

**Codification of knowledge and new division of labour:
What can we learn from the implementation of ISO 9002 in food industries?**

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**Codification of knowledge and new division of labour:
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Abstract: The aim of this paper is to describe the absorptive capacity of two food industries. The majority of studies present the absorptive capacity as a result of a firm's R&D investments. However, the absorptive capacity may also be developed as a by-product of a firm's manufacturing operations. Food industries have implemented a quality system in order to face the new European regulations and international competitiveness. This implementation has entailed a new rationalisation and a homogenisation of skills, knowledge and practices. To achieve these results, firms have integrated instruments, methods, statistics and other devices and drastically codified their practices. Firstly we would like to identify the absorptive mechanisms of quality systems, and secondly to study how codification can improve a firm's absorptive capacity. Codification is a capacity to create external memories such as tools, documents in order to rationalise or standardise knowledge, skills and practices. This can lead to the development of new technologies and new capabilities. In our case studies, codification involves an increase in analysis and a

continuous adjustment of the manufacturing operations to the evolution of the demand. This facilitates the absorption of the customers' requirements, but also the exploration and the exploitation of new opportunities in technology and in product development.

INTRODUCTION

Nowadays we can observe a movement of increased codification of knowledge in firms in order to rationalise organisations, to become more adapted to the environment or to justify a firm's competencies. There are many motivations and reasons for codification (see R. COWAN and D. FORAY, 1998). The introduction of Insurance Quality Systems and certification is one type of project which leads firms to codify. In the case of Insurance Quality Systems, firms don't just formalise their knowledge. Codification of their methods, procedures and skills is only a first step. There are different kinds of codification: the first stage will surely stay on the shelf if a second codification, the everyday codification which we refers to in this paper as recordings, were absent. This codification is normally tedious, boring and irksome. These daily recordings mean nothing on their own, but combined together they reinforce the absorptive capacity of the firm because they are selected, crossed, treated in many different ways and analysed. For example, previously, in Defial firm, bacteriological quality was controlled twice a day. Now as it is regularly controlled and crossed with the results obtained all along the production lines, Defial discovers there was a problem with a supplier. Recordings provide a story of mistakes and of repairs which help firms to guide their efforts on one critical point and not on another. The treatment of these recordings has resolved a lot of simple problems, but more importantly, it provides reasons to analyse systematically other parts of the product and of the process.

In analysing parts of the products or the process, firms discover other problems or just difficulties that they treat either with the same regularity and the same process of codification, or they change their process of codification and thus they obtain other results which lead to other actions and investments. For example, Defial has produced a lot of documents and has never brought back the former. This results in a

large mess. The solution was to simplify the documents which allow employees to give their opinions on the information to write. These codifications change the co-ordination inside the firm. For example, the co-ordination between departments and the information flow become more effective. Meetings are held more regularly. Tasks are developed which don't exist before. All these aspects are important because they are the consequences of codification. However what we want to discuss in this paper is the fact that codification amplifies the absorptive capacity of firms. It obliges them firstly to better understand what they do and secondly, codification is an exercise of transformation of data, a trial and error exercise which leads the firm to innovate by way of incessantly searching new techniques of treatment and of problem solving. I observed the increase in technology (computer, balances, detectors and other measuring equipments) to manufacture the product and to “lock” the quality of the production line.

In a first part, we present the framework of the study, in which we insert the lessons we learn from the evolutionary theory and definitions of absorptive capacity and codification to better analyse the empirical work. In the second part, we illustrate by way of two examples the story of technologies linked with the problems of codification and its consequences.

1. THEORETICAL FRAMEWORK

Division of labour and division of knowledge

Learning economy is nowadays confronted with a growing codification of knowledge and a change in the division of labour. Indeed the ancient division of labour associated with a centralisation of a part of technical knowledge inside the management area has been widely reconsidered. The demand for variety facing an

evolutionary environment has introduced a new co-ordination. The fact that the economies of scale were not any more sufficient for a firm to survive in a competitive market, has introduced a new division of labour in order to recombine knowledge which was too widely distributed in the workshop (F. HAYEK, 1980). The centralisation of a part of the technical competencies inside the management area with the vertical division of labour has been reconsidered in order to introduce changes for facing the growing variety of the demand. That explains why some new routines have been created in order to produce differently. Horizontal co-ordination described notably by Aoki is illustrative of this movement of more decentralisation inside the workshop and new informational information feedback loops (AOKI and ROSENBERG, 1989).

The creation of new bodies of knowledge in order to innovate has introduced some important changes since the knowledge may require a degree of generality in order to be understood within the practice community (ARORA and GAMBARDILLA, 1994b, LAZARIC and MARENGO, 1998). These new combinations have also required some attempts to codify the ancient “dialects” inside the workshop in order to produce a common language. Moreover the creation of this common language has deeply transformed the firm by introducing extraction and articulation of tacit knowledge. Consequently, these attempts to codify some part of the firm’s knowledge create new technical procedures in order to clarify and change the ancient division of labour. Through this process of codification, new extraction and new articulation of knowledge occurs which from a cognitive point of view forces a reconsideration the role of each department of the firm (LAZARIC and MANGOLTE, 1998). According to us, the codification process has to be understood in the context of this dual dimension with on the one hand, a new division of labour inside the firm and new combinations of knowledge, and on the other hand, a new trade-off between centralisation and decentralisation implying a new truce between the members of the organisation.

