Organization – Set up one or more cross-functional expertise units – Institutionalize informal relationships (Advice on setting up, Advice on using the IS, Advice on managing a loan contract, Knowledge of the entire process from back to client via the front) Training – Complete the training: technical product training for the front, global process training for the back Capitalization - transfer – Homogenize information and views on the entire process for front and back office (with different proportions) from three points of view (Client, process, economic legal environment)

Table 1.6. *Examples of knowledge management actions for a strategic competency (Source: [ISC 07])*

1.3.5. *Work organization and knowledge transfer*

The specific lines of thought given here are inspired by the analyses carried out at the CSD and the BU.

They revealed a large number of possibilities for action in the management of skills and knowledge in the Contracts field, but they were not exhaustive, since the study was conducted in a limited scope.

These actions can be classified into three main categories, depending on whether they fall within the scope of managerial organization, training actions or capitalization and knowledge sharing mechanisms. The ideas provided follow this classification. We give some examples below, concerning knowledge transfer.

1.3.5.1. *Organization of work by "tasks" or "business"*

Work organization and knowledge management

According to the analysis carried out, organization by "customer portfolio" seems better suited to a logic of skills development and know-how transfer. It makes it possible to strengthen proximity with the customer and to develop an overall vision of their activities over time. In addition, it allows the operator to give meaning to his action by combining general and practical knowledge (know-how). The "task" organization aims to optimize practical knowledge and deprives the operator of an overview of the processing process. It is part of a logic of specialization linked to ongoing productivity projects. Moreover, in a "task" organization, the role of the intermediate manager is limited to direct supervision and control, reducing his involvement. In a "business" organization, there is more involvement of the manager, especially in coordination and communication. As a corollary, organization by "tasks" hinders the development of managerial skills.

Work organization and associated risks

The "task" organization leads to an increase in risk in the processing system. The productivity logic associated with this system leads to a preference for quantity to the detriment of quality and specificity. In this respect, organization by "business" contributes to improving "customer knowledge" and makes it possible to reduce the risks related to the specificities of the latter, that is the risk borne by the institution.

The individual, the team and the community

In a "task" organization, the individual is isolated within a hierarchical structure that they do not necessarily understand as a whole. In this context, motivation problems can arise and influence the degree of operators' involvement. The transfer of knowledge becomes more difficult, since the operating mode can lead the operator to isolation. However, learning can only be conceived in a logic of interaction with other actors, who themselves possess knowledge and know-how. Organization by "customer portfolio" is

potentially more interesting from this point of view. For this transfer objective, the organization (at the operational level) must be a mesh structure of which the team is the elementary entity. The bringing together of the different teams, in a logic of sharing "business" knowledge, can then serve as a basis for the emergence of real "communities of practice".

1.3.5.2. *Training mechanisms*

Organization of working time for tutors

Today, a significant part of the training is provided by designated tutors, who are responsible for training newcomers. However, at present, it seems that there is no provision for the organization of working time for these tutors, who are also asked to carry out their daily treatment tasks. Under these conditions, the training becomes a delicate and dangerous style exercise for the tutor. In this perspective, it would be desirable to provide for a reduction in the workload of tutors throughout the training period, so that they can fully devote themselves to their mission of tutoring and accompanying newcomers. This form of *in situ* tutoring could possibly be supplemented by the implementation of e-learning tools to provide part of the distance learning if necessary. As a corollary, it is necessary to update existing documentation sources and to promote their use and accessibility, by reconsidering the nature of existing materials (digital format, tutorials, self-assessment tools, forums, etc.). The training provided and the pedagogical support used must also be adapted to reality on the ground and the expectations of the actors.

Reflection point: how can we integrate tutoring into the work plans of the appointed tutors?

Towards a recognition of the role and status of tutors

As a corollary to the previous point, it is also important to define the status and role of tutors in the field. Insofar as the latter play an important role in the training of business actors (operators), it is a question of reconsidering the status of trainer and especially of upgrading it (job description, incentives, etc.). This would make it possible to encourage vocations, especially among the most experienced actors, who wish to share their know-how and experience.

The tutor plays an active role ("facilitator") in the personal knowledge transfer system. In particular, he can contribute to expression on the

practices implemented because of his level of expertise and the specific knowledge he holds ("what", "how", "when", "why", etc.). His level of expertise, used in tutoring, can be used in other actions (capitalization, writing, animation of communities of practice, etc.).

Suggested reflection: how to value and recognize the missions carried out within the framework of tutoring in the career plan of tutors?

Role of the tutor in the knowledge transfer system

The role of the tutor is not limited to contributing to the acquisition of professional knowledge, skills and abilities by the employee concerned, through training activities in a professional situation. Through its position, it can also contribute to the reception, assistance, information and orientation of the company's employees who participate in training activities. As such, it is a relay for the HRD, which can assist the employee in the development and implementation of his professional project. This aspect must not be reduced.

Reflection point: how to integrate the tutor into the global knowledge transfer system?

Summary

The status of tutors must be recognized and valued, and the training system in place must be adapted to enable tutors to fully carry out their missions.

1.3.6. *Conclusion*

The study carried out has several advantages. First of all, it constitutes a solid working basis from which the actors were able to reflect on the adaptations to be made to the "Dynamics 2010" strategic plan. As such, the maps produced during the study have really enabled top managers to improve their knowledge of the field and the units they manage "remotely", often with an incomplete view of the knowledge actually available. The merit of mapping is also to highlight areas of knowledge that constitute real sources of value, at least at the level of business units (BUs), but which are not perceived as such by top management.

Beyond that, the investigations indicated that the modalities of work organization within the BU were not neutral and that they could hinder the

dynamics of knowledge creation within the units and, by the same token, parasitize the transfer of knowledge between the same BU. It is necessary, or at least preferable, to align the environment of the "sending" entity and that of the "receiving" entity of the knowledge. In concrete terms, within the BU studied, it became clear that the services organized by "business" had more detailed knowledge than those organized by task, in the very opinion of the operators. Behind the expression – "We don't work the same way!" – often heard in interviews, there is in fact different knowledge, developed in different contexts, so different skills. In this context, training must be seen as a lever to bridge the differences between the skill levels of different entities, in order to facilitate subsequent organizational learning and knowledge transfer between units. The study also indicated that field training was very important, but also often problematic, due to the lack of consideration of tutor workloads (in the case of in-house training). Therefore, the role of tutors must be valued within the institution and their time schedule must be adapted according to the number of young people to be trained.

In the case studied, therefore, changing the organization of work and training systems appeared to be an essential prerequisite for knowledge transfer. On this point, the players were cautious and wise, they did not give in to the technological mirage that would have consisted in deploying at great expense a ready-made solution supposed to solve all their problems. Knowledge is never "disembodied" and before thinking about technology, it is always better to think about men, women and the organizations in which they operate. Beyond this aspect, the methodology used (particularly the mapping process) seems to be an excellent internal diagnostic tool for organizations. It allows us to go beyond simple intuition and identify key areas of knowledge. The mapping of critical know-how can therefore be seen as a management tool to align skills with major strategic orientations.

1.4. The Sonatrach case

This paragraph is based on the study written by Djilali Benmahamed and Jean-Louis Ermine [BEN 06]. The part of this study presented here concerns the elements of a strategy for the transfer of professional activity know-how for the oil group Sonatrach. The part describing the strategic knowledge

analysis was presented in Volume 1, Chapter 2 on the strategic analysis of the knowledge assets. It also contains a brief introduction to Sonatrach.

1.4.1. *Introduction*

This study focuses on the feasibility of a know-how transfer approach in the oil industry, as well as on describing the conditions for success in such environments. It validates a formal, strategically oriented approach to know-how transfer based on knowledge engineering techniques.

The knowledge engineering method chosen for capitalization is the MASK method. The result obtained by this method is a set of models formalizing knowledge, developed from interviews with the holders of this knowledge (see Volume 1, Chapter 3). All the models, supplemented by all the information and documents, sheets, etc. related to them, constitute a field's "knowledge book". It capitalizes and disseminates a body of knowledge on a field, represents a structure of knowledge and indexes documents of the activity (descriptive sheets, memos, publications, hyperlinks, etc.) and multimedia content (video, images, sounds, etc.).

The first possible use of a knowledge book is to make it available to professional actors in a dedicated "knowledge space", integrated into the company's information system. This is what we call "knowledge server" or "business portal". This type of system is an element that contributes to organizational learning, since it provides stakeholders with business know-how that improves practices in work situations.

In addition, the MASK models are of great interest for pedagogical scenarios describing the approaches to sharing and appropriating the modeled knowledge. This makes it possible to define the content of learning devices [BEN 05].

Knowledge servers and Computer Environments for Human Learning (EIAH), such as e-learning, are the technical support systems for the transfer of professional activity know-how. In the vocational training issue envisaged, the knowledge book, representing know-how and best business practices, provides most of the content for the planned systems. This approach differs from a certain classical learning problem [BRO 94], which focuses more on the learner than on expert knowledge.

1.4.2. *Design of transfer devices*

The objective of the project is to achieve an indirect transfer of critical and strategic know-how. It is an "indirect" transfer according to the classic scheme (SECI process: Socialization, Externalization, Combination and Internalization) of Nonaka. This famous diagram of the ways in which knowledge is transformed in the company is instantiated in this project into sub-processes:

– the Tacit/Explicit transformation by the MASK process (more precisely MASK 1 which concerns capitalization by knowledge books – see Volume 1, Chapter 3);

– the Explicit/Explicit transformation through the construction and dissemination of knowledge explained by technical systems (Knowledge Servers and EIAH, e-learning type);

– the Explicit/Tacit transformation through the establishment of learning communities, which will have to evolve into communities of practice.

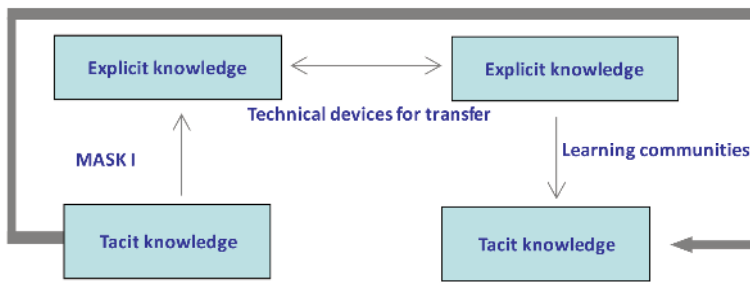

Figure 1.6. *Knowledge transformation methods within the project*

The system covers the most critical areas by aiming to develop a coherent plan of methods and tools to ensure their transfer. Several avenues are being explored: sharing mechanisms in the form of collaborative spaces, digital discussion, knowledge servers and transfer, particularly through learning, of these business skills using e-learning technologies, according to defined norms and standards that can then be "scaled up".

We use here the work already carried out [BEN 05] around the definition of a learning content based on the knowledge encapsulated in MASK models. This approach is based on the knowledge engineering foundations

encapsulated in the MASK models and those of educational engineering that can be used through educational scenarios. After having explained and capitalized the target business know-how, it is proposed to move from these MASK models to educational scenarios whose elements are described according to the IMS-Learning Design (IMS-LD) description language. This use of standardization reinforces scripting and responds to a vision of standardization and reuse of the content of the learning transfer device.

This approach allows for the development of learning activities that are realistic in a work context. Indeed, the knowledge to be learned corresponds to practices extracted directly from the professional activities concerned. Figure 1.7 describes the principle of developing learning content, based on the knowledge encapsulated in the MASK models and other complementary sources. This highlights the contribution of knowledge books to the definition of learning systems, including the central role of models, complemented by other elements.

