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Mentofacturing: a vision for American industrial excellence

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Executive Overview

To be world industrial leaders, America's basic industrial organizations will undergo a metamorphosis from manufacturing organizations to mentofacturing organizations. The focus in mentofacturing is the mind.

The industrial revolution from manufacturing to mentofacturing involves developing organizations that emphasize learning, human development, risk-taking, and technology transfer. While some argue that American manufacturing is being deindustrialized, we believe that a metamorphosis coupled with a shrinking labor force is facing America's basic industries.

Chaparral Steel is an example of such a revolutionary organization. It has evolved a multi-product market mill strategy and unique culture resulting in high product quality, low product cost, and close attentiveness to customer service. The firm's unique culture has developed from the core values and beliefs held by the company's founders. Chaparral Steel views employees as 'human resources' for development, rather than 'labor costs' for expenditure.

Article

Mentofacturing is a word to replace manufacturing in the English lexicon.[1] Whereas manufacturing means "made by hand," mentofacturing means "made by the mind." It describes the transformation currently underway in the leading, technologically sophisticated firms in America. It also defines the vision for American industrial excellence in the next century which places greater emphasis on the power of the human mind as opposed to the human hand.

Mentofacturing companies will look more like software companies, technology driven and operated by technicians and thinkers. Most importantly, they will be learning organizations which emphasize cognitive skill development. People will be viewed as human resources to be invested in and developed, not as labor costs to be consumed. The direction in which American industrial firms must move is clear.

In this article, we examine the concept of mentofacturing by discussing the experiences of one far sighted company—Chaparral Steel. The founders of this company were refugees, primarily from the traditional steel companies, who visualized creating a steel company unlike any other in the early 1970s. They started a company in Midlothian, Texas which conformed to the vision and values of mentofacturing.

Chaparral executives hold several basic beliefs about human nature. For instance, they believe that human beings are inherently good, energetic, creative, and trustworthy—capable of achieving great and wonderful things. And, the creation of a product emphasizes the work of the mind, not the hand—hence, mentofacturing. The human mind, not the hand, is most important to the organization.

The most successful American industrial organizations of the 1990s and early twenty-first century will be mind, not labor, intensive. They will be creative, learning, growing organizations where people are rewarded for taking risks and achieving success.

Integrating research and development activities along with product quality enhancement into the production process is one important aspect of this risk taking. Rather than being a staff function, research and development should be an integral part of product design and production.

Some writers contend that America is being deindustrialized. We believe that American industry is undergoing a metamorphosis from manufacturing to mentofacturing. The belief at Chaparral Steel is that the seeds of a new industrial revolution have been planted. The revolution is in how products are created. We contend that it will result in America's basic industries becoming healthy world leaders in the next century.

Chaparral Steel Company Background

Chaparral Steel Company, a state-of-the-art steel company, produces medium-sized steel products (reinforcing bars, beams, angles, large rounds, and other simply-shaped items) for sale to construction, automotive, railroad, mobile home, defense, appliance, and other firms. It began operations in 1975 as a steel mini-mill with annual capacity of 220,000 tons. With a major plant expansion in 1982 and continuous design and application of advanced mentofacturing techniques, the firm's current annual capacity is 1.5 million tons. Along with this six-fold plant capacity increase, the firm's workforce increased from 235 to 934, 880 of whom are directly involved in the steel-making process. Since 1986, the number of employees has dropped one to two percent each year while productive capacity and output have increased 100,000 tons annually.

Chaparral was incorporated in July 1973 with the mission of becoming the international low-cost producer of high quality construction and industrial grade steel products. Current indicators of Chaparral's corporate success are included in Exhibit 1. The results in Exhibit 1 are particularly significant when considering the average labor productivity in United States steel making is 3.6[2] manhours per ton, average profit margin is 6 percent[3] of sales, annual employee turnover in U.S. manufacturing averages 10 percent,[4] and that no other United States steelmaker has been granted the Japanese Industrial Standard (JIS) certification.

A traditional steel mill manufactures steel through a series of steps: (1) the preparation of iron ore; (2) mixing of ore, limestone, and coke for blast furnace processing into pig iron; (3) reheating and refinement of the pig iron for shaping into slabs or billets; and (4) reduction through rolling and re-shaping into bars,

Labor productivity of 1.38 man hours per ton and 1100 tons of steel per man year.
Sales of $451.5 million, a 20% increase over 1988.
Net income or profit margin of 11% of sales.
Products are 100% re-cycled steel, primarily salvaged automobiles with a scrap yield rate of 90%.
More than 90% of the workforce has participated in corporate sponsored continuing education.
Two-thirds of the employees own stock in the company.
Eight percent of gross profits are paid as profit sharing to all employees.
Employee turnover of less than two percent per quarter.
Japanese Industrial Standard (JIS) awarded for quality products, May 1989.