Evolutionary theory of the firm and the concept of routines

Through the notion of routines, evolutionary theory enters the organisational “black box” enabling a deeper insight into a firm’s behaviour and explanation of why technology is difficult to transfer (due to the attributes of cumulativeness, specificity and tacitness) and why it is becoming specific to the firm. If routines are considered as the locus of organisational memory, evolutionists emphasise on the incomplete articulation of knowledge because of the presence of tacit knowledge and because of the cost of articulation. We will try to show the evolution of this notion in recent research. We criticise the approach based on artificial intelligence works by showing that tacit knowledge is not always include in cognitive maps but is included in technical artefacts and operator’s bodies.

The concept of routine provides an understanding of a firm’s original structure which differs radically from the neo-classical production set. In NELSON et WINTER (1982), beyond the metaphor of routines as a “quasi genetic trait”, we find an explanation of economic agents behaviour which is totally different from that provided by the theory of rational choice. Economic behaviour is more defined in terms of “path-dependency” and of construction of skills, than in terms of pure choice and pure deliberation.

In 1982, routines were described as a mean to take into account a firm’s “capabilities” and to suggest some alternatives to the neo-classical production set. NELSON and WINTER deny not only the principle of maximisation but also the strict distinction between the choice mechanism and the set on which the choice takes place. Indeed, organisational routines include “know-how” possessed by the business firms and take into consideration the “knowledge of how to do” and the “knowledge of how to choose”. These criticisms are directed at the classical conception of the production set which implicitly recognise that all the technological know-how may be articulated or is articulated like a “book of blueprints”, that is to say “*the sort of thing that can be recorded, stored at negligible cost, and referred to when needed*” (NELSON and WINTER, 1982, p. 61).

On the contrary, the routines' perspective is based on repertoires that store different kinds of knowledge, and on technical know-how linked to the members of an organisation, or to the firm as a whole. Knowledge is therefore situated and distributed in each firm. Indeed knowledge is stored in different kinds of materials (tools, machines, plans, card index..) in various technical and organisational procedures, in the spatial configuration of the machinery, in the interactions between men, women and these machines, and in the body-and-mind knowledge produced by these interactions. All these ways of memorising and storing knowledge create "strategic assets" that are difficult to copy or to imitate.

NARDUZZO (1998) shows how artefacts affect routinisation. Focusing on a case study inside a community of technicians in Omnitel (a newly born telecommunication company), he considers why maintenance uses external memories to enable a better understanding of incidents and breakdowns. Data is stored in local computer memory and helps technicians to discuss how to solve problems (by using historical sequences representing time series in graphical way). The record of technical information in databases does not in itself change the technicians' competencies but facilitates the structuration of organisational memory. The external memory (here the computer) interacts with earlier memories, enlarging the repository of knowledge and enriching technicians' experience by allowing them to remember and to replicate certain procedures more easily.

The use of databases such as computer simulations helps technicians and engineers to conceptualise problems in abstract form in order to formalise their tacit knowledge in technical or mathematical language. These new tools provide opportunities to de-contextualise local knowledge and to transform it in more abstract terms. The use of generalised knowledge and abstraction increases the capacity to articulate this local knowledge in general categories which can be combined with each other (ARORA and GAMBARDELLA, 1994b). Of course, this process affects the structuration of

daily tasks as well as the division of labour. BABA and NOBEOKA (1998) in a recent study of 3-D CAD illustrate this labour dynamic by explaining the central role of these new tools in the development of products.

3-D CAD for example transforms the routinisation and the division of labour in a significant manner. The computer simulation helps engineers and designers to share a representation of works in progress. These new artefacts have also introduced new co-ordination mechanisms because components drawn in 3-D and prototypes assembled digitally can be a common reference during product development. Artefacts provide frequent interactions of trial and errors helping to overlap information and to integrate more quickly sequential tasks (enabling quicker verifications of various hypotheses than experiments with real prototypes). These new tools also reduce design problems that might occur later in the development process by accelerating informational flows between designers and engineers. Secondly, the full-visualisation of products, shared data and digital assembly enables engineers to improve their abilities of problem solving because they can be engaged with the formulation of more advanced hypotheses formation than with the 3-D CAD tools. BABA and NOBEOKA (1998) explain that while the routinisation of activity is affected by these new tools, the individual mental activity of operators is also altered. According to their theory, the greater codification provided by use of this new tools, facilitates the abductive reasoning processes by allowing new opportunities to re-combine structured knowledge: *“Therefore, in the 3-D CAD model, the knowledge fields of a specific product are first created and the pieces of knowledge are constantly recombined and re-integrated through abduction (...) This advantage can be achieved because relationships among sub-systems are clearly defined in the assembly feature of the 3-D systems and hence the recombination of the sub-systems is easily accommodated”* (BABA and NOBEOKA, 1998, p. 650).

To summarise these various examples, we can say that technical artefacts enrich the repertoire of knowledge of the organisation by creating new external memories. They

ease individual memories and create new performed routines which incorporate more articulated knowledge. Performed routines may produce more generalised knowledge increasing the incentives of codification in the division of labour. Nevertheless the process of knowledge extraction is highly contingent on organisational structure which provides incentives and justifications of this new combinative activity.

The process of codification as a process of transformation

Codification process is the ability to articulate a tacit and a general knowledge and to externalise it on various supports through the creation of a technical language (i.e. mathematical, natural or formal languages). It is the ability of human beings to extract their knowledge and create different kind of external memories. According to COWAN and FORAY (1998), codification involves three processes: a process of *creation of a language* (i.e. a mathematical language), a process of *creation of a model* (i.e. the structure of a formal language, of a thesis, etc.) and a process of *creation of a message*. By these processes of transformation of knowledge into a specific language and model, new information appear. COWAN and FORAY discuss the codification process at a national level, of a national system of innovation. In the case of the firm, we have to add the importance of infrastructures and of the technical tools (CAD, new software, etc.).

