ADAPTIVE MANAGEMENT FRAMEWORK: LINKING STRATEGY WITH EXECUTION IN THE STEEL INDUSTRY

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ABSTRACT

The steel industry is undergoing an enormous structural transformation that is being driven mainly by accelerated technological innovation. Newer and more refined ways of competing have emerged in this environment. Because of the transition toward more sophisticated technologies and strategies, analysis of the industry has become increasingly complex. These changes also create uncertainty. In order to deal with these issues of complexity and uncertainty, companies need to choose the right strategy and support it by an appropriate set of activities.

This study explores the link between strategy and execution in companies in the steel industry. To achieve this goal, the authors applied the Adaptive Management Framework as developed by Hax and Wilde (1996). This strategic framework contemplates three alternative strategic positionings: Best Product, Total Customer Solutions, and System Lock-in. Three adaptive processes, Operational Effectiveness, Customer Targeting and Innovation, provide the link for achieving the right execution.

Three companies -- Nucor Corp., LTV Corp. and British Steel plc. -- each with a different business model, were selected and individual research was done to understand how their internal processes are aligned to support the firm's strategy. Our research methodology was based on on-site interviews with key senior managers in each firm.

This study revealed that while in the low and middle end of the market all the companies pursue a Best Product strategy (searching for excellence in operational effectiveness), in the high end of the market, LTV and British Steel pursue a Total Customer Solution (via a strong Customer Targeting process). However, it is noteworthy to mention that British Steel has a strategic vision that may turn this company toward a System Lock-in strategy in the future. By showing new examples of innovation in the steel industry, the authors present the concept of system lock-in as a viable source of sustainable competitive advantage.

The thesis concludes with a prediction of the dynamics of the competitiveness between integrated mills and minimills using the systems thinking methodology. Finally, a set of recommendations for companies to speed up their search for enhancing competitiveness is provided. These recommendations are focused on what the authors consider the key drivers of success: Technology Management, Knowledge-Based Management and new dimensions of Compensation Systems based on Teamwork Performance.

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We are most grateful to Professor Arnoldo C. Hax and to Dean Wilde II for their ongoing support and encouragement as we developed this thesis. We found the discussions with Prof. Hax particularly illuminating, and we both are pleased to be able contribute in a small way to the enhancement of their Adaptive Management Framework.

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PREFACE

This project is primarily intended to explore the link between strategy and execution in the steel industry. We first gained an understanding of the set of activities a firm needs to develop in order to support its strategy. In this regard, we concentrated on understanding the distinctive type of capabilities a steel company needs to acquire that will enable it to execute its strategic choice.

This study began in the fall of 1996 as part of a structured thesis project at MIT which had the goal of testing the applicability of the Adaptive Management Framework in different industries. This strategy framework was originally developed by Arnoldo Hax and Dean Wilde II (1996), and is intended to provide a solution to the increasingly complex and uncertain competitive environmental analysis.

We decided to focus our analysis on the steel industry because it is an industry that has left its traditional path and is now immersed in a unique and complex process of transformation, which is discussed in detail in Chapter One. The second reason for choosing the steel industry is because both the authors have been working in this industry for more than ten years; consequently we have a greater understanding of the steel industry than any other industry we might have chosen.

We found that the Adaptive Management Framework (AMF) is a very comprehensive, yet simple, model for analyzing how companies link strategy with execution. In Chapter Two, we will describe this framework in detail.

In Chapter Three we give profiles of the three companies that form the core of our research: Nucor Corporation, LTV Corporation, and British Steel plc. The profiles provide a general overview before going into greater detail regarding each company's strategy.

In Chapter Four we analyze the diverse strategies pursued by these companies, and we have categorized based on the AMF framework. In Chapters Five, Six and Seven we present our research on each of these companies and how their adaptive processes (Operational Effectiveness, Customer Targeting and Innovation) support the companies' strategies.

In Chapter Eight we present a causal loop that shows the relevance of the AMF in developing strategic thinking in the steel industry. Additionally, we introduce the concept of "Industry in Transition" that helps to better understand the dynamics of the industry.

The basis of this research has come from our discussions with our advisor, Professor Arnoldo Hax, a living reservoir of knowledge and expertise.

The purpose of this project was not to carry on a benchmarking of the industry. On the contrary, from the outset we focused on understanding the critical processes that support some of the most successful steel companies' strategies. We decided early on that it would not be enough to read what others have written about those companies. Rather, we decided to visit the field and build our own impressions about how companies define their business model and then execute it.

Ultimately, we chose Nucor Steel, LTV Corporation, and British Steel plc. We selected Nucor because it is a different kind of company, due to its unique cultural assets and its technology. LTV, with its state-of-the-art technology, has proved to be a customer-driven company in many aspects of its business. Finally, British Steel, the third largest steel

producer in the world, has accomplished an impressive turnaround, both financially and strategically. A refreshing and progressive management style has led the company to achieve a dominant position in England.

CHAPTER ONE

THE METAMORPHOSIS OF THE STEEL INDUSTRY

1.1 A STRATEGIC INFLECTION POINT

The steel industry is at a "strategic inflection point" (Grove, 1996) that is reshaping it entirely. A strategic inflection point occurs when the balance of forces shifts from the old structure, the old ways of doing business, and the old ways of competing, to the new. Once a traditional industry, the steel business is rejuvenating its practices as well as its technologies.

In this introductory chapter we have analyzed the changes taking place in the industry and the new patterns of practices that producers have introduced in order to re-position themselves in this new environment.

1.2 TECHNOLOGY IN EVOLUTION

Until the mid-1980s technological change in the steel industry was measured in decades, sometimes in years. It took about 40 years for the North American industry to fully abandon the open hearth in favor of basic oxygen steelmaking, and almost as long for the flat roll industry to become 100% continuous cast. Such a pace of change is no longer

the case. Technological change in the steel industry has become virtually continuous, with a significantly compressed time horizon for choosing, implementing, and amortizing investments in new technology. In less than ten years, thin slab casting has progressed from an unproven concept to becoming the standard Greenfield configuration for most industry environments (Lichtenstein, 1996). Figure 1.1 shows how dramatic these changes have been from the 1970s to the 1990s.

Figure 1.1
The Technological Evolution in the Steel Industry

	1970s	1990s
Steel Production (million tons per year)	600	720
Dominant technology	Integrated Plants	Mini-mills
Major Producers (emerging)	US, W. Europe, USSR, (Japan)	USSR, Japan, US (China, Korea, India)
Environmental issues	Non-important	Very important
Energy requirements (GJ/t)	35-40 *	9-15 **
Labor (man-hour per ton of steel)	6-12 *	0.5- 1.5 **
Capital investment ($/annual t capacity)	1200 - 1500 *	300 - 400 **
Price of Steel ($/t)	400	300-400
* Integrated ** Minimills		

Source: Szekely/Trapaga, 1994.

1.3 THE 10-X FORCE

The phrase "10-X Force" refers to a change in an element of one's business in an order of magnitude larger than that to which the business is accustomed (Grove, 1996). A 10-X force may be a dramatic change in regulations, or a new technology that completely

changes the customary way of doing business. The deregulation of the U.S. telecommunications industry and the advent of the Internet are examples of a 10-X force.

The U.S. steel industry encountered the first 10-X force during the 1960s and 1970s when the global steel market emerged with new steel-making technologies that were developed in foreign countries. Due to the nature of production functions in an integrated steel mill, profits are earned only when firms operate above 70% to 80% of capacity utilization. Thus, it was possible that even small inroads by foreign competitors could rapidly force profits down in the face of inflexible labor and energy costs. When these inroads began occurring, U.S. firms responded by downsizing or abandoning various processes that could not be operated at required levels of capacity utilization. Instead, they concentrated on producing cold and hot-rolled sheet. Moreover, to protect the profitability of downsized industrial plants, an alliance of unions and political protectionists was forged to fend off further inroads into the domestic sheet market.

Overall, the steel industry has been immersed in continuous rationalization and cost-cutting in an attempt to reinvent itself and remain current with new and rapidly changing circumstances. During much of the past few years, the steel industry has benefited very little financially from its rationalization efforts. However, steel consumers have benefited from substantial real steel price decreases over the same period (Barnett, 1996).

Although domestic political alliances were forged in the 1960s and 1970s in an attempt to forestall external competition, a second and much bigger 10-X force arrived on the scene. In the 1980s and 1990s competition emerged from domestic mini-mills, a sector not subject to xenophobic maneuvers.

1.3.1 Minimills: A 10X Force

The minimill, as originally conceived, had several basic features: in terms of size, it generally had a raw steel annual capacity of 100 thousand tons or less. Its equipment consisted of an electric furnace, wholly dependent on scrap; a breakdown mill to reduce small ingots to billet size, or a continuous caster that casts billets directly from molten steel; and a bar mill. Minimills served markets in a relatively short radius of 200 to 300 miles from each mill.

Minimill operations are relatively simple. Scrap is unloaded in scrap yards, put in an Electric Arc Furnace (EAF), and then charged. When the scrap has been melted and refined into steel, it is poured into a ladle which discharges into a continuous caster, which results in billets. Presently, almost all minimills cast billets. These are then poured into a reheat furnace and when they have reached a temperature suitable for rolling, are converted into final products in the bar mill.

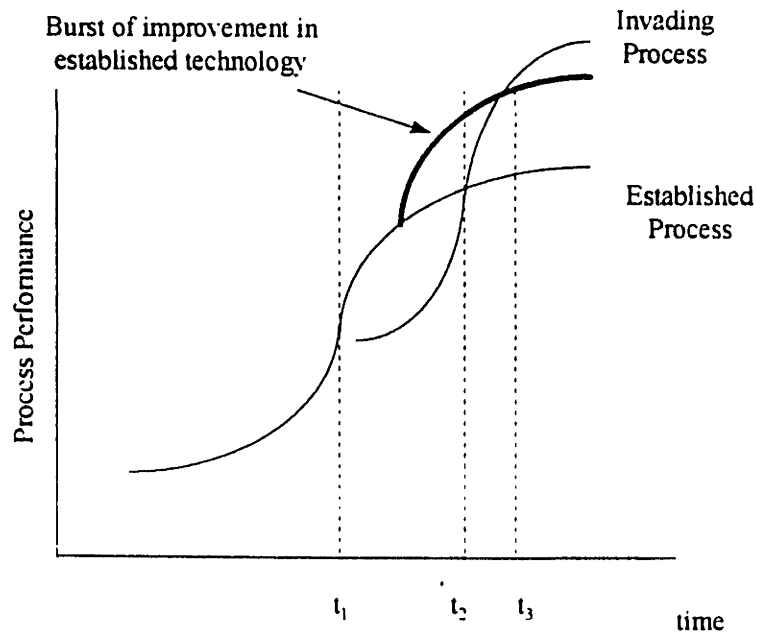
Since that original concept, however, the features of minimills have changed dramatically, particularly plant size and product breadth. For example, today Nucor's Crawfordsville and Hickman plants have a total capacity of 2 million tons each. This notable increase has caused an expansion of the market area beyond the traditional 200-300 mile radius, now reaching even into foreign markets. However, the 10-X factor is that minimills are now able to compete in the large flat-rolled segment of the industry.

1.4 S-SHAPED CURVE

To emphasize the concept of minimills as a 10-X force, we have used the concept of S-curve analysis, originally developed by Foster (in Utterback, 1994). The S-curve shows the evolution of a certain technology performance (either product or process) over time. Typically, a technology develops slowly at the beginning, accelerates, and then slows down, remaining basically stable after reaching maturity. A disruptive technology will outperform the existing technology. This is why technology managers must focus on screening what the next technology might be in order to maintain a company's competitiveness. Otherwise, sooner or later, a new technology will appear from a competitor's side. The effect of this invading technology is to cause a reaction to the existing technology and a hasty attempt to either retain the old technology's effectiveness or quickly embrace the new.

The invasion by the minimill technology into the steel industry illustrates the patterns examined by Utterback (1994) in his study of the emergence of a radical innovation. As in the case of other process-oriented industries, the innovation came from a supplier of process equipment (SMS from Germany) associated with a steel producer outside the flat-rolled segment (at that time Nucor was a minimill focused on non-flat products). The invading technology (in this case, the minimill) for the flat-rolled segment, resulted in overwhelmingly lower product costs. The established technologies (Blast Furnace and Basic Oxygen Furnace) are still going through a period of performance improvement that Utterback calls "burst of improvement in the established technology".

Ex..ibit 1.1
Utterback's "Burst of Improvement in Established Technology"



An excellent example of the old technology's resistance to remaining competitive is Nippon Steel Corporation's (NSC) focus on improving its present processes by linking continuous casting with rolling and welding slabs to affect a continuous process. These techniques, stemming from the Japanese devotion to lean manufacturing, seem to represent an integrated mill's attempt to catch up with the minimill technology; in fact, the minimill technology eliminates the need to reheat slabs between both processes since thin slab casting is coupled with the hot-rolling operation.