Exhibit 1. CHAPARRAL STEEL COMPANY Current Indicators of Corporate Success

beams, and other products. Chaparral, as a minimill, produces steel products using only steps 3 and 4. Scrap is melted in an electric furnace, removed to a continuous casting machine from which billets, slabs, or blooms emerge for rolling into various shapes.[5]

For the traditional integrated operation, several days are required to produce finished steel products. In Chaparral's mentofacturing process, products are finished in a few hours. A salvaged auto is shredded in 18 seconds; 30 minutes are needed to prepare and move the shredded material to the furnace; furnace time is 45 minutes followed by up to two minutes for pouring molten material into the caster; then one or two minutes pass before the billet reaches and is processed through the bar mill. Five minutes later bars can be loaded onto trucks for transport to customers or moved to inventory storage.

The Multi-Product Market Mill Strategy: Fit with Culture and Human Resources
Achieving success in implementing Chaparral's business strategy through mentofacturing requires a fit of its primary design variables, including structure and operating characteristics, management and workforce attributes, and human resource policies and practices. Exhibit 2 shows the key design variables used by Chaparral Steel to achieve a fit between the firm's strategy, culture, and human resources for successful performance in domestic and international environments.

The Chaparral corporate vision is embodied in the multi-product market mill concept. This is a mid-range concept of a steel mentofacturer, a firm that lies somewhere between a steel mini-mill and a fully integrated, traditional steel operation. Chaparral produces a broader range of steel products than that of a typical mini-mill and mentofactures these products with substantially greater flexibility than the large traditional firm. Chaparral is considered a secondary steel mentofacturer, one that produces products entirely from scrap material, or

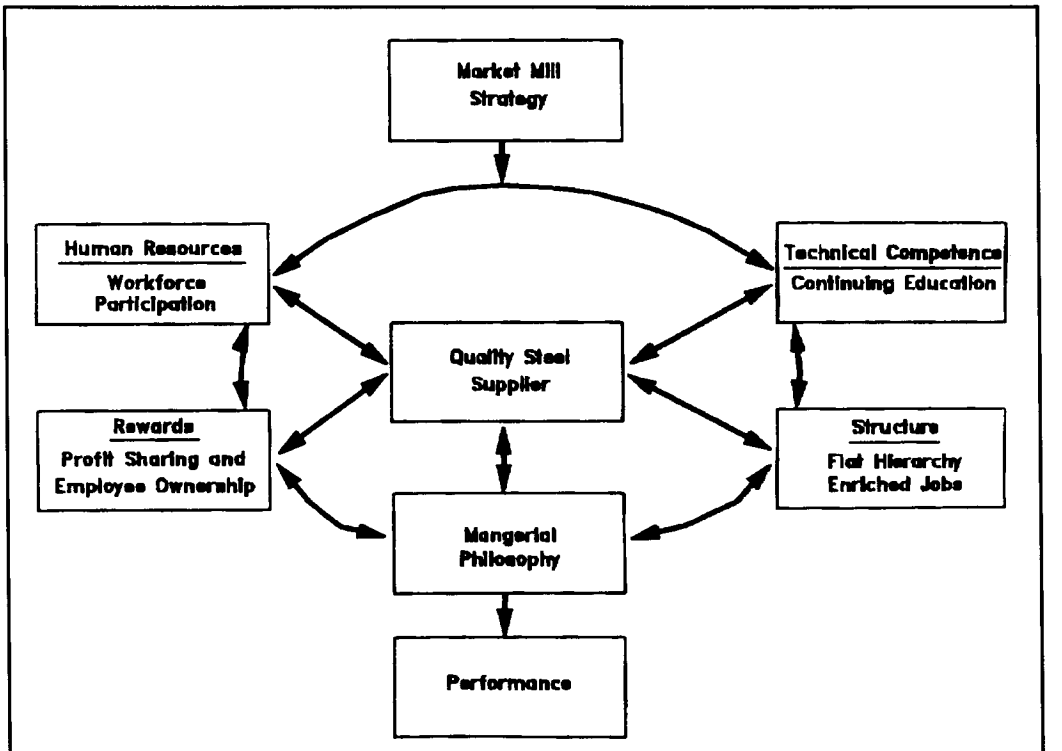

Exhibit 2. Chaparral's Design Variables

100 percent recycled iron and steel. The advanced production process and the nature of the raw material allow the firm to be very market sensitive. That is, the product mix can be quickly adjusted to meet market and customer needs.

