Trust, Codification and Epistemic Communities:  
Implementing an Expert System in the French Steel Industry

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Introduction

The aim of this paper is to examine the relation between trust and knowledge codification in the context of the implementation of an expert system in the French steel company, Usinor. The Sachem (Système d’Aide à la Conduite des Hauts Furneaux en Marche) expert system project, which was designed to improve blast furnace control, was initiated by Usinor in the 1980s as part of a larger programme of knowledge codification and centralisation. One of the objectives was to preserve knowledge and practices the company felt might face extinction during a period of massive layoffs that threatened to disrupt the traditional knowledge transfer patterns which had hitherto been carried out primarily via an apprenticeship system.

At first glance, trust might seem largely irrelevant to the development of an expert system. Such systems, after all, involve the use of information technology by ‘knowledge engineers’ to transform largely tacit ‘know how’ into a codified format that can subsequently be used as an aid in decision-making. The technical nature of such projects might suggest that they are largely neutral relative to problems of opportunism and trust.

We shall argue that trust was central to implementation of an expert system in the steel industry for three principal reasons that the project shared with most major efforts to codify and centralise knowledge in organisational settings: uncertain impact on decision-making power; causal ambiguity; and knowledge obsolescence (Johnson et al. 2002, pp. 251-57). 2

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2 The notion of causal ambiguity has been proposed as an explanation for the imperfect imitability of organisational competences in resource-based theories of the firm. See Rumelt, 1984; and Dierickx and Cool, 1989.
Knowledge codification was not politically neutral in the steel industry case for the basic reason that in organisational settings the distribution of knowledge is closely tied to the distribution of decision-making power. The right to make a decision in turn can bear on career opportunities and the longer term distribution of profits. Questions of trust were inevitably raised in the steel industry because of the risk that management, or other individuals and groups, would attempt to seize upon the codification process as a means to increase their status and power relative to those that had revealed their hitherto largely tacit or non-explicit know how.

The political dimension of knowledge codification in the steel industry was in turn closely linked to the problem of causal ambiguity. Blast furnaces are used for smelting and are capable of producing different grades of steel. The process involves coke, charred coal, various types of ore, hot air and gas being introduced into the furnace and then smelted. Dross is produced through a process of “decarburisation” and “dephosphorisation”. Since the resulting smelted scrap vary, melted metal must be analysed immediately in order to determine which gases should be added to it and at what temperatures.  

A number of problems can arise during this process, the most notorious occurring when ores do not tap properly and flow on one side of the tank. This happens when ores are insufficiently fluid and therefore create a kind of dome preventing gases from moving up the furnace’s throat. If intervention is limited in any way, ores and smelt scraps can suddenly sink back and cause a number of other problems, including obstructing the tuyeres and triggering explosions or gas emissions.

Team operators responsible for the continuous control of the blast furnace must be able to solve problems and make quick decisions. While this ability depends on the integration of pieces of articulated knowledge it largely takes the form of empirical know-how. Formal mathematical models describing the process have been produced but as of yet no formal model describing the entire set of relevant chemical and physical reactions has been devised. Expert knowledge is consequently tied to particular individuals and some of it inevitably defies articulation and is poorly reproduced and communicated. From the point of view of implementing an expert system, this implies not only a need to choose what knowledge will

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3 For a fuller description of the process, see Lazaric et al. (2003, pp. 1830-33)
be codified but also a need to choose between the possibly conflicting beliefs of the experts concerning the efficiency or particular practices or solutions. Since validating some beliefs at the expense of others is not neutral relative to status and decision-making power, knowledge codification required some generally accepted criteria for weighing and validating knowledge (Lazaric, et al. 2003).

Knowledge obsolescence enters into these dynamics because implementing an expert system, as with other major processes of knowledge codification and centralisation, is a process requiring considerable time and the problems tackled by the organisation typically will change during the process. New knowledge representations come into play at both the individual and the collective levels, and new objectives concerning knowledge creation and accumulation emerge at the organizational level. For this reason, large investments in codifying certain practices and routines often prove in vain because the problems to be solved are no longer the same. Expert systems, if they are to provide a longer term return on investment, have to be up-dated so as to continuously incorporate new non-explicit knowledge that emerges in the process of technical and organisational change. This implies a need for the longer term commitment to project of those actors – operators, craftsmen, lower level technicians – who arguably face the greatest risks in terms of potential loss of status within the organisation. We would argue that in the absence of trust this commitment will not be forthcoming.