However, thin-slab casting is itself now being threatened by the newest technologies. Another category of near-net-shape casting is strip-casting. This technology eliminates the need for rolling, reduces costs, and improves productivity even more dramatically. The first strip-casting plant will be in operation in September 1997 at NSC's

Hikari plant (Flemings, 1996). Initially able to produce only stainless steel, it will take some years for the process to be adjusted to carbon flat-rolled steelmaking.

As in NSC, other top producers are investing in new steelmaking technologies as a clear signal of the direction they will move in the future.

The requirement for specific assets and expensive equipment and some of the inherent characteristics of the steel industry may slow down the decision to shift toward these new technologies in the near future, and such decisions will be tied more to the equipment renewal decision-making process. However, from 2000 on, this change should accelerate dramatically.

The predominance of minimill technology reduces variances in operating costs between producers, with raw materials and energy the main components of operating cost structures. The scale of future mills will be significantly smaller; in fact, some authors have already started referring to them as "micro-mills". Consequently, there will be an increasing trend toward fragmentation, in contrast to the past trend of concentration. These smaller and more dispersed mills will focus on customers' needs much more than the old-style mills have to date.

However, for minimills to continue producing high-quality steel applications, such as exposed automotive sheet and plate for critical applications, they need to shift their philosophy concerning technological knowledge. They will have to create supplementary R&D organizations to cope with high levels of sophistication demanded by the new applications. This is no small task for companies that have traditionally viewed leanness as the fundamental tenet of their existence (Brimacombe and Samaresekera, 1994).

1.5 DRIVERS AND EFFECTS OF GLOBALIZATION

The world's total consumption of steel products in the year 2000 is likely to be around 714 million tons, some 62 million tons above 1995 figures. This represents an annual average growth rate of only 1.8%. According to IISI (International Iron and Steel Institute), the mature industrial markets of the European Union, NAFTA, and Japan will experience a decline in consumption, while the developing countries' consumption will increase above the average. Therefore, the competitive environment will vary from region to region.

This dichotomy in consumption growth adds an interesting aspect to the already dynamic technological behavior of the industry. One can predict that competitors in declining markets will focus on high value-added products, and this may slow down the advance of minimills, at least with regard to achieving high-quality products. On the other hand, in emerging markets, producers will focus on mass production and on low-value products to quickly satisfy what should be an explosive infrastructure demand (e.g., India, China). Therefore, integrated mills should still be the answer in countries that lack the necessary electrical system, whereas new types of minimill -- non-scrap dependent -- could prevail in countries with an abundance of natural resources (i.e., electricity, gas, and iron ore).

These views might be challenged by the dynamics of the technology that makes smaller, more flexible, multi-product, customer-oriented minimills possible. With scale and labor cost counting less in the decision-making process, the story would be quite different. In this new scenario, successful companies might be those that are well-integrated into the

supply chain of their critical customers, independent of growth trends in their home market -- again, minimills seem to have the advantage. Finally, issues of localization and globalization will make companies think in broader terms about the kind of generic strategies to consider.

In an interview with John Lichtenstein, Director of Metals and Resources of Arthur D. Little, he reflected upon the steel company of the 21st century. Lichtenstein's believes the following characteristics are part of a generic trend in the industry:

- Raw material and energy will dominate operating cost structures.
- While labor will be a small direct cost element, successful steel companies will have continuously trained, highly multi-skilled workforces.
- Steel companies will integrate seamlessly with their suppliers and customers.
- These companies will manage technology and innovation as critical competencies.

Independent of the strategic intent pursued by a company, and as a result of the globalization process, Lichtenstein (1996b) has identified five basic operational configurations that he believes will prevail in the industry:

Product specialist: This company targets a single product or group of products and seeks to become a leading global supplier with operations around the world. Company example: Siderca, in the seamless tube product.

Process specialist: This company focuses on building an international network of operations that use the same basic manufacturing processes. The strategic intent is to leverage the process learning across all operations to generate a competitive advantage in each area. Company example: Ispat, with the DRI process.

Global Market segment specialist: This company targets a single market segment--most typically automotive -- and usually a specific short list of customers within it. This company commits to participating at different stages of the value chain between their own operations and their customers (i.e., processing, blanking, or even stamping automotive sheet steel). Company example: Thyssen, in automotive materials.

Multiple Local Market specialist: This company targets a large number of highly fragmented customers in multiple, local markets as opposed to a small number of truly global customers. Company example: BHP, in the construction flat-rolled segment.

Regional generalist: The strategy of this type of steel company is to become a major supplier of multiple products to multiple market segments within a specified geographic region. Company example: Posco, producing a full product line.

1.6 THE SIX FORCES ANALYSIS

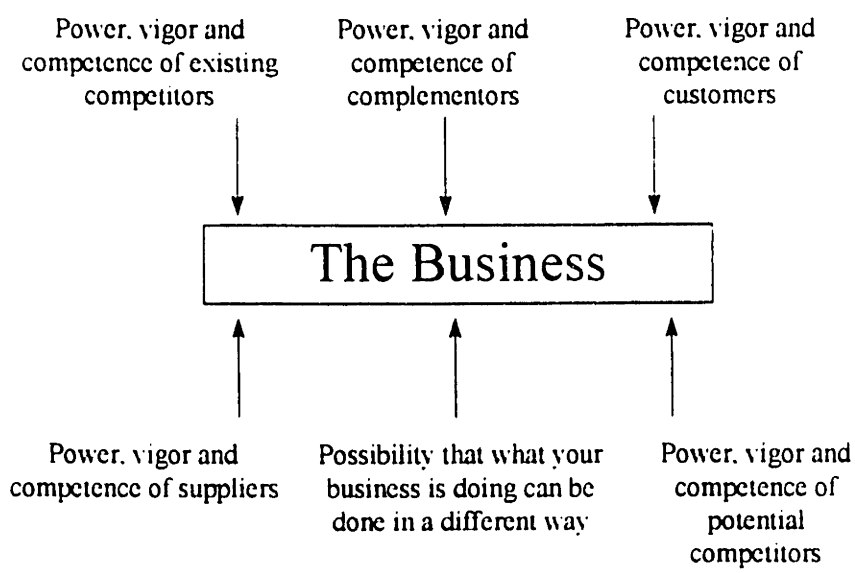
Having commented on how the minimill technology has impacted the steel business and how globalization will force producers to reconfigure their operations, we will now analyze the industry from a strategic point of view using the so-called **Six Forces Framework**. Modern literature on strategy has taken Porter's original Five Forces Model (Porter, 1985) and enriched the analysis with a sixth force known as "complementors" (Grove, 1996). Complementors are other businesses from whom customers buy complementary products. The classic example of complements is computer hardware and

software. Faster hardware prompts people to upgrade to more powerful software, and more powerful software motivates people to buy faster hardware.

In applying the Six Forces Model, we will focus on the U.S. industry only because it combines technology and regulatory changes more dramatically, and also because it is most competitive in terms of number of players and customer power.

Exhibit 1.2

Six Forces Diagram



Following is an analysis of each of these forces.

Power, Vigor and Competence of Existing Competitors

Before of the introduction of minimills, the U.S. steel operated as a typical quasi-collusive oligopoly, working together to set prices that would produce profitability for the least efficient producers. They not only agreed on when to increase or decrease prices but also when to invest in capacity expansion. Obviously, an increase in capacity always followed an increase in demand, never the contrary. This kind of cooperative-competitive

environment does not happen any more. The steel industry has turned into a highly competitive industry with excess capacity and no dominant players. Rivalry has intensified significantly with the emergence of the minimill technology and the constant barrage of foreign products.

Power, Vigor and Competence of Suppliers

Companies that use the minimill technology may be caught in a dilemma created by a shortage of scrap in the future. The resolution of this problem will depend on some coordination of the scrap supply chain and on the development of scrap substitutes (i.e., direct-reduced iron, iron carbide, pig iron, etc.). In the case of integrated mills, the power of iron ore suppliers is not critical.

Environmental pressures in developed countries, and the fact that there are different risk/returns along the value chain, will drive de-integration. The trend to de-integrate some processes of the value chain could make the industry more complex to analyze. De-integration will bring fragmentation, more rivalry, and a growing need to define sound interfaces between suppliers and customers. Partnerships and joint ventures will likely prevail in the industry.

Power, Vigor and Competence of Customers

The market most representative of this force, the automotive segment, holds tremendous bargaining power. Its main characteristics are:

- Increasing demands on technical specs and service level.
- Globalization of the industry

- Customer concentration
- Increasing rivalry
- Ability to use substitute materials.

Some steel producers have decided not to participate in this segment (e.g., Nucor) to avoid keeping entire staff departments dedicated to a single customer.

Possibility that what your business is doing can be done in a different way

Steel has been threatened by many other materials, such as aluminum and plastics, in the last decade. Either through individual or joint efforts steel produced have succeeded in accelerating the pace of research and development. It will depend on the success of these efforts whether steel begins to take back rather than lose market share.

The choice of the right technology will be critical to keeping up with the competition. Hence, steel producers are threatened not only by substitute materials but also by substitute steel technologies.

Power, vigor and competence of potential competitors (Barriers to entry)

With the emergence of minimills, scale has declined dramatically and so has the capital required to further expansion. The minimill has brought the minimum efficient scale down to 1.5 to 2.0 million tons, and correspondingly reduced the cost of entry to $400 million. The prospect that thin strip casting will further reduce the scale to 0.5 million tons will greatly exacerbate this tendency. Since Nucor's start-up of the first CSP thin slab mill, another 22 mills have initiated operations or are under construction. New entrants will cause the less-efficient mills to close down, as long as global demand remains constant.

Asset specificity is and will remain an issue, although these technologies are always subject to sale to less-developed regions.

Power, vigor and competence of complementors

Broadly defined, concrete, aluminum, plastic, glass, and even electronics are steel complementors in the sense that all of them are needed to build the final products (buildings, cars, appliances, etc.). Consequently, the companies that produce these products are also complementors.

Although they compete with one another for customers, steel companies are also complementors in expanding the market for steel. Some companies have begun to see each other as complementors in certain projects. The ULSAB project (Ultra Light Steel Auto Body) that we discuss in the following section, is an example of cooperation. Another example is the exchange of technological information among companies. This is particularly noticeable when they do not compete for the same geographic market. Cooperation between British Steel and Nippon Steel, or between Nucor and Hylsa are examples of this trend.

1.7 CO-OPETITION

Ray Noorda, founder of the networking software company Novell, invented the term *Co-opetition* to mean: "You have to compete and cooperate at the same time." The

combination of the two words implies a more dynamic relationship than the words "competition" and "cooperation" suggest individually.

Among the different ways that steel companies have found to cooperate, the one that clearly distinguishes itself is the consortia ULSAB. Steel producers from around the world are working together on this program to design the lightest possible steel car body. Thirty-two steel companies from fifteen nations and five continents are participating. The recently completed Phase I of the project determined that a typical mid-size sedan could take off as much as 35% of its body-in-white weight -- while achieving a cost saving of $154 per vehicle -- using current techniques and without sacrificing vehicle safety. Phase II, continuing through 1998, will validate the concepts of Phase I by developing and testing prototype bodies-in-white.

In 1992 three major European tinplate manufacturers, British Steel, Rasselstein and Hoogovens, began to jointly design a new can together with CarnaudMetalBox (now part of Crown Cork and Seal) which is a global can manufacturer. The objective was to reduce both the cost and weight of the can as well as to introduce a new, visibly different can end. Consequently, like ULSAB, the design activity involved both product performance and manufacturability (Edington, 1995). We will discuss this example in greater detail in Chapter Seven.

Many other traditional forms of cooperation exist such as strategic alliances, joint ventures, cross-licensing technologies, etc. These ways of cooperation among competitors are intended primarily to expand the use of steel, to make the pie bigger, by focusing on creating better products. What is still in the embryonic stage is the search for cooperation, beyond the industry, in order to create new, entirely different, applications.

1.8 THE CHANGING STEEL INDUSTRY

We have discussed the radical changes that new technologies have brought to the industry in terms of scale, costs, globalization effects, etc. This has created a competition that it is based primarily on operationally effective processes. Every company, independent of its technology, has to strive to reduce costs.

According to Barnett (1996), the next decade will continue the process of rationalization and cost-cutting. As mentioned earlier, the inroads of minimills will keep prices and profits low and capital expenditures modest. New technologies will not only cut costs and improve quality but also provide a certain homogeneity in this industry that, over the long run, will tend to reduce cost differences internationally.

Strategic management of the technology has become a critical issue in maintaining a company's competitiveness. As we discussed earlier, many possible paths are appearing for steelmaking, and many of them are not yet in the commercial stage.

All these factors, combined with the issue of globalization, will force companies to innovate their strategies and practices. In the following chapters we will expand these concepts when analyzing the industry through the Adaptive Management Framework.