As a market mill, Chaparral's three-fold strategy is (1) to be on the cutting edge of technology; (2) to be the easiest steel company with which to do business; and (3) to develop the human side of the enterprise. Chaparral's grand strategy is one of concentrated growth in which the firm directs its resources and expertise to a limited range of steel products using the most modern steel-making technologies. The strategy results in high product quality, low product cost, and close attentiveness to customer service. Products are sold domestically to oil exploration, construction, and industrial equipment manufacturing firms, and globally to Japanese, German, and Canadian distributors and wholesalers.

Much of Chaparral's success can be attributed to its strategy of being on the leading edge of technology, or technically innovative. This is not only in the production process but in all aspects of its market mill operations.

For example, one illustration of innovation occurred in steel bar production technology. Chaparral had a production line which produced 3,000 feet of steel bars per minute. The steelmakers wanted to run the production line faster, but they encountered a problem with the bar becoming airborne. After months of experimentation and planning, Chaparral's bar mill steelmakers found that they could enhance production by splitting the bar in two in the midst of a run, thus producing two bars at 3,000 feet per minute. Next, they went to four bars at 3,000 feet per minute. The Japanese have purchased the license to use Chaparral's innovative splitting technology.

The various elements of the market mill are presented in Exhibit 3. For the most part, Chaparral focuses on process technology and tends to be line-driven, technically innovative, and capital intensive in producing long-run or large-batch standardized steel products.

The technology-directed nature of the market mill clearly focuses attention on improvements in process technology. However, innovations and/or technological advances may also take place through any of the interactive links represented in Exhibit 3. For example, a customer suggested to a Chaparral representative one

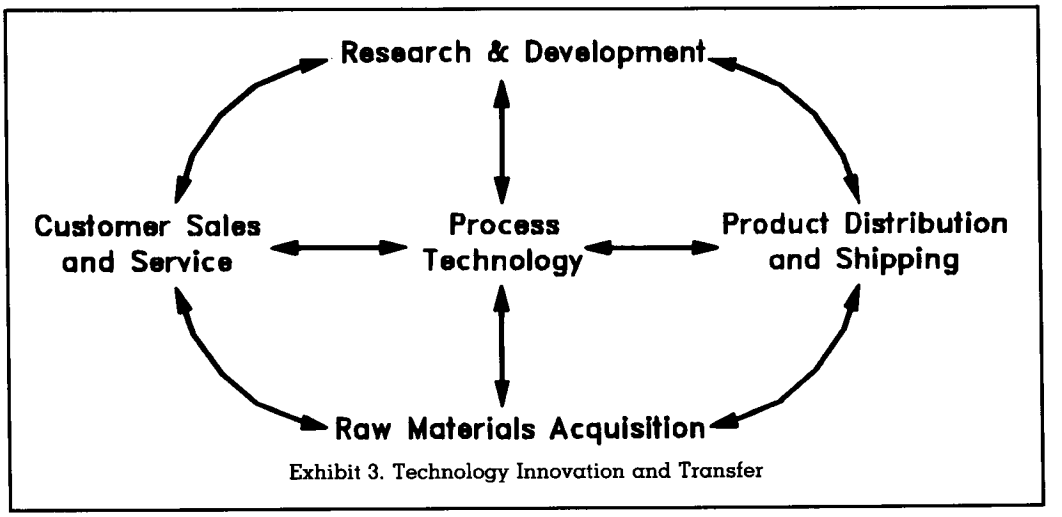

Exhibit 3. Technology Innovation and Transfer

Monday morning in Los Angeles that he would buy more steel if minor modifications of size and shape of a particular product could be made. This customer request was discussed in the production planning meeting Monday afternoon in Midlothian. A decision was made that the customer's specifications could be met, and by Wednesday the steelmakers at Chaparral were producing the new product. Delivery took place in less than two weeks.

Chaparral's Culture: Linking Strategy and People

Chaparral Steel has a unique culture which has its roots in the values and beliefs of the founding team. These values and beliefs have been elaborated upon, embedded, and extended until they permeate the entire company. The five central values and beliefs of the founders were:

- trust in people to be responsible
- take risks for achievement and success
- challenge to grow in knowledge and expertise
- be open to learn and to teach
- make work fun and pleasurable.

Founders play a particularly important role in the creation and transmission of the culture of any organization. Chaparral recognized this fact and formed the FOUNDERS CLUB during the first year of operations.[6] This club was for all employees, not just officers, managers, or executives. As Chaparral Steel has grown, the FOUNDERS CLUB has been extended to all employees who have served 10 years or more with the company.