All things can't be codified; there is a basic tacit knowledge (M. POLANYI, 1967; P.A. MANGOLTE, 1997). Knowledge may be difficult to articulate because it is anchored in some particular productive contexts or because it is bodily anchored in certain artisan techniques. These may be articulated later on or may stay deeply tacit. As WINTER (1995) argues, there are different cases: (1) the non articulated and non articulable, (2) the non articulated but articulable (because of high costs of articulation or because people don't want to articulate), (3) the articulated but private (kept by a person), (4) the articulated but shared and generic (LAZARIC and MANGOLTE, 1998). The codification process creates a community of practices that amplifies the know-how of the firm and relies on shared and articulated knowledge.

Codification is only one part of the know-how. We must take into account as well the practices and competencies of the firm. As cognitive science concludes, the implementation of an expert system doesn't provide the knowledge of the expert, but creates some automatic rules different from intuition and imagination because of their uncompleteness (DREYFUS, 1984; HATCHUEL & WEIL, 1992). Codification creates more knowledge, more information to integrate, to assimilate and to exploit. It doesn't provide the user with the knowledge of the firm.

The sociology of innovation (M. AKRICH, 1989; CALLON, 1989) has characterised the process of codification as a production of tools and as a consequence of standardised knowledge. For example, as Sophie DUBUISSON (1997) observes, codification is a capitalisation of information, which allows to characterise the Demand step by step. Procedures, instructions and guides help the decision making by a standardisation of actions and practices, transforming some activities into routines and focusing the judgement of actors on other problems. For example, the author describes in a firm restaurant the activities of employees and she realises that codification doesn't reduce the freedom or initiatives of employees, but contributes to have standardised artefacts, to stabilise services offered the customers and to combine differently diverse initiatives. Codification produces a dynamic and combination of tools and procedures. It allows to save some knowledge and to integrate it into the routines of organisations.

The process of codification is the transformation of a knowledge in a more "explicit" form, in an information. It can be to write procedures of a machine, to write what the people do or to explain some results of an scientific experiment. Hence codification is a help, a support of action. As Michel de FORMEL (1993) explains objects and reports are the knowledge base of the police inspectors. During an enquiry, policeman use tools and objects as proofs to make sure of their charge. F. CHATEAURAYNAUD and C. DE BESSY (1995) show the same critical point with experts. Experts use artefacts, tools, documents as proofs, as supports of their expert appraisal and valuation. According to GOODY's (1979) opinion on the revolution of alphabet, writing transforms the cognition of persons and develops new competencies by the

reader. This author develops the same reasoning for computers. Computer brings new methods, new norms and new rules due to its own configuration. He concludes that codification is a process of transformation and creation of external memories and of tools because it implies new forms of reasoning.

The studies in cognitive science and artificial intelligence have showed that we can never replace men. What artificial science has proved is the fact that we have to change our goals: “*machines cannot totally replace men, but machines can help men to think*” (BACHIMONT, 1993). We agree with this idea which implies that codification provides other results that firms can exploit or discover. This is why the process of codification can be analysed as a path-dependent process.

Thus codification has thus two consequences: one is immediate with the apparition of codified knowledge, we don't have the same co-ordination and organisation because skills and empirical knowledge (that have been forgotten) reappear with codification as an important and strategic task. The other is the results of codification which imply investing in new tools to exploit or explore the knowledge.

How can the codification improve the organisation?

According to COHEN and LEVINTHAL (1990), the absorptive capacity is « *the ability of a firm to recognise the value of new, external information, assimilate it and apply it to commercial ends* ». The absorptive capacity is critical to innovative capabilities. In order to survive, firms have to capt external information, diffuse it among its members and exploit it. This is the absorptive capacity of the firm. On the one hand, firms invest in R&D to generate innovations. On the other hand, research activities contribute to the constitution and the broadening of the firm's absorptive capacity. Defined as a set of knowledge and competencies, the firm's knowledge-base remains a preliminary condition in the assimilation of spillovers from public research

institutes and private R&D efforts. Research inside the firm must have a strong complementarity with the knowledge to be absorbed. COHEN and LEVINTHAL propose two challenges to firms: the first is to recognise relevant information which is largely dependent on past knowledge, on « *prior related knowledge* », and the second one is the capacity to exploit, to learn from this information and to transform it into an additional competencies. The absorptive capacity is a capacity of valuation and exploitation of new information. The « *prior related knowledge* » will determine which latest scientific development to absorb or which critical information to capt. For example, firms that conduct their own R&D are better able to use externally available information.

In COHEN and LEVINTHAL (1990), the assimilation of external knowledge is directly linked to the general level of R&D spending. The formulation of knowledge assimilation remains a quantitative matter. On the other hand, ARORA and GAMBARDELLA (1994a) and HENDERSON and COCKBURN (1994) develop a different approach which describes how firms seize relevant external knowledge. ARORA and GAMBARDELLA (1994a) distinguish two different types of activity: evaluation of relevant inter-firm projects and exploitation of selected projects. In high-technology industries, estimations are based on the firm's scientific capabilities. Both scientific and the technological capabilities of the firm constitute to the absorptive capacity of the firm. Indeed, scientific capabilities are required in the evaluation of relevant inter-organisational alliances. It helps the organisation to develop its ability to identify and assimilate external knowledge. The technological capability implements and exploits knowledge derived from such alliances. Empirical measures of both capabilities consists of a qualitative description of the absorptive capacity by entering into the R&D function. The scientific capability is assessed by the average number of scientific publications by employees. The technological capacity is appraised by both the number of patents and the ratio of R&D expenditures to sales. HENDERSON and COCKBURN (1994) suggest a slightly different distinction. Competencies, defined as knowledge about how to perform, how to manage, how to innovate, etc. are mobilised in all the firm's activities and

