
Nature of Inventive Knowledge

All men by nature desire to know (in ancient Greek, τὸ εἰδέναι); an indication of this is the delight we take in our senses; for even apart from their usefulness they are loved for themselves; and above all others the sense of sight. For not only with a view to action, but even when we are not going to do anything, we prefer seeing (one might say) to everything else.

The reason is that this, most of all the senses, makes us know and brings to light many differences between things.

Aristotle, *Metaphysics*, Book A, 1, 980 a 21–27

It is with these words that Aristotle begins his major work, *Metaphysics*. This observation expresses a fundamental need in humans: knowledge is the expression of the metaphysical condition of humans, and metaphysics is expressed by the desire to know [VER 06].

We will see that the term “knowledge“ has two equivalents with different meanings: knowledge (singular) and knowledge (plural).

Our reflection will begin by questioning the nature of knowledge and its limits.

1.1. Knowledge levels

We start with knowledge in the plural form.

The approach to inventive knowledge begins with understanding the nature of knowledge, of which it is usual, first, to distinguish three levels: knowledge in everyday life, scientific knowledge and knowledge according to cognitive science, then to draw the limits.

1.1.1. Knowledge in everyday life

Knowledge of a thing means nothing more in everyday life than giving it its true name [SCH 25]. Thus, for Moritz Schlick, knowledge in everyday life (an object, for example) is constituted in three steps:

- an object is recognized;
- something old is rediscovered in something new (the object can now be designated by a familiar name);
- the name is found that belongs to the object and no other.

1.1.2. Scientific knowledge

Scientific knowledge consists of reducing one thing to another [SCH 25]. All understanding (in the sense of the search for an explanation) progresses by steps, by finding one thing in another, then another thing again in the first, etc. The ultimate degree is reached when there remains only a minimum of explanatory principles that cannot in their turn be explained. Making this minimum as small as possible is therefore the ultimate task of knowledge, while integrally determining each of the individual phenomena of the universe by means of this small number of explanatory principles [SCH 25].

1.1.3. Knowledge in the Japanese intellectual tradition

According to Nonaka, in Western philosophy, there has long been a tradition separating the subject who knows from the object that is known [NON 97]. For the Japanese intellectual tradition, the separation between subject and object is not so deeply rooted. This author's theory is based on the idea that these two approaches are complementary and that an adequate theory of knowledge creation must borrow elements from both approaches.

In Western philosophy, the foundations of the history of philosophy encompass two opposing, but complementary traditions: rationalism in essence says that knowledge can be acquired mainly in a deductive way through reason (mathematics, valuing precise and conceptual reasoning), while empiricism holds that knowledge can be gained inductively from sensory experiences (experimental science, personal experience in the field). In antiquity, rationalism was represented by Plato and empiricism by Aristotle. In the 17th century, rationalism was represented by René Descartes and empiricism by John Locke. Rationalism and empiricism theories were brought together by Immanuel Kant in the 18th century. Kant held that the basis of knowledge is experience, and asserted that knowledge arises only when the logical reflection of rationalism and the

sensory experience of empiricism work together. For Immanuel Kant, the human mind is not a passive tabula rasa, but active in ordering sensory experiences in time and space and supplying concepts as tools for understanding them [KAN 07].

For the Japanese, knowledge represents wisdom that is gained from the perspective of the whole personality (body plus mind). This approach provided a basis for emphasizing personal and physical experience rather than indirect intellectual abstraction. Inazo Nitobe pointed out that, in traditional samurai education, knowledge is acquired when it is integrated into our “personal character” [NIT 99]. While a Westerner “conceptualizes” things from an objective point of view, the Japanese emphasizes subjective knowledge and intuitive intelligence to “conceptualize” things by connecting to other things or people from a “tactile” and interpersonal perspective. They see reality in physical interaction with nature and other human beings [NON 97].

1.1.4. Knowledge according to cognitive science

For a very long time, the main method of studying thought was introspection, the reflection of the philosopher on their own thought [LHU 05]. But many philosophers of past centuries were also scientists, theoreticians and experimenters. The reflections of some non-conformists and the astonishing advancement of mathematical and physical sciences (mechanics and astronomy, in particular) made a good number of scholars see the world as a machine that one day could be explained by laws and mechanisms. The world of the mind should not escape it, whether its laws and mechanisms pre-exist and are innate or have also come to us from our perceptions. Gottfried Leibnitz said: “Thinking is calculating.” Knowledge would then be the objective trace that information leaves in us, who are complex mechanics [LHU 05]. In modern times, these functionalists and materialists rely on the work of neurologists or neurophysiologists. This reduction of the spiritual to known precise physiological phenomena is not something for tomorrow, but the patterns that emerge inform us about cognition and they can, for example, in the near future, guide us in the development of more efficient learning methods. The science of cognition (or cognitive science) gives us a multidisciplinary vision of the mental representation of the world, of memorization, of communication. It attempts to reduce mental mechanisms to a limited number of types of mental actions [LHU 05]. In the simplest, so-called standard, cognitive model [DOR 03], these are: filtering information, formatting it (decoding) and computing (combining, processing). Cognitive science categorizes relations between objects of thought (included in, instance of, analogous to, etc.). Memory is made up of stable representations of the world, verbalized (predicates, for example) or not (mental images). There are numerous works and schools of cognitive science: symbolist or connectionist. Is knowledge ultimately irreducible to objective information? Just as emergence theorists (John Stuart Mill,

C.L. Morgan, C.H. Lewes, etc.) see complex systems emerging from the interactive gathering of simpler components or systems, can we say that knowledge emerges from objective information? Connectionists apply this vision to the mechanisms of thought. We therefore inherit all these partly contradictory works. In practice, most authors agree that the mechanisms of knowledge are too subtle to be well modeled and they advocate the use of human and social sciences (psychology, pedagogy, sociology) to transmit knowledge. This approach is one of the current foundations of knowledge management, which increasingly calls upon the human and social sciences [LHU 05]. This will also be our posture, but with an attempt to analyze to what extent knowledge can or cannot be objective and codified.