The restrictive rules of bureaucratic systems are viewed as dysfunctional by the people at Chaparral Steel.

An example of trust with the Chaparral culture is found in the firm's "no fault" approach to sickness and absenteeism. Many firms have paid sick leave programs with numerous procedures for reporting sickness, lost time, and return to work. Chaparral does not have a paid sick leave arrangement as employees are salaried. An employee can be absent for a good reason, no reason, or a bad reason. Employees are treated as adults and the daily absence rate is less than one percent.

As refugees from large, rather bureaucratic steel companies, there is a strong element of informality within the cultural ethic of Chaparral. The restrictive rules of bureaucratic systems are viewed as dysfunctional by the people at Chaparral Steel. The unconventional is valued. For example, jeans and other informal dress were worn on Fridays in the early years. This informal dress code became symbolic of unconventional elements in the corporate culture. As another example, the janitor for the main building has dictated memos and letters to the president's secretary on several occasions as the need arose.

The relatively flat, participative, team-oriented culture at Chaparral includes only four levels. The executive team consists of 22 individuals whose titles range from general manager to president. Middle management includes 32 individuals, first line management consists of 97 individuals, including 67 technicians, and the production and maintenance team consists of 661 in those basic functions as well as 76 clerical employees.

The value placed on trust in individual responsibility and an appreciation for individuality is reflected in the results of two sets of personality and behavioral tests completed by Chaparral officers.[8] Both sets of tests show a healthy variance of individual differences, which are treated as complementary. For example, while some of the officers are very extroverted and enjoy high levels of interpersonal interaction, others are more introverted and quite comfortable working with less interpersonal interaction. Such differences in personality and patterns of interaction might be the basis for disruptive conflict in some

organizational cultures because the differences are interpreted as meaning something is wrong with the person who is different. At Chaparral, individual differences are appreciated and valued as individual strengths and unique contributions to the whole. As a result, the officers have been able to build a diverse and strong team which is multidimensional.

The lack of formality in the Chaparral culture has been extended to the architectural design of the office complex.[9] Everyone must walk through the Human Resource Department twice a day to get to their lockers, once in the morning and once in the afternoon. The purpose is to create the opportunity for informal interaction between human resource professionals and all employees. The locker room is located in the same building as the executive offices to create an informal opportunity for interaction between people.

The value placed on challenging individuals to grow in knowledge and expertise has led Chaparral Steel to focus on opportunities for excellence. For example, all production and maintenance employees participate with supervisory and management personnel in establishing well defined, challenging goals and objectives. They are not, however, told *how* to achieve them. This allows individuals and work teams to determine how they reach their goals, including determining the materials and equipment necessary to accomplish the task. They are free to seek out opportunities where they may excel.

The fit of strategy, culture, and people can be illustrated with the information systems technology initiative begun at Chaparral in 1987. Chaparral started business in the early 1970s with 20 to 30 customers and 11 or 12 different products. By 1987, Chaparral had 1,500 customers with 400 to 500 basic products, or well over 2,000 products on the site at any one time. Dave Fournie, a production manager, was given the challenge of making Chaparral a paperless firm where MIS systems could be used as a strategic tool. He began with a working group of 15 to 18 people from accounting, sales, shipping, inventory, the mills, and engineering. This work group papered a nine by twelve foot wall with nearly one hundred pieces of paper needed for interaction with one customer. The absolute minimum number of completed forms for any one customer was determined to be eleven or twelve pieces of paper, including a mill order, billet order, rolling order, an inventory transfer, manifest, and a few others.

Between 1987 and 1990, Chaparral was not able to eliminate all this paper. However, the company has progressed considerably by building a relational data base on a DEC system with an ethernet so that salespeople on the road, some maintenance people at home, and other Chaparral employees can network to the system. In addition, approximately thirty customers are on-line, primarily to check order status.

This advance in information technology has given Chaparral access to services, such as a railcar monitoring system, which allows orders to be computer tracked from the mill to the customer. The information is also immediately available to the customer. The crux of the extensive technological advance in this area was the learning that the Chaparral team experienced, beginning with Dave Fournie. An engineer by training and a production manager by trade, Fournie challenged himself to learn accounting, shipping, inventory control, and computer applications so he could lead his project team through the challenges of moving Chaparral from a paper-based, largely manual system to a state-of-the-art, information-based, computerized-system.