1.9 TRADITIONAL COMPETITIVE WEAPONS

In addition to the technological route that a company chooses, a second critical aspect is the need for state-of-the-art management in product development and information

technology as main weapons in customer targeting. We will consider this topic in Chapter Six.

A proliferation of new products seems to be the main argument for integrated, traditional steelmakers to remain competitive. The belief that tailoring to meet individual needs often causes companies to lose sight of their focus on their core technologies due to a too-broad product line. However, exactly this kind of product development is the key for companies to differentiate themselves from minimills, especially to retain their most valuable customer: the automotive segment.

Steelmakers often tailor their steel for each part of each type of vehicle. One reason is that vacuum degassing (VD), the technology driving much of the new product development, is relatively new. As steelmakers develop their VD practices, the new products may become more standardized. According to Darryl Martin, Director of Automotive Applications at the American Iron and Steel Institute: "Steel (production) practices have changed considerably in the last several years," and these improved processes have enabled mills to turn out new steel products that are fine-tuned to customer requirements. Rather than a revolution in steel chemistry, carbon steel has evolved from a vanilla commodity to a high-tech, highly differentiated range of products.

1.10 STEEL INSIDE?

To end this chapter we would like to challenge the conventional thought governing the industry. We began with our visit to British Steel, undertaken at the suggestion of our

advisor, Prof. Arnoldo Hax, to explore new possibilities for strategic positions in this traditionally minded industry.

When reading the next chapter that explains the Adaptive Management Framework the reader should realize that one of the possible business models, according to this framework, is called System Lock-in. This is the type of positioning that Intel, in the semiconductor industry, has successfully followed. Under this positioning, Intel has been able to achieve a competitive lock-in of customers and suppliers, thereby becoming a virtual coordinator of the whole computer industry.

Our hypothesis is that an Intel-like approach with similar positioning will be feasible in the steel industry in the near future. The building segment is one area, and there may be others, where today's complex markets will fall into this category. We will describe these possibilities in Chapter Seven.

1.11 SUMMARY

An intensely competitive industry to be in and a wonderful industry to analyze, the steel industry is accelerating its dynamics to unexpectedly become one of the more unpredictable businesses nowadays. This uncertainty requires a better understanding of the alternative positioning possibilities available to companies and what capabilities they need to develop. New ways of competition, new roles in the game (i.e., complementors), new pressures (globalization, higher environmental standards, higher customer standards) and new technologies will have and enormous impact on the future of the industry. The

Adaptive Management Framework that we discuss in the next chapter will bring clarity to this point.

CHAPTER TWO

THE ADAPTIVE MANAGEMENT FRAMEWORK

2.1 INTRODUCTION

Originally developed by Prof. Arnoldo Hax and Dean Wilde II, the Adaptive Management Framework (AMF) provides an answer to the complexity, uncertainty, and change that prevail in today's competitive environment. Most business fields currently face similar challenges. These challenges are chiefly controlled by accelerations in technological change, and they can best be summarized by the following statements:

- Differences in global, regional, and local competition and demand. However, independent of the geographic area where you compete, you need to have a single world-class level of performance.
- Customer requirements are escalating; they are perpetually insatiable and demanding.
- Growing importance of distribution channels: customer proximity provides information and control.
- Lowering of entry barriers and raising of exit barriers: the emergence of excess supply.
- Transformation of human resources: empowerment as a necessity, not just to make employees happy.

- Homogenization of brands: increasing pressure of generics.
- Ecology as a strategic issue: opportunity as well as a threat.
- The burden of restructuring which creates a climate of fear and distrust.

The Adaptive Management Framework is a comprehensive, although simple, strategy framework that can creates a distinctive strategic vision among managers. Some of the answers provided by AMF enable the linkage of distinctive strategic positioning with execution via responsive business processes.

In order to understand the difference between this framework and others, we will begin by discussing the central contributions of the AMF. We will begin with the following Exhibit 2.1.

Exhibit 2.1

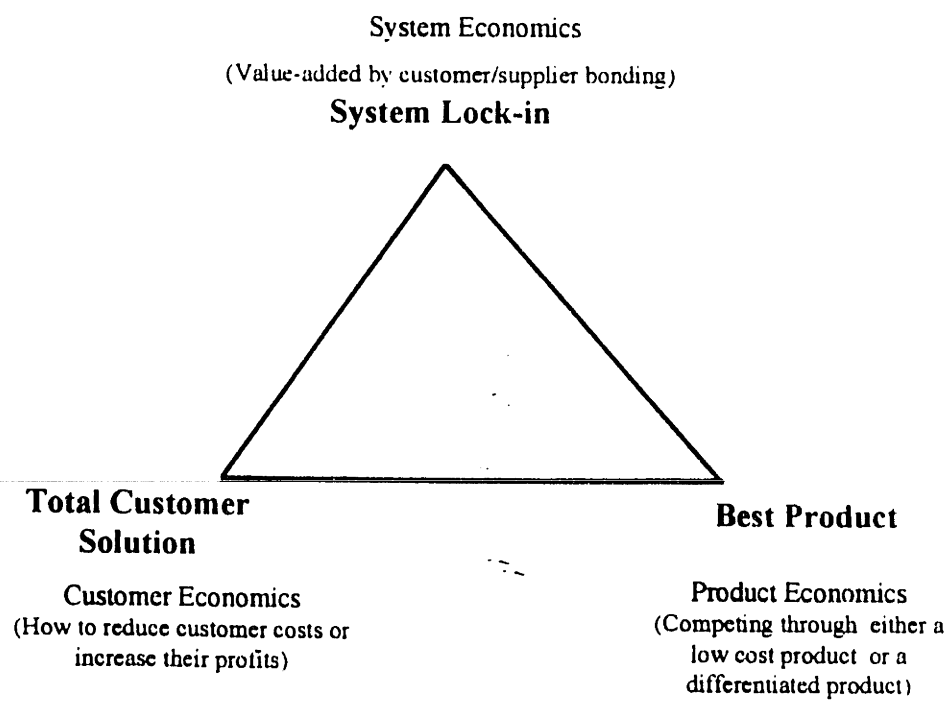
Issue	Adaptive Management Proposition	In contrast to
Creating a distinctive strategic vision	Three distinctive options for strategic positioning: • Best Product • Customer Scope • System Lock-in	Classic competitive strategy, competing through cost or differentiation
Linking strategy to execution	Adaptive processes: Aligning operational effectiveness, customer targeting, and innovation with strategic position	Parallel (and unrelated) development of strategy and operations
Uncertainty	Execute feedback as key part of adaptive processes: granular segmentation to focus, to test, to measure, to learn, to improve	• Forecasting • Annual/periodic reviews • Top down vs. Bottom-up • Radical change vs. continuous improvement
Discontinuous Change	Industries in transition	Product lifecycle

Source: Hax and Wilde, 1996.

2.2 BUSINESS MODEL: THREE DISTINCT OPTIONS

Depending on the bibliography one is familiar with, one will find that authors use different terminology to refer to the expression *business model*. Some refer to business model simply as *strategy*; others mention *strategic intent*; and others use *strategic position*. All refer to the same issue, and we will use any of the aforementioned expressions to refer to business model. The following Exhibit 2.2 shows the three distinctive strategic options that a company has, according to the AMF, in terms of the business model. We will discuss each component individually.

Exhibit 2.2

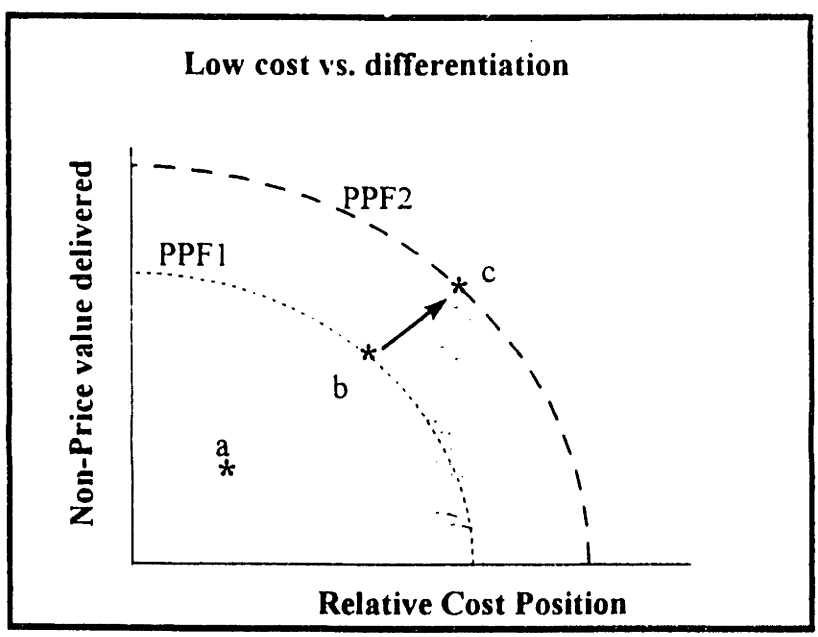


2.2.1 Best Product

Porter's classic view of strategy is portrayed in the lower-right position of the triangle. A company pursues a **Best Product** strategy either when striving to achieve the lowest cost possible, or when searching to produce the best product in the market in terms of differentiation.

Many would argue that the two options just mentioned are not alternatives but are complementary, and they cite the example of Japanese companies that have resolved the trade-off between cost and quality -- assuming that quality is the best measure of product differentiation. Let us have a look at the following exhibit (Exhibit 2.3):

Exhibit 2.3



Curve PPF1 represents the production possibilities frontier of a certain company. If the company is positioned at Point a, it means that it is inefficient since it is not taking advantage of its full potential. The first responsibility of managers is to move the company

from Point a to Point b. Point b is any point on the PPF1 that represents the combination of relative cost and differentiation which the company wants to incorporate. In order to gain differentiation, the company needs to sacrifice cost advantage and vice-versa. What Japanese companies have done to accomplish this is to expand the production possibilities frontier of their companies to PPF2 by working more intelligently. Methods like Toyota's Production Systems enable such companies to gain flexibility and cost reduction simultaneously. What they have essentially done is to move companies from Point b to Point c.

A winning company in this position should have the lowest cost and the best quality. Although many companies in the steel industry attain outstanding quality, only a few of them has consistently maintained the lowest price and simultaneously the best quality in the segments where they compete, mainly Nucor Steel. This has become so consistently true that Nucor is regarded as the price-setting company in the steel business. Customers are so convinced that Nucor will continuously provide both the best price and the best quality (measured as the combination of product's attributes and service level) that some have decided to build their own plants next door to Nucor's facilities.

A company focused on pursuing a Best Product Strategy will be mainly concerned with *product market share* as a measure of its competitiveness performance.

2.2.2 Total Customer Solutions

An alternative measure of competitiveness, as opposed to product market share, is *customer share*. It essentially answer the question: How many of their needs that match my product line do I satisfy? A telecommunications company may be very well-positioned at providing local telephone needs to final customers, but how much of the needs for cable, cellular phone, on-line access to Internet can also be provided by that company? Similarly, a steel company may be very well-positioned at providing the best product for exposed parts of a vehicle. However, how much does the steel company know about its customer's new product development projects? How certain can this steel company be that future customer needs, such as higher resistance and lower weight products, will not be met by another supplier? In other words, what are the boundaries and how extensive is this company's *customer market share*?

Total Customer Solutions means creating a customer lock-in by thinking in terms of customer economics, learning about the customer, and satisfying its needs with products specifically tailored for it. A good example is one that took place many years ago in Argentina. Propulsora Siderurgica, a re-rolling steel company, decided to invest in its own service center (also called customization center) to provide blanks to its customers in the automotive segment. This initiative was greatly welcome because for the car companies it meant literally getting rid of non-core processes, with high labor content, high level of work-in-process and untenable numbers of people involved in planning and scheduling. In addition, for those car makers the possibility of outsourcing these operations gave them the advantage of concentrating on their core processes and strengthening their strategic position.

For Propulsora Siderurgica the benefits also were tremendous. By taking charge of this "irrelevant" process, the steel company made sure that each piece of steel used in a car would have Propulsora's logo on it.

Some years later Siderar (a company resulting from the merge between Propulsora Siderurgica, Aceros Paraná, and other firms) following the same strategic thinking of Propulsora, decided to invest in a stamping plant to provide stamped steel blanks to several companies. This was a step beyond the one taken by Propulsora, and was intended to increase even more customers' switching costs and to assure a complete lock-in. Obviously, for Siderar, it represents an increase in fixed assets, involved more people and more work in process; however, the profitability of the segment more than compensated for the cost.

LTV also understands this need to customize each piece of steel according to its customers' needs. Following early involvement in its customers' product development process, LTV identifies current and future product needs and quickly develops new steel solutions for each of them.

British Steel redesigned its marketing and distribution structure by creating its own network of 40 service centers to cover customer needs, also developing a logistics system that is an example of a supplier-driven partnership. British Steel has also established an Automotive Engineering Group to step up the company's support for vehicle and component manufacturers and to provide lightweight steel vehicle solutions for the future. We will go back to the LTV and British Steel examples in Chapters Six and Seven.