Defining Trust

While the above discussion makes it plausible that trust-building was an essential part of the knowledge codification process in the French steel industry, it will nevertheless be useful to spell out the role of trust more precisely. What do we mean by trust and how does our notion of trust relate to the problems of uncertain impact on decision-making, causal ambiguity, and knowledge obsolescence?

There is, of course, very little agreement in the literature on how trust should be defined. Moreover, discussions of trust are often riddled with distinctions or qualifying adjectives, such as ‘weak’ versus ‘strong’ trust, ‘thin’ versus ‘thick’ trust, or ‘personal’ versus ‘institutional’ trust. The use of these qualifiers can be explained by the fact that the meaning one attaches to trust in its vernacular use is strongly context dependent. The qualifiers serve to
make explicit the distinctions that, in everyday language, are conveyed by the other words and phrases that are used in conjunction with the word trust. For example, if we say that X is not really trustworthy but that X can be trusted to fulfil his side of a contractual agreement there is no contradiction. There is no difficulty in understanding that a distinction has been drawn between what one can expect from X in general what one can expect from him in a particular contractual arrangement, given the incentives and constraints that he faces. This is the kind of distinction that is captured by the contrast between ‘contractual’ and ‘goodwill’ trust (Sako, 1998) or between ‘weak’ and ‘strong’ trust (Livet and Reynaud, 1998).

The multiple ways in which trust is contextualised in the literature raises the question of whether there is a set of properties that are common to the various uses of trust. Or, is it the case that we are dealing with a number of basically different concepts? We would argue that despite important differences, the various contextualised meanings of trust share the following three properties.4

1) When we say that an individual trusts we invariably have in mind a tripartite relation of the following form:

   X trusts Y to do Z

   Y can be another person, an organisation or an institution.

2) X is vulnerable in the sense that Y is a free agent and could conceivably act in ways that harm X. The intuition here is that without such vulnerability we do not consider the relation to involve trust. Of course, in any particular instance it may be that X fully expects Y not to act in ways that cause harm. This expectation could be based on any number of considerations, including what X knows about Y’s interests or the constraints Y operates under. What is essential is that Y in his capacity as a free agent could act to cause harm. (see Pettit, 1998).

3) X has reasons for his expectations regarding Y’s behaviour and in this sense trust is justified.

In the case of Usinor’s Sachem project, the basic tripartite relation we are interested in is

4 For an extended discussion of these definitional aspects, see Lorenz, 2002; and Nooteboom, 2002.
between the blast furnace operators or experts (X) who are holders of tacit knowledge and the management team (Y) responsible for codifying at least some parts of their tacit knowledge and using it for implementing an expert system. Vulnerability (property 2) enters into the relation because of causal ambiguity and the operators’ uncertainty over the impact of the knowledge codification process on their decision-making power and position within the organisation. To the extent that an expert system succeeds in routinising decision-making processes that previously depended on the tacit knowledge of skilled operators, it threatens to reduce their organisational usefulness. Thus, for the operators, a key question is whether to trust that management will develop and implement the expert system in a way that respects their interests and preserves their position within the organisation (Z).

Property (3) requires that X has reasons for trusting Y and that trust is justified in this sense. This condition raises the general question of the foundations or sources of trust about which there is a vast literature. One of the key distinctions made in this literature is between the micro and macro foundations for trust (Nooteboom, 2002; Williams, 1988). Micro foundations include such factors as perceptions of self interest. That is to say, X may trust Y to do Z because of what he or she believes to be the case about Y’s economics interests. Micro foundations may also include bonds of friendship or love between the two agents. Macro sources include such factors as sanctions from some authority (the law, organisation, or patriarch) which may constrain an agent’s behaviour and make it more predictable. They may also include internalised norms of proper conduct which also serve to reduce uncertainty regarding an agent’s likely behaviour.