Human Resources—Not Labor Costs

While some traditional industrial organizations treat labor as a cost of doing business, it is more appropriate to view labor as the vital human resource and

asset that animate the enterprise. Chaparral Steel's ability to outperform United States and Japanese steel firms for tons of steel produced per man-year is based on the innovations, technological advances and the constantly developing skill and knowledge base of its people. The firm invests heavily in its employees, and human resource policies and practices are directed toward making each employee into an entrepreneur and a business partner. Policies and practices developed by the executive team help frame the human resource responsibilities for selection, orientation, compensation practices, safety and health issues, as well as organizational development. The mission of the human resource team is to be a catalyst for change, which is consistent with the company's strategy of developing the human side of the enterprise, and varies significantly from the traditional manufacturing organizations treatment of labor.

Chaparral currently produces one ton of steel in 1.38 man-hours (see Exhibit 1), which compares to Japan's 3.0, and the best American competitor of 2.0. Sales dollars per employee were an impressive $528,487 for fiscal year 1989. These numbers are a result of continuous improvement in equipment and process technological advances made by employees.

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Employees' ability to make improvements are enhanced through continuing education. For example, Chaparral formalized its commitment to continuing education in establishing a 3 and ½ year program registered by the U.S. Department of Labor, Bureau of Apprenticeship and Training, Manpower Administration, and the Texas State Technical Institute. The program represents a major investment by the company and an equally heavy investment in employee time. It enables employees to develop competence while getting credit for their enhanced talents. Its purpose is clearly stated in the program booklet's introductory section.

"It is the intent of Chaparral Steel to provide the broadest possible growth experience for every person employed by the company. We believe that the company grows in excellence in direct proportion to the growth of its people."[10]

Each employee spends approximately four hours each week in a class room three out of four weeks for ten of twelve months or approximately 120 hours each year. While in class, the student receives an additional $20 per week for expenses to help defray their costs. Most of the education occurs on the job in cross training by more experienced employees. The firm has also worked to build a strong, positive bond among all employees across all four organizational levels. This is accomplished by emphasizing the commonality among all at Chaparral rather than highlighting the differences between any groups, such as management and nonsupervisory employees.

Training and education efforts are delivered through numerous means, ranging from on-site education programs conducted by outside professionals and/or Chaparral Steel experts, to off-site seminars and courses sponsored by universities, trade associations, and even customers. Every individual has an education matrix or grid which includes objective knowledge and cognitive skill areas to develop within specific time frames or milestones. More than ninety percent of employees are involved in continuing education. This compares sharply with national statistics which show job training going mainly to managers and professionals, fifty percent to sixty percent of whom receive job training. Only twenty percent to thirty percent of machine operators and craft workers receive job training.

Executives also participate in continuing education. Several, including the president, maintain relationships with universities across the United States and Canada. For example, to enhance their writing skills and creativity and

imagination, senior management brought in a professor of English who teaches creative writing on an on-going basis.

Chaparral Steel's annual turnover rate is less than two percent per quarter (half of which is voluntary). Achieving this requires a very effective selection process. The Human Resource Department, which receives between 150 and 160 applications each month, sight screens each resume. Initial interviews are then arranged which focus on characteristics such as oral communication ability, energy level, sincerity, and other attributes related to the individual's capacity to become an active team member. Eight applicants are normally interviewed before one is referred to a department.

The second interview is approximately three to four weeks following the initial interview, allowing the applicant time to discuss the job with those who are already employed by the company. The second interview, which lasts for most of one workday, is with the immediate supervisor and work group members. If the applicant is approved by the hiring department, then the Continuing Education Department interviews and tests the applicant. Previous job references are verified and a physical examination is administered by a local clinic. The entire process takes about six weeks, though it may be longer since the required one week orientation program is offered only once a month.

The performance ranking is not measured against job requirements or a job description (Chaparral does not have job descriptions nor restrictive work practices) but against the employee's goals and objectives.

Other practical applications of the human resource strategy can be found in the firm's compensation. Everyone is salaried and shares in the firm's profits. Chaparral is non-union and sixty-two percent of the employees own company stock. In one effort to unionize Chaparral, a union organizer said, "You fellows have it good here. We'll help you make it even better." While a reasonably good union campaign, the effort failed. The compensation system emphasizes the individuality and distinctive competencies of each person, with pay allocated for knowledge and performance. No two people at Chaparral receive the same pay. In part this is because salary adjustments are issued on the employee's anniversary data of employment as opposed to a common date, such as January 1.

While compensation arrangements and employee performance evaluations are obviously linked, salary decisions and supervisor review of employees is separated by a few days to several months. At the start of the budget year, supervisors rank their employees from best to worst in terms of overall performance and job knowledge. The performance ranking is not measured against job requirements or a job description (Chaparral does not have job descriptions nor restrictive work practices) but against the employee's goals and objectives. Supervisors make salary adjustments when funds are available for adjustments. Salary information is confidential but not secretive.

