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*Creating
Knowledge
in a High-Tech
French SME*

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INTRODUCTION

When facing new problems, to reduce uncertainty and to save time, companies, as well as individuals, are known to have some standard solutions. Learning is seen as encoding inferences from history into routines guiding behavior (March and Simon, 1958; Cyert and March, 1963; Levitt and March 1988). Only when those routines fail are companies supposed to seek new solutions, and accept to create new knowledge. But knowledge creation has become a crucial aspect of organizations' competitive strategies. Huseman and Goodman (1999: 107) held that *"knowledge, in the form of relationship, know-how, and experience, has become an asset."*

In the 1980s, organizational learning and/or knowledge creation emerged, indeed, as an important managerial and organizational issue (Easterby-Smith, 1997; Schein, 1996; Senge, 1996). More and more, organizations are supposed to have skill in experimentation with new approaches, and in learning from best practices (Garvin, 1993). Still, until recently, discussion about organizations usually referred to large firms. To develop organizational and managerial theories, few studies used SMES for conceptualizing and theorizing (Chaston, 1999; Pedler *et al.* 1997). Scholars always mentioned large corporations as their frame of reference. Only in the 1990s did SMES become a fashionable research topic and a subject of interest for policy makers. Within the new network economy, which is extending its frontiers " *between markets and hierarchies"*, SMES are expected to play a growing role in innovation and employment creation.

Despite the growing interest in SMES, we still need more data on the way individual SMES deal with knowledge creation that results from intentional and planned efforts to learn. Case studies may be useful where the paucity of empirical data is a limitation. As Neilson (1997: 48) puts it, *"seeking in-depth understanding within the contextual bounds of the case study provides a basis for developing new insights"* as well as *"new hypotheses and propositions to be tested in additional contextual environments."*

Various definitions have been proposed for knowledge creation and organizational learning /1/. According to Garvin (1998: 51) *"a learning organization is an organization skilled at creating, acquiring, and transferring knowledge, and at modifying its behavior to reflect new knowledge and insights."* Fiol and Lyles (1985) also give a very acceptable definition of the concept of the concept: *"Organizational learning means the process of improving actions through better knowledge and understanding."* Knowledge is often accepted as being guided, among

others, by cause-and-effect beliefs (Lyles and Schwenk, 1997; Sanchez *et al*., 1996: 9). Learning is usually identified with change (Dixon, 1999; Normann, 1985; Sanchez and Heene, 1997; Swieringa and Wierdsma, 1992). It can change the kind of knowledge a firm develops (Sanchez and Heene, 1997: 7).

Here I will present the case of a high-tech French SME I will refer as Allcapt. The data I will use was collected during a field research I conducted between 1996-2000 in the company's plant in (AB), a medium-sized town situated in the central part of France, with its headquarters situated in (BA), a Parisian neighborhood /2/. Allcapt's experience may constitute additional data for comparative approaches, where similarities and differences in various patterns of knowledge creation process and problem solving may be identified.

Allcapt designed the temperature sensors for the Vulcain engine of Ariane V launchers. Developing new skills, know-how and competencies by training the people resulted in success. But a rapid extension of the company and of its (AB) plant represented a second challenge to the management. Allcapt, who developed technical skills and knowledge, had no expertise in Human Resource Management (HRM). Following a conflict, that materialized with a strike, Allcapt decided to learn management skills to deal with a very particular workforce (*see below*). At the present period the company is dealing both with industrial relations and quality problems /3/.

As Allcapt solved a technological innovation problem, the question remains: Will the company be able to deal successfully with the organizational and human aspects of learning and knowledge creation? The present paper is part of an ongoing research on managerial strategies and people's (and union representatives') reactions to them. For the study of transition periods, as Yin (1989) stresses it, *"the questions the investigator will more frequently ask are 'why' and 'how.'"* The paper is more likely to try to answer the 'how' questions: How did top management solve the problem of the technological knowledge and skill gap in order to innovate? How, after the rapid development of the company, and related industrial relations problem, did managers interpret the events leading to conflict? What strategies did they develop? How did Allcapt people implement them? The study of these aspects is interesting if we have to answer the following question: Does it make sense to speak about learning and knowledge creating organizations, or is it more relevant to deconstruct learning in its various dimensions and analyze them separately?

After giving a brief presentation of the company's history and evolution, and a description of the technological innovation challenge, I will present the management's attempts to create an appropriate HRM strategy. Conflicting objectives, obstacles to collective sense making, and the ambiguity of internal and external knowledge creation about human resource management characterize this process.

A Brief Presentation of the Company and of its Evolution

The (AB) plant, which employs 360 people, is part of Allcapt, an affiliate of an American holding since 1972. Allcapt specializes in the design, development, manufacturing and marketing of measurement systems and sensors for aerospace, space, and defense industries, as well as for nuclear and marine applications, and for process industries, in general. Their customers are well-known large firms such as Air Liquide, Airbus, Alcatel, Matra Marconi Space, Rolls Royce, SEP (now a division of SNECMA), and SNECMA, an engine manufacturer.

Allcapt and its (AB) factory date from 1960, when a French engineer created the company. In 1965, in order to benefit from lower labor costs in Spain, a subsidiary (hereafter referred to as Icapto) was created in Madrid. Before retiring, in 1972, the owner sold the company to an American holding. Since 1975, Allcapt is organized in three divisions: Aerospace division, nuclear division, and systems and sensors division for marine applications.

The examples below represent two important events:

a) The temperature sensors for the Vulcain engine (developed for the European launcher Ariane V by SEP, Société Européenne de Propulsion) represent a successful case of innovation in conditions of total uncertainty (Bagla-Gokalp, 1999). The existing tools being useless, Allcapt had to go through an innovation. The company learned through licensing, trial-and-error and by doing.

In the 1980s, the Ariane V launcher was a big project for ESA (European Space Agency). The French group CNES (National Center for Space Studies) opted for a new design for the Vulcain engines, using liquid oxygen and liquid hydrogen, together with a new design for the turbo-pumps. New instrumentation capable of functioning in extremely harsh conditions was needed to provide information on the engine's internal conditions and deliver this data to the computers controlling the launcher.

However, as the engine itself had not yet been developed by SEP, no precise data about the temperature of burned gases and cryogenic fluids, the pressure, the vibration level, and the velocity, was available, except those provided by numerical modeling and simulations based on extremely simplified hypotheses.

SEP wished to use both thermocouples, smaller and easier to integrate in less accessible locations in the engine, and resistance temperature detectors (RTDs), which are much more precise. Contrary to aircraft, there was no knowledge about what kind of measurement will be accurate, and in which parts of the engine one should insert the sensors. The thermocouples and RTDs were designed to measure cryogenic temperatures of liquid oxygen and liquid hydrogen (about - 150°C) the propellants used in Vulcain engine. They are pumped from reservoirs by turbo-pumps and atomized into the combustion chamber through several hundreds of co-axial atomizers. No existing sensor was able to operate in the expected conditions. Given the uncertainty of the conditions within the engine, it was difficult to specify *a priori* the characteristics the sensors would require. Conversely, the development of the Ariane engine required sensor information to ensure safety constraints will be met. Thus, development of the engine and sensors had necessarily to proceed together, step by step.