1.2. The limits of knowledge

We are dealing here with knowledge in the singular form, which consists of a cognitive capacity (to sort and exploit information) and a learning capacity (to ensure interpretation that will give meaning). Edgar Morin points out “the blindness of knowledge” that are error and illusion, which come from the use of knowledge without having first examined its nature, with its cerebral, mental and cultural characteristics [MOR 00]: “Knowledge of knowledge should be considered as a primary necessity” [MOR 08a]. According to the same author,

there is a central problem, still misunderstood, that of the necessity to promote a knowledge capable of understanding global and fundamental problems in order to include partial and local knowledge in it [...] The supremacy of a knowledge fragmented according to disciplines often makes it impossible to establish the link between parts and wholes and must therefore make way for a mode of knowledge capable of understanding its objects in their contexts, their complexes, their wholes [...] It is necessary to develop the natural ability of the human mind to place all its information in a context and a whole and to teach the methods for understanding the mutual and reciprocal relationships between parts and wholes in a complex world [MOR 00].

This questioning of the need for a prior knowledge of knowledge was already one of the essential points of Immanuel Kant’s philosophy of knowledge, for whom it is the ability to know that organizes knowledge, and not the objects that determine it: he indeed showed that human knowledge has definite limits. Rather than asking, as was traditionally the case, whether our knowledge reflects reality, Kant asked how our knowledge reflects our cognition. According to him, knowledge is derived from experience, but it needs to be ordered by the mind and it is possible, thanks to reason, to describe the structure that experience must have in order to discover universal truths about our world [KAN 07].

Just as Nicolas Copernic showed that the Earth revolves around the sun and not the other way around, Kant asserted that the “center” of knowledge is the knowing subject (human or rational being) and not an external reality to which we are simply passive. It is no longer the object which obliges the subject to conform to its rules, but the subject which gives its rules to the object in order to know it [KAN 07]. The immediate consequence of this is that we cannot know reality in itself, but only reality as it appears to us in the form of a phenomenon.

From these limits of knowledge, we will retain above all the need to structure our ability to know, which will be expressed by the exploration of its mechanisms and its results. This prompts us to consider an object of interest as a dematerialized entity carrying knowledge.

1.3. Value chain and knowledge evolution chain

The question that follows concerns the identification, structuring and use of knowledge in an organization: how can the knowledge already produced by an organization be characterized so that such knowledge is put into action for the benefit of this organization’s technical strategy and perspective?

The aim is to develop a management tool that can help company managers understand where the added value produced by knowledge is and to act to enhance this resource [ERM 18a]. Thus, there are two ways to build a knowledge evolution chain [ERM 12]:

- the first is directly inspired by Porter’s famous productive value chain [POR 85];
- the second is a sequence of cognitive activities that acts on knowledge processing procedures in the company, proposed by [BRU 08] using Porter’s approach to the value chain: this chain is called the DIKW chain.

1.3.1. *The knowledge value chain inspired by Porter*

1.3.1.1. *Porter’s knowledge value chain*

The value chain is a management concept that was designed, developed and popularized by Michael Porter [POR 85]. This concept makes it possible to systematically analyze the company’s sources of competitive advantage and its activities. Starting from the principle that a company can be divided into a series of basic functions or activities (design, manufacturing, marketing, etc.), the analysis

focuses on the latter, articulated along a value chain. The value chain here represents all the basic tasks of the company: from the generation of ideas to the sale of products and the services associated with them. The value chain analysis describes the different steps for a company to obtain a competitive advantage over its competitors by proposing an offer valued by customers. The sources of competitive advantage of each activity of the company are in its cost/value ratio. It is therefore necessary to define a chain of activities that creates value beyond the costs generated.

Figure 1.1 illustrates a classical value chain with all its related basic activities. These basic activities or tasks are broken down into two broad categories: primary activities and support activities. Primary activities are those directly involved in the manufacture and sale of products. They are specific to the product or at the center of strategic activities analyzed. Support activities, as their name suggests, are indirectly involved in manufacturing and sales. They are generally common to all of the company's strategic products or center of strategic activities and facilitate the proper performance of primary activities.

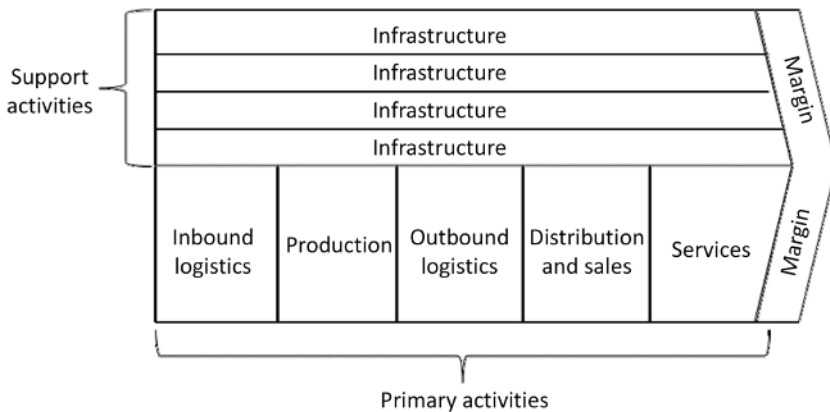


Figure 1.1. Porter's general-purpose value chain

Primary activities are directly involved in value creation. They include inbound and outbound logistics, production, distribution and sales, and service activities:

- inbound logistics includes the activities of reception, storage and allocation of the means of production necessary for the product (handling, inventory control, return to suppliers, etc.);

- production uses these means of production to transform them into finished products or services (processing, packaging, maintenance and upkeep of the generation facilities, quality control, etc.);

- outbound logistics collects, stores and delivers the product to the end customer or distribution networks;

- distribution, marketing and sales include all activities associated with providing the means by which customers can buy the product and are encouraged to do so, such as advertising, promotion, sales force, selection of distribution channels, relations with distributors, pricing, loyalty, etc.;

- services include all activities that maintain or increase the value of a good, such as installation, repair, training, supply of spare parts and product adaptation.