Second, the campus-style design at the Midlothian facility and the architectural arrangement of the office/working area complex place all employees on an equal footing. For example, the executive offices and the steelmakers' locker rooms are housed in the same facility. This encourages interaction between executives and workers. The executive board room is also designed not to create separation but to promote interaction with the work areas of the company. The continuing education/training suite is better equipped and more lavishly appointed than the boardroom.

The challenge value in the Chaparral culture led its people to seek the JIS certification for a variety of structural steel products. The quest for this certification began with informal discussions with the Fujiyama Enterprises Corporation of Tokyo, Japan, between December 1986 and November 1987, at which time a first draft of the JIS application was made with the American Bureau of Shipping

(ABSTech).[11] During the next six months, additional information was requested by the Japanese and an audit of Chaparral was undertaken by ABSTech on behalf of the Japanese Ministry of International Trade and Industry (M.I.T.I.). This was the first time that M.I.T.I. had agreed to accept inspection and audit data from an external agency.

In May 1988, Chaparral made a formal submittal to M.I.T.I. for JIS certification. Between June and August of 1988, the M.I.T.I. officials expressed a strong interest in the actual values of Chaparral's operating parameters, which the company refused to divulge on the grounds that it was proprietary information. Histograms on chemistry, tensile properties, and dimensional values of various steel products were agreed upon to be given to a second set of ABSTech auditors, a procedure which had been requested by the Japanese.

The second audit report and formal JIS application were officially filed with M.I.T.I. in December 1988. While the Japanese ministry continued to seek information on Chaparral's casting molds and operating parameters, this proprietary information was never forthcoming. During the first week of April 1989 the M.I.T.I. granted Chaparral Steel authorization to use the JIS certification, thus becoming the first American steel company to have this authority and only the second in the world outside of Japan, the other being a Korean steel company. While the JIS certification has benefitted Chaparral in its new and growing Asian market, it has had a secondary and unanticipated benefit in the European market. Specifically, the Europeans understood the JIS certification as a mark of excellence and quality, therefore desirable.

Past, Present, and Future

The manufacturing sector of the economy generates twenty-five percent of the GNP with about twenty-five percent of the workforce. This sector of the economy is projected to continue to produce about twenty-five percent of the GNP with as little as five percent of the workforce.[12] Rather than deindustrialization, it appears that we are improving operations efficiency and organizational effectiveness.

The early years of the twentieth century were the golden years for the American steel industry. U.S. Steel was the largest industrial enterprise in the nation as of 1909. The strength of the U.S. steel industry was not seriously challenged through World War II. It was, however, the demise of the Japanese and German steel industries. This left the steel industry in the United States with little international competition, to its unfortunate, long-term detriment.

During the 1950s, 1960s, and early 1970s, steel production capabilities were redeveloped with modern technology and equipment in Japan and West Germany, as well as in Korea. Major steel producers in the United States were slow to recognize and respond to the developing international competition. By the early 1980s, the U.S. steel industry was embattled by a variety of internal and international forces which threatened its long-term survival.

To enter the U.S. steel industry in the early 1970s was a risky and uncertain proposition. It required the identification of a market niche, distinguishable within the larger context of the steel industry, and the formulation of a strategic plan to excel within the niche.

The people and culture at Chaparral Steel have made a success of the company's market mill strategy in turbulent and changing times. In the larger industrial context, the mentofacturing sector of the American economy is undergoing a metamorphosis involving a smaller population and increased corporate emphasis on human resource development. It is a revolutionary period in American

mentofacturing. People are becoming more important and critical to mentofacturing success, *not* less important.

Lessons to Learn: Guidelines and Pitfalls for Traditional Manufacturers
Chaparral Steel was built from the ground up. There was no existing culture or technology which had to be changed or modified. The corporate founders began with a clear slate and creatively constructed a mentofacturing firm. They assumed that they had sufficient discretionary control to actually make a difference in what was, in many ways, a mature industry. The founders did not accept the constraints and assumptions of convention steel industry wisdom. They viewed the acceptance of industry constraints as part of the industry's bureaucratic pathology. Instead, they were guided more by their imaginations, vision, and creativity.

Certainly not all organizations have such an opportunity nor are all top executive teams willing to assume the risks associated with norm-breaking behavior. Even for those willing to assume the risks, the movement from a manufacturing orientation and philosophy to that of mentofacturing may not be easy.

Guidelines and Expectations
There are six guidelines which may be used by existing manufacturing firms considering a transition to mentofacturing. While they cannot guarantee a successful adjustment for an established manufacturing firm, they certainly will aid in facilitating the process.

