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Demystifying the Learning Organization II

The Case of Chaparral Steel

In the mid-1990s, Chaparral Steel, a "minimill" in Midlothian, Texas, received a great deal of attention for its success in competing with low-cost non-U.S. producers. In its first 8 years in operation, it grew from 250,000 tons of produced steel at start-up time to the 10th largest steel producer in the United States in 1998. Breaking all previous efficiency records in the process, Chaparral received the following lauda-tory analysis in *Fortune* magazine:

> Chaparral is remarkable because, like a sculling crew that pulls in flawless synchronism, it has all the basic elements of good management—customer service, empowerment, quality, training, and more—working in concert. As a result, it produces *steel* with a record low 1.6 hours of labor per ton, vs. 2.4 hours for other mini-mills and 4.9 hours for integrated producers. (Dumaine, 1992, p. 88)

According to *Fortune*, Chaparral Steel owed its success to observing general "principles of good management."

Dorothy Leonard-Barton (1992, 1995), who studied Chaparral Steel extensively, attributed its success to organizational learning. The former CEO of Chaparral Steel Gordon Forward himself stated that "we are a learning organization" whose core competence is the "rapid realization of new technology into products" (Leonard-Barton, 1992, p. 23). Here are some examples of organizational learning at Chaparral:

> Managers assume that the performance of any purchased equipment can be improved…. Some improvements are novel enough to be patented. The rolling mill equipment its vendor believed limited to 8-inch slabs is now turning out 14-inch slabs, and the vendor has tried to buy back the design. (Leonard-Barton, 1995, p. 11)
>
> When cooling hoses burst during the first few weeks of starting up the new…project, a group of operators, a welder, a foreman, and a buyer spontaneously gathered to discuss the problem, then scattered to seek solutions…. In this case (quoting a senior operator)… "Everyone

> telephoned some person they thought might know how to fix the problem—vendors, experts—and within three to four hours, we were getting calls back… and we worked the problem out." (Leonard-Barton, 1995, p. 10)

These examples reflect the dual mission that CEO Gordon Forward set for all employees: fulfilling their individual functions and continually improving production. In doing so, they were expected to solve production problems, improve production processes and equipment, import new knowledge into the organization, and share their knowledge with others (Leonard-Barton, 1992).

Exemplars of organizational learning like Chaparral are a double-edged sword. On the one hand, they inspire and invite learning through imitation. "By benchmarking against such companies," wrote Leonard-Barton (1992), "managers can derive principles to incorporate into their own particular visions" (p. 36). These exemplars may even tempt managers to take bold steps to transform their own companies into learning organizations. On the other hand, these exemplars may actually contribute to the mystification of organizational learning by feeding the gap between visionaries and skeptics (see Chapter 1). No matter how inspiring the ultimate vision, studies of these organizations rarely offer a well-marked path for getting there. Furthermore, the reality of promoting organizational learning is demanding, fraught with setbacks, and simply much more mundane than the heroic exemplars. This reality may increase cynicism and the belief that organizational learning is nothing more than another fad or gimmick.

In this chapter, we shall argue that managers *can* learn from Chaparral Steel's example. In order to do so, however, they need a framework for systematic comparison that enables them to identify both the similarities *and* the key differences between their organizations and Chaparral. The multi-facet model presented in this book offers such a framework. Our reanalysis will build on descriptions of Chaparral Steel from previous studies and interviews with Gordon Forward rather than on original research (Kantrow, 1986; Leonard-Barton, 1992, 1995; Luthans, 1991; Preuss, 1998). It will show how Chaparral implemented a unique configuration of OLMs, especially the online/internal organizational learning mechanisms (OLMs). It will also identify features of Chaparral's learning culture, managerial policies, and leadership that make these OLMs effective. Finally, it will show how the particular design of learning at Chaparral was shaped, at least in part, by a specific set of contextual conditions. Such an analysis provides a more finely grained basis for comparison with other organizations and for understanding what principles can be adopted and what cannot.

❖ ORGANIZATIONAL LEARNING MECHANISMS AT CHAPARRAL

The scope and intensity of organizational learning at Chaparral can be attributed to the extensive use of OLMs, especially what we referred to in Chapter 2 as "online/internal agent OLMs." These mechanisms fuse work and learning together: The same people who do the work do the learning, and they do both at the same time and place.