Support functions support the primary functions and help to improve their efficiency. They include infrastructure, human resource management, technology development, and procurement and supplies:

- infrastructure covers the administrative activities that are essential to the smooth running of the company: these activities include general management, planning, finance, accounting, legal activities, external relations and quality management. Infrastructure also includes the procedures that cut across the various steps of the value chain and the activities they encompass. Finally, infrastructure develops and manages the company's information systems;

- human resource management is concerned with all activities relating to the recruitment, hiring, training, development and remuneration of personnel, etc.;

- technological development is concerned exclusively with technologies directly related to products and associated services or to the production process (process, improvement of a raw material, etc.). The development or acquisition of other technologies is the responsibility of the relevant functions or activities;

- procurement and supplies concern the procedures for acquiring the resources necessary for the primary and support functions. They are involved in the entire value chain.

The value chain constituted by primary and support functions is a general framework for analysis that must be adapted to the specificities of the company or its industrial sector. For example (Figure 1.2), the value chain (excluding support functions) of an airline has few similarities with the general-purpose model developed by Porter. However, the logic remains the same and in all cases consists of representing the sequence of activities that create value for both the customer and the company.

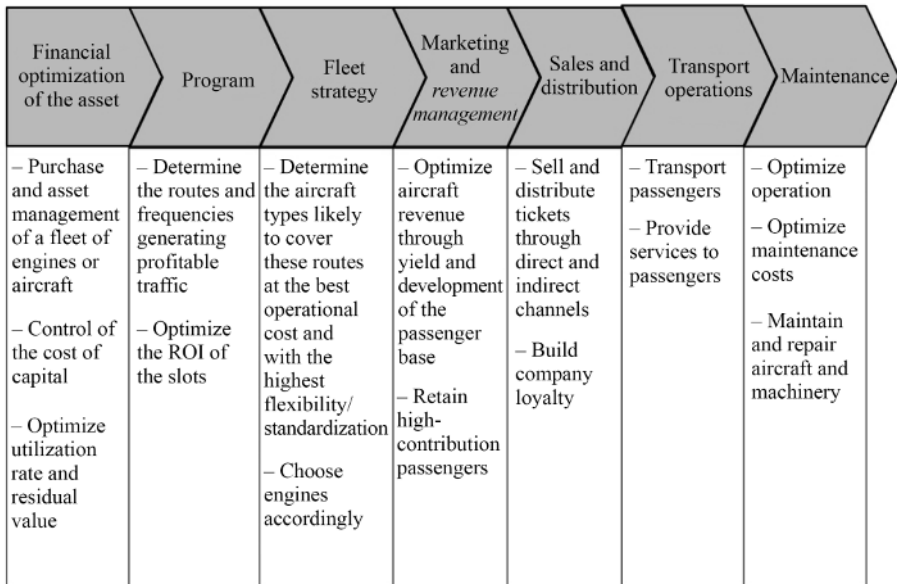


Figure 1.2. Example of an airline value chain

The analysis of a company's value chain makes it possible to assign a set of specific costs to each activity and to determine which activities contribute the most to the creation of value for the customer or for the company. For example, the three activities that create the most value for an airline are the program, marketing/revenue management and the business loyalty activities (mainly through the negotiation of framework agreements) carried out by the sales departments. The other activities, although necessary for the proper operation of an airline, create little value compared to the three activities mentioned above. At the end of this analysis, the company can identify the activities or parts of activities that are the source of competitive advantage and those that can be outsourced or that do not need to be strengthened beyond industry standards. Optimizing the entire value chain is generally not possible due to the corresponding limited resources of any organization. Moreover, it is not necessarily desirable, as a number of activities, although required for the smooth running of the organization, contribute very little to the overall value creation and are not a source of competitive advantage. Analysis of the value chain helps us to identify critical activities. Concentrating investments on the key success factors of these decisive activities is generally sufficient to ensure, if not the success, at least the sustainability of a company.

1.3.1.2. *Porter's value chain applied to knowledge*

Following Peter Drucker [DRU 92] and Alvin Toffler [TOF 90], Mahmoud Moradi, Stéphane Brunel and Bruno Vallespir observe that society has gradually become a knowledge society [MOR 08b]. According to these authors, the competitiveness of companies increasingly depends on the ability to produce, transfer, use and protect the knowledge produced internally [TEE 00]. "In a world of rapidly changing markets, products, technologies, competitors, laws, and often social constructs themselves, constant knowledge-based innovation becomes a very important source of major competitive advantage. Therefore, in an increasingly unstable economy, the only palpable certainty within companies is knowledge" [MOR 08b].