The relative importance of micro and macro foundations will depend in part on whether Y is an individual or a collective entity (organisation or institution). Micro foundations are especially relevant for interpersonal forms of trust (i.e. where Y is an individual). These sources may be established through an interactive learning process whereby X learns or discovers things that are relevant about Y’s interests or normative values (Lazaric and Lorenz, 1998; Lorenz, 1993).

In case where Y is an organisation this sort of mechanism arguably is precluded, since organisations are not cognitive entities in the same way that individual are and they do not in any obvious sense have reasons, self-interested or otherwise, for behaving in one way or another. This, however, does not mean that trust in an organisation is purely inductive and
based on a simple extrapolation of what has been observed of its behaviour and performance in the past. The sources of trust in an organisation may be macro in nature. For example, we may trust an organisation because of what we believe to be the case about its internal governance structure and how its incentives system sanctions employees’ behaviour and encourages them to fulfil the requirements of their various functions and roles (see Lorenz, 2002).

Where does the case study at hand fit relative to these to the distinction between micro and macro foundations? We shall argue that trust in the case of the Sachem project combined aspects of both foundation mechanisms. Blast furnace operators came to trust the management team responsible for developing and implementing the expert system in part because of what they learned through daily interaction about managers’ interests and objectives. For example, through such interaction the operators came to appreciate that management’s objective was not so much to eliminate their expertise and organisational role as it was to transform and preserve it in the interests improved enterprise performance. They also developed trust based on a macro mechanism involving the forging of a consensus between management and labour around a set of rules for validating beliefs in the knowledge codification process. The following sections describe the nature of these rules and how the consensus was established.

**Trust and epistemic communities during knowledge articulation and codification**

*Articulation and codification of knowledge*

In general, it is important to distinguish between “tacit”, “articulable”, “articulated” and “codified” knowledge. We argue that the knowledge of a person or an organisation is articulable (and possibly may be articulated) when it can be made explicit by means of language. In the same vein, articulated knowledge is knowledge that has been rendered explicit through language. Language, in this context, refers to a system of signs and conventions that allow the reproduction and storage of knowledge in such a way that it can then be communicated and transferred between individuals.

The process of articulation involves the extraction of knowledge from the person holding it and the transformation of this personal knowledge into a generic form (Winter, ibid; Mangolte, 1997). One obstacle to this process is that the holder of personal knowledge may be unwilling to cooperate in divulging it. Another obstacle is more technical due to the fact that parts of knowledge that are held tacitly may defy articulation and remain poorly reproduced
and communicated independently of the interests of the parties concerned. Finally it is important to consider that the degree to which articulation will actually be pursued may differ radically between firms, depending on the associated costs and benefits accruing to the firm, the firm’s strategic vision and the importance it places on the building of capabilities (Teece, 1998; Zollo and Winter, 2002).

Articulation should be distinguished from codification (Zollo and Winter, 2002) since as a rule only parts of the knowledge that have been articulated will be encoded on a particular medium: text, computer hard disk, etc. This distinction is crucial in the case of the Sachem project since, as we have observed, the initial articulation process revealed different and competing understandings of blast furnace technology. Correspondingly there was a need to establish choice criteria that were acceptable to the operators and technicians whose participation was critical for the success of the project. One way to understand this process of arriving at an organisational compromise is in terms of the creation of an “epistemic community”.

The role assumed by an epistemic community is quite distinct from that of a “community of practice” as discussed by Brown and Duguid (1991) and Lave and Wenger (1991). Communities of practice emerge spontaneously through the shared activity or practice of a group of agents. Around this shared practice the agents develop a common language and they come to share tacit knowledge. Such communities contribute to organisational performance notably through the way they serve to mobilise tacit knowledge in the interests of collective learning and problem-solving.