cover a larger set of knowledge than that of the absorptive capacity. The authors distinguish the architectural competencies and the component competencies. The latter refers to local and applied knowledge mobilised in daily problem-solving. Such knowledge is locally embedded and dedicated to specific disciplinary areas. Architectural competencies comprise capacities in using, combining and developing component competencies. They determine the capability of the firm to integrate different technologies, different modes of organisation and to transform them into strategic advantages. HENDERSON and COCKBURN (1994) show that architectural competencies are positively correlated to research productivity.

The development of memory plays a key role for the acquisition and exploitation of information. The more the firms will be used to take into account different concepts, rules and learning, the easier will be the external information assimilated. Prior learning will affect subsequent learning performance: « *the ability to assimilate information is a function of the richness of the pre-existing knowledge structure: learning is cumulative, and learning performance is greatest when the object of learning is related to what is already known* » COHEN and LEVINTHAL (1990). Beyond this cognitive structure, the communication system inside the firm also plays an important role in the exploitation of knowledge. Gatekeepers are experts who recognise the value of knowledge, but this information has to be diffused within the organisation. Here the mechanisms of centralisation and decentralisation are important for exploiting information.

In the literature, the cognitive and organisational approaches are studied in depth in order to apprehend the absorptive capacity. However, technical devices as absorptive mechanisms are not taken into account. Our question is how the absorptive capacity can be developed as a by-product of a firm's manufacturing operations, or how information can be transformed inside the firm into a strategic competency.

Progressively, we turn to the concrete mechanisms of absorptive capacity such as reports, documents, tools. For example, V. MANGEMATIN and L. NESTA (1998) propose to explore the links between a firm's absorptive capacity and the characteristics of external information and to describe exactly the means of the transfer and assimilation of information. They try to analyse the relationship between the process of absorption and the vehicles of absorption. The process of absorption can be codified or tacit, applied or fundamental. It depends on the characteristics of the vehicles of absorption (readings, technical device, meetings, etc.). For example, there are several ways one can learn how to master a new software, either by reading its handbook or by being tutored by an expert.

Information is transferred through reports, documents, technical device, instruments, personnel contact, scientific papers, patents and so on, yet, we don't know how information is transformed, how it is diffused through the organisation, in other words how it is implemented and contributes to build new competencies. The authors suggest that there are different learning mechanisms behind the transfer and its vehicles: learning-by-doing, learning-by-trying, etc., but these are not discussed, no attempt is made to enter in the black box of learning, nor discover the huge number of vehicles of absorption.

Finally, ARORA and GAMBARDELLA (1994b) argue that instrumentation has changed a lot of things in the process of innovation. Computers make simulation easier and offer possibilities which didn't exist before: « *the use of general and abstract knowledge in industrial research has received a great impetus from advances in three areas: theoretical understanding of problems, instrumentation and computational capability. The complementarity between these three areas is apparent, and progress in all three areas is together changing 'the technology of technical change'* ». Not only can researchers test theories more rapidly and effectively using sophisticated instruments and greater computational power, they can also test theories that could not be tested using 'old' experimentation technologies. Following ARORA and GAMBARDELLA's thesis, we

can argue that the absorptive capacity is enable by technical tools, machines and devices. The technology that changes the technical change also modifies the absorptive capacity of firms. A study of these devices, instruments and codification is necessary to proceed to the study of the absorptive capacity of production units.

2. CASE STUDIES

The specificity of ISO NORMS

ISO Norms are characterised by the codification of knowledge allowing actors to construct their understanding of the organisation. The aim is to describe or model the manufacturing operations in order to obtain a better communication system or a better organisation. Procedures are developed to rationalise schemes which govern actor's behaviours. As SEGRESTIN argues (1998), ISO norms don't cause firms to implement an universal quality system, there are several ways of justifying the manufacturing operations quality.

ISO 9000 is one sign of quality among others. Food industries compete to offer customers (distributors and consumers) the best signal of quality. In order to obtain diffusion of their reputation, they commit themselves to large projects of certification. These can be AOC¹, Label Rouge or IGP certification and so on (G. ALLAIRE and R. BOYER, 1995; F. NICOLAS and E. VALCESCHINI, 1995). All these certifications result in large codification of their know-how or of their geographical links. These increasingly arduous competitions strengthen the choice of the producers about the specification of their process and products. However it offers customers additional information and summary of producers' knowledge. Customers have information

¹ Appellation d'Origine Contrôlée

about the product and now they can have information about the process. There exists specific signs which refer to specific production processes.

But firms are faced with two problems: (1) the *relevance* of the quality signal, and (2) the *credibility* of the quality signal (E. VALCESCHINI, 1999). In order to be relevant, the signs have to meet the needs of clients. This refers to all the codification of the quality signals established by the law. For the second problem, it is necessary to implement a quality system. According to the AFNOR² definition, the quality system is a codified and systematic system of control and justification necessary to obtain the regularity of quality of the production process and necessary to gain the trust of customers. It results in a large number of rigorously codified procedures of control at each step of the manufacturing operations (i.e. for the choice of raw materials, for the product specifications, for the description of the manufacturing process, for the objectives and procedures of control, for the professional qualifications, etc.). As firms cannot audit themselves, a third party was created such as AFAQ³ in France. The necessity for a quality signal is due to the sophistication of the process and of the product, due to the increasing opacity of transformation and the rising differentiation and innovation in food products. There are other reasons but our aim is to discover the impact inside the firm in terms of competencies, organisation and technology.