For these authors, this view that companies have about sustainable competitiveness acts as a proposal for intellectual resources to become active structural elements of the company's global strategy. Companies capable of managing knowledge as efficiently as possible will offer their customers increasingly efficient services and products, thus reducing personnel and infrastructure costs, improving decision-making and innovation, improving the reaction time of structures, allowing the rapid development of new product lines, responding more quickly and efficiently to problem solving and ensuring the transfer of best practices in the most efficient way possible [MOR 08b]. The literature illustrates many records of success based on effective knowledge management seeking to embark on such efforts in the face of these challenges [ALA 05]. The multiple challenges that organizations have to face lead them to develop different frameworks, methods, models, perspectives, strategies and procedures. Based on the analysis and adaptation of formalization frameworks, other authors have adopted a knowledge management system consisting of six elements: context, goals, strategy, culture, knowledge management procedures, and technological and organizational structures [APO 99]. This system can be used to carry out a comparative analysis of the efforts to be made for better knowledge management [MOR 08b].

According to Ermine and Moradi, the knowledge value chain is, relative to a given organizational framework, necessarily determined by a field of activity, characterized by products or services [ERM 12]. Within the organization, this chain begins with data, transformed into information, then into knowledge, then into skills and finally into abilities.

It is a sequence of knowledge-related activities (creation, codification, sharing, transfer, identification, evaluation, etc.) that acts on the company's knowledge capital. According to Porter, a company is profitable when its sales exceed its

expenses [POR 85]. Producing added value that exceeds the cost of manufacturing is the goal of any competitive strategy.

Integrating knowledge management into the framework of the innovative company means moving from the company's ability to manage its knowledge capital to the ability to use this knowledge to help its innovative employees to develop inventive skills and transform these individual skills into a portfolio of product/service innovations aligned with the organization's strategy. These transformations are included in a value chain: the knowledge value chain.

According to [BRU 08], the evolution mechanisms highlighted in the knowledge value chain fall into two main categories:

– The first category is real and objective. It can be performed by humans and the reasoning can be automated:

- transforming reality into data means receiving signs through perceptual filters in an observational activity, so as to constitute data banks;

- transforming data into information means coding data through conceptual filters in a structuring activity. Data processing gives form and function to data. The conceptual filters, the context in which the meaning is made, the relevance and the purpose are the main transformations of the data that will end up producing information.

– The second category goes from information to metacognition. In this category, human participation is paramount and, by its nature, it is intangible and subjective, so the role of information technology becomes the main element:

- transforming information into knowledge means building models through theories, in a learning activity: the clear understanding of information is the objective that naturally leads us to knowledge. Understanding, realization, modeling, insight, authentication, application, control and refinement and use constitute the basis of transformation activities towards knowledge generation. Processed information, experiences and theories in an identified semantic context are the highest level of knowledge;

- transforming knowledge into competences-capacities means developing a set of practices (know-how) in action, in a context of experience: producing knowledge through practice, through action, is a process of reflection that leads actors towards greater skills. If competence is defined as quick, accurate and precise advice, allowing an explanation and justification of results through reasoning, it also allows decision-making. Thus, the transformation activity allows adaptation to environments through intuition and experience, learning, and memorization. According to Bierly and Kessler, three paths have been established that lead to individual metacognition: experience, spirituality and passion [BIE 00];

- transforming competences into capacities means building a knowledge strategy, through filters that achieve strategic alignment, within a global vision of the organization: the conceptualization, integration, management and distribution of people's competences in the organization lead to organizational capacity. According to Bierly and Kessler, the transformation of people's potential into organizational capacity requires having an idea of the transformational direction, a coherent organizational culture and structure, and being able to be one of the actors of knowledge transfer [BIE 00].

This analysis, summarized in Figure 1.3, gives us the tools (signs, codes, models, practices, strategy), cognitive activities (perception, conceptualization, theorization, action, strategic alignment) and postures (observation, structuring, learning, experience, vision) to implement [ERM 18a].

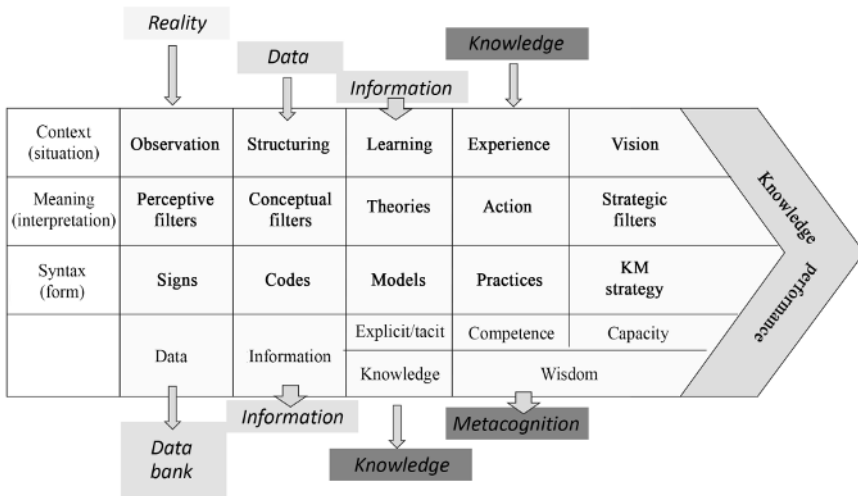


Figure 1.3. *The knowledge value chain*

At each transformation step in the chain, if the organization implements the appropriate management tools, it increases its cognitive capacities, as described in Figure 1.4.

The first phase is the construction of its organizational memory by storing and processing data. Then, the implementation of procedures and information processing tools gives meaning to this data accumulation by allowing them to be used for operational or decision-making purposes. Knowledge management enables the company to become a “learning company”, that is, it optimizes the use of available information (“the right information, to the right person, at the right time”) to create,

acquire and transfer knowledge and modify its behavior. This knowledge is embodied in individuals through action: they acquire experience and are able to behave intelligently, that is, to adapt to new situations and to think of inventive solutions to the problems they experience in their daily activity. If this individual inventiveness is recognized and integrated into an overall strategic plan, then the company develops a portfolio of new products and services that can satisfy its customers or new markets and it becomes a mature and innovative company in the full sense of the term.