> [After the introduction of a new product and production process,] the pulpit controls operator is carefully checking the timing on the line with a stopwatch…. He wants to achieve split-second timing. Asked who suggested he perform this function (which is often given to a process engineer elsewhere), he is surprised at the question: "No one." He considers it obvious that improvement is always part of his job. (Leonard-Barton, 1992, pp. 26–27)

Online/internal agent OLMs enable employees to produce changes in organizational routines, standard operating procedures, or norms of behavior while carrying out their specific functions.

The heart of online/internal agent learning mechanisms at Chaparral was constant experimentation carried out by everyone from management to the operators. There was no research and development department separate from production because it was considered to be a part of everyone's job (Leonard-Barton, 1992, p. 29). Employees at every level were expected to come up with ideas for improvements and, if possible, try out their own ideas on the spot.

Even operators were given opportunities to acquire and use the most advanced scientific knowledge, even if it meant travel (Kantrow, 1986). There were, of course, engineers and technicians working at Chaparral, but even they had line functions and worked closely with supervisors and operators so that experimentation was a joint project. Forward believed that putting operators, engineers, and maintenance workers in constant contact was the best and quickest means of testing out new ideas (Kantrow, 1986).

These experiments took place at the same time and at the same place as the production process. Innovation and experimentation were simply a part of everyday work routines. In the words of Gordon Forward:

> The lab is the plant…. Of course, we don't give the whole plant over to laboratory work, but the whole plant really is a laboratory—even though it's one of the most productive steel mills in the world. We don't stop operations to try crazy things, but we do try to do our research and development right on the factory floor. (Kantrow, 1986, p. 99)

The fact that experimentation and process improvements took place online meant that management had to tolerate disruptions to production. The great benefit was that the results could be implemented immediately without further engineering or testing because the experimental environment and final production environment were the same (Leonard-Barton, 1992).

Chaparral provided a rare and extremely valuable opportunity to observe internal/online mechanisms. Off-line OLMs are relatively easy to comprehend, identify, and institutionalize because they are based on a clear distinction between working and learning. Online/internal agent OLMs, on the other hand, are difficult to observe because they are tightly integrated into the flow of work itself. In many organizations, they are not fixed or formal entities but rather temporary structures that take shape as needed through informal interactions and interpersonal networks. Their informality makes them difficult to create and manage.

At Chaparral, online/internal agent OLMs did not evolve in some naturalistic way but rather from conscious management choice and design. The impetus for these design features was CEO Forward's own learning from experience in a large, bureaucratic organization (Luthans, 1991, p. 67). Forward jokingly compared big, separate research facilities to cemeteries because “good ideas are dying there all the time” (Kantrow, 1986, p. 2). He believed that no matter how much money was invested in R & D (an off-line/external agent OLM), this knowledge did not flow to the people who were supposed to use it. On the other hand, line workers and managers who came up with good ideas for change were unable to get this knowledge adopted and implemented by the organization (Luthans, 1991).

Because Chaparral Steel was created as a completely new, self-contained plant, it offered an opportunity to design an alternative from the bottom up. The idea of making R & D a line function was a strategic choice based on the belief that the key to maintaining competitive advantage as a low-cost steel supplier was combining manufacturing with technology. Thus, the physical and organizational structures of Chaparral were all carefully aimed at integrating work and experimentation through what we call online/internal mechanisms.

One of the key decisions in the design of online/internal mechanisms was keeping the number of employees at Chaparral Steel to less than 1,000. Small size facilitated both knowledge production and

dissemination. It enabled employees to know each other personally, influencing the desire and willingness to share information. Even more important, it made it easier for employees to develop "transactive knowledge" (see Chapter 7 on dissemination). In other words, it was possible for every Chaparral employee to know whose expertise they needed in order to solve a problem or create an innovation. It also enabled them to know who might need or make good use of their own knowledge. Forward considered small size (in terms of number of employees) so important that he stated flatly that he "simply wouldn't consider" getting much bigger in the present location (Kantrow, 1986, p. 97). Rather than increase its scale of operations to stay competitive, Chaparral sought strategic opportunities that enabled it to maintain its small size.