The cognitive functions of an epistemic community, on the other hand, is not limited to problem-solving based largely on the exchange of tacit knowledge, but extends to the realm of validating and disseminating explicit knowledge amongst a group of practitioners (Cohendet and Llerena, 2003). It is this fundamental difference between knowledge sharing and knowledge validation that, in our view, distinguishes a “community of practice” from an “epistemic community”. As Haas (1992) expressed it:

“… an ‘epistemic community’ is a network of professionals with recognized expertise and competence in a particular domain and an authoritative claim to policy-relevant knowledge within domain or issue-area (…..) This network has (1) a shared set of normative and principled beliefs, which provide a value-based rationale for the social action of community
members; (2) shared causal beliefs, which are derived from their analysis of practices leading or contributing to a central set of problems in their domain and which then serve as the basis for elucidating the multiple linkages between possible actions and desired outcomes (3) shared notions of validity—that is, inter subjective, internally defined criteria for weighing and validating knowledge in the domain of their expertise; and (4) a common policy enterprise—that is, a set of common practices associated with a set of problems to which their professional competence is directed, presumably out of the conviction that human welfare will be enhanced as a consequence.” (Haas, 1992, p. 3)

While the notion of epistemic community was initially developed by Haas (1992) and others to analyse knowledge dynamics within broader professional and scientific networks, it can help us to understand the way individuals belonging to diverse groups and communities of practice within an organisation come to accept the diffusion of their private knowledge and co-operate in the codification process. The emergence of an intra-organisational community whose members are tied together through subjectively shared “criteria for weighing and validating knowledge in their domain of expertise” is not something that can be administratively mandated. The steel industry case suggests that such communities have to be constructed through a process of learning that involves trust building (Lazaric and Lorenz, 1998; Moingeon and Edmonson 1998). Moreover, in lieu of the problems of causal ambiguity and knowledge obsolescence, such communities remain more or less fragile structures open to reassessment on the part of the ‘experts’ whose participation is crucial to their survival. The process, we will suggest, begins with establishing a set of organizational rules for establishing legitimacy around the criteria used for validating knowledge and thus for achieving political compromise during the codification process (Lazaric 2003).

Trust building inside an organisational hierarchy: the Sachem project

The Sachem (Système d’Aide à la Conduite des Hauts Furneaux en Marche) expert system had an impact on the social status and prestige of many of the company's practitioners, notably the blast furnace experts, whose practices had to be reviewed following the disclosure of their know-how. Securing the co-operation of the company's employees was extremely difficult in the circumstances and depended to a very large extent on the discretion of practitioners but also on the ability of management to build trust around a set of rules and procedures for knowledge validation and codification.

Usinor began building its epistemic community by carrying out a horizontal co-ordination exercise aimed at identifying the different ways in which the various communities of practice
carried out similar tasks. The stage was concluded with the compilation of “Xperdoc” (a kind of knowledge handbook), which was put together during the articulation and codification phase by a small group of experts, knowledge engineers and technicians. In 1987, the Sachem initiative was initiated mainly due to the efforts of a part of the staff who believed that artificial intelligence could help memorise a large part of the knowledge held by experts. This idea was only implemented in 1990 under the supervision of Francis Mer, the company’s top manager, who took a particular interest in this new tool in his efforts to improve Usinor’s productivity. During the course of a year, over one hundred artificial intelligence applications were tested in collaboration with Usinor’s R&D centre, IRSID. The implementation of artificial intelligence benefited from European subsidies and a 40-strong team spent 5 years working towards the creation of systems and their diffusion inside the group. Following this first stage, 17 technical solutions were selected, one of which was the Sachem project. This was first implemented in October 1996, following a long period of discussion within the company, which focused mainly on the following crucial questions: What kinds of knowledge should be articulated and stored? How should practices be selected? How can such practices be transposed into a new tool? How can the loss of tacit knowledge be avoided as the importance of articulated knowledge increases?

In order to identify the ‘best practices’ and key know-how, 13 experts were chosen among those who had co-operated in writing “Xperdoc”. Experts were selected according to know-how and location, in order to ensure a ‘fair’ representation of the various types of knowledge prevailing in the different plants (Sollac Fos, Dunkerque, Lorfonte Patural, etc.). The team worked with six knowledge engineers in order to extract the “core know-how” and articulate it (400 interviews were conducted).

It was this team that ultimately forged Usinor's epistemic community, and in the process ensured that the diversity of know-how found in the team was represented to a degree that avoided the emergence of a climate of distrust towards the ways in which knowledge was being articulated. Following an initial stage of translating the words or natural language of the ‘experts’ into codes, the stage of knowledge acknowledgement and validation was launched.