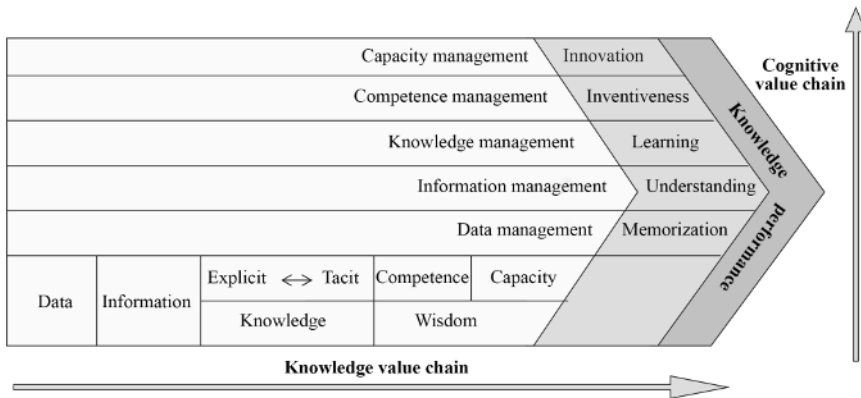


Figure 1.4. *The knowledge value chain as an advancement of the company's "cognitive capacities"*

1.3.1.3. Competence and capacities

1.3.1.3.1. Competence

Competence is a standardized requirement for a person to perform a particular function correctly. It encompasses a combination of knowledge, skills and behaviors, all used to enhance performance. More generally, competence is the condition or quality of becoming suitable or competent by having the ability to perform a particular role. For example, management competence highlights capacities to design systems, as well as negotiation skills. A person has competence as long as the skills, abilities and knowledge that constitute that competence are part of the person, enabling the person to perform the effective action required in a certain work environment. Therefore, a knowledge, technique or ability cannot be eliminated, but a competence can be eliminated if what is needed to carry it out is not available. Expertise is an individual characteristic and a result of the individual's capacity to adapt to different physical and social environments. Prahalad and Hamel define competence as the foundation of competitiveness [PRA 90]. Competence can

then be defined as the individual mobility, integration and transfer of knowledge and capacities in order to achieve desired outcomes.

For Guy Le Boterf, acting competently involves three dimensions including: “the activity as a contextualized action aspect, the available resources (including knowledge) aspect, either personal or accessible resources in one’s environment and the reflexivity (or distancing) aspect, that is, the conceptualization of action” [LEB 06].

1.3.1.3.2. Competence–capacity

Competence–capacity is a dynamic concept moving from a concept in the process of being made in an intellectual dynamic towards an operative dimension in a dimension of effective practicality [LEB 06]: thus, competence–capacity is seen in an act, in a situation, in a construction in finalized actions. It would be, so to speak, an intermediary between competence and capacity, but only from an individual perspective.

Still, according to Guy Le Boterf, competence–capacity involves the following resources:

- theoretical knowledge: understanding a phenomenon, concepts, assimilating patterns, schemes;
- procedural knowledge: knowing how to do it, methods, operating modes;
- procedural know-how: knowing how to carry it out;
- know-how from experience: lessons from practical experience;
- social know-how: “know-how-to-be”, habitus, professional socialization.

Competences are “particular capacities to implement assets in an organized way in order to achieve goals; they are used in intentional and finalized actions where they are built and enriched by learning” [TAR 03]. Competences express an intention to achieve goals through action. The accumulation of individual and collective knowledge and the learning achieved in their implementation generate skills, capacities and competences [TAR 03]. Some authors translate competence–capacity by the term “capability”.

1.3.1.3.3. Capacity or “capability”

For Jacques Tarondeau, capacities are defined as “routines for implementing assets to create, produce and/or offer products or services on a market, routines that are immaterial by nature” [TAR 03].

Capability is the ability to perform an action [MOR 08b]. In terms of actors within the organization, capability is, for these authors, “the sum of competences and capacities that can potentially lead to achievement, the highest level of competence” [MOR 08b]. Grant sees “organizational capability” as the result of the integration of knowledge into productive activities [GRA 96]. Making competence executable and profitable in this way will generate distinctive competences and dynamic “capabilities” for the organization. Whatever term used, the authors agree that capacity is endowed with a value that is clearly superior to all other possible resources within the organization.

1.3.1.3.4. Knowledge

For Jean-Noël Lhuillier, erudite knowledge is a set of knowledge regarding a broad field and without any notable lack [LHU 05]. Knowledge makes up the main codes for interpreting incidental messages that will allow the extraction of new information that will interfere with knowledge: the Latin term *cum prehendere* (comprehend) means to put with, to incorporate. We understand incidental information when it fits well into our existing codes, when it complements them without contradicting them. Competences are operational knowledge acquired in a situation and validated, usable for action [MEI 97]. If this operational knowledge covers a broad field, it then makes it possible to deal with quite unforeseen situations. Jean-Noël Lhuillier introduces the key concept of knowledge for competent actors, “competent” as defined by Le Boterf, where this qualifier designates those who have “a disposition to act in a relevant way with respect to a specific situation involving resources” [LEB 98]. Thus, through relevance, this disposition becomes a capacity. According to Le Boterf, competence is seen as knowing how to act, but it is necessary to be able to act and to want to act. In relation to an organization, we can talk of strategic competence (for the organization), if it is useful for the core business (defined from the core competences), vulnerable (difficult to acquire for the organization but easy to lose) and rare (difficult to acquire for competitors). Creative ideas are “emerging new knowledge” that “require informal experimentation” ([ROB 97], quoted in [LHU 05]).