As Allcapt had a privileged relationship with SNECMA for more than 15 years (*see below*), the company was encouraged by SNECMA to consider SEP's bid. Specializing in processing thermocouples since the 1970s, Allcapt was, indeed, a credible candidate. Allcapt's management took advantage of the existence of Icapto, the above-mentioned Spanish company affiliated to Allcapt. ESA's European funds had been distributed mainly to countries such as France and Germany. When Allcapt's managers applied for the SEP bid, they specified Icapto as the supplier of required sensors. In that way SEP would subcontract a Spanish company. They knew that allowing Spain to participate would give a big advantage to Allcapt, in addition to a good quality/cost ratio. When a second campaign was launched by SEP, having already been contracted for thermocouples, Allcapt applied again, adding that they would be assisted by one of the company's American suppliers (hereafter referred to as Nimco), who designed RTDs for industrial applications. Allcapt was contracted to develop all the required temperature sensors.

b) After this technological innovation, Allcapt was more confident, and the managers decided to expand. One should not forget that between 1986-93, when hit by the economic recession, Allcapt fired 70 employees

out of 180, and it was not until 1993 that a recruitment campaign took place, to return to the number of employees Allcapt had before the recession.

In 1993, to import new expertise, Allcapt acquired a company that specialized in pressure transducers. In 1995, it created a second joint venture in Russia (the first being created in 1988). In 1997, Allcapt acquired a US company that specialized in fluid regulators, and the pressure product line of a French company. More recently, in 1999, Allcapt overtook two other companies, one in France, one in England, meaning that within the last five years Allcapt bought four new companies. Today, the company has about 20 service networks in France as well as abroad, to compete in global markets.

Allcapt is continuously growing, and the engine of the change is the Aeronautic Equipment Division (AED). Since the second half of the 1990s, the (AB) plant managers modified the company charts several times and tried to improve the organization of work and of the (AB) plant. Very recently, the executives opted for a matrix organization /4/. Between 1997-1998, the company hired 90 people, and moved, in January 1998, into a new, much bigger plant. In 1999, the staff of the (AB) plant doubled to reach 360. The (AB) plant also introduced a team approach: "*Now we have teams of 15-20 people with their objectives, and they are responsible of the final result for given products. They are working on team priorities, team spirit, setting objectives in quality, quantity, and time schedules. They have to conduct the production from A to Z, and this adds a kind of competition among various teams, as the performances of each will be publicized*" (Industrial Manager, January 2000).

Allcapt had a very bureaucratic personnel office. Following the rapid growth, the Finance Manager, whose office is in (BA), has been in charge of HRM. While everybody seemed to be proud of the new, very modern high-tech plant that attracted important visitors and local politicians, the plant managers had to face a strike, followed by more than 90% of the operators in the shop floor. The meeting between union representatives and the Finance Manager at (BA) was a failure. Following the strike, the CEO contacted a private consultancy group I shall refer to as M&M. After an audit, the group diagnosed that Allcapt needed innovative strategies in HRM. M&M recommended some actions and formulated several proposals that the company is trying to implement.

Technological Problem Solving and Innovation

For years Allcapt worked for one single important customer, SNECMA, a French engine manufacturer. In 1972, Allcapt was contracted, indeed, by SNECMA (mainly because its founder graduated from the same engineering schools as several of their managers) to process temperature sensors (thermocouples) licensed by an American company: *"SNECMA furnished the drawings and all the details on the conception"* (Industrial Manager). During the initial stages of the company's development, Allcapt's management drew heavily on networking and personal knowledge to reduce uncertainty and risk. During this *"mono-customer period"*, as the managers call it, the company operated in a very comfortable (almost routine) context *"with this friendly customer who represented more than 70 per cent of Allcapt's sales"* (Technical Manager, 1999).

With the SEP bid, facing a challenge, the (AB) plant engineers and managers had to create new knowledge and competencies. After a painful learning by trial-and-error period, Allcapt succeeded in designing and processing sensors, and eventually got through a product diversification, to process, progressively, new sensors for potential customers /5/. Several improvements to the sensors were realized, indeed, by substituting more resistant alloys for the metals, and by more carefully insulating the wires of the RTDs and thermocouples: *"We did more than copying drawings and instructions from licenses. We acquired a competency in processing both the sensing elements of the temperature sensor and the materials. The SEP project has been a springboard for us. We now manufacture our own sensitive parts and continue to work on the composition of the ceramics to adapt them to the specific needs of new customers"* (Materials Manager).

How Allcapt came through this difficult experience? Through the semi-structured interviews I conducted with (AB) plant managers and engineers, I caught the various stages of innovation, where the slow transition from routine and established solutions and behaviors to more creative solutions, and to truly innovative behavior, was visible.

Learning from others, learning with others

To deal with uncertainty, Allcapt initially (in 1988-89) chose platinum resistance RTDs developed by Nimco as the best candidate, *"because to wind platinum wire on ceramic mandrels, and to heat them to high temperatures requires that the platinum and the ceramics have the same coefficient of thermal expansion. Nimco developed the ceramic having*

this property. However, early formulations of this were not sufficiently resistant to required conditions' (Materials Manager, 1997). Allcapt then tried to adapt these RTDs using existing know-how through licensing. In 1990, after a two-year development period, Allcapt's RTDs failed in tests specified by SEP, and Nimco was not interested in investing any more resources for this product.

The Production Manager contacted an engineering school (NCIC) in a small town close to (AB), which specialized in the development of industrial ceramics. Two scholars, S1 and S2 from NCIC were offered grants: S1 for the glass covering the mandrels, and S2 to improve the ceramic mandrels. As the problem of the glass was relatively easy to solve, I will focus on the ceramic mandrels. S2 was expected to formulate a new powder with the appropriate proportions. Allcapt was short on time and had to push S2 to accelerate the process. Nevertheless, S2 was not working full time on this project, letting students and trainees deal with it. As the RTDs had to be validated by SEP in 1995, in order to have a full-time researcher on the SEP project, Allcapt contracted, in 1992, the present Materials Manager, who was recently graduated from NCIC and who had been a student of S2. He became a 'translator' helping two different cultures to communicate /6/.

The difficulty to adapt the product to the needs of industry was the next major problem. The Materials Manager recalls that at NCIC they were used to tinkering and that they were not interested in industrial or standard processing of the product they designed and developed. He had a hard time to *"transfer this technology from the laboratory to industry,"* according to his own words. In June 1993, the machines, ovens, and other technology were bought to process the ceramic mandrels at (AB) plant, after adapting them to Allcapt's specific needs. Still, to process standard products was not that easy, and the mastering of the various stages of the production and of the details of the operations in order to produce a consistent powder and ceramics took some time. Once his contract ended, the Materials Manager left Allcapt.