Each of the efforts described above are clearly intended to create customer lock-in by providing the best customer benefits (i.e., stamping process outsourced), by targeting with bundle products (i.e., early participation in the customer product development), and by

customer service innovation (i.e., seamless product integration in the customization process, and coordination of the supply chain).

2.2.3 System Lock-in

A third way to measure one's market share is by *complementors' share.* As mentioned earlier, Intel and Microsoft are good examples of complementors. Microsoft benefits when Intel develops a faster chip, and Intel benefits when Microsoft pushes forward new software development that will spur demand for faster chips. However, Intel's perception is that Microsoft does not push hard enough. Andrew Grove has said: "Microsoft does not share the same sense of urgency to come up with an improved PC." Intel needs new applications in order to avoid saturating the market, and it is motivated by the fact that the other chip manufacturers might catch up. Due to the ability of Intel's next-generation chip, the Pentium Pro, to handle full-screen, 24-frames-per-second output, which will allow even more CPU-intensive video applications, Intel needs software programs that take advantage of these capabilities. Therefore, what Intel needs is a cheap and widely used video application. To this end, Intel invested over $100 million in ProShare, a videoconferencing system that resides in a desktop computer. Intel is aware that it must eliminate bottlenecks down the supply chain in order to expand the chip's use and continue with scale and cost advantages. However, Intel also looked for cooperative help among several complementors to finance this venture. Telephone companies provided ISDN (Integrated Services Digital Network) lines and Compaq included ProShare in all of

its business PCs (Brandenburger & Nalebuff, 1996). We see clearly that Intel market power may be measured not only in terms of market share of the PC business but also in terms of complementors' share (software companies, PC makers, telecommunications companies, etc.).

When British Steel thought of expanding the applications of steel in the growing soft drink and beer containers segment, it brought the project to a container manufacturer. By subsidizing the transformation of CarnaudMetalBox's manufacturing lines to support the production of steel cans instead of aluminum cans, British Steel was able to gain a complementor's share and subsequently the system share. Furthermore, British Steel did it jointly with Hoogovens and Rasselstein. Why bring competitors into the game? Simply because this is the way to make your technology become the new standard, to create second sources that encourage buyers to adopt your technology, and to promote internal competition pushing toward the improvement process.

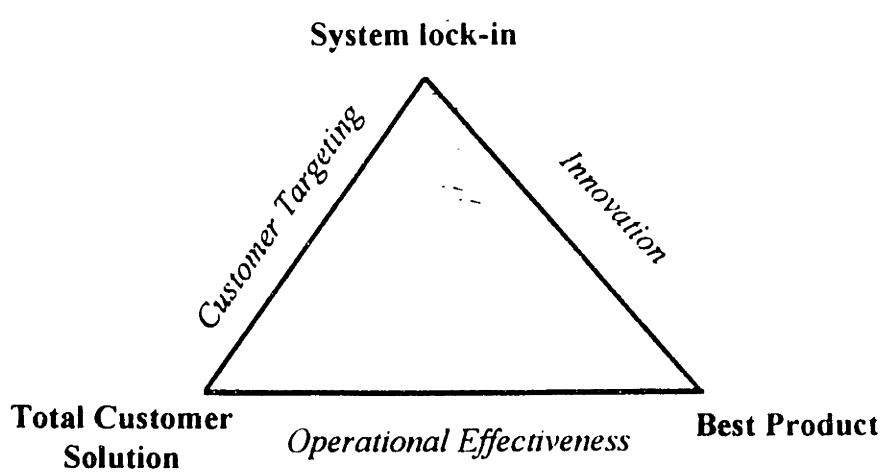
In summary, the Adaptive Management Framework proposes three possible, alternative ways of positioning. In the following Exhibit 2.4 we summarize the concepts involved in each alternative. The strategic intent is to break each one down in terms of scale, scope, and bonding. In Chapter Four we will go back to these concepts when analyzing the strategic position of the three companies that constitute the core of our research: Nucor Co., LTV Co. and British Steel plc.

Exhibit 2.4

	BEST PRODUCT	TOTAL CUSTOMER SOLUTIONS	SYSTEM LOCK-IN
SCALE	Product - Market Share	Customer - Customer share	System - Complement share
SCOPE	Narrow Unique -Low Cost -Differentiation	Bundled / Broad Channels	Nurturing complements
BONDING	Link to product: First to market, dominant design.	Link to customers: customer lock-in, e.g., learning, customization.	Link to system: - competitive lock-out - standards ownership

2.3 LINKING STRATEGIC POSITIONS WITH THE ADAPTIVE PROCESSES

If defining the right strategy is important, so is executing it properly. The Adaptive Management Framework explores the critical activities that a company needs to perform in order to support that strategy. By going back to our triangle (p. 29), we can re-design it along the following lines:



While each corner of the triangle represents a strategic position, each side represents an adaptive process. We call "adaptive process" the set of activities that a company must undertake in order to support its strategy. In other words, depending on what strategic position the company wants to be in, the emphasis that it will have to put on one process with respect to the others. We will describe each of these processes below.

2.3.1 Operational Effectiveness

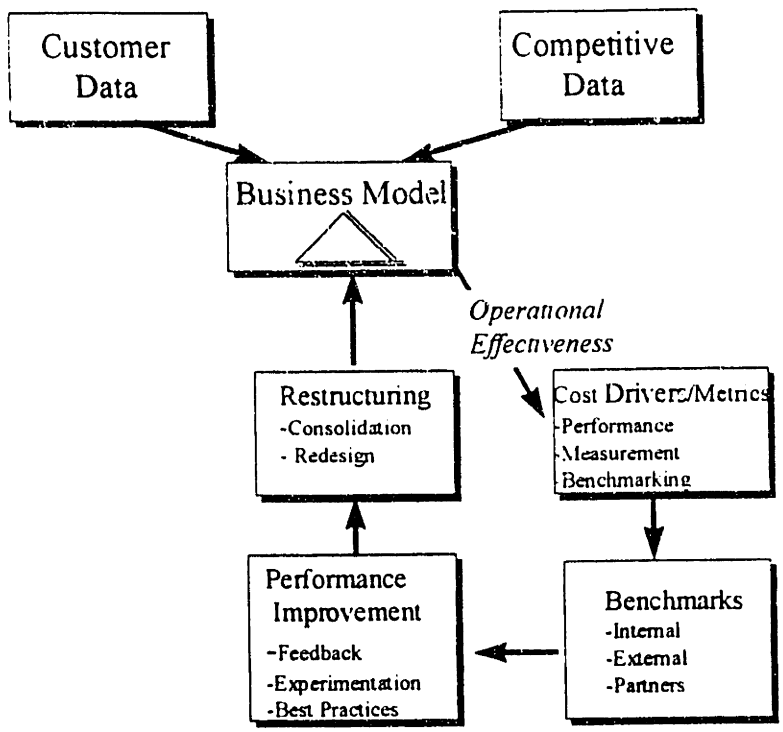
Operational effectiveness, as an adaptive process, is related to the degree of operational excellence that a company reaches throughout its value chain. This means that operational effectiveness does not apply exclusively to the manufacturing operations. On the contrary, a world-class company in this dimension is one that has achieved an outstanding operational level at any stage of the whole value chain.

Operational effectiveness deals with pushing out the productivity frontier and gives companies a broad set of techniques, some of them started by Japanese companies, that have been applied worldwide. Among these techniques, we could mention:

- TQM
- Time-based competition
- Lean Manufacturing
- Continuous Improvement
- Empowerment

Let us have a look at the following Exhibit 2.5.

Exhibit 2.5



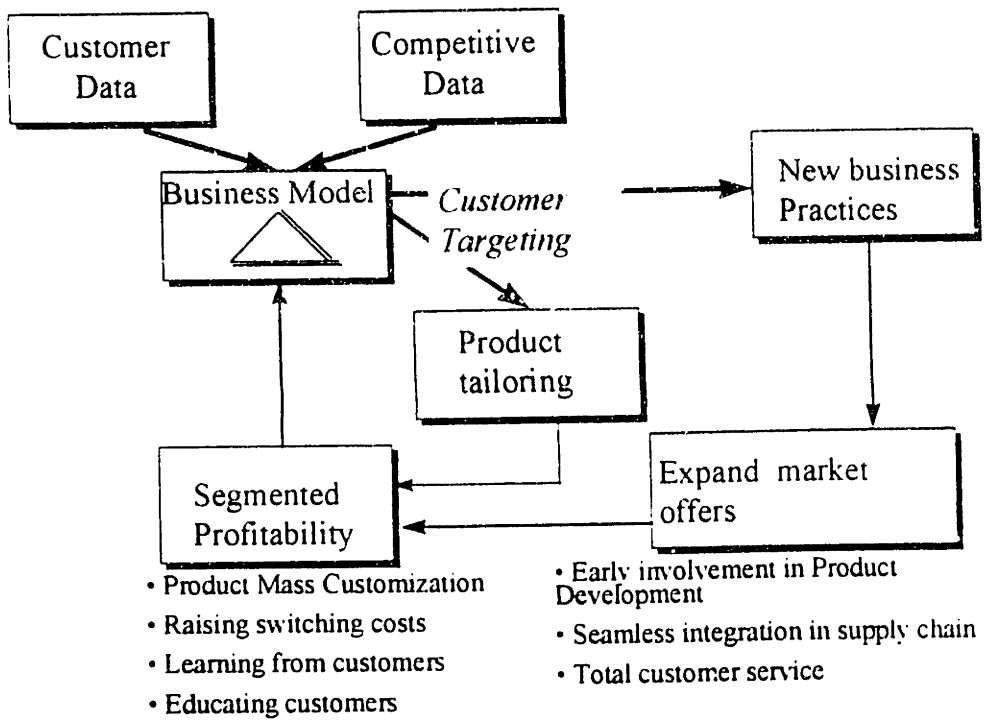
This exhibit illustrates that operational effectiveness is mainly driven by performance measurement analysis. By having a suitable set of metrics, performing a credible competitive profile analysis, giving feedback to the operational level, and finally modifying existing practices, a company achieves superior operational effectiveness. Nucor is our favorite example of a high-performing company in this dimension. Furthermore, in the case of Nucor, the loop metrics-visibility-motivation-correction-metrics plays a fundamental role in pushing the outer limits. Each shop-floor operator glances at a computer that instantly indicates the bonus they are getting at the current level of performance. We will refer to these concepts again in Chapter Five.

2.3.2 Customer Targeting

Capital One, the credit card company, has been successful in what its CEO, Richard Fairbanks calls the "Balance Transfer" process. His strategy resulted in enormous value creation from a portfolio valued at $200 million in 1988 (Signet Bank Card) to market value of $2.4 billion (Capital One). By pioneering the use of information technology in the credit card business, they targeted certain groups of consumers with special offers -- their own customers as well as others -- selected from a huge database. They carefully analyzed new packages of offerings (i.e., interest rate, fees, promotions, etc.) and then tested them in small groups. The successful trials were converted in mass offerings for that segment.

In the industrial field segmentation is equally critical. Traditionally, steel companies used to define their marketing structure in terms of products (i.e., sections, plates, strip, tin-plate, etc.) or in terms of a broad definition of markets (i.e., Export, Domestic, Region X, etc.). Steelmakers have also learned the customer lesson and most of them divide their efforts into strategic business units (SBUs) organized to serve a certain customer segment (i.e., automotive, home appliances, containers, building, etc.). While LTV and British Steel do have this type of structure, Nucor does not. The reason is that Nucor does not need it to pursue its strategic intent. We will expand these concepts in Chapter Six. Exhibit 2.6 summarizes Customer Targeting as an Adaptive Process.

Exhibit 2.6



2.3.3 Innovation

The authors of the AMF Model had observed that large companies tended to follow one of two typical business development "styles":

(a) ***Ready, Aim, Aim...***: Companies following this model fail to get real-world data and experience. They have good ideas, which remain just that -- ideas.