The physical design of Chaparral Steel, which was related to size, provided an infrastructure conducive to the development of online/internal agent OLMs. First, all of Chaparral's operations were located in one plant, enabling employees to exchange information face to face without travel or sophisticated knowledge management technologies. Other features of the plant's physical design facilitated accidental meetings among all levels. The plant headquarters were situated in close proximity to the furnaces and mills as well as the employees' locker room (Leonard-Barton, 1992). Workers and line managers with ideas or problems did not have to go far to meet with higher levels of management. Indeed, they were likely to run into each other at least once or twice a day so that no one would have to wait very long to move information up or down. In fact, there was nothing really "accidental" about these meetings at all because they were facilitated by conscious design.

The organizational design of Chaparral complemented the physical design in enabling online/internal agent OLMs to take shape just about anywhere or anytime. The one-story headquarters building was symbolic of the flat organization that kept hierarchical distance and formality to a minimum. From the standpoint of management, informal onthe-spots meetings were neither interruptions nor distractions but rather integral parts their work. In addition, there was an intentional absence of the normal bureaucratic barriers to innovation. Chaparral employees were not required to follow bureaucratic procedures or receive management approval before trying out improvements. Decision making was delegated down the hierarchy so that even line supervisors could authorize tens of thousands of dollars for experiments without receiving permission from above (Leonard-Barton, 1992).

Rather than emphasize clear roles and a strict division of labor, management assigned both units and individuals to numerous tasks. Everyone had line responsibilities and operators performed 40% of the maintenance work. The company had a marketing department, but every employee was considered to be in sales (Leonard-Barton, 1992). Another unusual strategy for blurring boundaries was requiring all employees to work night shifts regardless of seniority. This strategy meant that organizational knowledge was not concentrated during particular hours but well dispersed across the entire 24-hour day (Leonard-Barton, 1992).

Requiring employees to fulfill multiple functions and develop multiple skills enlarged the scope of their interests, understanding, and involvement in Chaparral's operations and activities. It also increased the likelihood that employees would encounter and learn from people outside their functional specialty. This design feature made the organization more flexible, counteracted competition over turf, and encouraged knowledge sharing.

Not all organizational learning at Chaparral took place through online OLMs. There were also regularly scheduled, off-line meetings for discussing problems and ideas for improvement. However, a foreman estimated that "90 percent of the problems never make it to the morning meetings" because they are solved online (Leonard-Barton, 1995, p. 8). In other words, most problems were dealt with through the online mechanisms. This quote attests to the power and efficiency of these mechanisms.

Another common off-line OLM at Chaparral was travel. As mentioned, the company encouraged

all employees to travel for the purpose of acquiring new knowledge. Teams of managers, foremen, and workers visited suppliers and competitors in the United States, Japan, and Europe. Gordon Forward observed that many important breakthroughs occurred during travel because the time together led to openness (Luthans, 1991). In addition, research projects were cosponsored with U.S. academic institutions to import cutting-edge knowledge into Chaparral Steel.

Whether or not new knowledge was acquired internally or from without, the efficient dissemination of knowledge was generated by the same features of the organization that promoted online/internal OLMs for experimentation. The intentional blurring of horizontal and vertical boundaries facilitated intensive networking and knowledge sharing among employees. The lack of bureaucratic barriers meant that results of experimentation and knowledge imported from outside could be quickly implemented and disseminated. Organizational members had no trouble imitating others and adopting their performance improvements as standard practice (Leonard-Barton, 1995).

OLMs for dissemination, however, were not left to chance. Chaparral used some well-planned strategies for making sure that knowledge was shared:

> For instance, in "commissioning" (ramping-up to problem-free production) of [a new mill] only two teams of operators are being trained. Each team works a twelve hour shift (with paid overtime). After the initial eight weeks of grueling schedule, these operators will be dispersed among the rest of the crews, to diffuse the knowledge they have created and assimilate about the idiosyncrasies of the [production] process. (Leonard-Barton, 1995, p. 13)

This method of disseminating knowledge by dispersing a highly skilled group of workers is common practice at Chaparral.