In 1993, after testing the product, the first 'critical review' of the RTD by SEP was not in favor of adopting it. The platinum was still not resistant enough, and the sensor presented an insulation problem. In 1994, the present Materials Manager was recruited, this time as Project Manager, to deal with the development of the RTD. With the assistance of the product quality person, he conducted product validation studies, where he discovered the number of operations to process the RTDs, and the necessity to develop an expert understanding of each process step: "*It was a great*

learning experience. Her method was interesting: to cut the product in a multitude of components and parts, to see where the problem is coming from. Before that, I concentrated on the mandrels. I then realized that this was just a very small part of the RTD. I got a broader view of the product" (Materials Manager).

It appeared to Allcapt's management that there would be no perfect sensor, because "*this is not an exact science: there are several parameters to control such as resistance, conductance, and strength; one cannot have them all within a single material. One has to find a compromise among these parameters. It's a genuine trial and error process*" (Industrial Manager, 1998). "*If you want to improve the glass, and eliminate the bubbles, you have to leave it in the oven for a longer period. However, this will damage the platinum wire... Even today, only slightly over one-third of the total RTD output is delivered to the customer as 'usable'*" (*Materials Manager, 1998*) /7/.

Negotiating Design and Accuracy

Allcapt's managers rapidly learned that innovation is always a compromise: "*For a new sensor to be designed, those who develop the launcher will ask for the best and the most rapidly feasible sensor, those who work directly on the engine will ask for the most accurate and reliable sensor that is easy to use. The finance division will ask for the least expensive sensor. These are people with different (and sometimes, conflicting) concerns. Ultimately they must negotiate. The final decision is always a compromise that blends scientific, economic, commercial, 'human relationa',l and managerial aspects*" (Production Manager).

RTDs not only necessitated a compromise among the parameters as expressed by the Industrial Manager and the Production Manager, but they also forced people dealing with various aspects of the innovation to negotiate, in accordance with the expectations of those who analyse the technology as a 'social construction' (Bijker, Hughes and Pinch, eds. 1987; Mackenzie 1990, Mackenzie and Wajcman, eds. 1985) /8/. So, when the product was refused by SEP, Allcapt's managers were under great pressure, thinking that SEP was ready to abandon them and that they had to prove their trustworthiness.

The major problem was the pressure level set to test the sensors. To Allcapt's management, it was clear that SEP should accept to lower it. There was no option, indeed, to delay Ariane V launch. The AED Manager of the general management team with its headquarters at (BA) defended the

idea that to be able to innovate one has to accept some flexibility: "*Given technological and time constraints, processing new RTDs that match SEP's expectations was not feasible*" (AED Manager).

Allcapt had to negotiate with SEP in order to lower the pressure constraints by modifying the 'measurement points' (i.e. the various locations in the engine where the temperature sensors were to be placed) and the AED Manager knew that SEP's Instrumentation Division Manager was the appropriate person to negotiate. Moreover, the AED Manager had known him for many years and was able to anticipate his reactions /9/: "*By experience I know that you always have to negotiate at the management level. The engineer who calculated the pressure levels the sensors would face was a young theoretician, not very well acquainted with practical problems. It is very hard to negotiate with engineers when they imagine that if they lower the standards, they will lose their credibility, and that this may damage their career. If his boss tells him to do this, he will be freed of the responsibility if something goes wrong*" (AED Manager, 1996). Together they sought the acceptable solution: The initial pressure level in the measurement points indicated by SEP engineer was 400 bar. After negotiations, the maximal pressure was lowered to 240 bar, a level the RTD could resist. The success of the compromise was evident when the product was accepted in December1994, and Allcapt began the processing of sensors in 1995.

Dealing with Complexity

According to the already mentioned managers, working for SEP for RTD innovation has been an invigorating experience. They think that after this successful innovation helped Allcapt achieve a reputation as a reliable and serious company. They are eager to credit this project with helping Allcapt to accept uncertainty, to deal with complexity and to develop a culture more based upon challenges and aggressive strategies, rather than routine solutions in a protected environment. This experience introduced a true break out: "*In our company's life, one can easily distinguish two periods: before SEP, and after. When we were working for SNECMA, we wouldn't know what it means to have a relationship with other companies. It was a relationship between two equivalent units or rather, between two individuals with similar functions in each company. With the SEP project we began to discover the complexity of our relationship with our customers, and our customers' customers. We learnt a lot about the complexity of networks (…). This was an apprenticeship to*

complexity. Things got even more complex when the first RTDs failed and when we contracted NCIC. For the first time we also worked with academic researchers with their different culture, and learnt to co-operate with them (…). We have learnt about analyzing situations, to make choices, and to accept the entire responsibility of our choices. This was a huge cultural change (…). When the top management understood that we had now achieved a new level of maturity, they were more eager to design new strategies" (Production Manager, 1998) /10/.

The SEP contract has also been an opportunity to acquire new technology and knowledge. One such example was the acquisition of specialized software for modeling. For the RTDs designed for Vulcain 1, the company sub-contracted a Belgian firm. In 1997, Allcapt invested in this technology, and the engineer in charge with modeling has been trained to master and use the computer programs such as Pro Mechanica. Pro Engineer enables getting 3D imaging of all the parts and components, and the project managers are proud of being closer to reality. The role of R&D also increased rapidly in areas such as high temperature and cryogenic ceramics and ultraviolet pyrometers.

The project managers have been transformed into multi-skilled people: "*If you look at the background and career of our first project managers, you can see the evolution: 15 or even 10 years ago, they would be promoted from the ranks of good technicians, who had a very good insight of the product. Today, the technical dimension is less important and we stress that they have to be very good communicators, inside as well as outside (…) And they must be fluent in English*" (Technical Manager, 1998). The expertise the company sought from their R&D people also changed, as Allcapt hired people specialized in specific domains of expertise, e.g. materials, optics, etc. "*The adoption of ISO 9001 would not have been possible without this expertise*" (Technical Manager, 1998). One of the consequences of this project was, indeed, the ISO 9001 accreditation in 1992, making sure that Allcapt meets the new European standards.

Dealing with Human Resource Management Problems

As Allcapt's main challenge is to manufacture reliable sensors, workers' craft, skill and knowledge are considered the company's most important assets. Competence building and "*the culture of individual and collective responsibility have been one of Allcapt's initial challenges*" (Industrial Manager, 1996).