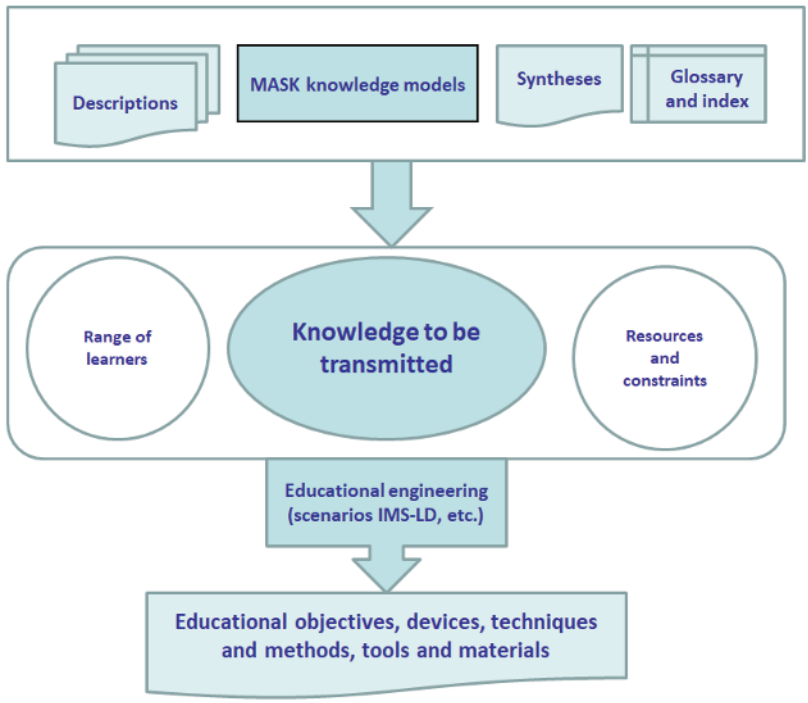

Figure 1.7. *Principle of learning content development*

Educational design must take into account not only the content and tasks to be carried out, but also the "learning relationships" that will update the learning.

1.4.3. *IMS Learning Design*

This paragraph summarizes the main principles of the IMS-Learning Design (IMS-LD) model and the elements used in the rest of the work. The principles on which IMS-LD is based are:

– a person has a role and carries out activities that may involve the use of resources, services and/or tools;

– each person can have one or more files, each of which has properties characterizing him/her;

– there are two generic roles: the "staff" and the "learner". Learners can receive support during their work over the course of the activities. Activities with objectives and prerequisites have a specific structure, use resources and produce results. These results can be re-injected into other activities;

– with an IMS-LD description, learners will carry out their learning by playing a "learner" role, possibly using resources, services and tools and collaborating with other "learners" learners or with staff role actors.

In practice, IMS-LD does not impose a specific educational model, but this model can be used with a large number of scenarios and educational models, hence its recognized flexibility. A learning unit [KOP 05] is a complete unit of pedagogical work organized according to a conceptual approach to learning and which brings together related resources, web links and several learning materials and services in a single folder containing:

– an XML "manifesto" that describes the method, part, acts, roles, activities, environment, properties, conditions and/or notifications of the specification, which also indicates the resources associated with it;

– the group of documents or resources mentioned in the XML "manifesto".

The result is a document, in accordance with the IMS standard, in the form of an XML file, called a "manifesto". It describes a very detailed

pedagogical scenario and links the actual resources in each format with it. A batch of information written in IMS Content Package is used as it contains resources that it links to the IMS-LD structure defined in the "Organizations" section of the IMS-LD package. This description can be stored in the object bank, by referencing it in a metadata sheet, so that it can be easily found during a search.

1.4.4. *From the knowledge book to educational engineering*

This paragraph is based on the study written by Djilali Benmahamed and Jean-Louis Ermine [BEN 07].

"Educational engineering" is the set of techniques used to analyze, design and implement our learning content, while using the principles of cognitive engineering [RAS 94] and educational scripting.

Educational engineering therefore consists of defining the content of a training course by means of a structural identification of the knowledge and skills targeted, of carrying out an educational scenario of the activities of a course defining the context of use and the structure of learning materials, of defining the infrastructures, resources and services necessary for the dissemination of the courses and the maintenance of their quality.

The modularity of the educational package is an important condition for building learning paths adapted to learners. This modularity, the basis of customization, is both the most important for success and the most difficult to achieve. Based on the original educational content, it:

– analyzes the theoretical progression of knowledge to identify logical and coherent sub-sets;

– distances learners from their teachers in order to avoid the need to group learners in the same place, to leave the initiative "followed" by the course largely to the learner, to allow learner/teacher communication in a synchronous and/or asynchronous way and to offer the teacher a follow-up of the learner's learning path;

– ensure the presence of a tutor whom learners perceive more as an advisor who is personally assigned to them than as a teacher;

– form groups of learners, bringing together participants in the same curriculum, who share their experiences, comment on the pedagogical content and share their knowledge in this field.

This form of training (e-learning) disseminates the knowledge applicable by the learner in his operational context, which allows the permanent enrichment of the knowledge base. Knowledge management itself improves the effectiveness of e-learning.

The prescription of educational scenarios is increasingly being done using standardized description languages that can be grouped under the term Educational Modeling Language (EML) [GOU 05]. IMS-Learning Design is a specification that aims to describe learning and to design the e-learning learning device, in order to ensure standardization and reuse. It is emerging as a standardization of educational modeling languages [CHO 03] that overcomes the limitations imposed by the different models of representation of the educational processes that preceded it (such as simple sequencing, for example) and enriches their elements with three levels that define resources, added conditions and properties and finally notification. We use IMS-LD for our description work.

The transition to educational scenarios will be described through IMS-LD elements (in the form of "learning activities" with "learner" and "staff" roles, educational objectives, prerequisites, expected productions, etc.), according to a metaphor similar to theatrical staging. According to the IMS-LD description (Figure 1.8), learners will achieve their learning by playing a "learning" role, using resources, services and tools and collaborating with other learners or "teacher" role actors. The three levels of representation (static, dynamic and event-driven), proposed by IMS-Learning Design, allow the specification and implementation of a wide variety of educational content. Level "A" defines the educational elements that make up the scenario, groups the activities according to a given model and takes into account the relationships between these activities, which remain constant in the learning process.

This project was limited to level "A" which meets the needs identified for the design/prototyping of the device. This scenario takes the following form:

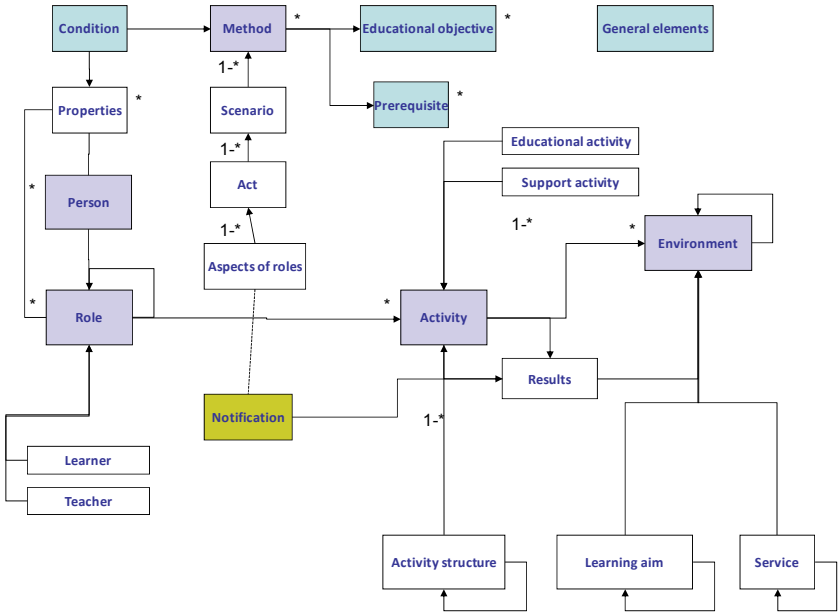

Figure 1.8. *General diagram of pedagogical modeling with IMS-LD*

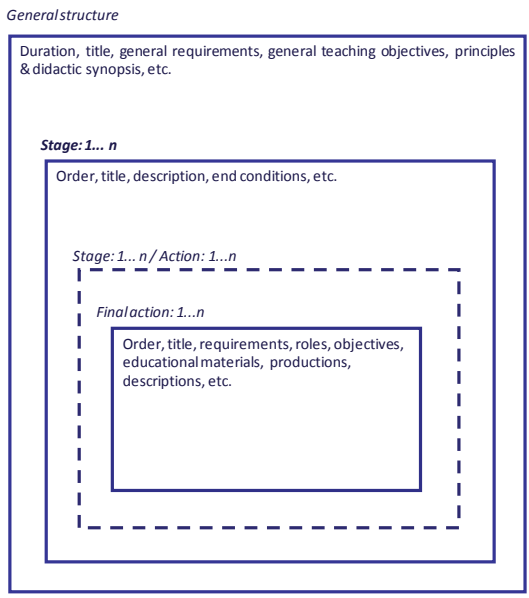

Figure 1.9. *General structure of the scenario*

The passage proposed here is based on a knowledge book (MASK I) and designs the educational scenario based on the main activity model. The level of granularity of the educational scenario corresponds to that defined by the activity models. The task models remain a source of inspiration, allowing us to complete the different descriptions and elements that require more detail. This also involves other MASK models, such as concept models.

The general structure of learning activity is inspired, in its entirety, by two models: that of corpus (OIDK model in chapter 2 of [ERM 18a]) and that of the main business model. The translation of the models thus developed gives an indication of the contribution of MASK modeling to the definition of the content of the device. It consists of exploiting the different elements of the knowledge book (in addition to the models, other elements have been used: descriptive sheets, synthesis volumes, general glossary and index, etc.) to define the different IMS-LD elements.

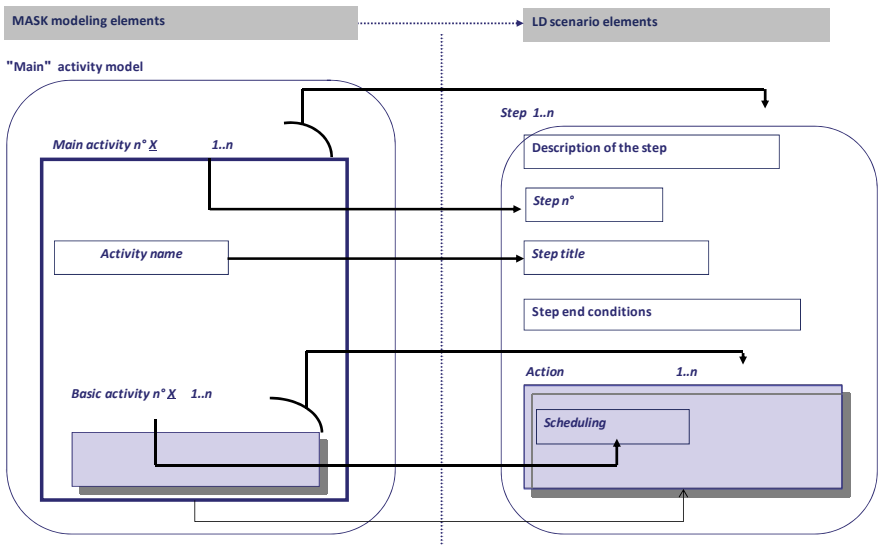

Figure 1.10. *Definition of activity steps from MASK models*

In addition, description in XML is a key factor for the reuse of content. Indeed, the ability to separate the content from the form of a document is a necessary feature in property reformulation. For the sake of reuse and interoperability, it is useful to use the XML content description so that it can be distributed in different contexts and on different media. An intermediate

description consists of structuring this content in a table and aims to "introduce" its writing in XML. Table 1.1 gives an overview of the logic of this structuring. Then, the CookTop editor, for example, was used to generate the XML file describing the learning content.