As this example illustrates, knowledge at Chaparral was transmitted primarily through people and interpersonal interactions. Face-to-face knowledge transmission was quicker and more efficient than engaging in a process of making knowledge explicit, generating written reports, translating it into formal procedures, and then transmitting it through training and support. It was also self-reinforcing and a bit risky. Because so much knowledge was transmitted informally and could not be accessed through written documents, people needed to interact and communicate directly with others if they wanted to stay on top of things.

❖ PRODUCTIVE LEARNING AT CHAPARRAL STEEL

Viewed through the multi-facet model, the existence of online/internal agent OLMs provided a necessary but insufficient condition for productive learning. Understanding productive organizational learning requires a systematic analysis of the culture, the psychological climate, specific management policies, and the context in which learning occurs. In this section, we look at each of these facets as they apply to Chaparral Steel.

The Cultural Facet

As described in Chapter 3, the cultural facet refers to the behavioral norms and the underlying values that regulate behavior in OLMs. The various accounts of Chaparral Steel provide ample evidence of the existence of the five norms that we consider essential for productive learning: inquiry, issue orientation, transparency, integrity, and accountability.

Norms of inquiry were clearly evident in Gordon Forward's description of the influence of his

educational background on his role as the CEO:

> I feel my research background [showed me] how to deal with the mystery and intrigue of solving the puzzle. To me, the inquiry, the breaking through to new vistas, the finding of solutions, is what it's all about. (Luthans, 1991, p. 64)

This same norm of inquiry was reflected in numerous comments from workers to the effect that they were always asking questions and constantly trying to learn more about what they were doing (Leonard-Barton, 1992). It was also evident in the example given earlier of employees who doggedly pursued information and knowledge from a variety of sources in order to fully understand a problem and arrive at a solution.

Issue orientation was manifested by egalitarianism and respect for the individual, which were shared values in Chaparral Steel (Leonard-Barton, 1992). The strength of issue orientation at Chaparral was summed up nicely by this statement: “Knowledge is valued not so much for the pedigree of its source but for its usefulness” (Leonard-Barton, 1992, p. 36). Everyone's ideas were taken into consideration, regardless of function or level in the hierarchy. Indeed, the ideas and opinions of operators were especially valued because they were the closest to the work itself. Another element of issue orientation is the fact that innovations were usually seen as team efforts involving multiple inputs rather than individual accomplishments (Leonard-Barton, 1992).

Transparency was closely coupled with inquiry and issue orientation at Chaparral. Employees at all levels were encouraged to say what they think—even to the CEO. Gordon Forward put it this way:

> I actually like to deal in incomplete thoughts—in other words, a thought that you haven't really fleshed out yet, but one that you want to bounce off of someone. It's kind of like brainstorming. I've seen… more stilted structures stifle this kind of interaction. The approach was, “Don't talk to me until you've come to a conclusion.” (Luthans, 1991, p. 70)

Chaparral employees repeatedly stressed that they freely shared their ideas even if they were unsure about their quality (Leonard-Barton, 1992).

Forward also gave expression to the norms of integrity (and inquiry), which we have defined as a willingness to admit ignorance or error:

> When you're operating in a technical field… trying to go one step beyond research, one of the things you learn fast is that you can't fool yourself…. You've got to be open in your questioning…. And you can't succeed by pretending to know things that you really don't. You have to go find them out. You have to try an experiment here, and experiment there, make your mistakes, ask your questions, and learn from it all. (Kantrow, 1986, p. 101)

The norm of integrity was also manifested in a millwright's report that he was actually pleased when someone less knowledgeable than he caught him in an oversight because it saved him from making a costly error (Leonard-Barton, 1992).

Finally, in Chaparral Steel's culture, accountability was expressed in a number of ways. The proper response to making mistakes was to admit them and then take action to fix them (Leonard-Barton, 1992). Because of blurred functional distinctions and the general ownership of problems, everyone was responsible for ensuring results, and no one could hide behind the claim that “it's not my job” (Leonard-Barton, 1992, p. 27). Accountability was also reflected in the wide latitude for experimentation but also in the demand to apply successful results. As illustrated in the description of the online/internal agent OLM, all employees were expected to act on and disseminate new

knowledge.

