Knowledge Management's Social Dimension: Lessons From Nucor Steel

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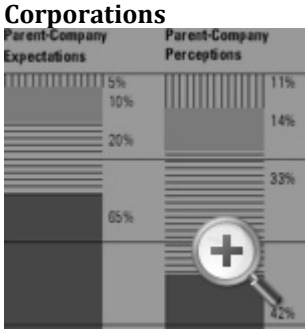
A gap exists between the rhetoric of knowledge management and how knowledge is actually managed in organizations. There is widespread awareness of the economic value that creating and mobilizing intellectual capital can unleash. Yet, for most companies, the reality rarely matches the potential. As the CEO of a commercial-services company lamented in an interview, "We provide pretty much the same services in every location. But my regional managers would rather die than learn from each other." Our research suggests the CEO's experience is not an isolated one. In fact, too often, actual knowledge sharing doesn't just fall below executives' expectations; it doesn't even match their perceptions about the extent to which knowledge is being shared within their organizations. (See "The Potential vs. the Reality of Knowledge Sharing: Survey Results from Three Large Global Corporations.")

The Potential vs. the Reality of Knowledge Sharing: Survey Results from Three Large Global Corporations



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Building an effective *social ecology* — that is, the social environment within which people operate — is a crucial requirement for effective knowledge management. Nucor Corp., the world's most innovative and fastest-growing steel company for the past three decades, is a case in point. The company's phenomenal success cannot be explained without examining the exemplary social ecology that Nucor has created for accumulating and mobilizing knowledge. By adopting a similar framework, any company can convert itself into an effective knowledge machine.

The Central Role of Social Ecology in Knowledge Management

Because all knowledge starts as information, many companies regard knowledge management as synonymous with information management. Carried to an extreme, such a perspective can result in the profoundly mistaken belief that the installation of a sophisticated information-technology infrastructure is the be-all and end-all of knowledge management. Effective knowledge management depends not merely on information-technology platforms but more broadly on the social ecology of an organization.

Social ecology refers to the social system in which people operate. It drives an organization's formal and informal expectations of individuals, defines the types of people who will fit into the organization, shapes individuals' freedom to pursue actions without prior approval, and affects how people interact with others both inside and outside the organization. The determinants of social ecology are culture, structure, information systems, reward systems, processes, people and leadership. The word ecology suggests that the social system should be viewed not as a random collection of disparate elements but as a comprehensive whole in which the various elements interact with one another.

Information technology (IT) certainly plays a central role in knowledge management. IT is the only viable mechanism to connect efficiently large numbers of geographically dispersed people. IT can be used effectively, or it can be misused. Technology providers (such as Lotus, Microsoft, Oracle and SAP) strive to disperse the technology to as wide a customer base as possible. Thus, for most companies, IT platforms are neither proprietary nor unique and therefore provide at best a temporary advantage. Sustainable advantage depends on how smart the company is at using the technology. And that depends fundamentally on the social ecology of the organization. Senior executives echo that perspective. (See "Drivers of Knowledge Management: Survey Results from Senior Executives at Global Fortune 500 Companies.")

Penetrating the Knowledge-Management Agenda

In a world in which the half-life of new knowledge is becoming ever shorter, an effective knowledge machine must excel at two central tasks: creating and acquiring new knowledge, and sharing and mobilizing that knowledge throughout the corporate network. Unless an enterprise continuously generates new knowledge, it will soon be playing tomorrow's game with yesterday's tools. And unless knowledge is pumped efficiently throughout the network, the enterprise will not only pay the price of reinventing the same wheel but will also risk becoming prey to competitors that are able to replicate its ideas rapidly.

So the intellectual capital of an enterprise is a function of the stock of knowledge accumulated by individuals and units — and the extent to which such knowledge is mobilized across the enterprise. An analogy may be found in the concept of money supply. Economists measure money supply as a product of two factors: the stock of notes in circulation multiplied by the velocity of circulation. Similarly, an enterprise's intellectual capital consists of the stock of knowledge held by individuals and corporate

units multiplied by the velocity at which such knowledge is shared throughout the organization.