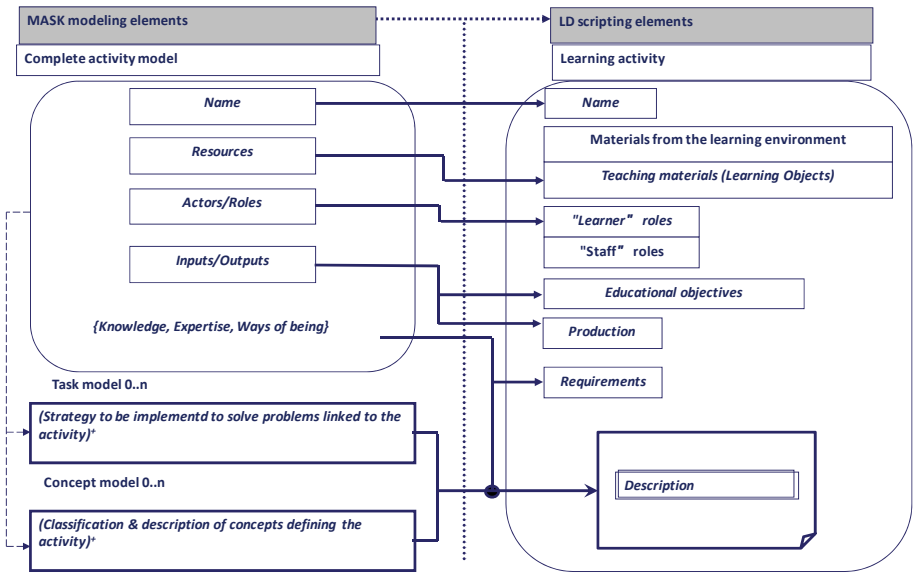

Figure 1.11. *Definition of learning activities from MASK models*

Each step in the table is described in more detail. Then, each action gives rise to a specific "learning activity" whose title is that of the activity described by the model of the activity being processed and whose roles correspond to this model's "actors/roles". The various teaching materials to be used are also defined, in the form of a list with the specifications of each material.

Finally, the help of the experts interviewed was sought for the proposal (or even the definition) of some techniques to facilitate the appropriation of this knowledge. It was also a question of designing quizzes, based on the different models of phenomena, the latter containing detailed descriptions of the different physical phenomena of the profession. At this stage, we therefore have sufficient elements to design and implement our learning system.

<table>
<tr><td colspan="5">Duration: At the designer's choice and depending on the nature of the learning process</td></tr>
<tr><td colspan="5">General structure of the Learning activity "Reservoir Engineering"</td></tr>
<tr><td colspan="5">Title of the session: Learning the trade of reservoir engineer</td></tr>
<tr><td colspan="5">Overall educational objectives:...</td></tr>
<tr><td colspan="5">Global prerequisites: Adaptability to the development plan and the economic and strategic contexts, some current business knowledge...</td></tr>
<tr><td colspan="5">Didactic principles and synopsis: Alternate individual and collective steps, Alternate synchronous and asynchronous phases, etc.</td></tr>
<tr><td colspan="5">Steps (References of steps and conditions of execution...)</td></tr>
<tr><td>No.</td><td>Start at the start?</td><td>Wait for the end of the step</td><td>Stage title</td><td>Next step</td></tr>
<tr><td>1</td><td>Yes</td><td>/</td><td>Preparation of the upstream project</td><td>2</td></tr>
<tr><td>2</td><td>No</td><td>1</td><td>Participation in the project launch</td><td>3</td></tr>
<tr><td>3</td><td>No</td><td>2</td><td>Model construction</td><td>4 or 5</td></tr>
<tr><td>4</td><td>No</td><td>3</td><td>Uncertainty management</td><td>3</td></tr>
<tr><td>5</td><td>No</td><td>3</td><td>Implementation of the optimal development plan</td><td>/</td></tr>
<tr><td colspan="5">Scheduling of the steps:
at the choice of the designer at the choice ☒ of the actors ☒ see above table☑</td></tr>
</table>

Table 1.7. *General structure of our scripting*

1.4.5. *Methodology for exploiting the results of knowledge engineering in an educational engineering process*

The objective is to rewrite the elements of the knowledge book (in particular the MASK I models) into pedagogical elements for the design and development of a learning-based knowledge transfer system. It is therefore a question of:

– designing the educational path to be followed by the learner(s), according to their levels, the evolution of their learning, etc.;

– produce educational elements from a knowledge book, in the form of quizzes, level tests, evaluation tests, etc.;

– specify educational tools that can be integrated into learning systems, such as e-learning.

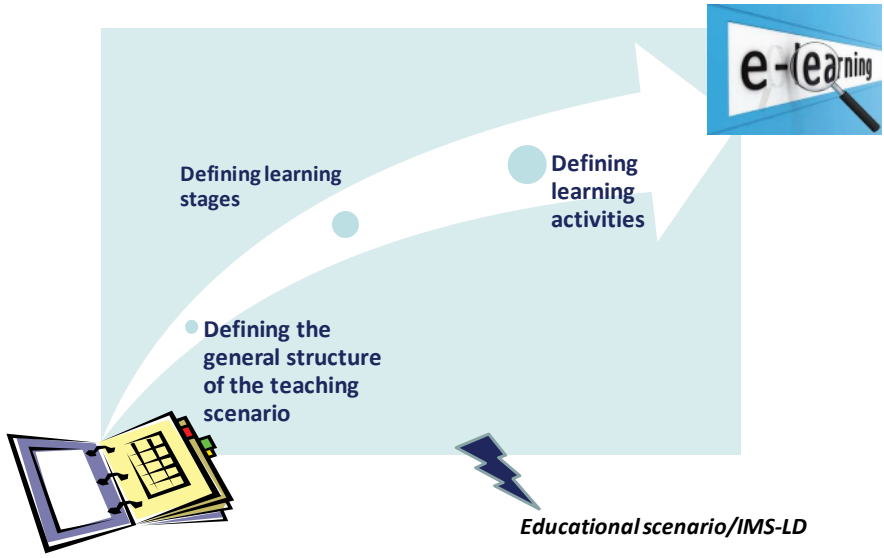

Figure 1.12. *From the knowledge book to educational engineering*

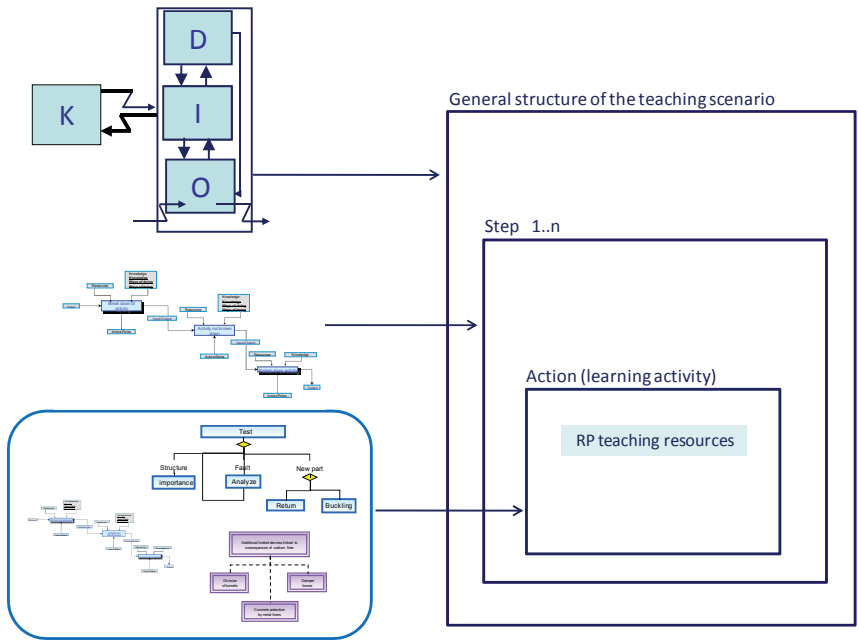

Figure 1.13. *Rewriting pedagogical educational scenarios*

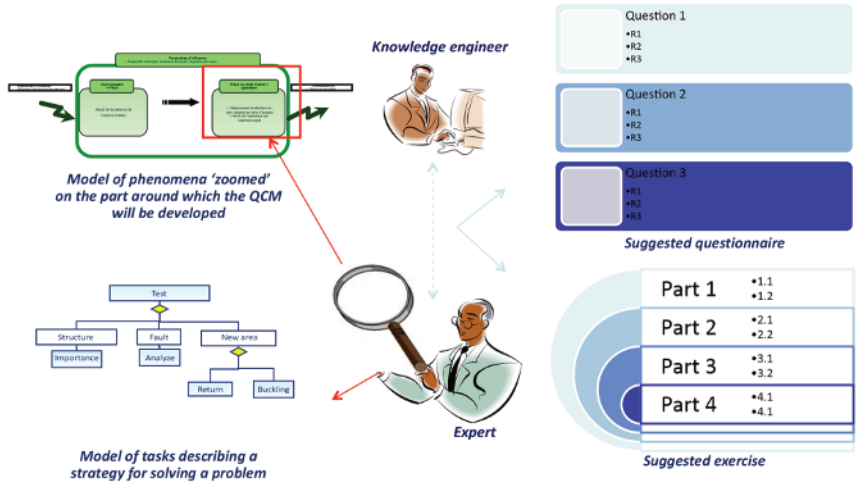

Figure 1.14. *Rewriting into educational elements*

The results obtained are:

– The "intermediate" rewrite of:

- the general structure of the Educational scenario;

- description of the different stages of the Educational scenario;

- the description of the different activities of each step;

- description of roles and resources for each activity.

– the generation of XML manifests of the Educational scenario with all its components;

– the conceptual components ready to be integrated into a learning device, such as EIAH (Computer Environment for Human Learning).

1.4.6. *Quizzes to evaluate*

The quizzes, prepared mainly from phenomenon models, are presented in the form of Multiple Choice Questionnaires (MCQs). MCQs are information gathering tools that can be used to:

– validate the sum of the learner's cognitive, methodological and technical achievements by asking questions focused on the objectives that have been previously learned. This will be referred to as a summative evaluation;

– check whether the learner is progressing and approaching the previously defined objective, while following a pre-established program. This will be referred to as a formative evaluation.

The summative quiz technique was used, first to "position" the learner's level (beginner, intermediate or specialist) in reservoir engineering. The overall evaluation of the answers and the technical gaps detected guide the personalized educational path proposed to the learner. This technique is also used to measure the acquisition of knowledge by learners at the end of each level. This is one (or more) exercise(s) composed of a set of questions covering all or part of the course and to be completed in a limited period of time. The answers provided allow an assessment of the degree of knowledge acquisition.

The formative quiz technique was also used during the learning process. It is an MCQ, carefully constructed and provided with commented solutions for each item. This aims to provide a tool that offers learners the opportunity to self-evaluate. The results obtained, in the form of scores, will allow them to measure the gap between their actual knowledge and that targeted by the course objective and to be able to situate themselves within the path previously established to achieve the said objective, on the other hand.

The evaluation generation freeware, the "HotPotatoes" software, was used to implement the quizzes. It offers the possibility to create different types of exercises and to value each question independently. It also offers great ease and modularity in response analysis, which makes it possible to use the evaluations created in a formative context in which learners, whatever their answers, will always obtain information enabling them to understand errors and correct them.