1.3.2. *The DIKW knowledge evolution chain*

The knowledge evolution chain is a sequence of cognitive activities that act on knowledge processing procedures in the company. The most famous is the so-called DIKW (Data, Information, Knowledge, Wisdom) chain, which describes all the transformations to move from perceived reality to data, information, knowledge and then to wisdom. As this last concept is not well developed within the context of the

company, we have opted for “metacognition“. A complete study of this chain can be found in [ROW 07].

Figure 1.5 describes the DIKW knowledge evolution chain at four levels: data, information, knowledge and metacognition.

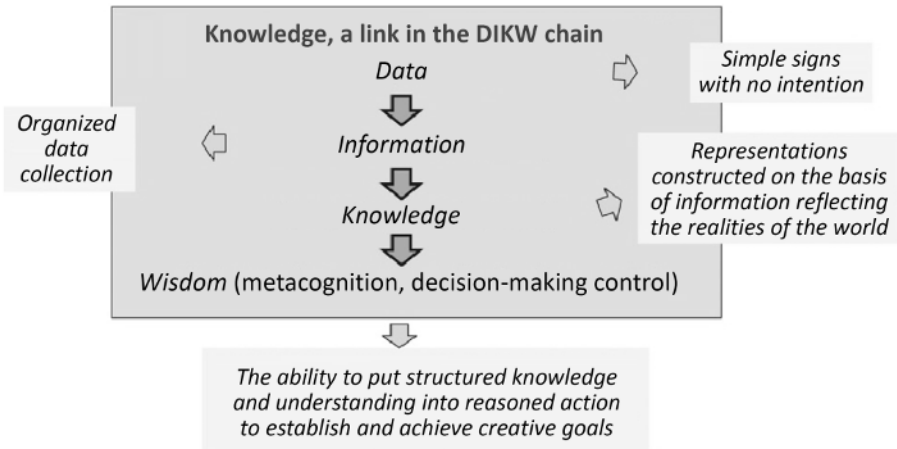


Figure 1.5. *DIKW chain*

1.3.2.1. *Level 1: data*

Digitized information and simple signs are binary messages [LHU 05], which are addressed by the information theory [SHA 49]. Data are very simple information, still quite objective, but already cognitively interpreted (examples: ASCII code, hieroglyphs, ideograms): they are defined as raw facts [BIE 00].

Data is “the recording, in a code agreed upon by a social group, of the measurement or tracking of certain attributes of an object or event” [BRU 08]. For these authors, a datum can be qualitative or quantitative. It contains no intention (thus situated at level 0 of the teleological scale) or project, which gives it its objectivity character and therefore has no meaning in itself. Data are defined [VER 96] as something given, granted or admitted by all, that is, as elements on which something can be discussed or can allow an implication. Other authors have argued that data are guaranteed true facts, which are the raw material of evolved elements [DAV 85].

It is only by giving meaning to this datum that the individual will obtain information that will allow them to say “that they know” or “that they have retained”

something. Giving meaning is therefore achieved by expressing a purpose: from the Greek *τελος* (finality) and *λογος* (reason), teleology is the study of purpose [JUL 84]. Human history can be considered according to the order of causes (causal approach) or according to its goal (teleological approach): in the usual sense, *τελος* means the end, the completion (in the sense of ultimate accomplishment or fulfillment), while in the philosophical sense *τελος* represents the final cause [GOB 00]. The teleological explanation based on the whole is opposed to the mechanistic explanation based on the parts. Here, the purpose will be backed by activation, by putting into action of knowledge.

1.3.2.2. *Level 2: information*

The only unambiguous definition of information is the mathematical definition given by Shannon [SHA 49], according to a probabilistic point of view of information produced by a system. The calculation of the amount of information received through a set of messages is made from the arithmetic mean of the probability of occurrence of each message [ERM 18a].

According to Jean-Noël Lhuillier, elementary information is more global and more interpreted than data, and is made up of the elementary meanings conveyed by the media (sentences, voice inflections, cinematographic effect, etc.) [LHU 05].

According to [BRU 08], information is a collection of data organized to give shape to a message, most often in visible, pictorial, written or oral form, so that it reduces uncertainty and conveys something that triggers an action. “Information produces a new point of view on events or objects, which makes visible what was invisible” [BRU 08].

To distinguish information from data, Jean-Louis Le Moigne relies on the concept of moment: an information is moment 1 (primary information) when it has not undergone any logical or arithmetic processing after its creation. It is moment n when it has undergone n treatments (consolidation, associative or correlative combination) [LEM 90]. This author considers that data are moment 1 and information of moment greater than 1. Information is defined as a representation, a draft, a sketch, to give a general shape [VER 96]. It is made up of data that have been transformed and that are significant for the beneficiary. It has real or perceived value in current or estimated actions or decisions [DAV 85]. The meaning given is partly determined by the receiver’s existing knowledge. Thus, to Moradi and Brunel, information is significant, useful and allows explanations to be given (second level of learning) [MOR 08a] as a data formatting procedure [BIE 00].

With regard to data, we thus observe a one degree rise in the teleological scale.

1.3.2.3. *Level 3: knowledge*

The most common definition of knowledge is “Justified True Belief” (JTB) [CHI 82].