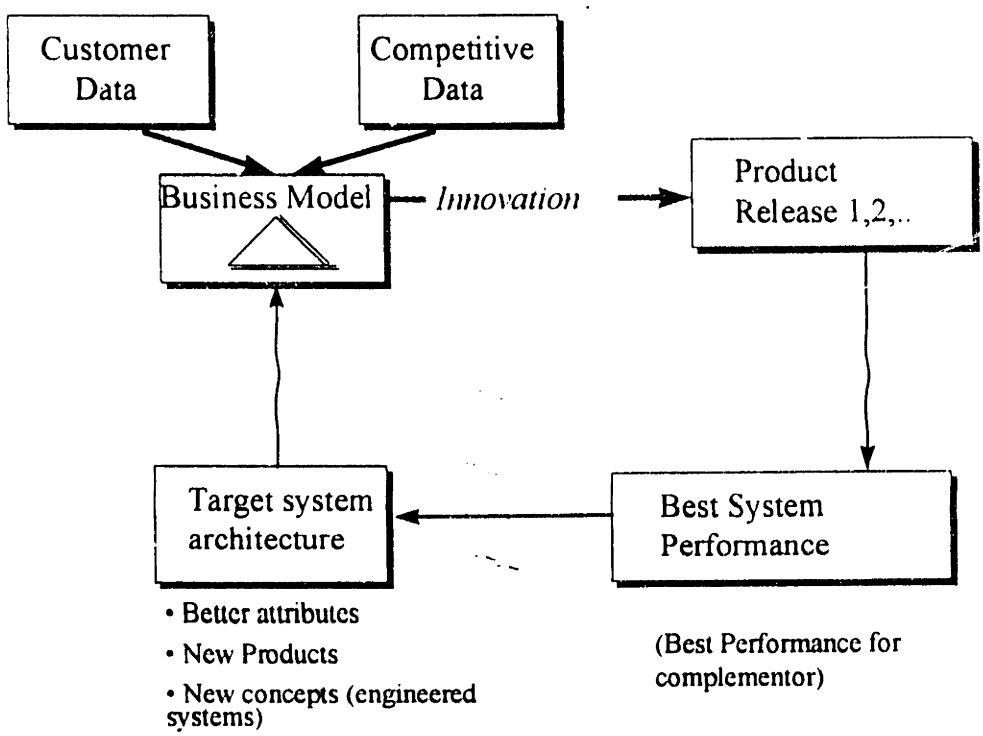
(b) ***Ready, Fire, Aim...***: Companies following this model tend to take a shotgun approach using empirical data is not assimilated into their strategy. Good ideas, but not sufficiently thought through.

Adaptive Development, on the contrary, proposes:

- Balance speed, empirical evidence, and conceptual design.
- Prioritize front-end analysis, extensive back-end analysis into a continuously adaptive business formula.
- Continual release of new products into a family of products. The learning process begins when the product is delivered to the customer. Once again, the customer is the focus not only in strategy and development, but also in execution.

The following Exhibit 2.7 summarizes Innovation as an Adaptive Process.

Exhibit 2.7



The next Exhibit 2.8 shows the results of a survey carried on by Eric von Hippel. He determined that a great deal of importance in the innovation process regarding certain technologies, products, or service, stems from customers.

Exhibit 2.8

(%)

	Innovation developed by:					
Innovation Type	User	Manuf.	Supplier	Other	NA (n)	Total (n)
Scientific instruments	77	23	0	0	17	111
Semiconductor & printed circuit board process	67	21	0	12	6	49
Pultrusion process	90	10	0	0	0	10
Tractor shovel-related	6	94	0	0	0	16
Engineering plastics	10	90	0	0	0	5
Plastics additive	8	92	0	0	4	16
Industrial gas-using	42	17	33	8	0	12

Source: von Hippel (1988).

Although we have mentioned only innovation in product development, there are other no less critical dimensions of the innovation process. Cost reduction and Service are areas where companies used to focus in order to support their strategies. Going back to the steel industry, Nucor is a good example of customer-centered innovation. Despite Nucor's lack of a formal R&D department, the process of innovation is carried on extremely well. We found at least six sources of innovation in Nucor's improvement process:

- Customers play an important role in providing new challenges. When a customer asks for a new solution, Nucor commits multi-disciplinary teams that are integrated into the customer's work as a way of determining a reasonable solution.

- A second source is Nucor's employees. Nucor is accustomed to sending workers to visit its customers. They bring with them ideas about how to improve a certain process or a certain product.
- A third source is internal benchmarking.
- A fourth source is the external benchmarking, Hylsa freely exchanges technical information with Nucor.
- A fifth source is the equipment and materials suppliers.
- A sixth source, last but not least, is Nucor's managers.

2.4 SUMMARY

In summary, we have seen that strategic position and execution are closely related, with the adaptive processes as links. Exhibit 2.9 summarizes the concepts that we have discussed so far.

Companies may -- and should -- change their positioning over time. The competitive weapons that are today's winners, may not be tomorrow. On the other hand, there is dynamic in each process itself. What is acceptable today, from a customer point of view, tomorrow may not be. The dramatic changes in information technology are an example of how a business can be transformed. Thus, customers have come to expect and demand ever-increasing features.

Exhibit 2.9

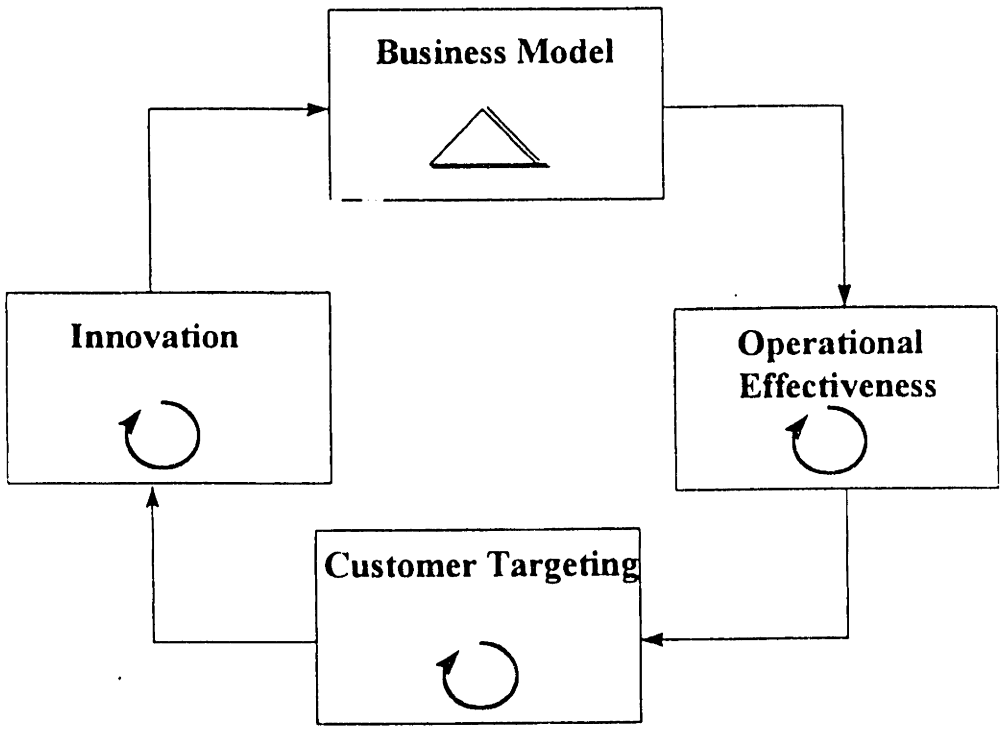
ADAPTIVE PROCESS	BEST PRODUCT	TOTAL CUSTOMER SOLUTIONS	SYSTEM LOCK-IN
	↓ Product Economics	↓ Customer Economics	↓ System Economics
Operational Effectiveness	Best Product Cost	Best Customer Benefits	Best System Performance
Customer Targeting	Target Products Multiple channels	Target Customer Bundles Customer Segmentation Customer Ownership	Target System Architecture Complementary applications
Innovation	Product Innovation Time to market Dominant Design	Customer Service Innovation Seamless product integration Total Customer Service	System Innovation Full backward compatibility

The diagonal of this chart is called "the consistency corridor", showing the main relationship between strategy and Adaptive Process. The shading in the remaining boxes means a secondary degree of importance of the Adaptive Process in a certain strategy.

This framework helps to understand where a company is and where it would like to be. Thus, both an existing and a desired strategic position analysis should be performed. With the results of both analyses, a company will realize clearly what set of new core capabilities must be developed to better position them in the desired scenario.

A simple way of understanding the link between strategic position and adaptive processes is shown in the following Exhibit 2.10.

Exhibit 2.10

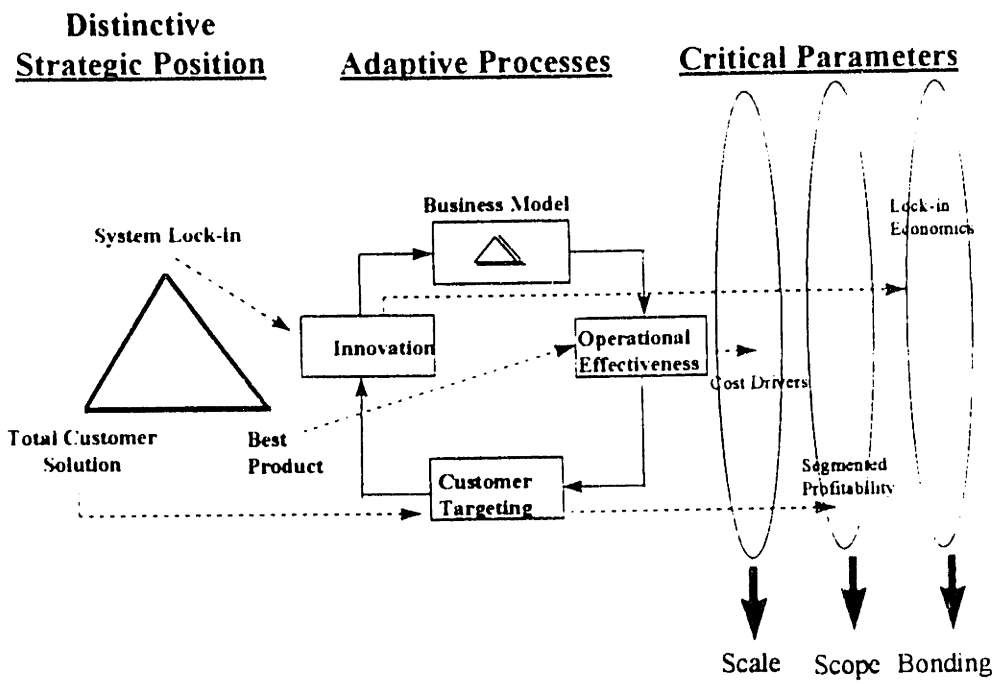


One last way of understanding the concepts proposed by the Adaptive Management Framework is the following Exhibit 2.11 that relates once more each of the distinctive strategic positions with the corresponding Adaptive Processes and now with the Critical Parameters involved in each of the positions.

Notice that there is a sort of correspondence between each of the dimensions. A Best Product position should be mainly supported by an excellent Operational Effectiveness process, which in turn is very metrics-driven. A company in the Total Customer Solution approach should emphasize Customer Targeting and consequently the segmented profitability analysis is crucial. Finally, to be in the System Lock-in position requires an

outstanding Innovation process to help the generation of Lock-in Economics in the whole system.

Exhibit 2.11



CHAPTER THREE

COMPANY PROFILES

In this chapter we will introduce the companies that were analyzed in our research. The purpose of this section is to provide readers with a better understanding of the business in which these companies currently operate. The three steel companies are Nucor Corporation, LTV Corporation, and British Steel plc. We will describe the main characteristics of each company, such as principal activities, product scope, production facilities, and technologies and an overview of the most recent financial information.

After presenting these profiles, we will explain the main reason for choosing these firms as the subjects for our project. Then we will present a comparison of the most relevant financial and economic data for the last fiscal year of each company. Finally, we will present a set of financial data for conventional benchmarking in this industry.

3.1 LTV CORPORATION

LTV is recognized as an industry leader in quality-critical steel, including electrogalvanized and hot-dip galvanized sheet, carbon electrical steels, and other specialized products. Most of its product mix is processed beyond the hot rolled band stage, which indicates the active presence of this company in the value-added segment of the market.

LTV operates two modern, integrated flat rolled steel plants, the Cleveland Works and the Indiana Harbor Works. Among LTV's capabilities at these facilities are two hot-dip galvanizing lines, two vacuum degassing facilities, and a continuous anneal line. The company also operates a modern finishing mill including a hot-dip galvanizing line in Hennepin, Illinois, as well as tubular and tin mill product facilities in several locations. One of LTV's sources of competitive advantage comes from the fact that it has two high-quality flat-rolled steel mills in the Midwestern region. Hence, the company is considered a highly reliable supplier.

LTV is the third largest steel producer in the United States, accounting for 8.2% of total domestic shipments of steel mill products. In terms of flat rolled steel sheets, LTV is the second largest domestic producer in United States.

LTV's strategy is to pursue the highest possible levels of product quality and the lowest possible costs through continuously improving efficiency and productivity. In addition, LTV is focused on providing superb service to its customers, in particular to the automotive, appliance, electrical equipment, service center, and container segment of the market. LTV will continue to focus on the flat-rolled steel business with particular emphasis on high-value-added steel products for quality critical markets.

LTV was in Chapter 11 bankruptcy for seven years, from 1986 to 1993. Since it emerged from the period of bankruptcy, it has reduced its long-term debt to $150 million and reduced its unfunded pension obligations from $1.6 billion to $935 million. Post-retirement healthcare and other insurance benefits are down from $2.0 billion to $1.6 billion.