These quizzes are nothing more than "translations" of a set of phenomenon models, chosen in collaboration with experts. The business phenomena, which are the basis of knowledge, describe the domain which is the subject of modeling. These phenomena are described in a qualitative

way, often based on quantitative models (mathematical models, etc.) which are not very conducive to a professional activity understanding. This exercise focuses on the expert's techniques and the practice of using these techniques. The corresponding quizzes are identified to highlight the usefulness, process and key points of these points [CAS 04].

1.4.7. *Conclusion*

The objective, both scientific and industrial, was to design and test a complete knowledge management method for the transfer of professional activity know-how. In conclusion of what has been achieved, the method can be structured around five phases: Strategic analysis – Professional activity analysis – Strategic alignment – Capitalization of tacit know-how – Design of knowledge servers and Computer Environments for Human Learning (EIAH), e-learning type. The first four phases have been described in Volume 1, chapters 2 and 3. The part exposed here concerns the last phase, which is essential for the transfer of knowledge.

1.5. The CEFRIO intergenerational knowledge transfer project and the case of Hydro-Québec

This paragraph is based on the study prepared by the Knowledge Management Club [GDC 05][1].

1.5.1. *Project context*

Organizations are currently facing a massive departure of their most experienced employees and managers. With the retirement of the baby boomers, combined with a labor shortage, there is no doubt that this reality will continue for several years to come. In such a context and in an increasingly "knowledge-based" economy, making the shift to knowledge management is proving to be a strategic issue. The challenge is all the greater as the increasingly rapid evolution of technology imposes on organizations the need for different management of knowledge and human

1 Study incorporating a summary article published on November 28, 2008, by Lucie Vachon on the CEFRIO website.

learning. CEFRIO (*Centre francophone d'informatisation des organisations*) is interested in the various issues related to knowledge management and, in order to help organizations meet this challenge, it set up an action research project in 2004 on the intergenerational transfer of knowledge in the Internet age.

CEFRIO is a liaison and transfer center that brings together nearly 160 university, industrial and government members as well as 57 associate and guest researchers. Its mission is to help organizations be more productive and contribute to the well-being of citizens by using information technology as a lever for transformation and innovation. In partnership, CEFRIO carries out research, experimentation and strategic monitoring projects throughout Quebec on the appropriation of Information Technology. These projects affect all sectors of the Quebec economy, both private and public. CEFRIO's activities are mainly funded by its members and by the Government of Quebec, its main financial partner.

1.5.2. *Methodological approach*

This action research project was carried out with four partners: Hydro-Québec, the Régie des rentes du Québec, the Régie du bâtiment du Québec and TELUS (a Quebec telephone company), as well as with a team of university researchers associated with CEFRIO. The main objectives of the project were to help organizations to:

– find the best ways to identify critical and strategic knowledge;

– experiment with innovative ways of transferring knowledge;

– implement strategies to enable them to maintain, transfer, renew and enrich their collective knowledge in order to improve their overall performance.

In each organization, the use of pilot projects as a learning tool was favored, with the objective of broader deployment within the organization thereafter.

Before even committing to a knowledge management strategy, it is important to be adequately prepared to be able to make the most appropriate choices in terms of directions and actions to be taken and to ensure that the

process is cost-effective. The approach used was therefore divided into two main phases. The first phase is an upstream step and is more specifically part of the organization's knowledge enhancement efforts to identify the knowledge capital and, in particular, the knowledge domains that will require priority attention in knowledge management approaches. In the second phase, the aim is to identify and test the most appropriate means of knowledge transfer taking into account the context and needs of the company and to develop an action plan to implement a knowledge management strategy.

The upstream preparation phase was carried out mainly in three stages, which were not necessarily carried out with all partners, taking into account their prior level of progress in knowledge management.

The first step was a feasibility study to determine the Directorate, Group or Division where the pilot project should be carried out and to identify the resources needed to carry out the action research. The feasibility study, by identifying the organization's specific needs, objectives and processes, demonstrated that there were indeed risks of loss of critical expertise and knowledge. In doing so, it confirmed the need to engage in a knowledge management process to ensure that individuals with critical knowledge do not leave the organization without having transmitted their strategic knowledge necessary for its current and future development. In addition, the completion of the feasibility study increased awareness among knowledge managers and knowledge holders of the need to shift to knowledge management. This was the beginning of obtaining the support and assistance of managers and mobilizing troops for the project, two conditions that are essential to the success of such an approach.

The second step used the method of strategic analysis of an organization's knowledge capital described in Volume 1, Chapter 2 (in this chapter, a complete study concerning the Hydro-Québec company is developed). The aim was to identify strategic knowledge within the organization. This was done by first mapping the organization's knowledge and then assessing its strategic importance. Knowledge mapping is a means of identifying and representing the resources of a knowledge capital in an organization. It is, in fact, an inventory of the knowledge it possesses. As for the evaluation of the strategic importance of this knowledge, this step was carried out through a criticality study of the identified knowledge. A criticality study to locate the strengths and weaknesses of the knowledge

assets and to assess their vulnerability in relation to the organization's strategic orientations. Ultimately, this analysis made it possible to identify the areas of knowledge on which efforts must be focused in terms of capitalizing, sharing and renewing strategic knowledge.

Finally, the last step of the feasibility study was to ensure that the knowledge management approach based on the mapping of critical knowledge was consistent with the company's strategic approach. To do this, the strategic alignment approach was used. The approach allows critical knowledge to be compared with the organization's strategic directions in order to reflect the gap between its knowledge capital and what it will need in the future. The organization is then able to determine, in its strategy, the knowledge to maintain, be developed or be abandoned.

The feasibility study helped the partners to identify critical knowledge and then explore, in a second phase, ways of transferring knowledge. As part of this project, the partners, in collaboration with various research teams, experimented with, among other things, co-modeling of knowledge, knowledge books, the expert directory, social network analysis and the knowledge base and skills development.

1.5.3. *The intergenerational aspect of the CEFRIO research project in the context of Hydro-Québec*

Hydro-Québec is a major producer of electricity and a major energy distributor in North America. Electricity production is 96% hydropower. It is a state-owned commercial corporation whose sole shareholder is the Government of Quebec.

Hydro-Québec has 21,000 employees. Many retirements are expected in all job groups:

– more than 500 employees per year between 2003 and 2008;

– more than 800 employees per year between 2008 and 2011.

The age curve is unbalanced (Figure 1.15).

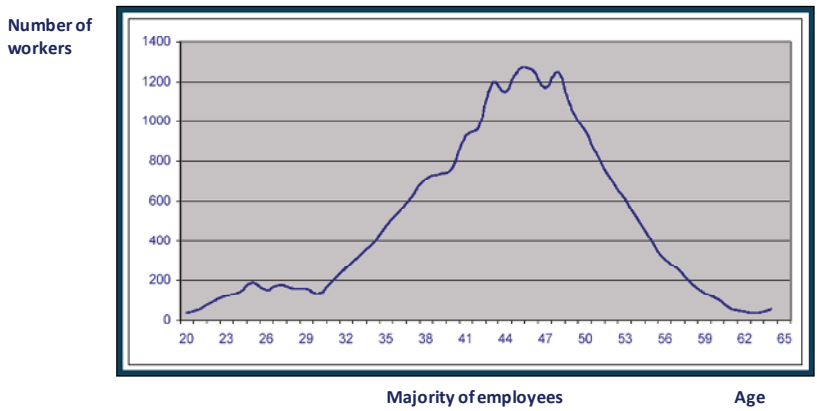

Figure 1.15. *Age pyramid at Hydro-Québec*

The context in Quebec is characterized by:

– aging, a decline in the working population: "Grandpa Boom";

– a slowdown in population growth;

– a massive departure of the most experienced employees (experts);

– 40% of the public sector workforce (about 21,000 people) will leave between 2001 and 2010.

The context at Hydro-Québec is characterized by:

– a succession management plan (Succession and Development Department, HR department);

– identification of strategic skills;

– vulnerability diagnosis;

– the choice of optimal strategies to ensure the capitalization, sharing and transfer of knowledge and know-how.

The transfer of (tacit) knowledge is a delicate task. Additional difficulties are added:

– taking into account different generations;

– the definition of generation in the sense of a cohort: to refer to a group of people born in the same period of time and who share the same key moments (age of school entry, age of marriage, etc.) (Table 1.8);

– the distinctive characterization of generations: marked by a historical context, based on values at work, on different technologies, distinguished by different learning styles and levels of education, built on age differences, etc. (Table 1.9)

VETERANS 1922-1942	BOOMERS 1943-1960	GEN Xers 1961-1980	NEXTERS 1981-…
Great Depression (1929) Second World War	Vietnam War	Oil crisis	Columbine High School massacre
Dedication Fidelity Respect for authority Meticulous Duty before pleasure	Optimism Personal satisfaction Team spirit Dislike of conflict	Diversity Entertainment Autonomy Work/life balance Multi-tasking	Optimism Civic feeling Success Technical ability Multi-tasking

Adapted from Zemke *et al.*, *Generations at Work*, 2000, AMACON

Table 1.8. *Characteristics of each generation*

Main behaviors	Juniors	Seniors
Attitude at work	Single task	Multi-tasking
Attachment to work	Attachment to the company	Work/life balance
Learning style	Dependent on	Autonomous, Autodidact
Attitude towards technology	Reserved	Familiar
Report to the authority	Respectful	Challenging the situation
Recognition	Dedication	Need for immediate gratification

Table 1.9. *Main behaviors*

1.5.4. *Main work carried out*

The main work carried out in the intergenerational dimension of the mission at Hydro-Québec is as follows:

– population sampling: profile, age, responsibility, seniority at Hydro-Québec, private sector experience, territorial experience, etc.;

– adaptation of the criticality criteria grid;

– studies of transfer plans carried out in 2002–2003 at Hydro-Québec;

– In-depth preparation for generation characterization:

- according to Hydro-Québec's reorganizations (significant dates);

- according to the technological fields (analog/digital);

- according to the statutory profiles (engineer/technician);

- depending on the business (expert, support, field), etc.

1.5.5. *Conclusion and outlook*

Following the completion of this action research project, initiatives were implemented to ensure that a greater number of Quebec organizations could benefit from it, including the development of a decision support grid that will allow organizations to choose the most appropriate methods of knowledge transfer in their context.

The experiments carried out to date have not only enabled the partners to test new methods to capture their respective knowledge, but also to effectively transmit this knowledge. Now, these organizations benefit from a more strategic management of their knowledge capital and are undoubtedly better equipped to avoid – or at least limit – the problems associated with knowledge loss and thus ensure that individuals with critical knowledge do not leave the organization without having transmitted their strategic knowledge necessary to pursue its activities.

1.6. Case study on choosing a knowledge transfer method

This paragraph is based on the study prepared by the Knowledge Management Club [GDC 09].