There are two concepts of knowledge, that which is generally derived from tacit knowledge and knowledge from an explicit system [GRA 96]. Acquiring knowledge represents level 4 (analysis) and level 5 (synthesis) in a knowledge level increase system because it allows the previous levels to be exceeded by showing the overall structural form of an entity and implementing new structures based on itself. It is a system that is both created and creative. For example, knowing and identifying the main elements of industrial isomorphism makes it possible to prepare their implication in a competitive strategy.

Nonaka defines knowledge as a justified opinion that increases an entity’s capacity for effective action [NON 94].

For Edgar Morin:

The concept of information must be secondary to the idea of computation which processes information [...] We extract information from noise from redundancies and we transform elements and events into signs [...] Knowledge is organizing and it presupposes a relationship of openness and closure between the knower and the known. The issue is to conceive openness which conditions closure and vice versa, the problem is that of the border which isolates the cell and at the same time makes it communicate with the outside. The cerebral apparatus is separated from the external world by its mediators which bind it to the world [...] Knowledge also supposes a separation from oneself: my mind knows nothing of the brain on which it depends and what my mind knows of my body, it could only know by external means, the means of scientific investigation [...] To know is to produce a translation of the realities of the external world. We are co-producers of the object we know by cooperating with the external world and it is this co-production that gives the object objectivity: we are co-producers of objectivity, but this objective theory does not cancel out the subjective character of the subject [MOR 05].

Knowledge emerges from elementary information through interpretation, contextualization, analogy, conceptualization, abstraction, generalization, inference, induction and deduction, etc., using elaborate codes [ERM 08].

According to [BRU 08], knowledge cannot be separated from the carrier. Contrary to information, knowledge is both a memory and a mechanism for the construction of a representation resulting from an acquisition of information and an action. Knowledge is then the fruit of a clear and certain perception of something: acts, facts or the state of understanding. Knowledge can be viewed from several perspectives: (1) a state of mind, (2) a goal, (3) a process, (4) a condition for accessing information or (5) a capacity [BRU 08].

1.3.2.4. *Level 4: wisdom or metacognition*

Wisdom is defined as the ability to make the best possible use of knowledge, experience and of understanding through the exercise of coherent judgment [MOR 08b]. Addressing wisdom represents “level 6” (assessment) of cognitive enhancement because it goes beyond the previous levels by being able to make conscious value judgments based on well-defined criteria. Metacognition is an action-oriented concept, adapted to structural knowledge during activity planning, decision-making and their implementation. These authors then define metacognition as the ability to make better use of knowledge to set and achieve desired goals.

For David Julia, wisdom unites theoretical knowledge with the realization of a practical ideal [JUL 84]: the wise person is distinguished from the scholar because they live their doctrine and their life is in itself a realization and a testimony of the truth. The wise (σοφός) is the person who devotes themselves to individual research on the mysteries of the world and their own behavior [GOB 00]. The term σοφός first meant skillful and was a simple qualifier. It became a noun and acquired an intellectual meaning where knowledge and fame were associated. With Socrates, the word σοφία takes on the meaning of knowledge acquired by experience, as opposed to bookish knowledge. For Aristotle, “what the Greeks call wisdom is the highest of all the sciences”.

As a first approach, metacognition is the cognition of cognition, which regroups knowledge and cognitive activities that take cognition as their object and contribute to the regulation and control of its operation.

For us, metacognition will be the ability to put structured knowledge and understanding into reasoned action in order to establish and achieve intellectual creation goals.

1.3.2.5. *Knowledge evolution chain and valuation*

For the organization, only the output at the end of this chain is valuable. The final value is obtained by an accumulation of intermediate values that are indispensable to its creation: data collection, structuring of information, reasoned organization of information, learning and strategic analysis [ERM 12].

Note that this evolution is another way to illustrate the dialectic ascension described by Plato¹, who teaches us that research activity is knowledge, based on a direct theoretical and abstract vision of conceptual principles and on a reasoning to establish the models of these conceptual principles: it is an increasingly abstract analysis which is interested in the essence of beings envisaged by the theoretical gaze. These conceptual principles, envisaged by abstraction, are therefore the essence. The act of theory that the subject applies to the creation of knowledge requires a psychological subject (psychologic designating that which concerns the mechanisms of thought) to release its essence. According to Plato, the dialectic ascension describes the ascent along the scale of knowledge, the dialectic representing the duality between an element and the ascending representation of this element. At the lowest level, that is, at the level of sensible realities, is opinion, based on practice, constituted by belief and by conjecture which is the representation of belief. At the highest level, that is, at the level of conceptual principles, is knowledge based on intellectual abstraction, constituted by abstract reason and by discursive reason which is the representation of abstract reason. To make the link with Immanuel Kant's vocabulary, the concept of intellectual abstraction is similar to the concept of pure reason and the concept of practice is similar to the concept of practical reason.

This evolution is also characteristic of the passage from potential (where everything is in the making) to creation. It should also be noted that this evolution of knowledge towards a goal of actionability places the knowledge actor (or knowledge worker; see section 9.8) at the center of the knowledge creation process, as the pivot of technical innovation. Therefore, the knowledge actor should not be seen as a financial burden, but as a source of value. This aspect of source of value is easily illustrated by a field metaphor, which characterizes the actor as the bearer of the knowledge of their specialty, which, in the presence of an eventual problem common to the organization, calls upon them to react with respect to their knowledge, especially without identifying them with a function in the organization.

1.4. Inventive knowledge concepts

In very general terms, inventive knowledge is knowledge necessary for the development of an invention that can generate intellectual property rights.

1.4.1. Current and fruitful ideas

Here, we consider an abstract approach to the characterization of ideas generated according to their potential for inventive activity, by examining a category of

¹ Plato, *The Republic* (Book VII).