The task of accumulating knowledge can be further disaggregated into three subtasks: *knowledge creation* (learning by doing), *knowledge acquisition* (internalizing external knowledge) and *knowledge retention* (minimizing the loss of proprietary knowledge). The task of mobilizing knowledge can also be disaggregated into a set of subtasks: *knowledge identification* (uncovering opportunities for knowledge sharing), *knowledge outflow* (motivating potential senders of knowledge to share it), *knowledge transmission* (building effective and efficient channels for the transfer of knowledge) and *knowledge inflow* (motivating potential receivers to accept and use the incoming knowledge).
Myriad pathologies and pitfalls can (and often do) bedevil every element of the knowledge-management process in many organizations.1 (See "Common Pathologies and Challenges in Knowledge Accumulation and Knowledge Sharing.")

A common pathology is the "knowledge is power" syndrome, which plagued one European global engineering company. At the time of our interviews, the company had three business areas (BAs). Each BA president had complete responsibility for his business globally — except in North America. There, all operations reported to the president of Market Area (MA)-North America, who in turn reported directly to the CEO. The three BA presidents objected to the arrangement, advocating that the company abolish the MA-North America position and that they directly control activities in the region. The result was an extremely limited transfer of technological know-how from Europe to North America. As one BA president explained, "People know that it is the BAs who create the technology and control it. They also realize that, in the middle of the technology pipeline between BA headquarters and MA-North America, there exists a control valve. The hands on that control valve belong to us. We can open that valve, or we can keep it shut. Sooner or later, people are going to realize where the power in this company lies. Of course, we want to share our know-how with North America; but we will do so only after we obtain complete control over them." After a frustrating three years, the CEO concluded that he had little choice but to accept the BA presidents' power and abolish the MA-North America position.

Virtually all the pathologies that companies exhibit emanate from some type of dysfunction in the social ecology of the enterprise. But companies can avoid such pathologies and create an exemplary social ecology for effective knowledge management as Nucor Corp. did.

The Social Ecology of a Knowledge Machine: The Case of Nucor

Nucor Corp. has been the most innovative and fastest-growing steel company for the past 30 years. Nucor's success can be explained only by analyzing its social ecology. As an example of how a knowledge machine works, Nucor is far more interesting than, say, professional-services firms such as Andersen Consulting or McKinsey & Co., whose only

output is knowledge. Even though Nucor's end product is steel — a tangible, nondifferentiable commodity — the company has been a knowledge machine par excellence for decades.

Since the late 1960s, the U.S. steel industry has faced numerous problems — such as declining demand, substitution from other materials, foreign competition and strained labor relations — and has reported one of the poorest profit-and-growth records in the U.S. economy. Despite operating in such a fundamentally troubled industry for more than three decades, Nucor has enjoyed an annual compounded sales growth rate of 17%, all generated internally without Nucor making any acquisitions. Furthermore, between 1968 and 1998, the company's profit margins were consistently well above industry medians, and average annual return to shareholders exceeded 20%. Starting from virtually ground zero in 1968, Nucor had become one of the largest steel producers in the United States by 1999. (See "Nucor Corporation: A Business Profile.")

Nucor's phenomenal success cannot be explained by its industry structure, access to raw materials or other external factors. (See "Nucor's Performance Cannot Be Explained by External Factors.") Nucor achieved its success by excelling at a single task: becoming and remaining the most efficient steel producer in the world. It did so by developing and constantly upgrading three competencies that were both strategic and proprietary: plant construction and start-up knowhow, manufacturing-process expertise and the ability to adopt breakthrough technologies earlier and more effectively than competitors.2

How Nucor Accumulates Knowledge

Nucor's social ecology allowed the company to excel at the three subtasks associated with accumulating knowledge: creating knowledge from direct experimentation, acquiring external knowledge, and retaining internally created or externally acquired knowledge.

Knowledge Creation.

Nucor's success at knowledge creation sprang from three elements of its social ecology: superior human capital, high-powered incentives and a high degree of empowerment (which included both a high tolerance for failure and a high degree of accountability).