The Psychological Facet

The published accounts of Chaparral Steel did not delve deeply into the psychological climate of the organization. Nevertheless, there was enough evidence to make inferences about both psychological safety and commitment to the organization. The clearly evident norms of transparency and integrity implied that employees experience a high degree psychological safety. In one telling quote, Forward provided an interesting perspective on this facet:

> In a research laboratory, risk is accepted as the norm, since the cutting edge is fraught with uncertainty. In contrast, risk is usually anathema in a production environment…. Chaparral managers avoid riskless projects because a "sure thing" holds no promise of competitive advantage…. This positive attitude toward risk permeates the company…. If everyone experiments, learns, and innovates, then neither success nor failure can be heavily personalized. (Leonard-Barton, 1992, p. 32)

To the extent that this statement reflected the thinking of organizational members in general, it contains two critical assumptions that apply to psychological safety. First, mistakes were considered not only normal but actually necessary occurrences, so there was no shame in making and admitting them. Second, everyone made mistakes, and most innovations were collective efforts. There was little fear of being blamed personally for errors.

The multi-facet model also maintains that people will expend the extra effort and take the risks involved in learning to the extent that they feel committed to the organization. Leonard-Barton (1992) described the workforce at Chaparral as "highly dedicated" (p. 33). The organization was deliberately understaffed and demanded much more of employees than most organizations, but employee motivation appeared to be very high and absenteeism very low (Leonard-Barton, 1992), providing some indication of high commitment.

The psychological climate and the cultural norms at Chaparral reinforced each other. Their positive strength accounted for the effective functioning of the online/internal agent OLMs. In this respect, Chaparral differs from organizations in which effective OLMs constitute cultural islands where learning norms may be more operative in OLMs than in the organization as a whole. Just as the online/internal agent OLMs were tightly integrated into the flow of work, the learning norms appeared to dominate the organizational culture as a whole.

Leadership

By this point, it should be obvious that the leadership of Gordon Forward, who was with the organization from its founding in 1973 until his retirement, played a key role in shaping Chaparral Steel as a learning organization. This is evident from the impact on the organization of his training as a researcher and his personal experience. It is interesting that the descriptions of Forward and interviews with him say little about his personality or leadership style. Instead these sources indicate two channels of influence (see Chapter 6) through which Forward and his top management team promoted the strategy of online/internal agency learning in Chaparral Steel. The first channel was Chaparral's overall mission. As we have already noted, workers in Chaparral Steel were assigned the dual task of performing their work and improving their production processes. The second channel was a set of policies that either promote organizational learning directly or supported it through human

resource practices.

The Policy Facet

The multi-facet model points to three issues that need to be addressed by organizational policy in order to promote learning: tolerance for error, commitment to learning, and commitment to the workforce. In his interview with Fred Luthans, Forward said, “We don't have policies” but rather “basic ideas.” This was, of course, stretching a point. However, Forward was expressing his disdain for bureaucratic rules and procedures that are “designed to catch the 3 percent who [are] trying to cheat in one way or another” (Luthans, 1991, p. 69). By minimizing the number of formal rules and procedures, Chaparral Steel manifests trust in its workforce, trust that they will rise to and meet the challenge of beating the competition through continuous innovativeness and superior efficiency.

From the founding of Chaparral Steel, management instituted policies to support the organization's multiple missions of production, problem solving, improvement of production and products, importing new knowledge into the organization, and sharing knowledge with others. These policies facilitated the development of online/internal agent OLMs and cultivated the cultural norms and psychological climate conducive to effectiveness.

Developing policies that promote a tolerance for error is one of the most difficult areas for management because it is not always possible to clearly distinguish between errors that stem from legitimate risk taking and those that stem from negligence or incompetence. Nevertheless, Chaparral had a policy that provided employees with the freedom to take risks. Gordon Forward explained this policy as follows:

> People say [risk taking] isn't very smart. But I respond that I think what they are doing is really risky. They ask, “What do you mean?” I say, “To me, the biggest risk, particularly in the business world of today, is to do nothing.” Plenty of firms are afraid to take risks and I see this reluctance as a major risk itself.… The other thing is that people need the freedom to [achieve their goals]. We all figure we'll make some mistakes along the way, but that freedom is important. (Luthans, 1991, p. 69)

Tolerance for error is manifested in Chaparral Steel by the preference for new recruits who are risk takers and for deliberately taking conscious risks.