1.6.1. *Knowledge transfer methods*

Knowledge transfer methods are grouped into four categories, the characteristics of which are described in Table 1.10:

No.	Category	Methodology	Objective
1	**Training**	In person	Transmit theoretical knowledge to a homogeneous group of people, physically present in the same room as the trainer
2		Unsupervised self-study (e-learning)	Acquire knowledge autonomously, at a distance, through the use of electronic media and evaluate the knowledge acquired
3		Supervised self-training	Acquire knowledge in a focused, distance learning environment through the use of electronic media and evaluate the knowledge acquired
4		Virtual classes	Transmit theoretical knowledge to a homogeneous group of people gathered but not physically present in the same place
5	**Scenario**	Alternate learning	Make available a body of knowledge on a given subject for a dedicated community
6		Learning through apprenticeship	Acquire a specialized know-how from a master (or expert)
7		Individual coaching	Produce a change in the coachee's behavior (in his activities and relationships with people at work)
8		Team coaching	Obtain the cohesion of teams already formed through a strong and constant emulation for the development of a project
9		Sponsorship	Orienting, advising an actor in his evolution and acquisition of knowledge. For example: integration into a team, taking charge of a role, evolution of one's skills, etc. Supporting the person's development
10		Educational games / Role-playing games	Acquire experience through a simulation exercise or role-play between several members of a group
11	**Transfer medium**	Knowledge servers	Make available a body of knowledge on a given subject for a dedicated community
12		Business workshop	Guide users step by step in their daily tasks using tools and other resources based on a model of their activity, integrating their best know-how
13		Guide to workstation know-how	Share knowledge of the essential expectations related to a role and identify the elements of the company's knowledge capital to be used to perform the corresponding tasks at the workstation

14	**Knowledge Network**	Project group (includes working group)	Have a specific project (a common work project) carried out by a group of designated persons, within a given time frame with temporary resources, to acquire and share knowledge
15		Community of practice (learning community)	Share, develop and enrich the practices of his/her profession with people who carry out the same activities and who have a common understanding and who give the same meaning to this activity and to the community. Act as a support network, especially for learning
16		Network of experts	Collect and share information of common interest among experts

Table 1.10. *Knowledge transfer methods*

1.6.2. *Evaluation criteria and their ranges of variation*

The evaluation is conducted with a focus on knowledge transfer as a process, described in Figure 1.1, which identifies several elements characterizing the transfer mechanism (knowledge holders or source, recipients or target of the transfer, knowledge to be transferred, parameters that may influence the transfer, etc.).

The ranges of variation of the evaluation criteria are divided into three zones (low, medium and high). Where possible, value ranges have been defined to characterize each of the three ranges:

Criteria	Low zone	Medium area	High zone
Delays / Emergency			
Time limit after which the transferred knowledge must be operational	< 3 months	3 to 9 months	> 9 months
Source and target intersect	Often	Few	No
Work environment			
Size of organization	< 50 people	50 to 250 people	> 250 people
Resources (projector, room)	Very limited		Satisfactory
Number of trainers available	Too weak		Satisfactory
ICT equipment	Very limited		Satisfactory
Accessible documents	Very few		Satisfactory

Nature of the knowledge transferred			
Widespread knowledge	Widespread		Very uncommon
Theoretical versus practical knowledge	More theoretical		Rather practical
Capacity to capture knowledge	New knowledge		Stabilized knowledge
Inadequate adaptability of knowledge to the context of use	Can be used without adaptation		Require considerable adaptation
Difficulty in integrating knowledge into uses	Easy to implement		Difficult to implement
Multidisciplinary knowledge structure	One domain only		Many areas of expertise
"Holders" of knowledge			
Number of holders	Few actors		High
Availability	Not very available		Very available
Motivation for the transfer	Very low		Very large
Distribution into sites	One site only		Many sites
Experience	Low		Great
Pedagogical capacity	Low		Great
"Receivers" of knowledge transfer			
Proportion of actors to be trained by organization	Low		Strong
Availability	Not very available		Very available
Motivation for the transfer	Very low		Very large
Distribution into sites	One site only		Many sites
Pre-transfer experience	Low		Great
Homogeneity of experience with transfer methods and tools	Low		Great
Homogeneity of trades	Low		Great
Ability to concentrate	Low		Great
Learning autonomy	Low		Great

Table 1.11. *Criteria and characteristic areas of their range of variation*

The results of evaluation by these criteria have been homogenized through successive comparisons between the same criteria of different but similar methods. To this end, tests on concrete cases were carried out.

1.6.3. *Example of evaluation (classroom training)*

The evaluation of each method consists of classifying it according to one of the following four levels of suitability for the knowledge transfer process: adequate method, partially adapted method, non-advised method, method without influence.

The color code (for a color version of this table, see www.iste.co.uk/saulais/knowledge2.zip) for the criteria tables of the different methods is as follows:

Color	Interpretation
	Appropriate method
	Partially adapted method
	Not recommended method
	Method without influence

For this purpose, for each method in Table 1.10., for each criterion and for each of the three areas of variation of each criterion in Table 1.11, it is the method's level of adequacy.

An example of an evaluation is given in Table 1.12 for the classroom training method.

Face-to-face training	**Low zone**	**Medium area**	**High zone**
Fields			
Delays / Emergency			
Time limit after which the transferred knowledge must be operational			
Source and target intersect			
Work environment			
Size of organization			
Resources (projector, room)			
Number of trainers available			
ICT equipment			
Accessible documents			
Flow			
Widespread knowledge			

Theoretical versus practical knowledge			
Capacity to capture knowledge			
Inadequate adaptability of knowledge to the context of use			
Difficulty in integrating knowledge into uses			
Multidisciplinary knowledge structure			
Source: Transfer actors (“holders” of knowledge)			
Low			
Availability			
Motivation for the transfer			
Distribution into sites			
Experience			
Educational capacity			
Source: “Receiving” transfer actors			
Proportion of actors to be trained by organization			
Availability			
Motivation for the transfer			
Distribution into sites			
Pre-transfer experience			
Homogeneity of experience with transfer methods and tools			
Homogeneity of trades			
Ability to concentrate			
Learning autonomy			

Table 1.12. *Example of an evaluation for classroom training. For a color version of this table, see www.iste.co.uk/saulais/knowledge2.zip*

This work is carried out for all the methods studied.

1.6.4. *The case study*

1.6.4.1. *Presentation of the case study*

Business line

– A 400-person company headquartered in France that designs and manufactures control systems for oil and gas installations. A new activity is emerging in the field of renewable energies.

Organization

– The company most often sells its control systems directly worldwide. Its customers are oil or gas companies and boat builders. Its sales representatives are constantly traveling. It sometimes acts as a subcontractor to a prime contractor in charge of the complete installation. A partner sells their systems on the American market.

– Customer Service ensures the start-up of the system at the customer's premises and intervenes in specific cases.

Corporate culture

– Engineering company (including sales representatives); each department is relatively autonomous and manages its knowledge internally.

– The age pyramid is balanced. There are a sufficient number of experienced actors.

Context of the need for transfer within the Design Office (200 people)

– Strong growth (15–20% per year) and therefore need to train newcomers.

– Regular retirements, sometimes of employees who are the only ones able to keep track of long-standing projects still in operation.

– Difficulty in having a complete knowledge of the systems.

– Standardization to be improved.

Knowledge transfer needs for

– Sharing knowledge on how systems work.

Other background information

– Training rooms designed primarily for customers.

1.6.4.2. *Case study rating table*

For each criterion, the area of variation (low, medium, high) that characterizes it is determined from the descriptive elements of the case study. A comment justifies the area's definition.

Criteria	Zone (low, medium, high)	Commentary
Delays / Emergency		
Time limit after which the transferred knowledge must be operational	High	Acquisition of comprehensive (and not fully standardized) knowledge on systems operations will take more than 9 months to complete
Source and target intersect	Low	The engineers from the design office meet each other
Work environment		
Size of organization	Average	The design office has about 200 employees
Resources (projector, room)	Low	No material resources dedicated to this knowledge transfer action. These resources are intended for clients
Number of trainers available	Low	The systems operations trainers are experienced employees who are not available
ICT equipment	High	The level of ICT equipment is satisfactory
Accessible documents	Low	No accessible corporate documentation on how the systems work
Nature of the knowledge transferred		
Widespread knowledge	Average	Knowledge is held by a significant number of elders
Theoretical versus practical knowledge	High	The knowledge is operational and concerns the running of the system operation
Capacity to capture knowledge	High	Knowledge about how systems work is easy to capture, durable and stable
Adaptability of knowledge to the context of use	High	Knowledge of system operation must be adapted to customers' petroleum facilities
Difficulty in integrating knowledge into uses	Average	Knowledge of how systems work requires the acquisition of reflexes
Multidisciplinary knowledge structure	High	Knowledge of the systems used is based on many specialties
"Holders" of knowledge		
Number of holders	High	Many actors have knowledge about how systems work
Availability	Low	The old ones are very little available

Motivation for the transfer	High	Project alumni are involved in the transfer of knowledge about how systems work
Distribution into sites	Low	The design office is single-site
Experience	High	The elders are very experienced
Pedagogical capacity	Average	Elders are able to pass on their knowledge of how systems work
"Receptors" of knowledge transfer		
Proportion of actors to be trained by organization	High	New entrants and experienced engineers should be given mass training (hiring 30 to 40 new engineers per year) involving the oldest engineers
Availability	High	New and experienced engineers must follow the knowledge transfer course on how systems work
Motivation for the transfer	High	Learners are involved in learning how systems work
Distribution into sites	Low	The design office is on a single site
Pre-transfer experience	Average	Learners are experienced but not specialists in systems operation
Homogeneity of experience with transfer methods and tools	Low	Knowledge transfer is not carried out in a homogeneous way. People have different experiences and methods depending on their fields
Homogeneity of trades	High	Learners all come from the same trade
Ability to concentrate	High	Learners have a very good ability to concentrate
Learning autonomy	High	Learners have a very high degree of autonomy

Table 1.13. *Case study rating*

1.6.4.3. *Presentation of the case study result*

In the previous paragraph, each criterion was assigned an area within its range of variation according to the situation described. We should then refer to the evaluation table for each method (of the type presented in Table 1.12) and read for each criterion the result of the method's level of adequacy according to the area of variation characterizing the case studied (Table 1.13). For each method, it is then sufficient to count on all the criteria the number of times each level of adequacy has been reached, then normalize it by the total number of criteria.

A review has been made for each of the methods: it is presented below in graph form, which allows comparative analysis, based on maximizing the number of "appropriate method" results (color code: green) and minimizing the number of "not recommended method" results.

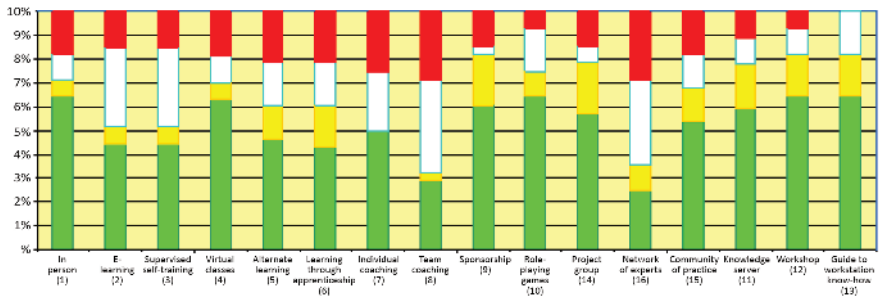

Figure 1.16. *Graphical comparative analysis of transfer methods. For a color version of this figure, see www.iste.co.uk/saulais/knowledge2.zip*

The "sponsorship" and "role-playing" methods seem well suited to the case, then, to a lesser extent, "face-to-face training" and "virtual classes". Once the training has been completed, the business workshop and know-how sheets would ensure good support for the actors and a good maintenance of their knowledge.

1.7. Case study in agroecology

This paragraph is based on the study written by Vincent Soulignac, Jean-Louis Ermine, Jean-Luc Paris, Olivier Devise and Jean-Pierre Chanet [SOU 11].

1.7.1. *Introduction*

Agriculture needs to become more environmentally sustainable while remaining economically viable. Several approaches have emerged, including agroecology and organic agriculture, which take into account interactions between living organisms. Agro-ecology and organic farming can be considered the opposite of intensive agriculture. The production and acquisition of knowledge by farmers is necessary to develop this sustainable (and productive) agricultural approach. Currently, knowledge for productivity improvement is available, but knowledge that meets

environmental, territorial and economic requirements and sustainability must be developed.