During the Chapter 11 period, management re-focused the company's product orientation toward high-end sheet steels used in automotive, appliance, and other

manufacturing applications. Currently, LTV is the largest supplier to U.S. automotive and appliance manufacturers, supplying an estimated 20% of their requirements. Approximately 60% of total shipments go directly and indirectly to these markets.

In the last decade, LTV has invested nearly $4 billion in capital projects to improve product quality, reduce operating costs, and enable the company to change its product mix to focus on high-end sheet products for high-end consumers. During that same period, about 55% of the company's capacity to produce steel was eliminated. Present capacity is approximately 8 million tons per year.

In late 1994, LTV management announced the formation of a 50% joint venture, known as Trico Steel, to produce 2.2 million tons of sheet steel in the southeastern United States. Other venture partners include British Steel and Sumitomo Metals (25% each). This facility will use the latest innovations in mini-mill technology, including a twin shell furnace, ladle metallurgical micro-refining, continuous casting of thin slabs, and direct hot charge rolling of thin-gauge hot band, designed to compete with more expensive cold-rolled steel in some applications.

The metallurgical purity of the finished product will be enhanced as up to 50% of the furnace charge will be directly reduced iron. This pure iron product will be sourced from two British Steel DRI plants being relocated from Scotland to Alabama. In addition to the enhanced quality this feedstock will impart to the finished steel, there will be a cost savings of approximately $50 per ton compared with high-quality, low residual scrap the DRI replaces.

LTV management believes that Trico will accomplish several strategic objectives. These include development of closer ties, technologically and commercially, with leading

international steel producers; profitable growth in its core steel business; strengthening LTV's position as a leading low-cost domestic high-quality sheet steel producer; and providing access to leading-edge technologies for steel production and geographic diversification within the United States. We would not be surprised to see Trico partners form another venture in the future to duplicate this facility in an emerging Asian country, where demand for steel is growing most rapidly.

Trico plans to remain non-union, and is making an effort to gain more flexible work rules than those at LTV or any unionized integrated producer today.

A large component of compensation will be incentive-based (along the lines of the Nucor system). The basis of this compensation system will include not only production, quality and cost, but also profitability.

We see this move by LTV into the minimill technology as critical and imperative for every integrated producers. In this learning process of operating practices, we expect to see some synergies coming from both cultures, including: highly decentralized, variable compensation, multi-skilled workers coming from the minimill culture, marketing expertise, product and process development coming from integrated mill expertise.

Financial Overview of LTV

In the following Exhibit 3.1, we present some financial information of LTV corporation.

Exhibit 3.1
LTV Corporation - Income Statement

($, mil)

	1994	1995	1st Q 96	2nd Q 96	3rd Q 96
Net sales	4,233.0	4,283.2	993.1	1,075.1	1,048.9
Cost of Goods Sold	(3,669.0)	(3,620.9)	(878.7)	(928.4)	(909.9)
Depreciation	(242.0)	(251.9)	(67.1)	(67.9)	(66.2)
Gross Profit	322.0	410.4	47.3	78.8	72.8
GPM (%)	7.61%	9.60%	4.80%	7.30%	6.90%
SG&A	(133.0)	(142.2)	(35.1)	(37.1)	(38.1)
Operating Profit	189.0	268.2	12.2	41.7	34.7
OPM (%)	4.46%	6.30%	1.20%	3.90%	3.30%
Interest & Other Income	27.0	53.8	12.2	11.4	12.0
Interest Expense	(14.0)	(11.2)	(3.0)	(2.5)	(2.5)
Pretax Income	202.0	310.8	21.4	50.6	44.2
Provision For Income Taxes	73.0	117.3	7.9	18.6	16.0
Net Income Before Preferred	129.0	193.5	13.5	32.0	28.2
Net Loss From Discontinued	(2.0)	(8.7)	-	-	-
Preferred Dividend Requirement	(2.0)	(2.2)	(0.6)	(0.6)	(0.6)
Net Income	**125.0**	**182.6**	**12.9**	**31.4**	**27.6**

3.2 BRITISH STEEL plc

British Steel is the third-largest steel manufacturer in the world, surpassed only by Nippon Steel and Posco. With production of 15.7 million tons in 1995, it is the largest producer in Europe.

For FY1996 (ending 3/96), British Steel profits reached £777 million. This is an impressive turnaround considering that the company lost £34 million in 1992 and £130 in 1993. The explanation for this turnaround is partly due to the weakening of pounds sterling in the currency market, but also to company refocusing on value-added products (i.e., engineering steels) and reducing its turnover dependence in semi-finished carbon steel products.

British Steel owns 51% of the stainless maker Avesta Sheffield AB, located in the UK and Sweden, and produces special sections in a former Kloeckner facility in Germany. In addition, it owns a plate facility in Tuscaloosa, Alabama and owns a 25% share of joint venture, TRICO, together with LTV Corporation and Sumitomo Industries. British Steel also has downstream operations in distribution, bar processing, and forging which have significant competitive positions in their own right (Salomon Bros., 1996).

Although it is virtually the only producer in the UK, it is not a monopoly. Its share of the U.K. market is 58%, leaving most of the rest to other EU companies. British Steel products are mainly used in construction (24%), automotive (20%), industrial plant construction (12%), and Packaging (9%).

British Steel has an overall low-cost profile, and today many of its facilities are benchmarks for European productivity, both in flat steel and long products. Among the

factors that contribute to this low cost are low effective labor costs, and competitive energy costs compared with less productive northern competitors or less well-invested suppliers in Spain and Italy.

The following Exhibit 3.2 contains the most recent financial information about British Steel as well as a breakdown of sales by product and market.

Exhibit 3.2
British Steel plc - Breakdown of Sales

(£, mil.)

	Fiscal yr. 1992	Fiscal yr. 1993	Fiscal yr. 1994	Fiscal yr. 1995	Fiscal yr. 1996
Turnover					
Uncoated strip products	854	860	955	1,163	1,288
Coated strip products	818	854	918	1,039	1,172
Sections and plates	968	871	931	1,027	1,159
Tubular products	469	438	390	370	351
.Wire rod	67	65	74	92	269
Semi-finished carbon steel products	294	228	237	253	162
Engineering steels				19	651
Stainless steel products	335	189			992
Total steel industry products	3,805	3,505	3,505	3,963	6,044
Distribution and further processing	649	685	566	712	920
Others	144	113	120	109	84
Total	**4,598**	**4,303**	**4,191**	**4,784**	**7,048**
Deliveries (in million tons)					
Uncoated strip products	3.50	3.60	3.80	4.10	4.10
Coated strip products	2.10	2.30	2.30	2.50	2.50
Sections and plates	3.20	3.20	3.20	3.30	3.50
Tubular products	0.90	0.90	0.80	0.80	0.70
Wire rod	0.30	0.30	0.30	0.40	0.90
Semi-finished carbon steel products	1.90	1.40	1.50	1.50	0.90
Engineering steels					1.40
Stainless steel products	0.30	0.20			0.40
Total steel industry products	**12.20**	**11.90**	**11.90**	**12.60**	**14.40**
UK	6.60	6.10	6.40	6.80	7.30
Other Europe	3.50	3.40	3.00	3.50	4.40
Other areas	2.10	2.40	2.50	2.30	2.70

Exhibit 3.2 (continued)

	1992	1993	1994	1995	1996
Sales	4,598. 0	4,303.0	4,191.0	4,784.0	7,048.0
Raw Materials	(2,011.0)	(1,859.0)	(1,687.0)	(1,882.0)	(2,711.0)
Employment Costs	(1,005.0)	(915.0)	(912.0)	(947.0)	(1,331.0)
Other Fixed Costs	(1,680.0)	(1,642.0)	(1,476.0)	(1,509.0)	(2,065.0)
Trading Profits	(98.0)	(113.0)	116.0	446.0	941.0
Trading Margin	(2.1)	(2.6)	2.8	9.3	0.1
Associates	21. 0	(19.0)	(19.0)	135.0	128.0
Interest	22.0	(17.0)	(17.0)	(7.0)	22.0
Pre-Tax Profit Adjusted	(55.0)	(149.0)	80.0	574.0	1,091.0
Extraordinary income				4.0	11.0
Pre-Tax (loss) / profit	(55.0)	(149.0)	80.0	578.0	1,102.0
Income tax	20.0	19.0	(10.0)	(107.0)	(276.0)
Minorities	-	-	(1.0)	(3.0)	(49.0)
Net income	(35.0)	(130.0)	69.0	464.0	777.0
No. of Shares(m)	2,000.0	2,000.0	2,000.0	2,000.0	2,000.0
Dividends	90.0	20.0	40.0	150.0	204.0
EPS (pence)	(1.7)	(6.5)	3.5	23.2	38.3

3.3 NUCOR CORPORATION

Nucor is the nation's largest mini-mill and fourth largest steel producer. The company's major divisions are: Nucor Steel, Nucor-Yamato Steel, Vulcraft, Nucor Cold Finish, Nucor Grinding balls, Nucor Fastener, Nucor Bearing Products and Nucor Building Systems. All of Nucor's production is continuously cast. In 1995, total production was 7.8 million tons, 80% of which was sold to outside customers, and the remaining 20% was used internally by downstream operations. Total sales amounted to $3.5 billion, with a net income of $274.5 million.

According to its CEO, John Correnti, there is no mission statement. Nucor's primary strategy is to make money. Nucor states its basic philosophy this way: "Nucor builds steel manufacturing and steel production facilities economically and operates them productively."

Mr. Correnti remarked that although Nucor has state-of-the-art facilities, only 20% of Nucor's success can be attributed to technology. The most important driver is the so-called "Nucor Style".

A major ingredient in Nucor's success has been its commitment to locate its diverse facilities in rural locations across America. As a result of deliberately selecting non-urban locations, Nucor has been able to establish strong ties to the communities in which it locates operations and from which it draws its workforce. The ability to become a leading employer and pay a leading wage has attracted hard-working, dedicated employees. This has also enabled Nucor to choose among states that are more committed to maintaining a climate that is conducive to business growth through reasonable tax structures, and

hospitable to Nucor's commitment to remain union-free. Nucor and its subsidiaries consist of nine businesses, serving specific targeted markets.

Steel production capacity has increased from 1.9 million tons in 1986 to 7.9 million tons in 1995. Nucor has a total of six mills (Darlington, South Carolina; Norfolk, Nebraska; Jewett, Texas; Plymouth, Utah; Crawfordsville, Indiana; and Hickman, Arkansas) that produce steel products. More specifically, four mills produce bar and light structural carbon and alloy steels, and two mills produce sheet steel. In addition, the new Berkeley County hot-rolled and cold-rolled sheet steel facility just began production in early 1997, with a projected annual capacity of 1.8 million tons and a projected average operating cost of $365 per ton. Furthermore, the 45,000-tons-per-year metal buildings plant at Swansea saw a ramp-up in fourth quarter 1996, increasing the company's metal buildings production capacity by 75% (Prudential, 1997).

Nucor was the first mini-mill to produce flat-rolled steel and the first in U.S. to utilize the thin-slab-casting process (SMS design) at Crawfordsville, Indiana in 1989. Afterward, Nucor built greenfield commodity-grade steel mills that use leading-edge technology at a very competitive cost and in most cases ahead of schedule, running them efficiently.

Nucor provides employees with a unique performance-related compensation system that rewards goal-oriented employees. All employees are covered under one of four basic compensation plans, each featuring incentives related to meeting specific goals and targets. This compensation system is highly based on performance bonus; two-thirds of total salary payments are incentives. For example, an hourly worker's average base salary is $10 per hour, but after the performance bonus (which could be as much as 200%), the worker may

receive a total hourly salary of $30. Therefore, an important segment of labor costs is highly variable compared to that of the traditional integrated mills.

Nucor has grown its sales and earning by 14% and 13%, respectively, over the past two decades. By the late 1980s, Nucor was growing by double digits, while many integrated steel producers were filing for Chapter 11. Market-to-book value was 3.52 in 1995 after reaching its peak in 1994 at about 4.7. This reduction in the stock price was due primarily to a weak pricing for hot-rolled sheet that account for 40% of the total shipments, as well as unexpected problems in the start-up of the iron carbide facility in Trinidad.

As with the two previous company profiles, we have included in Exhibit 3.3 some relevant financial information of Nucor Corporation covering the last three years.