This policy was also evident in the story of one of the company vice presidents who, as a supervisor, purchased new equipment that totally failed and cost the company $1.5 million. He himself was not punished for his error. Furthermore, he explained that employees were rewarded for having new ideas by being given the freedom to test them out, even despite the obvious risks. The policy of tolerance for error clearly trickled down to managers who, as mentioned before, avoided projects that entailed little risk but also gained little. By the same token, mistakes were admitted and corrected rather than covered up (Leonard-Barton, 1992).

Chaparral's belief in people and commitment to the workforce was clearly articulated by Forward and expressed through its employment policies from the beginning of the company. Forward recognized that organizational commitment was governed by a norm of reciprocity. If Chaparral were to gain its employees’ commitment, it had to show commitment to its employees. They had to feel that Chaparral had their interests in mind and that they belonged (Luthans, 1991).

Chaparral implemented this principle in treating all employees equally, investing in their personal development, and letting them share in the company's profits and wealth. For example, every employee was placed on salary rather than hourly wages, a manifestation and symbol of

egalitarianism and respect for workers that contributed to organizational commitment. Bonuses for everyone were linked to company profits. There was also a profit-sharing scheme and a program through which most employees were stockholders (Leonard-Barton, 1995).

Not surprisingly, given the organization's multiple mission, many policies that expressed commitment to the workforce also expressed a commitment to learning. When Chaparral was first set up, management decided not to look for workers with industry experience. Rather, they sought employees who enjoyed hard work and had a high potential for learning so that they could be socialized into the unique learning culture of Chaparral (Leonard-Barton, 1992). Job applicants underwent a highly selective and rigorous screening process that included extensive interviews with Chaparral employees at different levels. Pay was structured in a way that rewarded learning and skill development as well as performance (Leonard-Barton, 1992).

Chaparral invested heavily in employee development and training that focused both on helping employees self-actualize and improve performance. Eighty-five percent of Chaparral's employees were enrolled in courses with direct or fairly direct relevance to their jobs. The company had an extensive apprenticeship program for every employee, which included courses on generic skills and company-specific knowledge as well as on-the-job training for workers. In order to keep supervisors excited about their work, they were encouraged to take time off from their jobs for paid “sabbaticals” involving work-related projects. Chaparral used these absences to give senior operators opportunities to fill in for their supervisors. As a result, they gained valuable supervisory training and experience (Leonard-Barton, 1992).

❖ THE CONTEXTUAL FACET

The final stage in our analysis of Chaparral Steel looks at the context in which organizational learning emerged. The contextual facet is different from all of the other facets because it focuses on factors over which management has limited or no control. Managers can set up OLMs as well as set policies and exercise leadership that influence the psychological climate and shape cultural norms. However, the contextual facets—error criticality, environmental uncertainty, task structure, and proximity to the core mission—are relative givens. They represent both opportunities and constraints to which managers must respond and adapt in promoting organizational learning. Thus, identifying and understanding the contextual facet is particularly important for managers wishing to apply the principles of organizational learning from Chaparral Steel, or any organization, to their own.

The most obvious contextual factor in understanding Chaparral's success was the fact that it was a greenfield site. Although Forward and his associates did not think in terms of the learning organization, they carefully designed and built the organization from the bottom up with the intention of integrating production and learning. They did not have to contend with and change the existing physical plant, organizational structure, and culture to promote learning. Managers attempting to apply the lessons of Chaparral in an existing organization would need to consider a very different strategy for getting there.

The case of Chaparral Steel is consistent with the contention that a relatively high degree of environmental uncertainty creates a demand for organizational learning. For Chaparral, the major source of uncertainty was defining and achieving competitive advantage in a changing industry:

> We realized that this business has traditionally been labor-intensive, capital-intensive, and energy-intensive, and from the beginning, we knew that we had to design all of those things out of it. That was the only way we could be competitive with Third World countries. (Luthans, 1991, p.

65)

Chaparral Steel was designed from inception to be an international low-cost supplier of steel products, but that meant competing with Third World companies with access to a much lower-wage labor force. From the beginning, Chaparral had to invent a new strategy for succeeding in an environment where most American producers had failed.