Our subject deals with 9002 ISO norms. These refer to a large family of 15 manuals, ISO 8402 defining vocabulary, ISO 9004 proposing an organisational method for ISO 9001 (including design, production and control-final test), 9002 (including production and control-final test) and 9003 (control-final test only). Only the three last categories lead to a certification for firms and concerns codification at different level of activity. ISO norms cover 20 chapters, the two first devoted to hierarchical considerations about role, function and responsibility of actors in the firm, most of them concerning the analysis of processes characterising internal activity. The other chapters

² Association Française de Normalisation

³ Association Française d'Assurance Qualité

constitute logistic supports for the others (purchasing, training...). But an ISO procedure also supposes a quality insurance set-up specifying an action plan and corrective actions. As a result, the central point on which collective action will be structured is the quality hand-book in which every procedure is described.

The codification of knowledge then has an impact on: (1) the *degree of autonomy* of the firm's actors as it influences the more or less prescriptive character of the current regulation, (2) the attention actors pay to *organisational problems*, as it influences the more or less routine character of the solutions to problems, (3) the relationships between the different organisational units and the relationships between the firm and its environment, as it alters *communication protocols* in particular, (4) the evolution of *organisational competencies*, as it creates knowledge through externalisation of actors' tacit competencies. Finally, (5) it creates *new combinations of knowledge* through the work of experts who are supposed to rationalise them, to diffuse to all members of the organisation as procedures and to internalise the knowledge contained in the procedures into actors' behaviours.

Two main families of arguments justify a decision for quality certification. Firstly, a category derives from a necessity. Most of the time, it is the consequence of demand requirements. In this case, certification undergone by the organisation leading to heavy procedures and an excess of codification as explained above. A lot of practical experience of certification in industry has emphasised the fact that ISO 9000 leads to heavy procedures crystallising collective knowledge. The second category of ISO justification considers it as a *constructive step to a more ambitious strategy* of Total Quality Management. Several examples of diverse organisations from various economic sectors such as electric equipment, mechanic or social organisms provide interesting attitudes towards the codification phase of ISO certification. A common reaction for these different companies is that codification is perceived as a more broad evolution of the organisational structure. Codification concerning working procedures must be respected by employees but above all has to be evolutionary.

According to LAMBERT and LERCH (1998), experience shows that many organisational changes engaged to conform to ISO norms failed because of some exaggerated attempts at codification of knowledge. Several organisations take the pain to write down in explicit terms some internal processes due to the importance of tacit knowledge involved. Other companies report after obtaining the certification that ISO procedures are just a new layer of prescriptions that nobody use such as piling up of procedures (notably deeply tacit knowledge) which is redundant. On the one hand, the reasons given refer to the difficulty to describe explicitly partly-structured process, and on the other hand, the fact that sometimes the processes identified by ISO are not linked to the real processes of organisation. The failure can be attributed to the fact that codification is a dynamic process and implies daily changes in the organisation and manufacturing operations. SEGRESTIN (1997) notes that ISO norms have local and specific implications and leads to unexpected results that we are going to discuss in the next parts.

Methodology

We choose two different firms in order to make a comparison. They are chosen because they have similar unexpected consequences: the massive codification results in the introduction of new materials, new devices (balances, detectors, etc.) and daily recordings changing. This presents two interesting cases of codification as a source of transformation. The different codification of practices and manufacturing operations doesn't stay static but induces a new dynamic of treatment of information, new resolution of problems and creation of new devices. Codification is for both firms a source of reorganisation and technical transformation. They differ due to a number of different elements but their study give us a more detailed information on the codification process: (1) on the *standardised procedures and technology* to control the quality and (2) on the *dynamic and exploitation* of codification.

The first case study illustrates the unceasing characterisation of demand. Codification in this case helps people to specify more and more precisely the desires of the customers. The second case study emphasises on the importance of technical artefacts which change the rules and the co-ordination in the firm. These two firms have different organisational and technological path dependent processes. Three aspects will be studied in more detail: (1) the change in mechanisms of *centralisation/ decentralisation*, (2) the evolution or the *creation of jobs*, the diverse training and learning will be underlined, (3) and finally the different perspectives on the *absorptive capacity*.

	DEFIAL	SODELEG
Employees number	300	69
Activities	Meat transformation	Onion dehydration
Products	Frozen steak	Dehydrated onion and carot with different thickness
First certification	1995	1997

DEFIAL or the unceasing characterisation of the demand

DEFIAL is a food industry which transforms meat. Because of its environment, the pressure from its competitors, the new regulations and new requirements of demand, the firm DEFIAL was obliged to obtain the ISO 9002 certification and to build an effective quality system. In the 90's, the organisation of DEFIAL changed: knowledge was codified, its relation with its suppliers became more severe and a laboratory was created for analysing, testing new tools and detecting errors in the system.

The laboratory was created in 1991 and has progressively grown. It was forced by the demand and the codification process started in 1992. The laboratory has several objectives: to analyse bacteriology, chemical, biological quality of the product and to control all the production lines, the different operations, the material equipment and practices. It centralises the documentation and the treatment of information.