Exhibit 3.3
Nucor Corporation - Financial Information

Nucor Corporation - Income Statement (in million of Dollars)

	Year 96	Year 95	Year 94
Net sales	3,647.0	3,462.0	2,975.5
Costs and expenses:			
Cost of products sold	3,139.1	2,900.2	2,491.7
Marketing, administrative and other expenses	120.1	130.6	113.3
Interest expense (income)		(1.1)	13.5
Total costs and expenses	3,259.2	3,029.7	2,618.6
Earnings before Income taxes	387.7	432.3	356.9
Income taxes	139.6	157.8	130.3
Net earnings	248.1	274.5	226.6
Net earnings per share	2.83	3.14	2.60
Percentage of earnings to sales	6.8%	7.9%	7.6%
Return on average equity	16.6%	21.9%	22.4%
Capital expenditures	537.4	263.4	185.3
Depreciation	182.2	173.8	157.6

CHAPTER FOUR

THE BUSINESS MODEL FOR THREE COMPANIES

4.1 INTRODUCTION

The purpose of this chapter is to identify -- based on the Adaptive Management Framework -- the business model followed by each of the three steel companies to which we referred earlier: LTV Steel, Nucor Steel, and British Steel plc. The respective models may vary for somewhat in their adaptation to each company depending on the segment they are serving. Additionally, it is noteworthy to analyze the influence of powerful customers on each company's strategic positioning.

As mentioned in Chapter Two, there are three different dimensions or strategic options within which firms may position themselves in order to compete in a certain business environment. These three options are:

- Best Product - low cost or differentiated position;
- Total Customer Solution - reducing customer cost or increasing their profits;
- System Lock-in - value added by customer/supplier bonding (lock-in).

The AMF conceives these options as integrative and dynamic rather than alternative and static. This means that a steel company pursuing a Total Customer Solution strategy may focus on low-cost at the same time it focuses on customer targeting.

As a consequence of the enormous changes the industry has witnessed since the emergence of the minimill technology, increasing competition is leading to a survival strategy that forces every steelmaker to become a ***low-cost producer***. Furthermore, the introduction of minimills in the low end of the flat-rolled segment of the market increased the pressure on the more standard products -- hot-rolled and commercial grades in the cold-rolled applications -- making them even more commodity-like. Therefore, we do not expect to see any world-class producer neglecting to focus on this issue. Notwithstanding this permanent concern, steel producers have to achieve superior product performance in terms of quality. Hence, the general wisdom that used to prevail in the industry about the trade-off between quality and cost is no longer applicable.

The steel industry has in the past been regarded as a traditional, product-oriented, generally inflexible industry. This opinion prevails in the view of people outside the industry. However, steelmakers have had to innovate their practices in order to remaining competitive. Moreover, they have also had to develop new capabilities to maintain their attractiveness. New concepts that help to improve customer responsiveness were introduced by most world-class competitors. Among those concepts, we can mention: early involvement in customers' product design, electronic order linkage, just-in-time delivery, lead-time reductions, and customized products and services.

Meanwhile, steel producers suffer from the irrationality of this industry in terms of over-capacity. This problem was to some extent understood in Europe where companies decided to cut obsolete capacity to avoid even more savage competition. However, in the rest of the world, primarily the United States and Asia, there is considerable new capacity

coming along with the spread of the mini-mill technology. This, again, contributes to an even more intense focus on the cost structure of the steel companies.

In the process of developing new capabilities, technology has played a crucial role in configuring corporate strategy. Some companies have pioneered the concept of ***System Economics*** in an attempt to expand their share of the total market. In pursuing these efforts, a firm can explore different alternatives, for instance, cooperating among competitors and/or searching for potential complementors, even current steel substitutes, such as plastic or concrete. Although in an embryonic stage, there are currently some examples that support this vision; those examples will be carefully scrutinized later when we discuss innovation as an adaptive process.

4.2 SEGMENTATION IN THE STEEL INDUSTRY

In this section we will discuss conventional segmentation in the steel industry. Our purpose is to familiarize the reader with the prevailing segments of the flat rolled market in order to fully understand the positioning of firms in this industry.

Competition between the industry's mills depends upon each unit's product capabilities which are, in turn, determined by the technical advances each unit embodies, the quality of its upstream steel supply, and the extent and sophistication of its downstream facilities. Mills can be categorized according to their capabilities and the broad segments of the flat-rolled market in which most of them participate.

High-End

Second-generation and other extensively upgraded mills within integrated steel plants convert slabs to meet a full range of flat-product requirements across the market spectrum. The blast-furnace iron such plants produce is refined into clean steel that is low in residual-alloy contaminants, which is then continuously cast, rolled, and extensively processed into a diverse line of coated and uncoated sheet products. Rolling facilities produce sheets with an impeccable surface and with exacting properties rolled to extremely close tolerances of gauge and flatness. Applications include deep-drawing grades that shape auto body exteriors, tinplate grades, and other high-quality sheets, both coated and uncoated, that command significant market premiums.

Midrange

Mills in the midrange category consist of those within smaller integrated plants that also refine blast-furnace iron and continuously cast their slabs. However, they have rolling and other operating limitations that preclude their ability to consistently meet the stringent quality standards required of high-end producers. Midrange mills also roll steel for processing into a broad line of coated and uncoated sheet products, but generally for less critical applications. Still, their capabilities in terms of width, gauge, surface quality, coating, and other downstream processing exceed those of their low-end competitors, including the new minimills with thin-slab casters.

Low-End

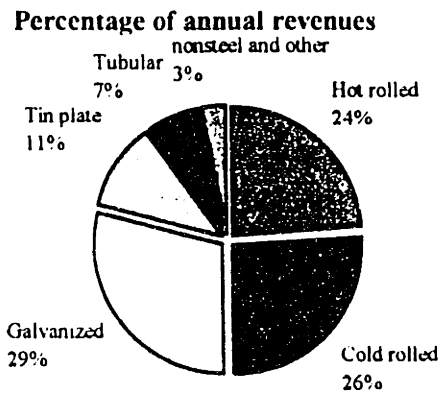
Mills with limited capabilities either in rolling or in related steelmaking or downstream processing operations rank in this low-end category. They generally rely on melting scrap in electric furnaces and even if they purchase the best available scrap, it contains residual alloys in amounts that exceed the upper limits specified for most high-quality sheet products. This drawback can be overcome by adding direct-reduced iron or some other diluent to the furnace charge, although steelmaking and overall production costs are thereby increased. Relative to their higher-ranked competitors, low-end mills also roll a more limited range of products. The flat products they market are often referred to as commodity-grade or commercial-grade steel and are purchased mainly for applications in which quality is less important than price.

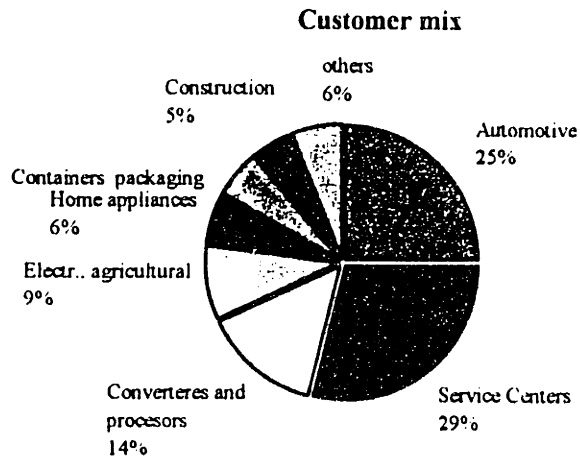
Minimill sheet producers, which are in the early stages of commercial development, presently run as low-end market participants. Given the extent to which their technology, centers around thin-slab casting, minimills can supply only a limited range of sheet products. Higher-quality sheets are beyond their current capability because of their dependence on scrap-base steelmaking, surface problems, width and gauge limitations at their rolling mills, and a scarcity of coating and other downstream facilities.

Exhibit 4.1 presents a breakdown of sales in terms of products and customer mix.

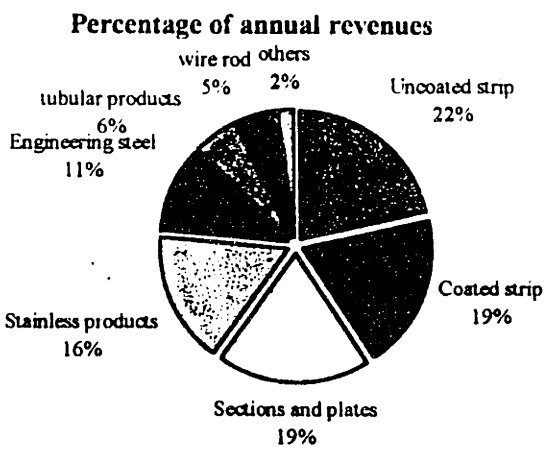
Exhibit 4.1
Product and Customer Mix

LTV





British Steel



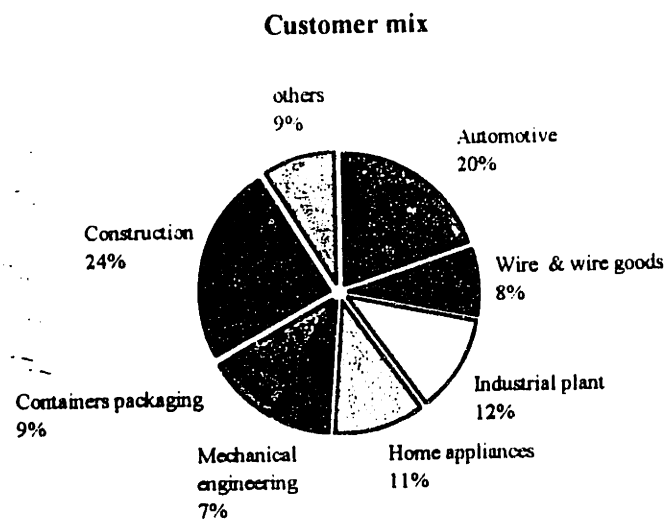
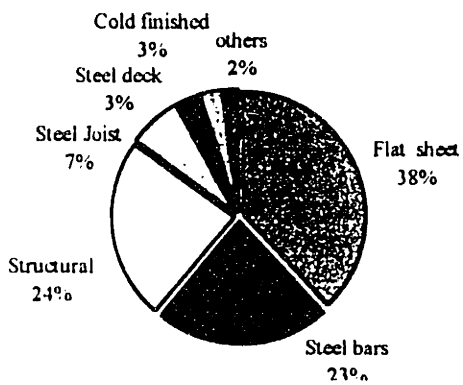


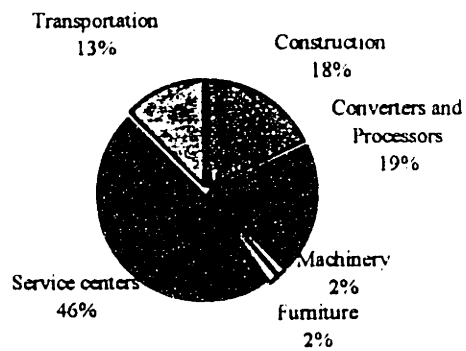
Exhibit 4.1
Product and Customer Mix
(continued)

NUCOR

Nucor - Product mix



Nucor - Customer mix
Flat segment



4.3 STRATEGIC POSITIONING IN THE LOW AND MIDDLE SEGMENTS

In this section we will analyze first the positioning of the three companies in the aforementioned segments of the market. Second, we will hypothesize upon the convergence of the minimill technology as a dominant player in those segments.

As noted earlier, these segments are currently the ones in which the battle between the new wave of mini-mills and the traditional integrated mills is taking place. Hence, this

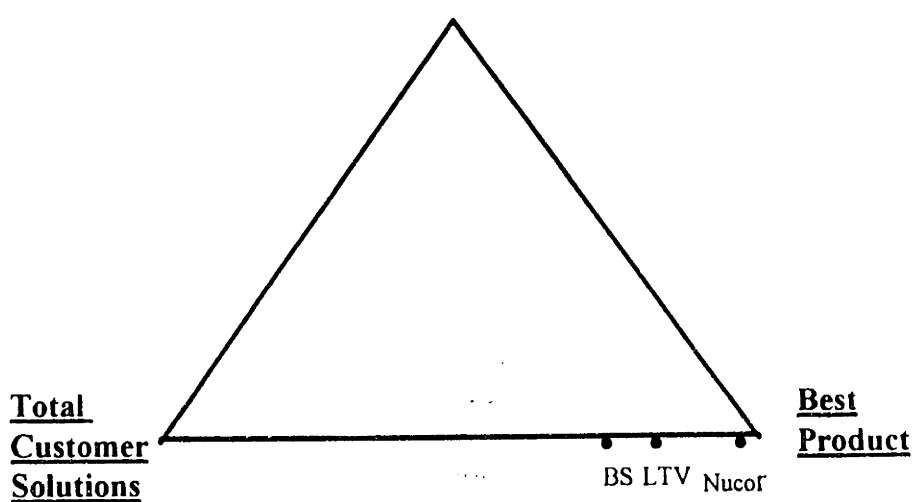
radical change in competition has led to a continue process of **emphasis on cost reduction** to enhance (in minimills) or at least maintain (in integrated mills) market share.

Accordingly, we do not see any major difference in the positioning of the three companies in an analysis of these market segments. Nonetheless, the percentage of product offered in these segments compare to the total product base varies considerably among the companies.

As shown in Exhibit 4.2, all three companies can be positioned in the ***Best Product*** dimension, pursuing a low-cost strategy.