Essentially learning became a strategic imperative and part of Chaparral Steel's core mission:

> We are always trying to push back the technological frontier…. Maybe our largest challenge is to cut the time it takes to get technology out of the lab and into operations. The kind of lags that many industries experience would simply kill us. (Kantrow, 1986, p. 99)

To be competitive, Chaparral aimed at attaining 1.5 to 3 worker hours per ton by enlisting accessibility to the most advanced technology and to a highly committed innovative workforce (Luthans, 1991). To engage workers' commitment and encourage their innovativeness, Forward formulated a dual-purpose mission that called for the simultaneous manufacturing of cutting-edge products that require the invention of "test-the-limit" designs and the continuous improvement of production processes (to maintain cost advantage). Because both objectives require learning and experimentation, learning fused with task performance and wove itself into the organization's mission.

The question for other organizations that wish to learn from Chaparral's experience is whether the nature and degree of environmental uncertainty demands the same learning imperative. Learning is only one strategy for achieving competitive advantage. The fact that all organizations face increasingly intense competition in the age of globalization does not necessarily mean that learning needs to be defined as part of the organization's core mission. Conversely, managers who wish to promote learning need to take into account the proximity of their areas of responsibility to the core mission of the organization. The multi-facet model suggests that units or processes that are ancillary to the core mission may not be able to attract the resources and commitment to learning evident in Chaparral and necessary for online/internal OLMs.

Superficially at least, error criticality does not seem to be a major driving force for learning in a steel manufacturing organization. Mistakes in steel manufacturing are costly but usually not fatal. Nevertheless, Forward did express the belief that, given the intense competition, any false move could prove fatal to the organization:

> We have to go like hell all of the time. If the price of what we sell goes up too high… all of sudden lots of folks will be jumping in. …We constantly chip away the ground we stand on. (Leonard-Barton, 1992, p. 24)

As evident from Forward's attitude toward risk, he believed that the greatest danger in the current situation is not taking risks, not pushing into the unknown for the purposes of learning.

The task structure is an important but often overlooked factor in shaping the potential for organizational learning. Chaparral was a minimill, which meant that it focused entirely on the production and sales of steel. In this respect, it was different from traditional U.S. steel producers that brought together mining, transport, and manufacturing of a wide variety of products, all under one organizational roof. Being a minimill made it possible for Chaparral to maintain its small size and to quite literally bring all its operation under one physical and organizational roof. As the case illustrates, these factors were extremely important in creating conditions for developing successful online/internal agent OLMs and for minimizing bureaucratic constraints.

The fact that Chaparral manufactured a small number of very specialized steel products also

facilitated organizational learning. It made it relatively easy for the company to sharply focus the relevant knowledge it needed, to match people with this knowledge, and to bring them together. Creating the necessary configurations of knowledge through online/internal OLMs would have been much more difficult if Chaparral were producing a wide range of products requiring different kinds of knowledge. Another factor that facilitated learning was the fact that Chaparral was producing a commodity and not a finished product made up of many different components with their own specialized technologies. It would have been much harder, though not impossible, to use online/internal OLMs for producing innovations in automobiles or even automobile manufacturing methods because automobiles involve so many different parts, materials, systems, and technologies.

Production technologies and work processes themselves also influence the ways in which learning can occur. Organizational learning structures are shaped and constrained by the structure of work, its pacing, its distribution across time and space, the numbers and types of people involved, the kinds of information involved in the work, and a variety of other factors. Leonard-Barton hinted at these differences in her description of learning at Chaparral:

> Just as continuous processing has great advantages for manufacturing over most batch processing, so the unimpeded flow of information aids learning more than fragmented, batch-processed information. (Leonard-Barton, 1992, p. 29)

The analogy between production processes and information processing can be turned around to suggest that information flow will be different in continuous processing environments than in large batch-processing environments. Woodward's (1965) classic study showed that relative to mass production, effective continuous process environments have shorter spans of control, more managers per worker, more skilled workers, lower formalized procedures, less centralization, higher verbal communication, less written communication, and a more organic structure. These features highlight the fact that, by nature, continuous process organizations emphasize problem solving, quick

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