On the other hand, the codification process has diverse objectives: (1) to check the quality of the procedures, (2) to anticipate faults, (3) to reinforce the knowledge of the production processes in order to make sure that the system works as expected, and (4) to facilitate the circulation of important information. The quality controls are decentralised, there are then new tasks to execute for employees, but the treatment of information is centralised. Thus the quality manager is forced to explain the objectives of these controls.

Since 1991, the laboratory has experienced continual growth. People have been employed for the maintenance of quality instruments, for the treatment of recordings (statistics), for the increasing number of analysis. At the beginning, operators on the production line or in the maintenance department didn't want to record what they do, how and why. First of all, it was difficult to explain knowledge in a generic form. The writing of technical procedures is a difficult task. Secondly, the problem came from the hierarchy that diffused a lot of instructions. This led to an important confusion. These documents were suppressed. Thirdly, the problem was to write what people do everyday to be sure to obtain a regular quality. However for the operators, quality is an usual practice and at the beginning of the project they didn't accept additional controls. Next, employees fulfil the recordings very well for two days for example, but afterwards they forget them. Thus in order to convince employees, quality manager spends a lot of time in meetings, training and development of new tools.

The treatment of these recordings is carried out separately from these operators so they don't understand very well the importance of these documents. The quality manager stays in the factory in order to discuss, to explain the objectives, to control and to explore the possibility of other recordings. The fact that the quality manager stays with operators and discusses with them the project has two decisive consequences: (1) he solves a lot of minor problems by discussing with employees (sometimes the problem is not important, sometimes it can be a source of other recordings, of other treatments in the laboratory), (2) he strengthens the links between all departments by exchanging informational flows and especially between the quality, laboratory, supply and production department.

Thus some aspects are decentralised, it means there is a transfer of competencies. For example, there is a centralisation in the treatment of data but a decentralisation of first analysis on the production line. Previously, it was the responsibility of the laboratory to do these first analyses. Now, the controlled competencies are decentralised and transferred to the production line. The laboratory is more deeply concerned with the measuring instruments, with the controlling of the production operations, with the statistics and ways of resolving the customers' requirements. The objectives of the laboratory are now to describe in detail the production process and to discover devices to explore new and still unknown faults.

There is an evolution of tasks on the production line. For example, a lot of new tools and machines have been integrated: detectors, balances and measuring equipment. Some of the operators have new tasks to do, and there was a transfer of competencies between all the people. Routines have been destabilised. At first, this was because of the new tasks to complete, though after technical training, they were simple to carry out. Secondly, because of the different visions of quality, people don't accept quality controls whereas others are completely involved. However competencies has evolved and now it is easier to rectify faults mentioned in a customer requirement. This production system works like a big machine. When a parameter has to be

added, the variable is implemented in the quality system to produce the information requested by the laboratory and the quality manager. Owing to different devices (balances, detectors, thermometers, continuous analysis machine, etc.), firm creates the information required by the clients. Due to this fact, there is an increase in recordings. This offers customers more information on the production processes and provide the firm more information for their technical or commercial development or decision making.

The absorptive capacity is improving. DEFIAL gained some clients, but the most important was to keep them. The system of codification is very specific. DEFIAL doesn't pay attention to procedures and to the codified knowledge of a particular person on a particular machine. The most important for this firm is the codification of everyday, the daily and regular codification and the creation of a partly activated organisational memory. Employees only write what they do for example: at which temperature, at which moment, with which products. Owing to this daily codification, the laboratory can break up the information and offer more services to the customers. The system resembles the KAIZEN system in Japanese firms: it contributes to unceasing improvements. However this system undergoes a process of trial and error such as the suppress of documents (because they are not accepted by employees) or the technical possibilities to perform a control on the production lines. In sum, at the level of co-ordination, the mechanisms of centralisation and decentralisation are still in movement, but we can observe a transfer of competencies from the laboratory to the production development such as continuous control of bacteria and chemical analysis. Employees in the production department were concerned by the quality problem. They have to announce any problem, even minor, that they meet. This is why the quality manager is always close to the production lines. These rules are difficult because measuring tools are now installed on the production lines. New tasks have appeared such as the records of information on a computer by an operator. The relations between departments become more tenuous, in general between the production department and the laboratory.

In conclusion, if we consider the communication system, employees communicate by traditional way either formally or informally (meetings, telephone calls, over coffee, and so on). In the laboratory, there are two extra persons, one for the maintenance of measuring

equipment and the other for analysis. There is no job evolution for the operators, but they have enlarged their prior tasks. More than half of the people have followed technical training either inside the firm or outside the firm. Certification imposes standardised devices and procedures, but the daily recordings have an impact on the professional qualifications, information flows and practices. Co-ordination between departments is strengthened thanks to these more frequent recordings, meetings and reports. However the daily recordings and new practices have modified the freedom to take initiatives of operators and thus their reactions. For example, in case of an incident, operators can now resolve themselves the problem whereas in the case of a rare incident the resolution of problems has become longer. We observed some change in the different posts because of different training periods and new materials. The daily recordings, the increasing number of chemical and biological analysis and the daily treatment of external information improves the absorptive capacity in terms of learning, competencies and technologies.

SODELEG or the technical devices to convince the employees

The second case study produces different results: the dynamics of the codification process and the increasing number of daily changes leads to new unexpected situations and developments.

SODELEG is a highly specialised enterprise. This firm dehydrates onions and carrots. The products depend on the international market price. The adoption of a quality system is required in order to have a better organisation and methods, but it is the pressure of clients that forces SODELEG to gain certification. The quality system differs from that of DEFIAL. The objectives are similar, but the organisation and the functioning of the system emerge in a different way. SODELEG is further away from its consumers. All the people have to be involved in the system, but the centralisation of documents is stronger. The quality manager looks after all modifications of procedures and participates in the change. The quality system is always in progress,

as SODELEG is still experimenting some different manners to do and is a young certified firm.