In addition, the design and implementation of sustainable systems requires different types of knowledge, often informal, partly from different categories of actors. Agroecology thus requires new knowledge and expertise. The diversity of actors and difficulty of experimentation, due to the long production cycles, constitute obstacles to the capitalization of knowledge. This is why knowledge management in agroecology is not currently sufficient. It is essential to use a collaborative approach to share knowledge, experience and innovations among the different people involved in the design and application of agro-ecological systems.

To solve this problem, we propose adapting the methods already applied in industry to knowledge management in agriculture [SOU 17].

With this in mind, the GECO tool (http://geco.ecophytopic.fr/) is a KM web application dedicated to agroecology, developed jointly by INRA, ACTA and IRSTEA as part of the French Ecophyto plan to reduce the use of pesticides in agriculture. The website is divided into two spaces: one is a "knowledge base" collaboratively enriched by contributors from the entire agricultural community and recognized by its peers. This database presents knowledge in the form of pages classified by concept, such as alternative practices, crops, pests, materials, pest auxiliaries, etc. The second space is a forum in which anyone can create a discussion topic related to a particular page of knowledge or a topic that is not yet covered in the knowledge base. To organize and structure all the information and knowledge available in the database and on the forum, and to allow their effective use during searches, the site integrates a semantic model allowing the creation of links between pages [SOU 17].

Designing such a tool is a long-term innovative task, which requires a thorough design, the involvement of many stakeholders, the use of sophisticated knowledge management techniques and recent IT developments. We describe below the initial prototype that allowed this development: KOFIS (Knowledge for Organic Farming and Its Innovation System) [SOU 12a, SOU 12b].

Sustainable agriculture has an anticipatory strategy to combat pests and diseases. A rotation, a succession of different crops over a period of more than five years, can thus be considered and implemented to effectively

limit the appearance of diseases or weeds. However, the importance of local characteristics, in particular soil and climate conditions, makes it particularly complex to produce the knowledge necessary to design a rotation that must meet various challenges (control of pests and diseases, production objectives, etc.). The challenge is therefore to determine whether knowledge management approaches such as communities of practice, knowledge engineering (MASK method), knowledge-based innovation (KBI), etc. provide a response in a context of high complexity knowledge production.

1.7.2. *Communities of practice*

The purpose of the community of practice method is to promote learning [WEN 98]. It is highly developed in the agricultural world in the form of a Local Professional Group (LPG) [DAR 99]. Local Professional Groups are made up of farmers who are geographically close to each other and who have the same cultural practices. These groups build a production of knowledge through action and through exchanges during field tours. The pedoclimatic variability justifies existence of the Local Professional Groups. Indeed, in sustainable agriculture, the knowledge for management of a crop is particularly adapted to a given pedoclimatic context. The construction of local knowledge is therefore a necessity. Sustainable agriculture brings soil and climate back to the forefront. It all starts there. And only Local Professional Groups have the necessary resources to build this local knowledge.

The combination of these field tours with classroom training seems relevant. Indeed, Local Professional Groups carry tacit knowledge based on experience. Face-to-face training has two additional virtues if it targets Local Professional Groups. On the one hand, experiences around the same culture can cross between Local Professional Groups from different small agricultural regions, or even be capitalized when they are common. On the other hand, being face to face is also an opportunity for the facilitator to provide scientific knowledge. Thus, this exchange can lead to technical sheets based on both empirical and scientific knowledge. Depending on the circumstances, the Local Professional Group is more or less structured within legal entities. The construction method of Local Professional Groups is associated with the geographical proximity of farmers but also with similar cultural practices. This neighborhood is justified by the need for regular contacts, as in all communities of practice, but also by the

educational benefit of field surveys. Everyone brings to it their intangible resources built on their experiences or from their own networks. Shared knowledge is transformed or rejected.

To succeed in this transformation, agriculture will have to become, for the most part, integrated type and, for the other part, biological type [INR 10]. This transformation of agriculture is largely based on the mobilization of knowledge and know-how. But in 2011, while many professional software packages are available to farmers, no structured, interactive and professional knowledge management software tools are available. This project therefore proposes to specify a knowledge management tool for knowledge sharing.

A survey of conventional farmers and sustainable farmers identified their different types of information sources available for plant protection. Figure 1.17 summarizes these main flows, their nature and origin. In conventional agriculture, information exchange is important, especially from cooperatives and traders. On the other hand, in sustainable agriculture, the appropriation of knowledge by farmers is fundamental, even though in conventional agriculture, knowledge management is also present. The latter is mainly done by exchange between farmers and in the best of configurations in the presence of an advisor.

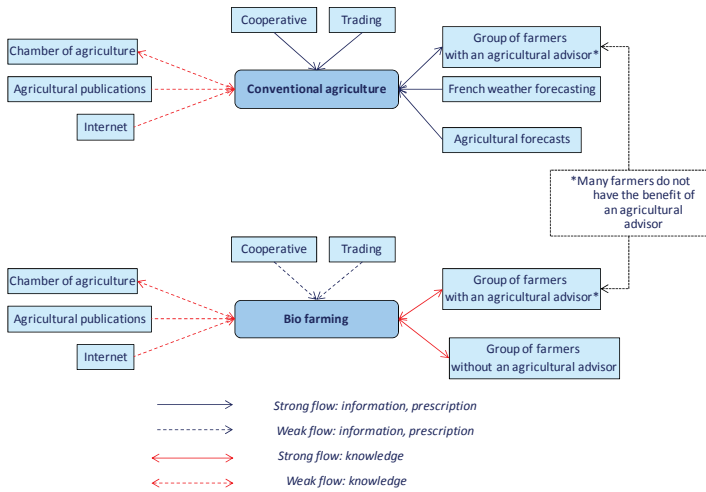

Figure 1.17. *Main actors in knowledge management in direct contact with conventional versus sustainable farmers. For a color version of this figure, see www.iste.co.uk/saulais/knowledge2.zip*

1.7.3. *Dynamics of exchange between the actors of the "agricultural knowledge system"*

The concept of "agricultural knowledge system" includes all institutions (consulting, education and research) involved in building sustainable agriculture. The interest in producing and learning knowledge as part of a partnership between actors in the wider agricultural world is growing because a tool accessible via the Internet facilitates new relationships through interaction. This exchange dynamic is represented in Table 1.14.

To From	"Sustainable" farmer	Agricultural advisor	Agricultural teacher	Researcher
"Sustainable" farmer	For farmers who are not neighbors or do not practice the same type of sustainable agriculture	For advisors who do not follow the farmer or do not participate in continuing education as a trainer	For all agricultural teachers (outside partnership with the farmer or participation in in-service training)	For all researchers
Agricultural advisor	For farmers who are not followed by the advisor or who do not participate in his ongoing training	For agricultural advisors who are not from the same region and who are not part of the same advisory networks	For all agricultural teachers outside partnership with an agricultural high school	For researchers who are not part of the same networks as the agricultural advisor
Agricultural teacher	For all farmers who are not associated with agricultural high schools or who do not participate in their further training	For all agricultural advisors not associated with agricultural high schools	For agricultural teachers between subjects or between agricultural educational institutions	For all researchers
Researcher	For all farmers	For agricultural advisors who are not part of the same networks as the researcher	For all teachers	Interactions already exist in publications and symposia

Table 1.14. *Types of interactions to be strengthened between stakeholders in sustainable agriculture*

1.7.4. *Role of actors in the knowledge management tool*

Not all actors have the same weight. Thus, central purchasing offices often enter into contractual relations with farmers through cooperatives or traders. On the other hand, research and agricultural advisory services often do not have a mandatory relationship with farmers.

Under these conditions, will all actors directly or indirectly linked to farmers have equal access to this knowledge management tool? On what basis will the roles of the actors be distributed on the tool? The development of a collaborative knowledge space is based on an ability to acquire others' perspectives. It is also necessary that the actors share the same objectives. The objective of a cooperative technical-commercial advisor, even in organic agriculture, is to sell inputs and buy agricultural production. Their participation in a knowledge management tool is therefore necessarily influenced by their interests. These are not necessarily shared by farmers. However, it is possible to distinguish between site users who may have writing rights (farmers, participants in the "agricultural knowledge system") and those who will only have reading rights (cooperatives, traders, local authorities, etc.). The intervention of the latter will be reduced to contributions in more open spaces such as blogs or forums. The tool therefore proposes the possible level of involvement of each category of actors as users of the tool in Figure 1.18.

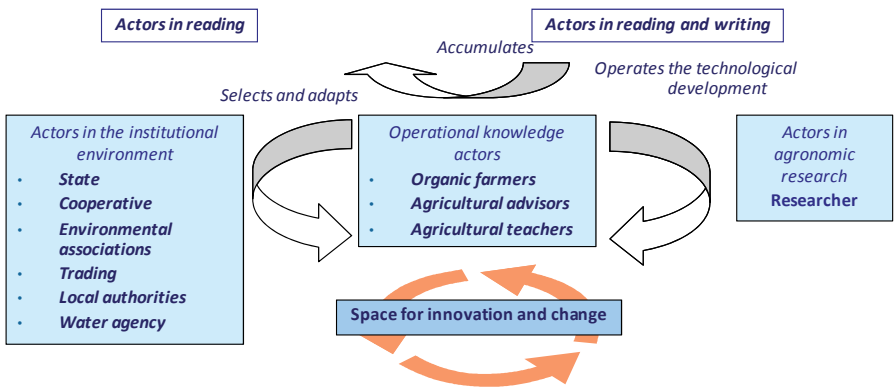

Figure 1.18. *Role of actors in the knowledge management tool*

In the reading actors' space, actors rooted in the institutional environment, such as cooperatives, influence farmers through their specific

demands. This involves a process of knowledge adaptation. In the space of actors in reading and writing, farmers are dissociated from researchers, given their communication difficulties. However, there is no question of curbing innovation by separating research actors from other development actors. Agricultural advisors or agricultural teachers can monitor and transfer academic knowledge from research.

1.7.5. *Critical knowledge capital*

In [SOU 10], the priority knowledge to be managed was identified, according to an expert opinion. The methodology used is similar to those described in the case studies in Volume 1, Chapter 2 for the strategic analysis of knowledge capital. The result is given in Table 1.15. The topics of the knowledge to be covered are classified in descending order of priority for farmers.

Knowledge theme
Weeds
Phosphate fertilization
Nitrogenous fertilization
Climate, soil
Rotation
Marketplace
Sulphur fertilization
Harvesting, storage
Potassium fertilization
Varieties
Slugs
Insects
Aerial diseases
Telluric diseases

Table 1.15. *Hierarchy of critical knowledge in organic agriculture*

1.7.6. *Models to represent knowledge*

1.7.6.1. *Models to represent thematic knowledge*

MASK 1 models (see Volume 1, Chapter 3) have been applied to the practices of some organic field crop farmers in the Auvergne and Burgundy regions. The profession recognizes the farmers selected for interviews as having an excellent command of their professional activity. The rigor applied to their choice respects the MASK methodology. Indeed, it requires respondents to have a high level of expertise in their field. We will present two types of models applied to field crop management:

– in the concept model applied to agricultural machinery for organic wheat cultivation presented in Figure 1.19, the farmer intuitively classifies the types of machinery by the logic of the work to be done on the crop itinerary. Each of the machines identified constitutes an entry point to sheets detailing it and images representing it;

– the task model specifies how an agricultural professional thinks. It specifies its strategy for solving a particular problem. To do this, it uses concepts present in the concept model. Figure 1.20 illustrates the weed control strategy for wheat management. It refers, for example, to the weed harrow, which is described elsewhere in the agricultural machine model.