Competence building without human resource management:

The production workers and operators are called '*compagnons,*' this term referring to highly skilled craft people producing unique products. The official propaganda stresses the role of experience, manual dexterity and practical and tacit knowledge /11/ [where formal, written information is an inadequate source (Collins 1992, pp. 56-58, see also Bagla-Gökalp 1996a, 1996b)], but also individual responsibility for every stage of the process: "*We want our people to understand the importance of following exactly the instructions indicated by the Engineering unit. They have to be conscious of the fact that we are producing 'a five-legged sheep.' Everything is 'in the hands' of our compagnons. If the worker accepts that each of his/her actions, movements, or decisions will impact the final product, s/he will not, for example, twist a wire with more strength than is required. If he errs, he should be able to inform his boss, even if the error is not detectable. To this end, to improve communication patterns and the human relations was a necessity*" (Industrial Manager, 1996).

Patience and precision are so important in handling the very tiny wires used for the sensors, that the company preferred to hire women who had previously been employed in the textile plants of the area, as the textile industry began to de-localize its operations to low-wage countries in the 1970s /12/: "*The company completed their training by providing them with some basic knowledge concerning the principles of electricity, the reading and interpretation of the measurements provided by the instrumentation, and of the drawings provided by the engineering unit*" (Industrial Manager, 1997). Allcapt managers tried to adapt existing skills within the company. As the sensing element of the RTD consisted of platinum wire 17 microns in diameter, wound around cylindrical ceramic mandrels, to handle the very tiny components and wires the managers preferred to look to *in situ* human resources and skills: they decided to train a female electronics operator at Nimco (US), to become a 'prototype technician.'

Later, she helped the company to hire two young persons to process the sensing element. She had to evaluate their manual dexterity and psychological capability to do this very specific job as there is no way to thoroughly formalize and codify them. She then trained them. As it was not easy to standardize the RTD manufacturing, one possible solution was to always assign this job to the same operators, and this was indeed included in the contract with SEP. The tacit knowledge of these operators was the guarantee for the reliability of the product, and SEP maintained some control over the processing of the sensors by controlling the identity of

persons who manufacture them. For other complex operations, people from technical schools were recruited and learned by doing, but the method was long and costly, as no existing skill was fitting Allcapt's needs.

The skill gap during the transition from school to factory is not specific to Allcapt /13/. In the 1990s, with the implementation of new products and the diversification of the sensors, the Industrial Manager became more and more conscious that creating an education program with in-firm knowledge acquisition by on-the-job learning and monitoring would be the solution. To improve competency creation Allcapt decided to create its own school with a more adapted curriculum. The Industrial Manager made every effort to communicate the relevance of such a project. As soon as the Ministry of Education accepted the project, Allcapt proposed a policy called 'qualification contracts' to those who applied for technical positions, and was helped by a lifelong education institute /14/. While employing these young persons on a part-time basis, Allcapt provides them a two-year education program, for a total of 900 hours, and eventually hires them according to their performance. Each newly recruited person was then assigned to someone senior with experience and who would train him. In 1997, when the experience began, they represented 40 % of AED's operators.

Interpreting the conflict

In January 1998, when Allcapt managers moved in a brand new and pleasant plant, the Industrial Manager thought that they had a unique work place in an economically depressed region. The plant attracted important visitors such as the mayor, and other local officials and politicians, and "*the operators would spontaneously come and shake hands, with a happy smile, and we were quite sure that things were going well. With the spring 1999 strike we understood that their attitude was superficial: they were not so happy as we thought.*" Some managers still think that this strike was the *strike of rich people*, as they have *life long employment in the plant, wages and working conditions that are above the average of this region* (AED Manager, 2000).

In March 1998, the union leaders felt that *"despite increasing profit, workers would only get crumbs."* Moreover, they feared that to win the incentive schemes the board of directors were trying to implement, managers at all levels would push their subordinates and the team to work

harder, to create *"more stress, frustration and inequality."* The union bulletin emphasized the unacceptability of this functioning seen as a *"threat to the team spirit, the cohesiveness and unity, to the quality and hence, to the competitiveness of the company."* Neither the Industrial Manager (who was preparing his retirement as he is one of the oldest in the (AB) plant and represents its memory and history and as such, has a charismatic power and legitimate authority), nor the headquarters in the Parisian suburbs, and particularly the CEO, were able to anticipate the strike.

The CEO opted for an auditing by the M&M consulting group, to understand what was going wrong. He is known to be a very authoritarian and strong personality and there is no doubt, his style of leadership and of decision making shaped the way Allcapt produced knowledge by choosing the M&M methods. M&M also influenced the process of organizational learning as they brought their concepts and tools to contribute to the way the company considers its functioning and problems. While the collective nature of organizational learning and knowledge creation is largely emphasized, top managers' influence and instrumental role in creating new organizational knowledge is well recognized (Cavaleri and Fearon, 1996; Lyles and Schwenk, 1997; Prahalad and Bettis, 1986). It is primarily the top management *"who interpret the importance of environmental events and who communicate their view"* (Lyles and Schwenk, 1997: 53), and *"who process organizational events through pre-existing knowledge systems"* (Prahalad and Bettis, 1986). Their theories, beliefs, and experiences influence the information they select. Top management's decision to imitate or to borrow from consultant groups or to learn from the relevant business literature, shape the process of knowledge creation. The management then communicates the valued new knowledge through statements, symbolic actions and speeches, and encourage it by rewards, incentives and bonuses, to provide a basis for acceptable behavior and desirable actions for the firm /15/.

For the audit, M&M consultants prepared a list of 80 people, who were partly designated by the management and partly by balloting, the majority coming from various levels of management. Semi-structured interviews were conducted to conclude that the problems concern the following points: a) the worker's vanishing feeling of being part of Allcapt; b) management problems; c) wages (including wage gaps between men and women workers); d) communicating and sharing information; e) job organization f) time management; g) human relations. Moreover, the separate doors to access to the plant as well as the perceived separation between the shop floor and the engineering specifications and procedures

unit (who gives the job instructions and the methods) were not easily admitted by the majority of workers. They were expecting more equity, expressing their need to be respected for their important contribution to the company's performances, and to be recognized as persons and workers. In November 1999, when I interviewed him about the situation before the conflict, the Industrial Manager added that the workers were also complaining about "*the existence of taboo subjects*" and about *"the practice of promoting by nepotism rather then merit."*

The Industrial Manager gave his own analysis for the reasons leading to the strike. According to him the problem was due to: a) the rapid increase of a heterogeneous population ("*The operators and the engineers don't have the same life nor the same career and it's difficult to make them cohabitate…Because of the growing number of workers coming from different worlds and having different lives, we had large teams. New recruits hired after the qualification contract constituted 30 to 40 % of the team, some people having to manage up to 60 people without any preparation*"); b) the power strategies of senior operators expected to behave as mentors for juniors to complete the training program ("*Some of them held the juniors in contempt. We were not smart: the best operator is not automatically the best mentor. And I have to mention this, the young people we recruited came from technical schools. This means that they are not good in mathematics, not good in French etc. They go to technical schools because they failed elsewhere, and not by choice. So you have the worst category. These guys are not the kind of population developing a respect for authority or for the institution and are difficult to manage. Don't forget that they we had to meet 220 of them to choose 22")*; c) the wage differences between the senior operators and the juniors who were pretending to have the same competencies and to do the same job *("Some of them became really efficient and make 8.000 FF, i.e. 6.400 FF in real terms, and they just don't accept the fact that the seniors doing the same job earn between 12.000 or 14.000 FF. Moreover, the operators don't accept geographical mobility: they want to stay here, in the region: to them, even 40 miles is not acceptable to look for a job. And engineers don't come easily here because the region is not attractive, and the turnover is high. So we have to take care of them. But the operators also refuse the idea that engineers must have higher wages because of their initial formal education and diploma"* (Industrial Manager, November 1999)*.