Blast furnace experts had to recognise their codified know-how, which had been radically transformed by computation. This stage was crucial, as it allowed experts to verify whether the codes did in fact represent what they had intended to articulate in the first place.
Knowledge validation was a long and difficult stage as consensus had to be reached before it could be concluded. Individual meetings, which saw experts having one-to-one discussions with knowledge engineers, and a collective one, including all the experts, took place. Local know-how had been radically transformed as the “knowledge engineers” had changed the way experts represented their own expertise. As it happened, parts of the general knowledge codified in the expert system had ceased to be meaningful to some of the experts and the knowledge engineers designed a linguistic model (in natural language) in order to translate the code. The experts were thus able to recognise their own expertise and acknowledge it collectively. Similarly to the interpretative model, which had translated the experts’ articulated knowledge into codes, the linguistic model converted codes into words. Different models had to be created because different levels of abstraction and local knowledge were required depending on their use.

The consequences of articulation and codification were very important because actual knowledge content changed drastically forcing some blast furnace experts to modify long standing beliefs and their usual interpretation of technical phenomena. One would expect some degree of resistance to this process. In fact, co-operation in the knowledge identification was successful partly because the blast furnace experts were acknowledged as the organizational knowledge carriers and their existing expertise was validated by the ‘epistemic community’. But also critical was that the company relied on the experts to assure the adaptation and continuous updating of the system in order to integrate on-going changes and improve its daily performance. Let us explain this process in more detail.

Knowledge change and validation in the epistemic community

The process of articulation and codification entail a radical change in knowledge because it involves the selection of parts of all available know-how. Moreover, it affects the content of knowledge, as, in practice, the traditional expertise anchored in an expert’s routines is alive. A first transformation occurs when experts put their practices and parts of their tacit know-how into words. This ‘explicitation’ creates articulated knowledge, which entails a first selection of know-how (see Nonaka and Tackeuchi 1995). Parts of know-how that are highly dependent on practices specific to particular plants cannot be articulated and resist extraction because of their ambiguity or by virtue of being highly personal. Experts’ knowledge may be difficult to disembodysty

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“Experts generally know what to do because they have a mature and practiced understanding. When deeply involved in coping with their environment, they do not see problems in some detached way and consciously work at solving them. The skills of experts have become so much a part of them that they need be no more aware of them than they are of their own bodies” (H. and S. Dreyfus, 1986, p. 44).

A second transformation takes place when articulated knowledge is turned into code (Håkansson, 2002; Lazaric et al. 2003; Zollo and Winter 2001). As technicians have their own ways of representing and selecting knowledge: parts of knowledge may be deemed useful simply because of the nature of particular technical parameters embedded in the expert system. In other words, the nature of the ‘container’ is far from neutral and can in fact change knowledge content by including unnecessary bits of know-how while excluding others. Consequently, the outcome is not a simple translation of existing knowledge into code but also a reformulation produced by the knowledge engineers and validated by the experts. Each stage of the process which takes place in the hand-over of live expertise and activated knowledge to the memory of an outsider and from one outsider to another entails a change in the preserved knowledge. This is neither a perfect equivalent nor a total substitute of the knowledge carried in the different memories.

Hatchuel and Weill (1992) argue that the container transforms knowledge content because each language has its very own ways of representing things. Repeated transmission through a variety of languages will always involve some losses as codes differ radically across languages. Moreover, articulation and codification are largely unpredictable because they are necessarily based on individuals’ willingness to participate in a process that is likely to depart from their initial experience: most implemented codes differ substantially from the original individual representations of their particular technical problems. This is the reason why the translation back into natural language and the validation by the experts that took place following the codification process was crucial to the project: it prevented experts from feeling they had lost their original know-how after they had passed it on to the knowledge engineer. As one blast furnace expert acknowledged:

“The validation procedure implemented with the knowledge engineer prevented us from becoming frustrated and helped us understand why our know-how remained important even in its human form”.