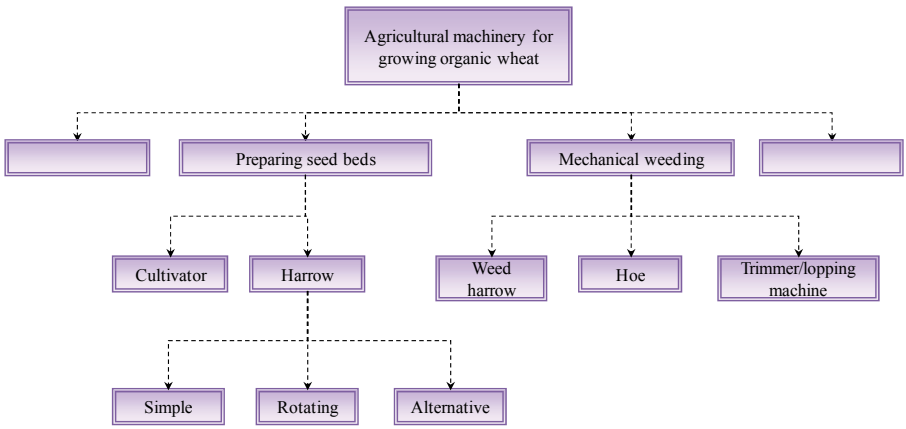

Figure 1.19. *Concept model for agricultural machinery*

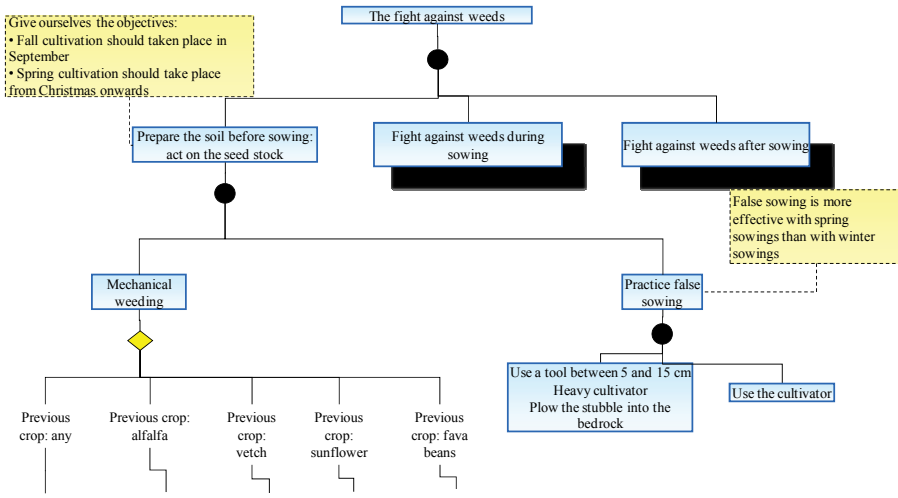

Figure 1.20. *Weed control task model*

1.7.6.2. *Models to represent typical cases of innovative cropping systems*

The tool should contain a library of innovative and sustainable culture systems in the form of test cases or monographs. This representation requires several elements to be described: the field of validity of the innovative cropping system represented, as well as its sustainability, the succession of crops, the technical routes with their decision rule. However, this sharing goes far beyond the representation of results. The method of calculating the results or their validation must also be identified, displayed or, in some cases, homogenized. This homogenization is not self-evident in the "Balkanized" landscape of referential produced by actors of diverse origin.

By definition, the knowledge to be modeled is contextual. The most suitable MASK method models are used for this purpose.

The validity domain of the innovative cropping system specifies the context of the test case or monograph to be described. The evaluation of the innovative cropping system identifies its value in terms of sustainability criteria. To express these parameters, the phenomenon model is used. It expresses well the idea of the global transition from one system to another. Figure 1.21 presents the context of farms in Burgundy.

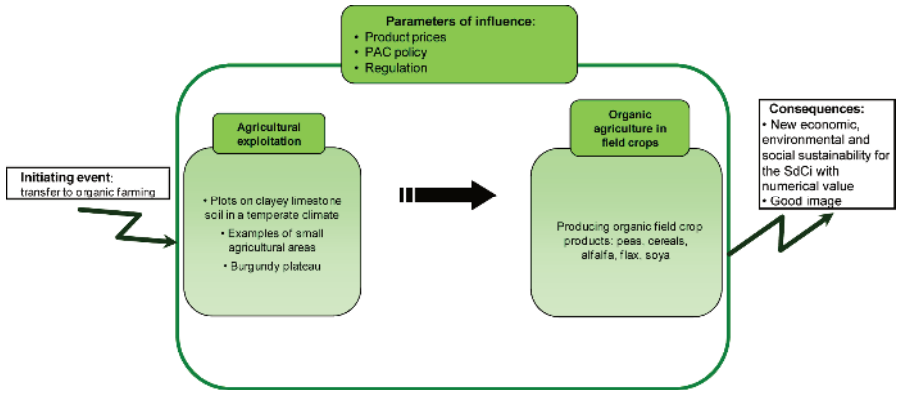

Figure 1.21. *Organic farming phenomenon model in large-scale farming (Burgundy plateau)*

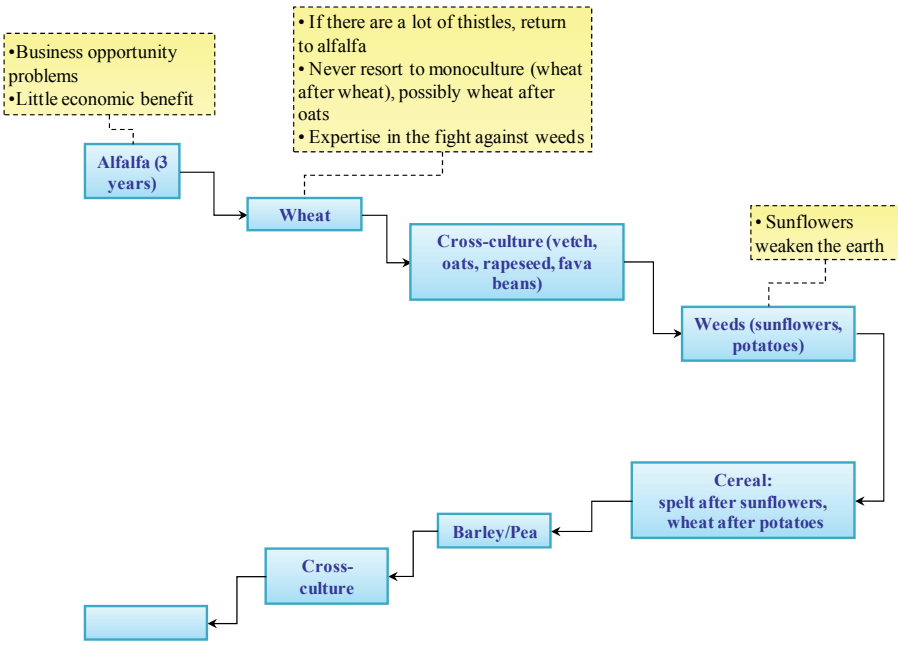

Figure 1.22. *Description of a crop succession*

Rotation, as well as technical routes, are production processes associated with a plot. For the rotation, we have briefly formalized the succession of crops. In Figure 1.22, an example for crop sequencing is given. Each culture

can be enriched with comments. By describing the technical itinerary, the model of the activity is appropriate. Each type of culture has a technical itinerary. Figure 1.23 illustrates this for wheat cultivation. A stage of this itinerary can be associated with one or more management rules. Each rule is based on a farmer's reasoning, associated with threshold values for indicators. It is quite simple and very often of the conditional type. This rule is formalized by the task model, already presented.

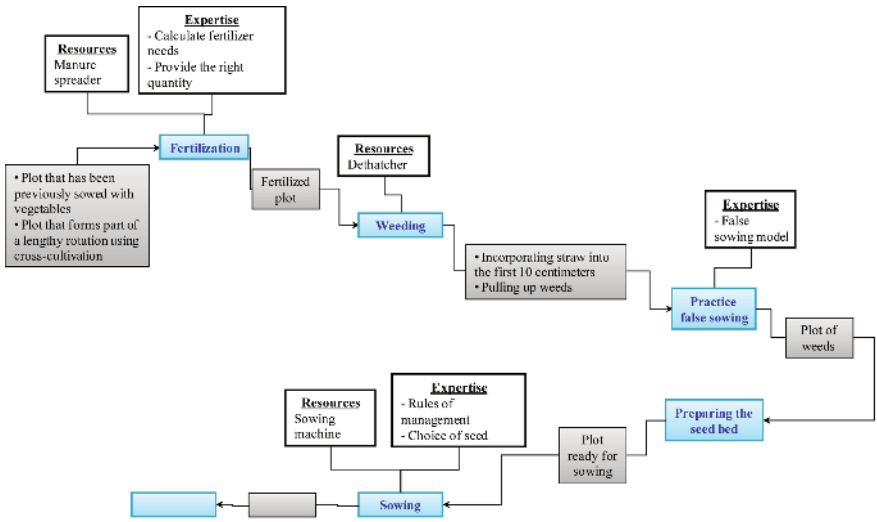

Figure 1.23. *Wheat Technology Route Activity Model*

These different models best represent the action inventories and routine procedures associated with innovative cropping systems. They concern strategic choices (rotation), tactical choices (technical itinerary or certain management rules) or operational choices. Routine procedures, particularly those related to risk processing, can be described using task models.

1.7.7. *KOFIS tool (Knowledge for Organic Farming and Its Innovation System)*

To represent knowledge, the limitation of the MASK method lies in the slight decline in the expertise of farmers interviewed. While capitalization of experience on an annual campaign scale is possible, it is much more difficult to obtain over a longer horizon such as that of rotation [DUR 88]. However,

after the specification phase, thanks to the knowledge models, a prototype, called KOFIS, was produced [SOU 12a, SOU 12b].

1.7.7.1. *Structure of the knowledge management tool for organic farming*

Figure 1.24 summarizes the place of the different contents associated with organic field crop farming in the KOFIS tool. It includes documents on the institutional environment, operational knowledge, as well as academic knowledge. There is also a place for exchange and innovation.

Users do not fully overlap with the actors identified by [MEY 08] as the hard core of innovative cropping system design, namely "farmers, advisors, research and development (R&D) engineers and a small number of researchers who have made design a research subject". Teachers, but also all researchers, have an important role to play in the knowledge management tool. On the other hand, they are much less present in the design of innovative cropping systems. The latter are favored by the presence of KOFIS. Innovative cropping systems can be stored in a library, but they are not the only content. This is also formed by thematic knowledge. Agricultural advisors or farmers have a role to play in renewing this knowledge as a result of the constant introduction of new practices. For their part, researchers provide academic knowledge, some of which is operationally exploitable. Finally, agricultural advisors or teachers are at the educational interface of this empirical and academic knowledge.

Then, in the space of exchange and innovation, all the actors are mobilized around two main types of content:

– either, they exchange ideas on innovative topics;

– or, they express themselves in discussion topics that are mirrors of the knowledge already explained in the "knowledge space".

The tool contains knowledge that is all the more unstable as the actors are active in modifying it. The organic farming knowledge book is thus part of a dynamic and collaborative approach, whose contributions come from local references obtained through professional organizations. On the other hand, thematic knowledge is more dynamic. It is not fixed and is therefore not the "moral property" of a single participant. However, this does not prevent the traceability of the various contributors.