Nucor was able to gain access to superior human capital by locating plants in rural areas that had an abundance of hard-working, mechanically inclined people. The company became a leading employer in those locations and offered a top-of-the-line compensation package, enabling it to attract an unusually large pool of applicants for every job opening. For instance, 1,200 applicants applied for eight job openings at Nucor's Darlington, South Carolina, plant. As a result, the company was able to use stringent selection criteria to hire conscientious, dedicated, goal-oriented, self-reliant people.

Nucor built on that foundation by investing in continuous, on-the-job, multifunctional training. Furthermore, it cultivated hunger for new knowledge through a high-powered incentive system for every employee — from the production worker to the corporate CEO. There was no upper cap on the incentive payouts. In the 1990s, for example, payouts for production employees averaged 80% to 150% of base wage, making those workers the best paid in the steel industry. The incentive structure for department managers and senior officers was even steeper.

There were several ways that incentives motivated Nucor's employees to push the boundaries of manufacturing-process know-how. First, because the incentives were a function of production output, employees could earn higher bonuses only by discovering new ways to boost productivity. Second, because the incentive payouts depended only on output that met quality standards, employees were motivated to develop innovations that would help them do things right the first time. Finally, because the magnitude of the bonus payouts was not limited and employees' discovery of new process innovations did not lead to a resetting of the standards, people were challenged to expand the frontiers of process know-how.

Whenever employees are encouraged to experiment, there is always the possibility of failure. A company that does not tolerate failure will severely inhibit experimentation, whereas a company that experiences nothing but failures will not survive. The following observation by Ken Iverson, Nucor's architect and, until recently, its chairman, illustrates how Nucor fostered experimentation within a context of accountability: "We try to impress upon our employees that we are not King Solomon. We use an expression that I really like, 'Good managers make bad decisions.' We believe that if you take an average person and put him in a management position, he'll make 50% good decisions and 50% bad decisions. A good manager makes 60% good decisions. That means 40% of those decisions could have been better. The only other point I'd like to make about decision making is, 'Don't keep making the same bad decisions.' …Every Nucor plant has its little storehouse of equipment that was bought, tried and discarded."[3]

Knowledge Acquisition.

Being a first mover in adopting breakthrough process technologies is always risky, particularly in a capital-intensive industry such as steel. Despite such risks, Nucor was not only the first U.S. company to adopt minimill technology, it was also the first company in the world to make flat-rolled steel in a minimill and to commercialize thin-slab casting. The company's extraordinary success in technology acquisition over three decades can be traced back to various aspects of its abilities, mind-set and behavior.

Because Nucor's social ecology drove every employee to search for better and more efficient ways to make steel and steel-related products, its operating personnel had a deeper mastery of the industry's manufacturing processes than personnel at other steel companies. Other steel companies sent senior executives and staff engineers to analyze emerging technologies, but teams of Nucor managers, engineers and operators made decisions about technology adoption. Thus, Nucor's technology-assessment teams went to equipment suppliers with a deep knowledge of both technological and operational issues. Given their mastery of manufacturing-process know-how, members of Nucor's

technology-assessment teams also had greater confidence in the company's ability to resolve unknown bugs that would inevitably appear during implementation of the new technology.

Nucor's leading role in the adoption of thin-slab casting technology is only one example of the company's ability to excel at acquiring knowledge. Until the mid-1980s, minimills could not produce high-end flat-steel products for automotive and appliance customers. Nucor made history in 1987 by building in Crawfordsville, Indiana, the first minimill that could make flat steel — an innovation that moved the company into the premium segment of the steel industry. By 1997, Nucor had built two more minimills using the process. Despite the fact that the company had obtained the technology from an equipment supplier on a nonexclusive basis, the first plant built by a competitor using the same technology did not appear until 1995.

Knowledge Retention.

Companies often lose sizeable chunks of their knowledge through the departure of employees. Nucor protected itself from such losses by successfully implementing a policy of no layoffs during recessions and by cultivating a high degree of loyalty and commitment among its personnel.