It was a succession of events and developments which lead to the transformation of the firm's practices. The most difficult task is to get individuals to record their activities. For this reason, SODELEG is adopting a system with technical artefacts in order to remind to employees what they have to do. Several investments were implemented. A lot of discussions forecast these investments in machines and tools required by the system. The quality manager who is not only responsible of the quality system, but also responsible for supply and organisation, spends a lot of time with employees. He organises meetings regularly because the creation of a communication system is hard and the diffusion of information still difficult. This quality system is a constraint for the majority of the people. Previously employees already performed a job of high quality, they don't require different equipment to control their tasks. In fact the system is more orientated towards the process and not towards the products, it is one of the reasons why people don't accept the controls.

Recently, the firm tried to integrate a system of product controls. However the new rules (using documents, recording, changing some habit, integrating new supervisors, etc.) are not totally acquired. The difficulties of the process of codification result from the fact that the empirical knowledge was for the most part oral strengthening as a consequence the difficulties of articulation and the willingness of employees to extract some crucial know-how. In the organisation which centralises the control, namely the laboratory, the checking procedures are now internalised and some new competencies are integrated and at the same time other checking activities are subcontracted by an external laboratory. So the organisational memory is highly dependent on external activities which may lead to some difficulties in the future.

Technical skills have not changed, but the environment, and the overall technical environment is still modifying. There are many tools to insure the security, the safety and quality: detector, balances, colours of the alimentary carpets, colours of the

brushes, and so on. The empirical skills don't disappear, what disappears is the ignorance of its existence. The codification emphasises their existence. At the beginning, the atmosphere was tense and the relations highly strained, but after the development of technical artefacts people understood the priority such as with the glass suppression, the pen suppression and so on. Codification accentuates the problem of badly structured ideas. This highlights the reason why employees resist to this process and are reluctant to articulate know-how. On the production line, a lot of tools and objects appear and have been created by the firm.

The relations with the suppliers are closer, not because of the certification, but SODELEG has now increased its capabilities in this area and now requires and discusses more precisely what it wants. Their suppliers are the farmers of the region. The relations are based on long term relationships. SODELEG doesn't require certification from these suppliers, but they now develop increasingly specific assets through close links between supply and demand.

To summarise and to characterise this process, we can say that the trade-off between centralisation and decentralisation has not really changed. There is no large transfer of competencies, but a centralisation of documents and information and the basic decentralisation of the quality system. That is to say that operators have to write down what they do and to ask the hierarchy when there is a problem. The tasks are enlarged and their capacity to solve problem in situ has not really increased. The relations between departments have not changed, but the relations between employees are still evolving.

The product has evolved. This is not because of the use of new technology, but because of the development of small aspects such as colour of alimentary moving carpet (which are now blue) and the alimentary cleaning brushes (now yellow), the suppression of glasses, of bottles, of watches, of ball-point pens, continuous control chemical quality, temperature, seize on the production line, oven controlled by

computer and so on. SODELEG invested in detection machines of faults and foreign bodies. Due to these artefacts (or by these suppression of artefacts), a phobia has been transferred to the employees. It means that the employees pay much more attention to the recordings because of these details. Because of these details and more significant changes (because the firms have bought new machines to control the process), the relations and the atmosphere in the plant have changed, exhibiting a climate of increased pressure.

3. DISCUSSION

We can observe the increase in analysis, in meetings, in exchange of information and in the evolution of some actors who take the advantage of the quality system to have a promotion.

ORGANISATIONAL CHARACTERISTICS		
	DEFIAL	SODELEG
Trade-off between centralisation and decentralisation	<ul style="list-style-type: none"> • Transfer of competencies from the laboratory to the production department • Creation of a laboratory and centralisation of documents and new analysis. 	<ul style="list-style-type: none"> • Centralisation of documents • Development and decentralisation of new analysis and of computer use in the firm
New roles for some actors	<ul style="list-style-type: none"> • Computer use, • Training periods in chemical or biological fields 	<ul style="list-style-type: none"> • Quality, • Analysis, • Recordings.
Creation of new departments	<ul style="list-style-type: none"> • Quality and laboratory department. 	<ul style="list-style-type: none"> • Quality department, • Laboratory analysis.
Reinforcement of links between the different departments	<ul style="list-style-type: none"> • Meetings, • Reports, • Treatment of analysis. 	<ul style="list-style-type: none"> • Reports, • Meetings, • Treatment of analysis.

We can observe the development of skills due to the evolution of devices, the importance of information and feedback loops between laboratory, quality, production and supply departments.

LABOUR PROCESS		
	DEFIAL	SODELEG
Enlargement of	<ul style="list-style-type: none"> • Data processing 	<ul style="list-style-type: none"> • New quality controls,

tasks	development, <ul style="list-style-type: none"> • Hygiene and security pressures, • New quality controls. 	<ul style="list-style-type: none"> • Hygiene and security pressures.
Transformation of tasks	<ul style="list-style-type: none"> • Tabulation of competencies for all employees, • Person in charge of quality on each line of production. 	<ul style="list-style-type: none"> • Tabulation of competencies for all employees.