In October 1998, when the CEO wrote a synthesis of the M&M diagnosis to be diffused at the (AB) plant, he insisted on the following: *"Our company has a technical/engineering culture. Sometimes several*

members of the same family work at (AB). Technical know-how, the nature of technology and the technical conditions of work are perceived as being good. The management style is qualified as 'technocratic' and 'authoritarian', with no delegation of power and this was inadequate as our operators' know-how, dexterity and experience are crucial to increase productivity and the accuracy of our products. They were not asked to express themselves and their ideas and suggestions were not taken into account... Alongside this skilled people, we also have a large number of young people who also need a relevant management style. Both consider the plant as part of their life and are not willing to change their job. They want everybody being considered with equal worth and dignity." The CEO followed the recommendations of M&M and stressed that he wanted "*true human resource management strategy to target individual and collective efficiency."* He asked M&M to educate the (AB) plant managers of all level.

Following M&M's advice, the CEO also decided to recruit a Human Resource Manager, as the Financial Manager was not supposed to be the right person to play this role /16/. M&M wanted Allcapt to recruit a HRM "*coming from the industrial world, to amanage work, workers and their competencies in order to adapt Allcapt's activities to the economic evolution of markets."* S/He should be *"a coach."* Among the competencies he should have, the following were emphasized by M&M: "*Good knowledge of labor relations law, good knowledge in human psychology, sociology of organizations, in qualitative and quantitative methods of personnel management, people's training and formation, and the willingness of analyzing the various jobs at (AB) and their evolution.*" He also had "*to use competency rather than power and be able to analyze situations while remaining in the action."*

Union representatives (the dominant union being CGT, a strongly left-wing union) reacted by stating that "*the only people who would benefit from the results of this audit is the boss of M&M"* (a written document, dated January 7, 1999): "*We do not need the outcomes of this audit...The top management throws money in organizing meetings with the consultants to train managers and executives in communication skill. The best way would be to find together new ways of solving problems, to save time, to detect what's missing, what's useless, and to improve things... What we want is to have good working conditions, to be respected, to participate in company's accomplishments and to take benefit of it, because the company should return us a percentage of what we produced."*

'Knowledge' and 'shared meaning' creation attempts

In organizations, decision makers adopt language to express beliefs that they would like to be shared, and articulate and codify them to improve the transfer process /17/. To construct collective knowing and "collective meaning" (Dixon, 1999: 50), more and more organizations use "*task forces, committees, problem solving teams, self-managed work teams*" (DeChant, 1996: 101). New knowledge is manifested in new structural arrangements, new culture, and new collective action (Normann, 1985). Usually consultants help the companies to define the tools. Swieringa and Wierdsma (1992: 93) state that "*in the 1980s, consultants emerged, who applied themselves more and more to linking directly educational activities and consultancy work...The essence of learning organization is that the process of organizational change coincides with the process of behavioral change. The management of organizational change processes is, within a learning organization, the leading of a collective learning process. Assistance with these processes is an area in which advising and education coincide, and therefore so do the profession of consultant and educator*" (Swieringa and Wierdsma, 1992: 137). Even though today's organizations are labeled "learning organizations," to the employees sometimes learning may signify "going back to school" and this feeling was also strong among managers and operators at the (AB) plant.

Following M&M recommendations, (AB) plant workers defined and adopted a *Charter of good behavior* and continue to develop several working groups: The "Improvement of everyday life" working group (including security and health issues), the "Problem solving working group" (including the elaboration of objective criteria for evaluation), the "Encouraging acceptable and respectful behavior to improve human relations" working group, the "Improvement of information circulation" working group. They operate now with 13 coaches and almost 60 participants. These teams regularly meet to study important issues and aspects of their sector of activity (temperature, pressure, etc.). Due to their regularity, these meetings are expected to raise (AB) plant staff's awareness of crucial and emerging issues. Information, analysis and action to be taken are discussed in these groups for agenda setting.

The outcomes of these working groups may be the creation of a collective ability to raise questions, to analyze situations, to create relevant information about them, and to propose agreed solutions, with workers contributing to improving things. But workers complain that some of the groups are not "natural" groups, as the head of a unit designated the people with whom he will work (Document of the Problem Solving working group

dated May 10th, 1999). In addition, there is a tendency to confuse the problems specific to a shop floor, and the four major topics the working groups are to handle. However, the meetings also have therapeutic effects: in the written documents, the managers and team leaders were criticized for lacking skills in communication, human relations, pedagogy, polite behavior, respect and solutions.

Allcapt executives and managers from all levels also benefit from an intensive training program, using methods such as Lacoursiere or Blanchard who were adapted by M&M to deal with motivation and team management who help developing a common interpretation of situations and similar approaches to problems /18/. (AB) plant managers and team leaders now refer to this model to perceive 'reality.' M&M also uses leadership games with different models of personality /19/ to rise the managers' awareness of the importance of leadership style in order to improve their relationship with the operators. The Industrial Manager believes that *"being trained by the same group (M&M) creates a homogeneity between (AB) and (BA) as well as between different divisions"* (November 1999). But managers from different levels did not easily accept the idea of being trained.

According to one M&M consultant I interviewed in March 2000, *"*C*oming from prestigious engineering schools, Allcapt executives and managers hated to be considered like learning kids. They are very confidant, and they think they know the best of everything. When I gave them an African game they reacted to mention that there is no time to play when serious problems are waiting for solutions. And then they realized that facing an unknown game they were in the same position as those who hear from them new instruction. They are learners in an apprenticeship situation."*

M&M wanted Allcapt to introduce employee evaluation schemes, and one of the working groups was assigned to the task of contributing to the definition of objective evaluation criteria. On January 13, 1999, the industrial manager informed the worker's representatives that the company would prepare the evaluation guidelines for May 1999, to help managers and team leaders to evaluate the competencies of their fellows, in order to make better decisions about whom to promote. Union representatives reacted very negatively, pretending that *"rewards according merit are always subjective."* The first evaluation attempt was a true fiasco.