The application of this ‘rule of validation’ built inside the epistemic community paved the way for trust building. In effect, the way experts co-operated in the construction of Sachem and their involvement in the process of extraction and articulation of their own expertise may
appear curious to external observers. Several arguments can explain their co-operation. First, senior experts and operators were not insensitive to the argument that part of their own memory had to be preserved and communicated to others. Most of them were encouraged to transfer their know-how before reaching retirement and were proud to participate in the passing of knowledge to younger employees. Secondly, operators, technicians and blast furnace experts in the steel industry belong to the same ‘community of practice’ and blast furnace experts in particular are very powerful because of their long-standing experience. Their own legitimacy is entirely based on their personal knowledge and not their hierarchical grade. To the experts, participation in the Sachem project meant that the company acknowledged their empirical knowledge and validated their extensive work. The rule of validation was, in this context, perceived as a signal: an implicit acknowledgement of local knowledge and a formal validation of live expertise present in the company that had not always been clearly identified by the hierarchy before. However, although this process helped some experts get a better understanding of the power of their personal knowledge it also highlighted the limits of their local know-how, because a part of their beliefs turned out to be either insufficiently reliable or only partially ‘true’.

A good example is provided by beliefs concerning a phenomenon called fluidisation involving an increase in temperature above the ores. At the Fos sur Mer plant, for example, some experts simply believed the process never occurred. Others attributed the observed increase in temperature to other causes. After the knowledge validation process, however, it was generally accepted within the community that fluidisation occurred and that it preceded the descent of ores by an hour. This provides an example of how some kinds of knowledge can suffer from the selection process. Some prior beliefs were slowly redefined as a matter of course: what had been known to be true appeared to be only partly so due to the discovery of new causal links between technical events. The causal links connecting separate technical events, which used to be tacit and intuitive, were tested and proven in a more systematic manner. This does not mean that the articulation process resulted in a scientifically grounded understanding of the blast furnace which still remains to be achieved. Nevertheless, it provided grounds for more robust beliefs and knowledge by changing the experts’ and operators’ local cognitive representations. Without a sufficient degree of confidence in this process of articulation involving lengthy discussions and cooperation among the experts, this change of prior individual and collective beliefs would have been difficult to implement, as
habitual beliefs were questioned and practices and solutions were selected by the ‘epistemic community’ according to their reliability.

Training policy and trust building

Prior to the introduction of the expert system, it took 10 years of ‘on the job training’ to become a confirmed operator. Now only 3 years of work within the company are required to reach operational status and 5 to become a confirmed operator. The new training policy has forced both experts and operators to reflect on their own know-how, as they now need to understand the ways in which they solve problems and justify their repertoires. This has transformed their knowledge and expertise, and while not eliminating know-how has activated new pieces of detached knowledge, predominantly based on know-that.

The training policy contributed to the build-up of trust in a further important way in that it broadened the range of workers' skills and generalised them by preventing operators from passively reacting to the data produced by Sachem and by helping them understand their meaning. This process had the added effect of increasing the degree of co-operation between different generations of practitioners operating within the company and helping disseminate knowledge that was previously open only to those partaking in the long established apprenticeship system. Finally, the fact that the workforce interpreted management’s efforts as a positive signal that helped involve different parts of the company in the process of collective learning and that the effort encouraged the formation of a provisional but positive perception of management’s intentions, were two factors that proved crucial to the success of the process. In short, the training policy was extremely well perceived by the company's employees and played a crucial role in stabilising mutual expectations in a context of high uncertainty.

The preservation of the blast furnace experts’ legitimacy: knowledge maintenance and updating

The training policy was also implemented in order to avoid a “cognitive prosthesis syndrome”. In other words, management had to ensure that both operators and experts remained constantly vigilant and active and did not become too confident in the new technological artefact. As an operator observed:
“We are not going to systematically listen its (the expert system’s) recommendations, we are not going to be blind, we have our experience and our practice as “hand-rail”. As the system is not locked in, we can interact with it, otherwise (when the system is locked in), I will not use it”.

In fact, Sachem requires a feedback from its users and the blast furnace experts in order to be updated. As a result, the system's recommendations, which stem from its interpretation of the data (especially the identification of causal links between different events), and the operators ultimate decisions are compared and scrutinised on a regular basis. All discrepancies between the system’s commendations and the operators’ ultimate are systematically deconstructed in order to detect divergences. This analysis allows the database to be enriched and updated. Parts of the tacit know-how that were not articulated by the operators and blast furnace experts and were considered insignificant during the first stage of articulation (in 1992) are gradually incorporated into the system. Updates are formalised in an annual meeting with the operators, foremen and experts. Experts play a crucial role in this context as they formalise and systematise the divergence analysis of users (operators) and introduce the new articulated knowledge later turned into codes by the knowledge managers. In this way, the system’s knowledge base is constantly enhanced by new articulated knowledge, a process that prevents it from rapidly becoming obsolete.