First, top level leadership's commitment to the basic ideas and values of mentofacturing outlined in this article is essential to a successful transition. This does not mean that replacement of leaders is necessary to bring about the change, but it does mean that leaders must be committed to the ideas and values embodied in mentofacturing.

Second, performance and rewards must be linked. Changing management's philosophy without making any basic change in the company's reward system is ineffective. Leaders' espoused ideas are not nearly as important as the matters related to the consequences of behavior. That is why Chaparral Steel considers the compensation system, profit sharing, and employee ownership so essential to the market-mill strategy. For existing companies, basic changes in the structure of rewards and consequences may be essential and will likely be experienced as revolutionary by those familiar with the ways of the old system.

The basic trust value in the Chaparral culture says that people will make fundamentally good decisions when afforded the choice.

Third, long term involvement in education and training must be made. The development and cultivation of a human mind is not a short-term proposition. And, the linkage between performance and rewards is accomplished through training. Education and training require time, nuturance, and continual effort. As education and training lead to enhanced employee competence, there is reduced need for close supervisory control. Self-managed work teams become a possibility.

Fourth, personnel selection through attrition is important. The basic trust value in the Chaparral culture says that people will make fundamentally good decisions when afforded the choice. Thus, when existing firms move from manufacturing to mentofacturing, there will be those who find the new ways anathema or abhorrent. Allowing people to self-select out of the new system is the perferred way to proceed. While it is time consuming, it is both more permanent and humane.

Fifth, there must be full disclosure of the new situation to employees. Hidden agendas of any nature will derail the fundamental culture upon which mentofacturing is founded. In existing companies where there are internal barriers between leadership and labor or in divisively unionized firms, this will be a

particularly knotty guideline. It presupposes trust among individuals and groups within the organization. If trust does not exist, faithfully following this guideline will help build it.

Sixth and finally, companies in transition should possess a reasonably high tolerance for frustration. Because the core founding values of mentofacturing are fundamentally different than those in most existing manufacturing firms, the change must occur in the very foundation. Some failure, regression to old methods, and disappointments will characterize the pathway of change.

Pitfalls and Risks

While there are certain guidelines and realistic expectations that existing manufacturing firms may use to change to a mentofacturing industry, there are also potential pitfalls and risks. Six of these are particularly important to highlight.

First, mistakes do happen. The mentofacturing philosophy is certainly no panacea which results in an error-free, perfectly functioning organization. Growing, learning, and dynamic systems are ones which, by definition, will encounter errors and mistakes. Allowing for them is essential to the shift from manufacturing to mentofacturing. The fundamental question at the point of a mistake is: Has someone learned something as a result of the mistake? Mistakes are not valued in their own right but in their potential to educate.

Second, it would be unreasonable to expect too much too soon. There are payoffs in morale, creativity, productivity, and profitability. However, for existing firms, there may be longer and more uncertain payback periods than for new firms. For very large companies, the transition and change periods may well be in terms of years, while for medium-sized and small firms the transition periods may be shorter.

Third, while we have discussed mentofacturing as a revolutionary approach to product creation and production, there is risk associated with destabilization of the organization. While evolution and revolution are fundamentally different processes, there is sometimes a fine line between transformation through evolution versus revolution. With a clear vision in mind of the end state desired, the risks of destructive destabilization of the organizations are reduced substantially.

Fourth, it is vital that there be consistency between the leadership's rhetoric and actions. Talking about trust, tolerance for mistakes, and confidence in employees will actually be counterproductive if leaders' behavior is contrary. Employees will focus more on behavior and actions than on what the company's leadership says. To the extent to which there is consistency between the leaders' verbal message and their actions, employees are going to be much more likely to depend upon what is said.

Fifth, it is important to guard against an unwillingness to accept the market's downside. One of the apparent paradoxes of organizational response to industrial uncertainties or downturns is to tighten the managerial control systems. While this may be a perfectly natural reflex, we would argue that it is counterproductive in the long run. Rather than tighten the control systems in difficult times, such as in down markets, leaders need to be the most flexible and supportive of employees.

Sixth, the changes required to move to mentofacturing particularly strain the mid-level managers in the system. These are the individuals who feel most at risk due to the increasing activity, responsibility, and growth on the part of operating level employees. Chaparral's sabbatical program is one way that the company responds to the growth and development needs of these mid-level managers.

Conclusion

A fundamental metamorphosis is occurring in America's basic industries. The manufacturing firms which are a core of that industrial base are becoming transformed into mentofacturing organizations. These mentofacturing firms are the future flagships of American's basic industries. They demand a different set of values, ideas, and skills on the part of all employees within the firm. Emphasis is placed on competence, not authority; capability, not position; mindedness, not manualness; and unity of effort, not division of labor.