The Industrial Manager recalls that some operators protested the results of their evaluations by placing them at the entrance hall. Indeed, managers from all levels interviewed their subordinates before being

prepared to conduct these interviews: "*Rather then discussing, they were judging each other. Filling the forms, the bosses pretended that the operator was badly performing according to the chosen criteria. Workers were angry. One worker put in the interview forms that his boss is a 'Japanese ant,' 'he just says Hi! Before giving the instructions and leaves: there is no communication'. Another hung his results with a conclusion: 'after 17 years at the (AB) plant I'm a bad operator.' When I arrived in March the situation was similar to warfare. But a*s *a charismatic leader with a paternalistic management style, the Industrial Manager promised to those who have been judged as bad workers, that he will deal with this issue and the battle ended.*" (Human Resource Manager, November 1999*).*

A year ago Allcapt did recruit a HRM. Among other things, he had to formalize skill and job descriptions for every post, so as to improve recruitment policies, implement 'objective criteria' for job evaluation, develop more adapted wage policies (i.e., considering the possibilities to implement the principle of wage according to merit), work through a better time management for all categories of workers (particularly because of the 35 hours working week who now is official). He also had to improve the communication in the plant because the workers were critical about the quality of information and its relevance or clarity, and on that particular point M&M put that "*one of the functions of management being sense making, messages and information must be clear and understandable.*" The HRM is concerned about information sharing, and was enthusiastic when he informed me that "*there is no taboo subject: We discuss every single topic. If you tell them that within five years the cost of manufacturing a plane engine was reduced by half, they understand it, they know what it means*" (November 1999).

The HRM wants to create his own methods "*based on respect of the other and direct verbal communication*" (February 2000). He is proud of spending several hours every day in the shop floor, watching operators in their work stations, discussing with them, observing the human relations, and observing human interaction in the company's restaurant during lunchtime: "*I want to see and to be seen. I want to observe situations, and to analyze their meaning.*" As Ferris and Fanelli (1996, pp 75, 79) claim, "*the true learning managers get out on the floor where the work is being done, and pay attention to people and their problems; they get to know employees through their work and the problems they encounter in producing products and services.*" The HRM discovered the importance of tacit knowledge (though he had not heard this concept), by observing people at work: "*The operators use their senses to gather information and data:*

The sound of the machine at a certain point, the surface aspect of the artefact they are constructing…Their eyes, fingers and ears try to feel what the operation needs to be. They create relevant knowledge that can not be formalized and transferred" (March 2000).

The HRM inherited some concepts and action introduced by M&M: "*The tools have been set before my arrival. It's okay when it comes to use the methods of coaching, supporting and delegating, and to the Blanchard Method with D1/D2/D3/D4. But for the remaining, I have my own vision of things. And what's important to me is not the tool as a tool, but the human being capable of taking action. We don't need a sacralization of the tools and my feeling is that to the person from M&M you interviewed, bringing tools and applying methods have became an end for themselves.*" /20/ (March 2000). As Dixon (1991: 167) states, when one is supposed to learn from management expert ready-made answers, this can be in contradiction to the concept of organizational learning. He is now in a difficult position, because the managers are being trained by M&M, whereas the HRM has his own ideas, methods, and rhetoric about the same issues. The (AB) plant staff is aware of this ambiguity, as the HRM does not feel comfortable with the intervention of the M&M, whose consultants behave as they have the power to influence the HRM's action.

CONCLUSION

The relationship between knowledge creation and learning is a complex one. The nature of knowledge organizations create depends upon the questions they raise, the way they interpret and attribute meaning to ongoing processes, the information they decide to gather as being relevant, the sources of knowledge they choose, and the nature of collaboration they develop. Allcapt's case indicates that organizational learning and knowledge creation may be identified with the attempts to constantly try to adapt to evolving situations and ongoing changes, and to prepare the future of the organization. But the company failed to generalize the ability to learn and create knowledge that was developed around a first successful experience. In Allcapt's case, one easily see two different models of knowledge development and learning: technological and organizational. The first was tackled by engineers who tried to learn through licensing, as well as through cooperation with research centers, and through importing skill, know-how, and knowledge. The company was not in a position of inferiority: rather it had the power. Moreover, the technological challenge was accepted by the (AB) plant as it was very rewarding to work for Ariane V. This was consistent also with the company's technological culture. After a painful trial-and-error period, Allcapt finally developed the new products the customers needed. There was much pride about this event. Despite all the difficulties the company faced and the resulting stress, the industrial relations were good.

For the second, i.e. organizational aspect, the top management plays an important role, and shapes the structures to be set as well as the methods to be used. Information about managerial skill, and knowledge about workers' competencies are imported from M&M, but in this case there is a power relationship between M&M and the (AB) plant managers. Technological learning seemed to be more neutral than learning managerial skill, and easier than adapting one's competencies and behavior to the model set by an outsider, whose legitimacy is not easily accepted. Not only managers from all levels doubt the efficiency of the training, but the operators are also suspicious about the new evaluation criteria. Even among the management and engineers, the idea of being judged not only for their technical skill and know-how but also for their relational and communication skills is not easily accepted.

The problem becomes further complicated when one knows that the newly recruited HRM, who spent almost a year to understand the nature of the company's operations and the skills they need, as well as the nature

of human relations, would like to take action following the outcomes of his analysis, rather than following M&M vision of things. He is a very sensitive person who likes to repeat that he loves people. He is very communicative and does not put distance between himself and people. He is comfortable negotiating with engineers as well as operators and union leaders, as he is very adaptable, and respectful of people. External knowledge and rhetoric circulates with his analysis and rhetoric, and Allcapt employees hardly distinguish between internal and external knowledge. This ambiguity is worsened by the retirement of the Industrial Manager in June 2000. The Industrial Manager will not be replaced. Thus, in addition to the power conflict between M&M and Human Resources Manager, one will eventually have to consider the 'sense making' struggle (which could eventually become a power struggle) between the Human Resource Manager and the second most powerful person of the (AB) plant, the former Production Manager (who is now Operations Manager for Allcapt and Icapto). He has been at (AB) for many years (whereas the human resource manager is the most recent person to have been recruited), and he is closely involved in the competency evaluation criteria definition, and in the development and functioning of the working groups who are part of HRM. One can consider that the (AB) plant may face a problem of ambiguity of power, and even a schizophrenic situation created by the presence of M&M, when for the creation of a shared meaning, the need for a legitimate leader and the unity of power becomes necessary.