LABOUR PROCESS		
Increasing the solving capacity facing new problem in the workshop	<ul style="list-style-type: none"> • Presence of the quality manager in the workshops, • Rapidity of treatment of information from the demand and exchange of information. 	<ul style="list-style-type: none"> • Presence of the quality manager in the workshops, • Importance of the raw materials and of purchase department.
New skills	<ul style="list-style-type: none"> • Technicians for the maintenance of the measuring equipment, • Data processing training for some operators, • New technicians for the biological and chemical analysis, • One new engineer for the quality management. 	<ul style="list-style-type: none"> • Development of competencies for the maintenance of the measuring equipment, • Development of competencies for the biological and chemical analysis, • One new engineer for the quality management.

The communication system is very important for the laboratory and quality department, it means that the truce, the co-ordination between members of the firm, should be improve by meetings, reports and better specifications of the products and the production processes.

STATE OF THE TRUCE		
	DEFIAL	SODELEG
Increased conflicts	<ul style="list-style-type: none"> • Between the quality department and the others, • Increase in the number of meetings. 	<ul style="list-style-type: none"> • Between the quality department and the others, • Increase in the number of meetings.
Modification of the hierarchical structure	<ul style="list-style-type: none"> • Creation of a chemical and biological analysis laboratory, • Creation of the quality department, • Importance of the quality justification in the strategy of the firm and in the decision process. 	<ul style="list-style-type: none"> • Creation of the quality department, • Importance of the quality justification in the strategy of the firm and in the decision process.

<p>New powers for some actors</p>	<ul style="list-style-type: none"> • Importance of the quality managers, • Importance of the laboratory, • Importance of the maintenance technicians and person in charge of quality on each line of production. 	<ul style="list-style-type: none"> • Importance of the quality managers, • Importance of the laboratory, • Importance of the person in charge of quality on each line of production.
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We can observe that the members of the firm understand the quality message thanks to artefacts and external memories. Thus, recordings and devices are important to build a satisfying representation of the production processes.

COGNITIVE CHARACTERISTICS		
	DEFIAL	SODELEG
Extraction of knowledge and its articulation	<ul style="list-style-type: none"> • Procedures, instructions, documentation, • Daily information. 	<ul style="list-style-type: none"> • Procedures, instructions, documentation, • Daily information.
Employee's resistance	<ul style="list-style-type: none"> • To record, • Reinforcement of difference between the groups. 	<ul style="list-style-type: none"> • To record, • To meet together in different meetings.
Employee's difficulties	<ul style="list-style-type: none"> • To understand the quality message, • To dialogue with the quality manager, • To record. 	<ul style="list-style-type: none"> • To understand the quality message, • To meet the quality manager, • To record.
Employee's incentives	<ul style="list-style-type: none"> • Training periods, • Presence of the quality manager. 	<ul style="list-style-type: none"> • Technical device, artefacts, • Presence of the quality manager.

Finally the absorptive capacity is improving due to the increase in technical training periods for the employees and the introduction of diverse devices on the production lines.

STATE OF THE ABSORPTIVE CAPACITY		
	DEFIAL	SODELEG
New information	<ul style="list-style-type: none"> • Demand requirements, • Stressing of supply specifications. 	<ul style="list-style-type: none"> • Stressing of supply specifications and of process specifications.
Product	<ul style="list-style-type: none"> • Frozen meat, 	<ul style="list-style-type: none"> • Fried onions,

improvements	<ul style="list-style-type: none"> • More information for the distributors. 	<ul style="list-style-type: none"> • More specifications about the products.
Reactivity	<ul style="list-style-type: none"> • Customers audit once a month, • New information to treat once a month, • Strengthening of the dialogue between production and quality department (KAIZEN methods). 	<ul style="list-style-type: none"> • New information to treat once a month thanks to actions inside the firm (meetings, suppliers evolution because of research in onion culture).

<u>STATE OF THE ABSORPTIVE CAPACITY</u>		
New employees	<ul style="list-style-type: none"> • Two quality managers • Two technicians for the maintenance of measuring equipment. 	<ul style="list-style-type: none"> • One quality manager, • A secretary.
New tools or devices	<ul style="list-style-type: none"> • Detectors, • Balances, • VIDAS (system to systematically control salmonella), • Infra-red control too, • Etc. 	<ul style="list-style-type: none"> • Detectors, • Balances, • Chemical continuous control machine, • Oven controlled by computer, • Etc.
New customers	<ul style="list-style-type: none"> • Army. 	<ul style="list-style-type: none"> • Mac Donald.

CONCLUSION

Nowadays, firms codify their knowledge for several reasons, this movement is both significant and spectacular. They try to formalise and articulate their knowledge to become more competitive, to participate in alliances, to become certified by ISO 9002 for example. According to Dominique FORAY and Robin COWAN (1998), “*the codification of knowledge, that is to say, the process of conversion of knowledge into a message which can then be manipulated like information, transforms several fundamental aspects of the economics of production and the distribution of knowledge*”. As we observe in the two case studies, firms try to create a different organisation, another way to develop their capacity. Codification changes their ability to resolve problems. This provides firms to exploit a fantastic propriety of men “*which resides in its ability to place its memory outside itself*”. These external memories are important for two reasons: firstly, to capt new information, and secondly, to develop new competencies.

In the case studies we have tried to explore why the codification process is not only the transformation of knowledge in a more explicit form (i.e. in information), but it also brings about new combinations of knowledge and new unexpected collective knowledge through the articulation of procedures, the description and the exploration of employees' daily tasks. But the most important aspect is the process of knowledge transformation and creation of external memories (tools and other technologies). Because knowledge is private and not always anchored in bodies (situated and distributed), but become more collective. This transformation of knowledge from private to public and collective one has of course many consequences in terms of the organisational truce.

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