“current” ideas and a category of “fruitful” ideas: “current” ideas correspond to those we have when we think, those that come when we look for them. “Fruitful” ideas correspond to the kind of idea in perpetual becoming, the ideas that “have us”, that arise when we are not looking for them, that have the double disadvantage of being very rare and of escaping the will of those who “possess them, but that have the advantage of possessing infinite dimensions” [MAR 09]. More concretely, “fruitful” ideas are those that have the capacity to generate profound inventive knowledge.

The critical analysis of the fruitfulness of the generated inventive knowledge is translated first by their characterization as actionable and adoptable, then by their characterization in inventive depth.

1.4.2. *Depth of inventive knowledge*

Jean-Noël Lhuillier notes that it is important to measure inventive activity [LHU 05], but that there is no metric. In response to this absence, we have sought to define a situational criterion based on the principle of patentability, that is, the generation of industrial property rights. We have proposed a situational criterion, by describing a situation that characterizes the inventive character of an activity, in which the organization is confronted with a technical problem such that:

- 1) it cannot be solved by a person skilled in the art with the current state of knowledge in the field (falls under scientific and/or technological uncertainty);
- 2) it requires complementary and new specific exploratory investigation works (falls under the exploratory field);
- 3) its resolution is accompanied by the creation of significant knowledge that substantially enriches the state of knowledge (falls under enrichment of the state of the art of the scientific and technical community).

We will complete this pragmatic situational criterion by a conceptual criterion of inventive creation linked to a capacity of epistemic mutation.

1.5. Cognitive and social dimensions of the knowledge actor

In order to shed our own light on the double cognitive and social dimension of the knowledge actor, we wish to show that the cognitive dimension follows erudition and that the social dimension will make it possible to generate the inventive work of the mind.

1.5.1. From erudite (scholar) to expert

A particularly significant illustration of erudition is provided by the monks of the abbey of Saint-Germain-des-Prés. After joining the austere congregation of Saint-Maur in 1631, when the abbey became an important intellectual center, the intense intellectual work of these Benedictines, which has become proverbial, revived antiquity and the religious past of France. With Dom Jean Mabillon (remarkable writer, died in 1707), Dom Bernard de Montfaucon (famous archeologist, author of a *Bibliotheca Bibliothecarum Manuscriptorum* dear to scholars, died in 1741), Dom François Clément (who continued Dom Rivet's *Histoire Littéraire de la France* (11th and 12th volumes), as well as Dom Bouquet's *Recueil des Historiens de France* (12th and 13th volumes), Dom Alexis Lobineau (author in 1707 of a new *Histoire de Bretagne*), Dom Michel Félibien (author of *Histoire de Paris*), the foundations of the study of inscriptions (epigraphy) were laid including those of ancient writings (paleography), of the Fathers of the Church (patristics), of archeology, of archives and documents of the Middle Ages: scholarly works that are continued today by the Académie des Inscriptions et Belles Lettres and the École Nationale des Chartes.

The erudite (scholar) is one who has exceptional knowledge: this term, which appeared in 1495, comes from the Latin *eruditus* (past participle of *erudio*, to instruct), while erudition designated teaching (until the 16th century), then profound knowledge (from the 17th century onwards) [DAU 71]. It is in this way that the Latin expression *saecula erudita* designates the enlightened centuries [GAF 34], which later gave rise to the Age of Enlightenment. Émile Littré confirms the meaning of erudition as profound knowledge [LIT 86]. We note with interest the grammatical formation of the term erudite in the past participle: the etymology reflects the important effort to be made to become erudite, after having been educated for long.

1.5.2. From expert to inventor

But the (immense) knowledge of the erudite will not come out of an intellectual center until it has been put into action; this brings us to the expert. Ironically, André Dauzat tells us that the term expert appeared much earlier than that of erudite, from the Latin *expertus* [DAU 71]. *Expertus* (tried, proven) is the past participle of *experior*, to learn by experience [GAF 34]. Here again, Émile Littré confirms the meaning of expert as one who has acquired by experience a great skill in a profession to the point where, by his proven extensive knowledge, is called upon to analyze and assess an area of his field [LIT 86]. Here again, note with interest the grammatical formation of the term expert in the past participle; the etymology

reflects the important effort to be made to become expert, after having studied, experimented and learned for long.

There is a striking parallel between the erudite and the expert, each being the reference in their field, the erudite in pure knowledge, and the expert in knowledge put into action. The putting into action of knowledge can take many forms, for example, the one leading to invention by stimulating creativity for the purpose of producing new and inventive knowledge [SAU 13]. It can also be the contribution of the capitalization of expert knowledge to the enrichment of knowledge in all the structures of a research institute [ERM 18b]. Another form of putting knowledge into action is the revitalization of the links between invention, innovation and intellectual property rights [SAU 16b] (see Chapter 3).

Next, we take a look at the contribution of the inventive knowledge of a community of experts, within an organization, to the stimulation of creativity and inventiveness of inventing and innovating engineers [SAU 16a].

1.6. Conclusion

From this very short exploration of the general background of knowledge, we understand the distinction to be made between the concept of knowledge and that of knowledge creation, resulting from the ability to know: the limits of knowledge come above all from the limits of the ability to know, in other words cognition, and to study this subject more and more recourse to the human and social sciences is required.

It is therefore necessary to structure knowledge, which will be the role of knowledge as an ability to know. This ability to know must also apply to the ascent along the DIKW knowledge evolution chain. This paves the way for the concept of knowledge capital (which will be developed in Chapter 4), from which the inventive knowledge corpus will be drawn. This inventive knowledge is defined as knowledge necessary for the development of an invention that can generate intellectual property rights.