NOTES AND REFERENCES

/1/ As Sanchez and Heene put it, "*The topic of organizational learning and knowledge has received much recent attention from a number of perspectives, including economic and organization theory* (Boisot, 1995), *organization studies* (Nonaka and Takeuchi, 1995), *technological change* (Durand, 1993), *social systems* (von Krogh and Vicari, 1993), *cognition* (Walsh, 1995). According to Senge (1990:1), "*learning organizations are places where people continually expand their capacity to create the results they truly desire, where new and expansive patterns of thinking are nurtured, where collective aspiration is set free, and where people are continually learning how to learn together*" using systems thinking, personal mastery, mental models, shared vision, and team learning. Senge (1990:14) stated that *"through learning we re-create ourselves, we re-perceive the world and our relationship to it",* concluding that a learning organization is an "*organization that is continually expanding its capacity to create its future.*" To Marshal *et al* (1997: 230) the management of knowledge would mean " *the attempt to recognize what is essentially a human asset buried in the minds of individuals, and leverage it into an organizational asset.*" Lassey (1998: 3) insists upon the importance of collective learning in organizations, and puts training as a crucial part of learning, adding that successful organizations are proactive learners: They plan their learning, develop skills which they will need in the future, they harness the informal learning networks, and utilize the existing competence of staff to maximize the development potential of organization, encouraging and supporting learning through the monitoring and appraisal system and through the organization's culture (its beliefs and attitudes): "*Organizations only exist in the minds of its members in the sense that without cooperation between the individuals that make up the organization, it cannot function. The organization itself only manifests itself in the behavior of its people. So, if an organization learns, there is a mutual changing of behavior*", therefore "*organizational learning is equivalent to organizational change*" (Lassey, p 6, p 8). *"Organizational learning and collective learning begins when there is a recognition that the rules no longer lead to behavior that produces the correct results and the collective behavior and the rules that govern that behavior are changed at the same time.*" (Lassey, p 10). Argyris (1977) proposed that organizational learning is a process of detecting and correcting errors. Nixon (1999:1) states that learning is sense making: it is the process that leads to knowledge. Senge (1990) distinguishes adaptive (or reactive) learning that is about responding to the

environment, from generative learning that is about anticipating the future environment, the learning style being closely related to the management style. Lyles and Schwenk (1997) also refer to the peripheral knowledge structure. The core set contains knowledge about the most basic of the firm's purposes and goals, while the peripheral set contains knowledge about sub-goals and about the behavior or steps necessary to achieve those goals. The peripheral structures are open to much more debate and disagreement than is the core set (p 59) Huseman and Goodman (1999: 107) define knowledge as *"information laden with experience, truth, judgment, intuition, and values; a unique combination that allows individuals and organizations to assess new situations and manage change*." Experience is seen as the essential bridge between what happened in the past and what is happening in the present. The truth is defined as the critical understanding that bridges the gap between objectives and results. Judgment is the ability to make sense of a situation that is completely unfamiliar. They see in values the lenses through which we view the world, one of the main guides when gathering knowledge, as they dictate the ways in which we determine what is important and test actions. Huseman and Goodman (1999, 73) believe that *"one major roadblock to organizational learning is mental models"* working as obstacles *"to stay in sync with the outside world* (...) *Once a company has adapted to a new environment, it is no longer the organization it used to be; it has evolved. This is the essence of learning."* (De Geus, 1997). Cavaleri and Fearon (1996:15-16) define organizational knowledge as *"the capacity for effective action over time, that results from the collective knowing, experience, and reflection of all members of an organization ."* Mason (1993: 843) coined the concept of strategic learning to describe *"the process by which an organization makes sense of its environment in ways that broaden the range of objectives it can pursue or the range of resources and actions available to it for pursuing these objectives."* One important distinction was to oppose single loop learning to double loop learning (Argyris, 1994). Single loop learning is when management reacts to existing system and detects and corrects its errors, while double loop learning prompts organizations to ask fundamental questions about policies and modifies the organizations' underlying norms and objectives. Effective double loop learning is a reflection of how people think –that is, the cognitive rules or reasoning they use to design and implement their actions (Argyris, 1998: 84). It is supposed to be painful: *"Double loop learning tends to be rather messy and untidy and not amenable to formulaic approaches*" (Douglas and Wykowski, 1999: 12). Swieringa and Wierdsma (1992 : 39) recall that double loop learning is

typically concerned with conflicts, disputes and contradictions between individuals, departments, factions and other groups. Lassey (1998:10), Swieringa and Wierdsma (1992) add the triple loop learning when the essential principles and the role or the mission of the organization are questioned. But Neilson (1997) states that with these approaches one can not see how organizations know when to employ one of these theories.

/2/ To analyze the single most important innovation case, the design of temperature sensors for Vulcain, the engines to be used for Ariane V launchers, I conducted semi-structured in-depth interviews in 1996-97 and again, in 1999, representing a total of 18 hours of tape-recorded data. In 1996-97, the Aerospace Equipment Division Vice-President (hereafter *AED manager*), the *Industrial manager* of (AB) plant, the Deputy-production manager, who now is the *Production Manager*, and the *Materials manager* who is working for the R&D unit and who reports to the technical manager have been interviewed twice. Both the *Production manager* and the *Materials manager* have been interviewed a third time, in 1999. In May 1999, I also interviewed a *Project manager* working at (AB) plant since 1998, and the *Technical manager*, who is also in charge of European programs. As part of my fieldwork, I also organized one visit to the company's headquarters at (BA) in a Parisian neighborhood, and three visits to the (AB) plant (two visits to the old plant and one visit to the new one, as in 1998 Allcapt moved to this larger plant situated in the same town), to observe people working or interacting, and to have informal discussions with the staff. AED, the most important and rapidly expanding division of the company, with a turnover of US $ 50 Million (projection 1998-99), representing 63.5 per cent of the total turnover, currently has 340 employees which is more than the total number of employees of Allcapt in 1994 (317). The division employs 115 production workers, and 60 engineers and technicians at the (AB) plant. The first part of the paper has been presented in a modified form in Leeds (Bagla-Gokalp, 1999). To analyze the ongoing organizational and managerial changes which constitute the second part of this paper, I re-visited the new (AB) plant 7 times: November 24, 1999; January 14th, 2000; February 2 and 16, 2000; March 3, 8 and 21st, 2000. During Winter 2000, the Aerospace Equipment Division (AED) manager became the *Aerospace business group vice-president* and is now responsible of marketing, R&D and commercial action of the whole company. The former *Technical manager* replaced him in this position. The management committee, which is at (BA) includes the manager of aerospace business group, the finance and purchasing manager, the development manager, the

quality assurance manager, the recently hired Human Resources Manager, the Industrial Manager of (AB) plant, the operations manager for (AB) and Icapto (who is the former production manager in my interviews), the systems and sensors division managers the nuclear division manager and the aerospace equipment division (ex technical manager).