Endnotes

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[1] Gordon Forward first used the term mentofacturing in an invited speech given at the 118th TMS Annual Meeting of the American Institute of Mining, Metallurgical, and Petroleum Engineers on Wednesday, March 1, 1989 in Las Vegas, Nevada.

[2] This figure is calculated from Tables 1A and 1B, page 6, of the *1989 Annual Statistical Report* (Washington, D.C.: American Iron and Steel Institute, 1990).

[3] This statistic was computed from 1989 quarterly and annual reports of ARMCO, Bayou Steel Corporation, Bethlehem Steel Corporation, CF&I, Co-Steel, Inland Steel Industries, Laclede Steel Company, Luckens, NUCOR, and USX Corporation.

[4] This statistic was gleaned from "Job Absence and Turnover Report—1st Quarter 1990" of *Bulletin To Management* (Washington, D.C.: Bureau of National Affairs, Inc., 1990).

[5] See Jack R. Miller, "Steel Minimills," *Scientific American*, 1984, *250*:5, 32-39.

[6] Founders are often thought of as the leaders of the enterprise, as reflected in the work of Edgar Schein. Chaparral's FOUNDERS CLUB was the brainchild of Dennis Beach who noted the importance of recognizing not only founding officers but *all* founding members, regardless of hierarchical position.

[7] The concept of "no fault" comes from Dennis Beach's notion that the human resource function should by run by 'adultry'; that is, people should be treated as adults and the organizational bottom line is to get the work done. Work organizations are not social welfare systems.

[8] Each of the officers at Chaparral Steel has completed the Myers-Briggs Type Indicator, which provides feedback on four dimensions. These are: (1) extroversion-introversion; (2) sensation-intuition; (3) thinking-feeling; and (4) judging-perceiving. Each has also completed the Fundamental Interpersonal Relations Orientation (FIRO-B), which gives feedback on three dimensions. These dimensions are: (1) control, (2) inclusion, and (3) affection.

[9] Some would argue that Dennis Beach created the architectual design in a manner to assure that he and the human resource personnel would not be lonely. The design certainly does stimulate interaction among all levels and types of employees.

[10] From the Introduction, page *i*, *Chaparral Steel Apprenticeship Program* (Midlothian: Chaparral Steel, 1987). This 50 page booklet provides the details of the apprentice training program used at Chaparral.

[11] Chaparral Steel actually dealt with ABSTech, which is the engineering and inspection arm of the American Bureau of Shipping.

[12] For a more specific discussion of the workforce and economic transition mentioned here, one should consult Robert Abeshouse, *Lifelong Learning: Part 1: Education for Competitive Economy: The High-Flex Society Working Papers* (Washington, D.C.: Roosevelt Center for American Policy Studies, 1987); William B. Johnston and Arnold B. Packer, *Workforce 2000: Work and Workers in the 21st Century* (Indianapolis: Hudson Institute, 1987); Norman Saunders, "The Aggregate Structure of the Economy," *Monthly Labor Review*, 1989, 112:11, 13-24; Robert J. Miller (ed.) *The Annals of the American Academy of Political and Social Science*, 1983, 470:11, 9-212.

About the Authors

Gordon E. Forward is chief excecutive officer and president of Chaparral Steel. He earned a Ph.D. from the Massachusetts Institute of Technology with a major in metallurgy and a B.S. and M.S. from the University of British Columbia, Vancouver. Forward was Senior Research Engineer for the Steel Company of Canada and General Superintendent for the Lake Ontario Steel Company before joining Chaparral Steel in 1973. In 1986, he became a Director of the Steel Service Center Institute of the United States. He is also Chairman of the Board of the National Super Collider Education Consortium, Inc. In 1972, Forward,

together with Professor John Elliott of MIT, was awarded the John Chipman Medal from the American Association of Metallurgical Engineers for basic research relating to the solidification of steel. In 1987, business author and lecturer, Tom Peters, selected Forward as Chief Executive of the Year.

Dennis E. Beach was selected as the chief human resources officer in 1974 prior to the start up of the Chaparral Steel Company. He was an original incorporator of the Company in 1973 while employed at Texas Industries, Inc. as corporate administrator-personnel research & development, a post he held for five years after leaving ITT-Continental Baking Company, Dallas, Texas. Beach has been a guest speaker at colleges including Wharton School of Business, Southern Methodist University, and Queen's University-Canada. He is presently serving on the Board of Directors for CUE, a division of the National Association of Manufacturers and is an executive member of Human Resources Planning Society. He earned a B.A. in business administration from Southern Methodist University majoring in personnel management with an accounting and economics minor.

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