When hit by a recession, the company reduced the workweek rather than the workforce. Employees regarded a reduced workweek and the correspondingly lower wages as a relatively attractive option when compared with the prospect of being laid off in a rural area where Nucor was the leading employer. Of course, reductions in the workweek did reduce wages and could have weakened the fabric of loyalty and commitment between the company and its employees. To counter that threat, Nucor's workweek reductions were always accompanied by a "share the pain" program: Any reduction in a worker's compensation was accompanied by a greater reduction in managers' compensation and a still greater cut in the CEO's pay (by as much as 70%). Nucor's response to recessions ended up strengthening the spirit of trust and respect within the company. Not surprisingly, Nucor enjoyed the lowest turnover rate of any company in its industry.

How Nucor Mobilizes and Shares Knowledge

Nucor's social ecology also allowed the company to excel at the four subtasks associated with sharing and mobilizing knowledge: identifying opportunities to share knowledge, encouraging individuals to share their knowledge, building effective and efficient transmission channels and convincing individuals to accept and use the knowledge they receive.

Identifying Opportunities To Share Knowledge.

Nucor was systematic in measuring the performance of every work group, department and plant and in making the performance data visible within the company. The routine measurement and distribution of performance data allowed individual units and corporate headquarters to uncover myriad opportunities to share best practices.

Encouraging Individuals To Share Knowledge.

Nucor's social ecology was also fashioned to encourage eagerness on the part of every work unit to share best practices proactively. Nucor relied on group-based incentives at every level of the organization. Such incentives ensured that one individual's superior performance would have a minimal impact on his or her bonus if the performance of the other individuals in the group remained below par. The incentives motivated individuals to share their own best practices with peer units in order to boost the performance of the entire bonus group. For example, the bonus of shop-floor workers depended not on their own performance but on the performance of their entire 25- to 40-person work group. Similarly, department managers earned an annual incentive bonus tied to the performance of the entire plant rather than that of their own department. In addition, the incentive bonuses of plant general managers depended on the performance of the entire company rather than just their individual plants.

Building Effective and Efficient Transmission Channels.

A company's knowledge base encompasses a wide spectrum of different types of knowledge —from highly structured, codified and thus mobile forms of knowledge (for instance, monthly financial data) to highly unstructured, tacit and embedded forms of knowledge (for instance, plant start-up know-how). Information technology is a highly effective and efficient mechanism for the transfer of codified knowledge, and Nucor, like many organizations, exploited the power of IT. Unlike many organizations, however, Nucor also excelled at the sharing of unstructured knowledge — a key driver for building and leveraging core competencies. The ability to transfer unstructured knowledge requires rich transmission channels, such as face-to-face communication and the transfer of people.

Intraplant Knowledge Transfers.

Nucor's goal within each plant was to build a social community promoting trust and open communication, in which each person knew everyone else personally and had ample opportunity to interact. Achieving that goal began with the company's policy of keeping the number of employees in each plant between 250 and 300. The small number, coupled with employees' long tenure, fostered a high degree of interpersonal familiarity. In addition, each plant's general manager routinely held dinner meetings for groups of 25 to 100, inviting every employee once a year. The format was free and open but included some ground rules. All comments were to remain business-related and were not to be aimed at specific individuals. In turn, managers guaranteed that they would carefully consider and respond to every criticism and suggestion.

Interplant Knowledge Transfers.

Nucor used several transmission channels when it transferred knowledge among plants. First, detailed performance data on each mill were regularly distributed to all plant managers. Second, all plant general managers met as a group three times a year to review each facility's performance and to develop formal plans for the transfer of best practices. Third, plant general managers, supervisors and machine operators periodically visited each other's mills. Such visits enabled operations personnel, the true possessors of process knowledge, to go beyond performance data and to understand firsthand the factors that make particular practices superior or inferior. Fourth, recognizing the special difficulties inherent in the transfer of complex knowledge, Nucor selectively reassigned people from one plant to another on the basis of their expertise.

In addition to sharing best practices across existing plants, Nucor systematically recycled process innovations from existing plants to start-up plants. The company built or rebuilt one or more mills every year. Rather than rely on outside contractors to build the mills, Nucor put together a group of engineers from existing mills. The internal group was responsible for designing and managing the construction of any new building or rebuilding project. Moreover, Nucor hired local workers to construct the mills and informed them that they were likely to be recruited later to operate the mills.