The constant activation of human skills is very important because, as Dreyfus and Dreyfus (1986) remind us, the coupling of human skills and machine capacity is crucial in order to trigger all the expert system’s potentialities. Indeed the expert system is not able to deal with new situations or solve new problems. Its ability is limited to the knowledge that has been already articulated. Without integrating new pieces of knowledge and codifying them, the system would become obsolete in the long run. All this means that the legitimacy of the blast furnace experts and their social status within the company are reinforced rather than diminished by the new technological tool and that the power of their expertise remains a key component of the new “epistemic community” (see Fleck 1998 for a similar discussion on this point).

However the process of knowledge articulation and codification was confronted by important uncertainties because it entailed profound changes for the old “communities of practices”. Trust and cooperation, in this context, were promoted by the way the importance given to the
training policy and to the elaboration of organisational rules served to signal management’s
good intentions to operators. For example, the rule of validation that was established
following the process of codification and the practice of examining any divergence between
the expert system's recommendations and the operators’ decisions acted as such a signal and
created a climate of collective learning that gave an active role to the blast furnace experts.
Such experts realised that the new system not only validated their existing empirical know-
how, but also helped disseminate parts of their knowledge thereby further enhancing their
legitimacy. This process was also successful because the management did not impose a strict
monitoring system and opted instead to create an “epistemic community”, a decentralised
team that had a high degree of autonomy with respect to the hierarchy itself and that was
accepted by the practitioners (despite the fact that it was precisely this team that was
responsible for the substantial centralisation of existing know-how through codification).  

Conclusion

The problems faced in creating an epistemic community in the context in the French steel
industry are in many respects archetypical of the new governance challenges that firms
embarking on ambitious projects of knowledge management confront. Such projects typically
cut across different communities of practices each characterised not only by a common
language and shared beliefs regarding problem solutions but also by shared expectations
regarding norms of knowledge transmission and sharing. Thus, creating an epistemic
community faces a double challenge, one cognitive and linked to establishing shared
cognitive frames across different communities, and the other normative and linked to the
development of trust around standards of knowledge sharing and validation.

The codification and articulation of knowledge are inherently linked to causal ambiguity
(Szulsanski et al., 2004) and radical uncertainty and for these reasons the process cannot be
perfectly monitored. Nor can it be adequately governed by means of a complete contract. This
inherently creates room for opportunism and vulnerability. In the steel ballast furnace case,
the holders of tacit knowledge could well have suffered from revealing part of their crucial

5 Paradoxically, this situation led to a degree of comfort that soon verged on excess confidence thereby forcing
the management to introduce procedures that required the staff to regularly review and question the formalised
data. This shows how routinized behaviour can carry a risk. When not confronted by novelty, it can lead to an
excess of confidence and thereby generate a degree of inertia that proves detrimental to its own evolution.
tacit know-how. Overcoming this obstacle to cooperation and knowledge sharing was linked to management’s decision to create a decentralised ‘epistemic community’ responsible for the self-management of the codification process. Management opted for this solution because they recognised that they were dependent on the willingness of the ‘experts’ working within the ‘epistemic community’ to divulge their knowledge and to commit themselves to the project’s goals. The choice of a decentralised self-managed structure helped to persuade the knowledge holders that management recognized the continuing value of their knowledge and expertise.

The training policy also played a positive role by demonstrating to the operators that the codification process amounted to more than a replication of existing knowledge. Knowledge holders could potentially benefit due to their role in updating the system, which required them to focus on activities that added value to the system. The permanent updating of knowledge inside the firm by the operators in the ‘epistemic community’ points clearly to the fact that they were the “sense makers ‘of this process. By demonstrating that their role goes beyond a simple enactment of knowledge codified in routines, it has served to increase their status and prestige within the firm.

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