/3/ The company loses money because of an important decrease in quality, interpreted as workers' resistance by the union leaders. When I interviewed the *After Sales Service Manager,* he informed me that there is no clear knowledge about that, no criteria to evaluate or quantify the problem, but just some chats and rumors. He thought the company would need a clear and shared definition and formal knowledge about this topic. The Industrial Manager gives his own theory: "*Our young operators were really careful when they were hired, before the employment contract was signed. Once they got the job, they behave, I guess, like the driver who is very careful the day he's willing to obtain his license and than once he has the license he drives less carefully and even, take risks.*" The company asked the present quality manager to produce detailed quantitative data that he prepared at the end of March 2000 and the company was looking forward to recruit a new Quality manager with extended functions.

/4/ Imitation is a common behavior for organizational design issues. Moss-Kanter claimed that matrix organization structures "*were first developed to aid technological innovation -the large-scale development projects in the aerospace industry- and are found more frequently in rapidly changing, highly innovating organizations*" (Kanter, 1996: 100). Also, "*dividing the organization into smaller (but complete business) units based on a common end use goal but not around function or specialty aids activation of innovation by producing structural integration at micro-level*" (p.101).

/5/ One of the targeted customers was Rolls-Royce, "*because Rolls-Royce, aside from being European, was the second most important aircraft engine manufacturer*" (Technical Manager, 1999). Allcapt first failed to interest Rolls-Royce, but progressively, developed a new strategy who happened to be successful after three years: "*We presented the high-tech aspect of the product, the teams who process it, the maintenance services, etc. We even manufactured prototypes for them to try. We created a 'service' relationship*" (Technical Manager, 1999).

/6/ For the concept of 'translator' see: Aitken 1976, 1985 and Gökalp 1992, 1994. A sociological approach developed at the Centre for Sociology of Innovation by French sociologists such as M. Callon and B. Latour at l'Ecole des Mines in Paris use also the concepts of 'translation' and 'translator', the latter referring to a social actor who is at the core of an innovation process that can be stabilized thanks to his/her translation when the various human, as well non-human, actors, are aligned around the same definition of a project (see: Callon 1986, Latour 1987).

/7/ *"During the initial periods, when SEP was waiting for 60 or even 80 RTDs, we would give them only 30, because of processing failures. We were doing exactly the same operations, and it was difficult to understand why sometimes we would have good products, and sometimes we would fail. Things are getting better but we know that we have to accept losing 30 per cent of our products"* (Materials Manager).

/8/ For analyses of innovation (theoretical approaches and case studies) see: Aydalot and Keeble, eds. 1988, Biemans, Branscomb and Keller, eds. 1998; Bucciarelli 1996, Dodgson and Bessant 1996, Fountain 1998, Gregersen 1992, Lundwall, ed. 1992, Miettinen 1996, Murray 1997, Senker and Sharp 1998, Von Hippel 1977, 1998.

/9/ Trust has become a major theme in managerial studies. See for example Blomquist, 1998 ; Krieger, 1988.

/10/ Kanter (1996: 105) speaks of a "culture of pride" in a company's achievements and concludes that success breed success.

/11/ For this concept, see: Polanyi 1958, 1966. Tacit knowledge can usually be represented in the form of graphs, presentations and other formal data, or it can be embedded into systems, processes, etc. Knowledge generation means, to Huseman and Goodman (1992:146), to turn tacit into explicit, by constructing methods by which the most talented and experienced employees may describe what they know. In this particular case, the knowledge could not become explicit. As put by the Industrial Manager: *"Experience is important, as we are learning by doing, rather than exclusively relying on R&D results. Only experience could teach people, for example, that if the thermal treatment of the material is done during a specific stage, this will cause a lengthening of its lifetime."* See also Bagla-Gökalp 1990, 1998. It is now widely accepted that knowledge

creating companies follow four basic patterns that exist in interaction in knowledge-creating companies: 1) From tacit to tacit which could be transferred through apprenticeship (learning one's 'master's craft skills', but it can not be leveraged by the organization as a whole; 2) From explicit to explicit, which is again a combination that does not really extend a company's existing knowledge base; 3) From tacit to explicit, allowing the knowledge to be shared; 4) From explicit to tacit, the pattern meaning that when a new explicit knowledge is shared throughout an organization, individuals may use it to broaden and reframe their previous tacit knowledge (Nonaka 1998:28-29).

/12/ Bagla-Gokalp, 1993.

/13/ In his study of a sample of 20 new technology based firms in the Aberdeen region, Keogh (1999) observed that SMES in this region tend to rely on identifying needs based on existing staff profiles coupled with loose projections for new business, based on their current financial performance, to stress the limitations of this strategy in the identification of human resource requirements.

/14/ In an interview for the advertisement brochure for 1999-2000 of a life-long education and training group, the *Industrial Manager* recognized that they helped Allcapt to solve the problem of skill gap, as no available education program in schools would train the specialized workforce the company needs for temperature and pressure sensors: *"They analyzed our skills and products and with the organization dealing with the metallurgical sector we are part, they helped us to create a qualification contract which is specific to the company's operations. They helped us to recruit 22 young people to be trained by mentors after the education program."*

/15/ Schein (1993) insists upon the importance of communication, as he refuses to see dialogue at the executive level as sufficient for a learning organization.

/16/ When I interviewed him in November 1999, the HRM also emphasized this mistake: *"To me, training is an investment, to the finance person it's a cost. We are conscious about costs but our duty is relational, human. So, in postponing the recruitment of a true human resources manager, Allcapt thought that it was a cost-saving, while it's the reverse."*

/17/ "Codifiability" refers to " *the ability of the firm to structure knowledge into a set of identifiable rules and relationships that can be easily communicated* " (Kogut and Zander, 1997: 22).

/18/ The concepts used are: D1 (the enthusiastic beginner, with high motivation but low competency level), D2 (the disillusioned learner, with decreasing motivation while competencies progress), D3 (the knowing professional, fluctuating according to problems to be solved and the solutions that work, where the competencies are being consolidated; D4 (the calm expert with stabilization of motivation and mastered competency). So, team leaders were given instructions on how to behave according the four stages. They were told that for D1 they have to learn to communicate by presenting the targets with a clear, understandable vocabulary and relevant concepts, to diagnosis the existing skills and competencies they can use and set up the methods and fundamental tools. For D2 they awere told to let the operators to express the difficulties they face, and explain the reasons leading to the choice of a particular method. For D3 they were told to encourage the learners to evaluate their results and to propose him a variety of situations using case studies or simulated problems. For D4 they were told to put in practice whatever is learnt.

/19/ The models are: "critical parent", "caring parent", "adult", "adapted child", "little professor", "spontaneous child."

/20/ Starbuck (1997) quotes Orlikowski's (1988: 179-267) study of a consulting firm where she raises a similar issue. She details the firm's effort to capture its experience as software. Consultants built software 'tools' that help them. At first, isolated people used these tools voluntarily, but informal norms gradually made their use mandatory. Thus, the tools both expressed and reinforced the firm's culture. Generalization made the differences among clients' problems less and less important. The consultants stressed the tools' strong influence on their perceptions of problems and their methods of solving them.

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