Nucor's unique approach to building and rebuilding mills yielded several benefits. First, existing process knowledge was recycled into new-plant design and construction. Second, construction workers knew that they were building the plant for themselves and had a natural incentive to build it well. Third, knowledge of the underlying process technology embedded in the plant design was carried over in the workers' minds from the construction phase to the operations phase. Fourth, plant start-up expertise emerged as yet another of Nucor's core competencies.

Convincing Individuals To Accept and Use the Knowledge They Receive.

Nucor's social ecology countered the "not invented here" syndrome in two ways. First, the structure of the company's incentives signaled strongly to employees that relying solely on their own efforts at knowledge creation could be costly — literally. Second, by making every unit's performance visible to other units in the company, Nucor made the workplace into something of a fish-bowl. Strong performers were showcased before their peers; weak ones were exposed to the intense heat of peer pressure.

A Framework for Building an Effective Knowledge Machine

Nucor Corporation avoided the pathologies that plague many companies and built an exemplary social ecology for accumulating and sharing knowledge. By following a general framework, other companies can transform themselves, like Nucor, into effective and efficient knowledge machines. The guidelines for companies fall into two categories: those for maximizing the creation and acquisition of knowledge and those for maximizing the sharing of knowledge.

Maximizing Knowledge Creation and Acquisition

To maximize knowledge creation and acquisition, companies need to set stretch goals, provide incentives, empower people, encourage experimentation and cultivate within the company a market for ideas.

Set Stretch Goals.

The easier the target, the less a company needs to create new approaches. Therefore, the starting point for developing a culture of knowledge creation is to set targets that cannot be achieved without some innovation. As Jack Welch, the CEO of General Electric, has observed, "If you *do* know how to get there, it's not a stretch target. …The CEO of Yokogawa, our Japanese partner in the medical-systems business, calls this concept 'bullet-train thinking'; that is, if you want a 10-mile-per-hour increase in train speed, you tinker with horsepower, but if you want to *double* its speed, you have to break out of both conventional thinking *and* conventional performance expectations."[4]

Provide High-Powered Incentives.

By definition, stretch goals increase a person's level of risk in performing a task. Unless the potential reward matches the increased level of risk, competent employees simply won't stay with the company. Stretch goals without high-powered incentives are likely to end up as lofty exhortations lacking power to stir people to seek new approaches.

Cultivate Empowerment and Provide "Slack" Resources.

Stretch goals and high-powered incentives stimulate a demand for new ideas. By contrast, empowerment and so-called slack resources — for example, time given to employees for playful experimentation — are supply-side tools that play a critical role in increasing the creative capacity of subunits. Companies that require employees to justify in advance how they allocate their time and other resources stifle experimentation. The "15% Rule" at 3M Corporation is a good example of how empowerment and slack resources foster innovation. According to the 15% Rule, scientists at 3M are allowed, indeed expected, to use 15% of their working time on projects of their own choosing that don't require advanced approval by superiors.

Equip Every Unit With a Well-Defined "Sandbox" for Play.

Creating a culture that values experimentation means encouraging a willingness to take risks. Senior executives, in concert with the board of directors, must undertake "bet the company" types of moves from time to time. But it would be suicidal to have a culture in which the power to make such moves is widely distributed throughout the firm. One way to encourage experimentation without subjecting the organization to undue risk is

to give people or units well-defined "sandboxes" for experimentation and play. If an experiment fails in such a context, the risks are likely to be acceptable. For example, a large hotel chain could specify that each hotel general manager has the freedom to experiment with 10% of the rooms on its properties. Or a retail chain could give each store manager the freedom to design and create one new merchandise department.

Cultivate a Market for Ideas Within the Company.

Every company must have a screening mechanism to determine which of the many ideas emerging from the various subunits deserve support and which should be abandoned. When senior managers stifle good ideas, the problem usually is not that the company has screening mechanisms but that those mechanisms are inadequate. Companies must accept the fact that no single individual has a monopoly on wisdom. They should create a culture in which an idea that is rejected by one's immediate superior can still be "shopped around" within the company without creating a perception of insubordination.

Maximizing Knowledge Sharing

The best ways to maximize knowledge sharing are: ban knowledge hoarding, use group-based incentives, codify tacit knowledge and match knowledge-transfer mechanisms to types of knowledge.