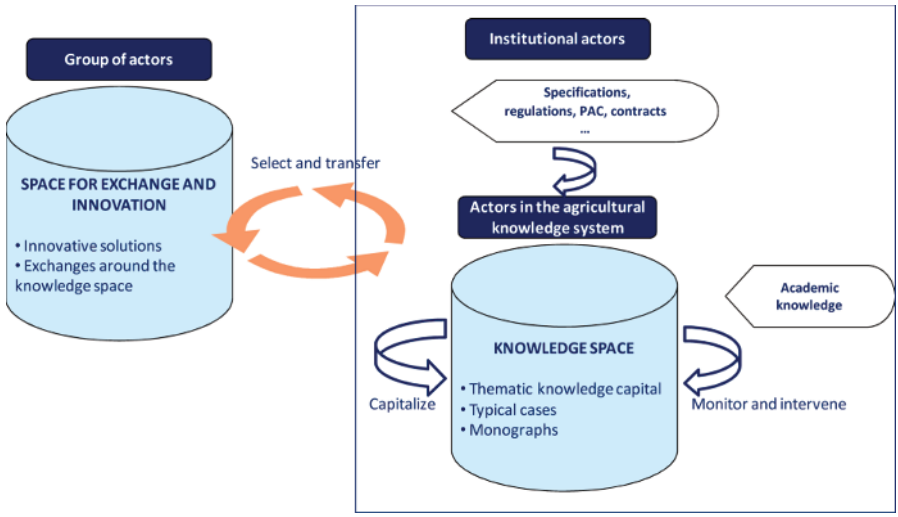

Figure 1.24. *Content of the KOFIS knowledge tool in organic field crop agriculture*

The KOFIS knowledge management tool can potentially cover all types of agricultural activities, whether they concern livestock, field crops, arboriculture, viticulture or market gardening. A much more important reservation therefore concerns the difficulty of finding knowledge adapted to the use context of interest to the user:

– the library of innovative culture systems is similar to a case base. By definition, each case is contextualized. Not all these models can be definitively grouped around a single small agricultural region without risk of redundancy, as a model can be applied to several small agricultural regions;

– moreover, even though thematic skills are more generalizable, the models and their associated contexts are multiple. For example, the weed control task model will not be constructed in the same way according to soil and climate conditions.

But, in the context of sustainable agriculture, the search for a minimum of coherence has led to the proposal to enrich each of the models with its conditions of use, for example on its pedoclimatic context. This contextualization concerns more particularly the activity model, but also the task model. Each of these models can be linked to a model of the phenomenon that is useful for clarifying contexts. But when faced with a problem posed by a user, the system searches the entire content of the

knowledge base to identify one or more relevant models associated with highly variable contexts. In this specific context of the search for relevant answers, the model of the phenomenon as envisaged does not help us. For this reason, there is a semantic enrichment of the knowledge the tool's elements. Above all, it will facilitate the relevant grouping of the most targeted models in relation to the research undertaken by a user.

1.7.7.2. *Innovation and knowledge space*

The C-K design theory [HAT 02] provides a better understanding of the construction of the tool's computer architecture. It reflects human reasoning in the face of a problem. Indeed, in order to make progress in solving it, we rely on knowledge acquired on the different terms of this problem. The search for solutions is located in the concept space and the knowledge used to solve the problem belongs to the knowledge space. When the problem is solved, the solution is validated as knowledge. By convention, we call [I] the concept space, which we call the innovation space, and [K] the knowledge space. In Figure 1.25, we propose to start from a concrete problem to explain the different operations between [I] and [K]:

In the example discussed here, the objective is to address the problem of thistles in a potato field according to organic farming principles.

The K-C disjunction: it marks the beginning of the design reasoning. A given problem – here the presence of thistles in a potato field – is transformed into a concept: a potato field without thistles. To initialize this reasoning, we start from knowledge about the control of pests in organic agriculture.

Departition: if the initial concept has no apparent solution, departition mobilizes knowledge to establish a second concept on which reasoning is possible. Knowledge of the types of pest control in organic agriculture leads us to a broader concept: the elimination of thistles in organic agriculture.

The partition has two operators: the restrictive partition and the expansive partition. The restrictive partition restricts the space for possibilities. Thus, no potato variety is able to prevent the appearance of thistles. The solution of genetic control is eliminated. The expansive partition offers new solutions. This process is creative, but new proposals, to be credible, must be built on knowledge. These proposals are sometimes far removed from the subject matter. Invention or surprise can then arise from reasoning. In our example,

the knowledge of thistle auxiliaries makes possible an original proposal added to biological control: the breeding of the larvae of the *Vanessa cardui* butterfly which feeds on thistle.

The C-K conjunction stops the design reasoning. If the final proposal has been evaluated positively, it moves from the innovation space to the knowledge space. It becomes knowledge. In the example presented, the results obtained will have to be evaluated to become knowledge.

These four operations of disjunction, separation, partition and conjunction are not automatic. They are implemented by humans. KOFIS must trace this design reasoning in order to exploit its full potential. KOFIS therefore has two web components: an exchange component [I] where the four operators of the C-K theory can register and a knowledge capitalization component [K].

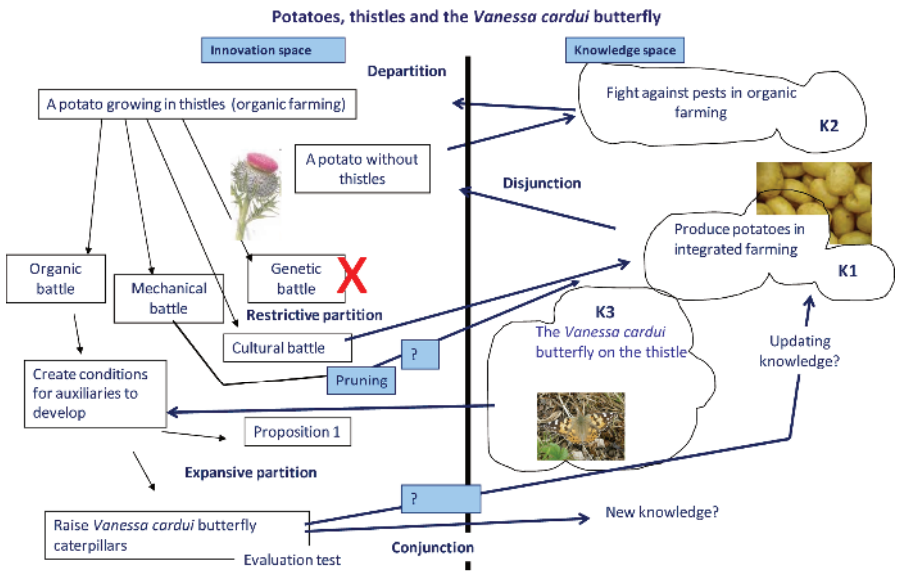

Figure 1.25. *Example of the two spaces [I] and[K]*

1.7.7.3. *System implementation*

The semantic web offers metadata that will characterize knowledge elements. Thus, the semantic web increases accessibility to content. This allows comparison of documents and the use of several types of resources. It

is a guarantee on the quality and authenticity of information sources through the control of content by the producer. In addition, the system exploits the semantic content associated with the identification of each farmer in order to create the most appropriate communities according to a logic that is not only based on geographical proximity. Depending on their interests, users find each other through profile matching.

To build these two spaces, two collaborative web tools accessible in "open source" were chosen, respectively Drupal for [I] and the Wiki tool "Semantic MediaWiki" for [K]. A shared semantics makes it possible to annotate the content. This agricultural ontology, partly based on Agrovoc, (FAO multilingual agricultural thesaurus See: http://aims.fao.org/website/Search/sub) links the two spaces.

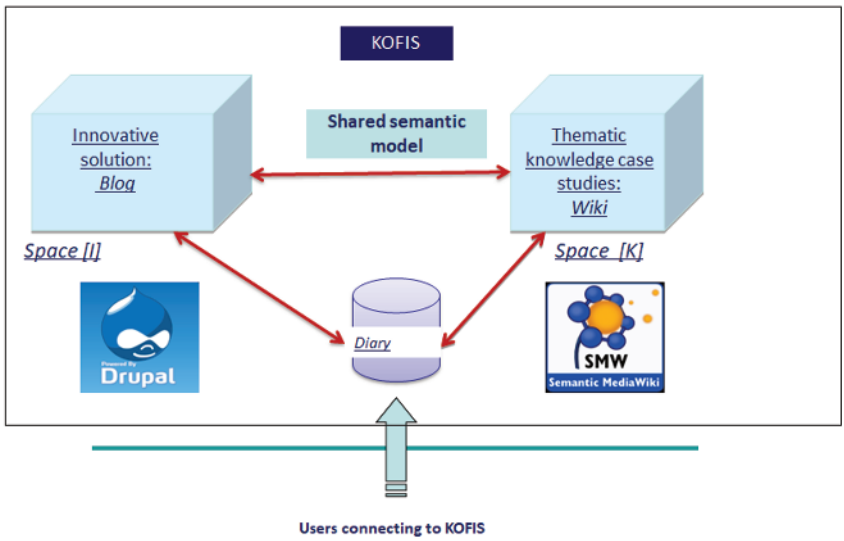

Figure 1.26. *KOFIS IT architecture*

1.7.8. *Conclusion*

The KOFIS tool (then its national operational version GECO) was designed to overcome the lack of IT knowledge management in agriculture. This project was based on analysis of the set of actors, the content and an original architecture proposal.

It is known that networking the members of an organization made it more capable of solving problems. Information and communication technologies have of course accelerated the construction of these networks. Thus, knowledge is developed through distribution and interaction between individuals and not only by capitalizing on the same person. But, even if this tool challenges the pyramid scheme of knowledge dissemination, there is a tension between the willingness to open the tool to allow effective interaction around feedback and the need to limit access to publishing to ensure the quality of the knowledge offered.

Overcoming this contradiction has led to the proposal of two spaces where the rights of the actors are not the same: a space [I] focused on innovative design, open to the greatest number of people, thus coexists with a space [K], less open, where knowledge is published. Its architecture exploits the capabilities of web2, also known as the social web, and the latest developments from the semantic web called web3.

To make the web collaborative and semantic, the solution chosen is based on two existing open-source tools. The tools chosen are Drupal and Semantic MediaWiki for each of the two spaces [I] and [K] respectively. These two tools are classic and relatively easy for a non-computer scientist to use. They each have a semantic dimension based on a thesaurus for [I] and an ontology for [K]. These two spaces communicate through a shared ontology.

Potentially, the number of KOFIS users is significant. The challenge is therefore to reach a critical threshold of users to support a largely self-regulating application. But one of the difficulties in managing such a tool is bringing together actors with different professional approaches. Indeed, if the choice of actors publishing in [K] is under control, it is by definition more difficult to examine all the exchanges between the actors of [I]. Monitoring by the project owner of the tool will be essential. Moreover, the culture of sharing is not self-evident. An individual or organization will keep knowledge or express it according to his or her personal interest in doing so.

The first feedback from stakeholders in the agricultural world has shown that there is a real collective demand and the first uses of GECO show the interest in this type of approach in agriculture.

1.8. Lessons learned from the case studies

A knowledge transfer or sharing device, whether supported by digital technologies or not, is a complex system, which is not reduced to a device for transferring or sharing information.

Knowledge, as we have seen throughout this book, is a very particular material, which depends as much on the people who hold it as on the context in which it is produced and used. Its transfer or sharing in social networks is very problematic.

We have shown, through many examples, that a knowledge transfer system requires a thorough analysis of the critical nature of the knowledge transferred, the people who can transmit it and the people who can receive it. Building the content that the device must transfer may require the use of knowledge engineering techniques and sophisticated capitalization. In addition, the contexts of use are essential to know to ensure the success of such devices, contexts that depend on the objectives and expected results of the transfer.

Knowledge management is therefore fully involved in the design, implementation and implementation of knowledge transfer systems. This transfer thus becomes one of the essential objectives of the KM.