Ban "Knowledge Hoarding" and Turn "Knowledge Givers" Into Heroes.

Every company must decide, implicitly or explicitly, which resources are to be treated as if they were corporate resources — and therefore "leased" to the business units — and which resources are to be treated as if they were "owned" by the business units. Consider, for example, brand names such as Nokia, Honda or IBM. Business units use those corporate brand names as a critical resource, but the brand name does not belong to any single business unit or subsidiary. To maximize knowledge sharing, companies must treat knowledge in a similar way; that is, as a corporate resource that cannot be hoarded by any particular subsidiary or business unit. It is also important to recognize, honor and even reward proactive "knowledge givers." In an effective knowledge machine, heroes do not merely invent leading-edge practices but also facilitate their adoption by other individuals and units within the corporation.

Rely on Group-Based Incentives.

Group-based incentives reinforce knowledge sharing as a cultural norm. In companies such as Nucor, incentives take the form of cash compensation. In other companies, such as Cisco, they take the form of sizeable stock options. The power of group-based incentives stems from the fact that they direct attention to maximizing the performance

of the entire system rather than that of an individual unit. Minimize problems with under-performers by ensuring that incentives are large enough to be meaningful, by making individual behavior visible within the group and by empowering the group to expel the chronic underperformer.

Invest in Codifying Tacit Knowledge.

Investing in codifying tacit knowledge — or complex, unstructured knowledge that resides in the minds and behaviors of individuals and groups — can have high payoffs. Consider Marriott International. In 1998, Marriott expanded from 1,500 to about 1,700 properties. Given an average of more than 300 rooms per hotel and 1.3 employees per room, Marriott's growth meant the addition of about 80,000 new employees in that year alone. With that level of growth, Marriott has been compelled to convert virtually everything that its people know about the operation of a hotel into codified, standard operating procedures. Without codification, the outcome would have been either highly inconsistent service or a dramatic decrease in the rate at which the company could grow. Of course, there is a limit to how much knowledge can be codified. Nevertheless, a company can reap many rewards from codification in terms of a broader sharing of knowledge throughout the enterprise and an increased development of new knowledge. Often, an explicit mapping of what a company knows is the basis for discovering what it does not know.

Match Transmission Mechanisms to Type of Knowledge.

The transfer of all knowledge occurs through one or more of the following transmission mechanisms: the exchange of documents, conversations and coaching and the transfer of people and teams. To be both effective and efficient, transmission mechanisms must be tailored to the type of knowledge being transferred. When it comes to transmission mechanisms, "effectiveness" refers to whether the receiver actually receives what the sender has sent; "efficiency" refers to the cost and speed of the transmission channels. Document exchange is a highly effective and efficient mechanism for sharing codified knowledge. It is often highly ineffective, however, for transmitting tacit knowledge. Conversations and the transfer of people, by contrast, are relatively inefficient mechanisms for sharing codified knowledge. But, for transferring tacit knowledge, they may be the only effective mechanisms.

Recreating Competitive Advantage Every Day

That intellectual capital is central to creating competitive advantage is widely recognized. But in an era of relentless technological revolutions and ubiquitous benchmarking, intellectual capital alone is but an ephemeral advantage. In the emerging economic landscape, competitive advantage must be recreated every day. To do so, companies must focus on creating and mobilizing new knowledge faster and more efficiently than competitors — and not get stuck in the mechanics of measuring the

worth of what they already know. A company's ability to function as a knowledge machine depends not merely on the sophistication of its IT infrastructure but more critically on the social ecology that drives the behavior of its people and teams. It is relatively easy for a company to adopt a sophisticated IT architecture, but it is even easier for competitors to neutralize or even leapfrog that architecture. Creating a social ecology that is free of pathologies, as Nucor did, is a much more difficult challenge. It requires building a whole ecosystem of complementary and mutually reinforcing organizational mechanisms. The bad news for companies is that this is a tough challenge. Any company can acquire a new piece of hardware, but not every company can overcome the difficulties and build an effective social ecology. There is good news, however, for the companies that succeed: Precisely because they have tackled such a difficult challenge, they will enjoy a competitive advantage that their rivals will find hard to beat.

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