Exhibit 4.2

System lock-in



Although we perceive a clear low-cost strategy among the firms being analyzed in this segment, we believe that because British Steel is downstream integrated, it has a set of elements that result in a more customized product compared to that offered by the other two companies. This set of elements relies upon the fact that (1) British steel provides a

broader range of products, and (2) British Steel owns service centers that further process the finished product to its customers.

The low end of the market is currently dominated by minimills that have pushed integrated mills toward the upscale segment of the market. Therefore, as mentioned earlier, the big battle now is in the middle segment of the market with a continuous emphasis on cost reduction and quality improvement.

In spite of this intense competition, we see the dominant strategy in this segment as remaining static as a low-cost producer, mainly due to the commodity appearance of products and the standard quality required by customers.

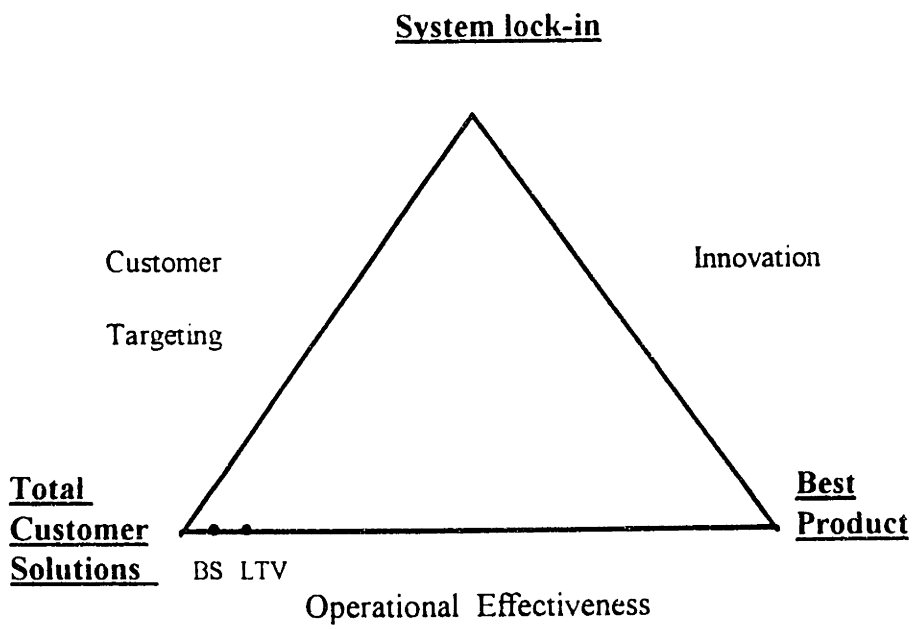
4.4 STRATEGIC POSITIONING IN THE HIGH END OF THE MARKET

As noted earlier, this segment of the market is characterized by highly sophisticated and demanding customers, primarily the automotive industry.

The positioning of steel companies in this segment is clearly different from the ones above described. Some customers in the high end of the market are highly concentrated on the consumption of a huge volume of steel and consequently they exert an enormous bargaining power. British Steel and LTV understand that, and configure their value chain and internal capabilities so they can deliver **Total Customer Solutions**. Exhibit 4.3 shows the current positioning of these companies in the high end of the market.

Exhibit 4.3

Positioning in the current high end of the market



We will describe this adaptive process in greater detail in Chapter Six, and we will explain the critical change in the mind-set of these producers. Again, technology has played an prominent role in the transformation of this business. Steel producers in this segment of the market are not merely suppliers of raw material; on the contrary, they have worked hard to be involved early on in the process design of cars. In doing so, they have been able to prevent, to some extent, the entrance of other competitors from the steel industry (i.e., minimills) and from others industries (plastics and aluminum).

These producers have tried to understand the customers' economics, and they have pursued cost reductions through process and product development, just-in-time delivery, electronic orders, etc. In this arena of the business, they have committed huge investments in R&D, information systems, and training in order to become leaders in providing answers and quick responses to the problem that arise in day-to-day business. This synchronization of effort strives to reduce customer costs and/or improve their competitive position. This new concept also contemplates a business environment in which companies work very close with their customers, sometimes even maintaining their own office at the customer base.

As noted earlier in this chapter, a new concept has emerged that could revolutionize the industry as a whole: the system provider. This concept will be analyzed in Chapter Seven when we present in detail the adaptive process -- ***Innovation***. In brief, the idea behind this new wave of thinking is to gain a basic understanding of the business in a global sense, find complementors that can also be today-competitors, and provide a value-added product or service with customer/supplier bonding (lock-in).

Therefore, in analysis which follow, we will consider two different scenarios. First, the current situation of the industry in this segment; second, the changes in the positioning of these firms according to the future trends of the industry.

In spite of its current dominant position in the low end of the steel industry, minimills are relatively weak players in this segment of the market. In addition, there is not only a technology limitation owing to the inability of minimills to provide the quality required in this segment, but also a lack of desire to be involved with these "sophisticated/powerful" customers. Providing total customer solutions to these clients requires many human and material resources that the current organizational structure of

minimills does not currently contemplate. However, we foresee some turbulence in this segment coming in a five to ten year timeframe. We estimate that minimills will penetrate this market as a consequence of, among other things, the following factors:

- the development of new technologies that will allow minimills to achieve high-quality products at a much lower cost.
- the current battle between minimills and integrated mills will grow into a fierce competition among minimills themselves.
- as the barriers to entry continue to lower and consumption is relatively strong, we foresee much more capacity coming into the market at the turn of the century.
- This, together with the fact that enormous capacity is currently installed in the U.S. and China, will cause extra instability for the industry as a whole.

All these reasons signal important changes in this sector. Trico is the first minimill owned by an integrated producer, which clearly confirms one of the factors just described. More and more, this kind of joint ventures between the two cultures will be seen as attempts to enhance the single focus of minimills (low cost) toward total customer solutions.

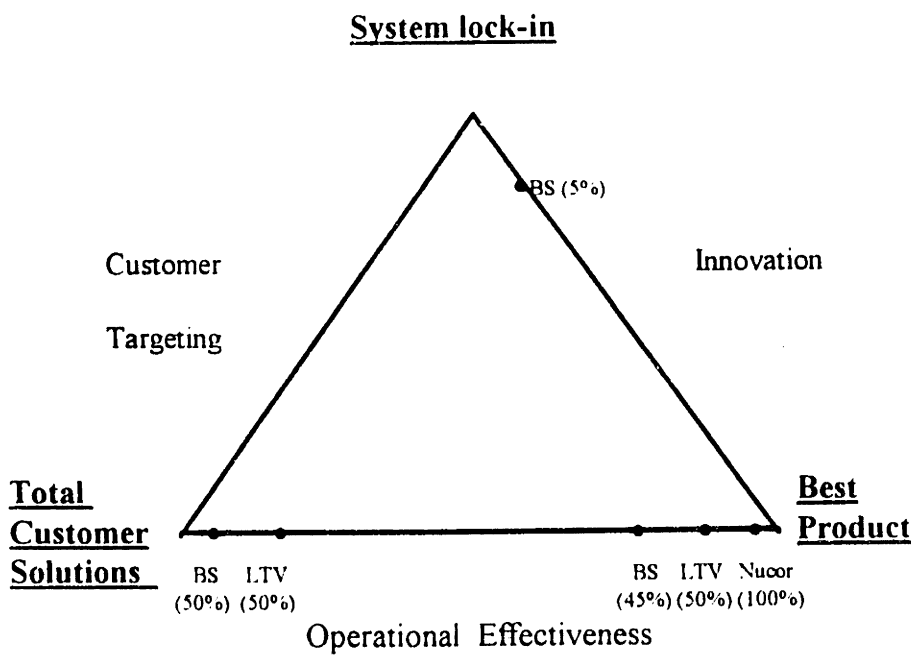
The dynamic of these changes will re-shape the positioning of steel companies all over the world. However, we believe that due to the nature of this industry, operational effectiveness excellence will prevail as an unavoidable requirement for the next generation of mills.

4.5 POSITIONING IN THE ENTIRE INDUSTRY

In the following Exhibit 4.4, we present the current positioning of these three companies, as well as our forecast of their future evolution in the industry as a whole.

Exhibit 4.4

Current positioning in the entire industry



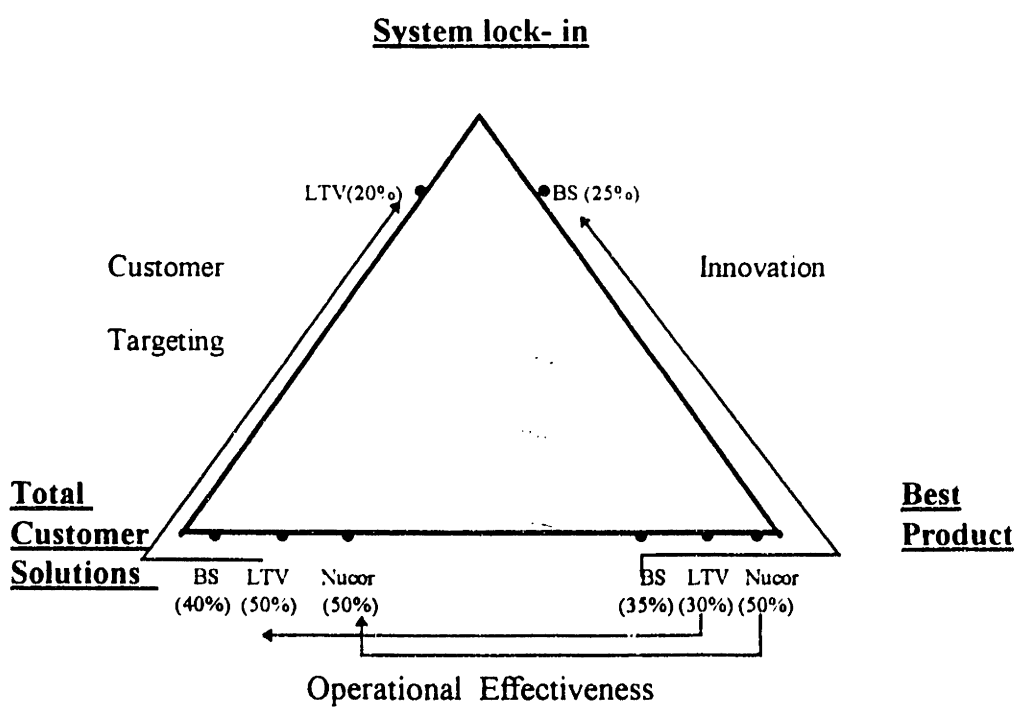
In this Exhibit, the percentages represent the relative importance of each positioning compared to the total strategy followed by each firm. Although none of the firms were included in the System Lock-in dimension for the low, middle, and high end of the market, we believe that even in an embryonic stage, the positioning of British Steel in the building segment is a clear example of targeting the system architecture. It is noteworthy to mention that these percentages were obtained directly from conversations with CEOs and/or Directors of Corporate Strategy at these firms.

4.6 FUTURE POSITIONING IN THE ENTIRE INDUSTRY

In Exhibit 4.5, we show our forecast of the evolution in the positioning of these companies at the turn of this century. However, we should note that these predictions do not necessarily coincide with those currently in the minds of the CEOs of these three firms. In later chapters, we will address the sustainability of the current strategies, and we will provide a set of recommendations that are in line with the transition and the dynamic of this industry which will take place in a relative short time.

Exhibit 4.5

Positioning in the industry for the 21st Century



As noted earlier, we foresee a move from the low-cost strategy (best product) to more value-added products in an attempt to provide a bundle of products and services that

enhance customers' total perceived value. Again, the innovation process, both in process and product development, will play a fundamental role in transforming the steel industry. Hence, only those who have the tangible and intangible capabilities and resources to undertake this process are going to achieve a sustainable competitive advantage.

CHAPTER FIVE

ADAPTIVE PROCESS: OPERATIONAL EFFECTIVENESS

Up to this point, we have depicted the dramatic changes in the steel industry; second, we explained the Adaptive Management Framework; third, we profiled each company; and then we introduced each company's business model.

In the next three chapters, we will explain how each adaptive process is critical to supporting a given strategic position. In doing so, we will devote most of each chapter to depicting examples that have arisen in our research. The methodology we have employed is to explore the so-called "consistency corridor" that is shown in the following Exhibit 5.1 and that reflects a close relationship between a given strategy and a given adaptive process.

Exhibit 5.1
The Consistency Corridor

Strategy / Adaptive Process	Best Product	Total Customer Solution	System Lock-in
Operational Effectiveness	Consistency Corridor		
Customer Targeting		Consistency Corridor	
Innovation			Consistency Corridor

In this chapter, we will focus our analysis on **operational effectiveness**. We will extensively analyze Nucor as an outstanding example of operational excellence. This attribute made it possible for Nucor to become one of the leaders in the steel industry.

First, we will cover two of the main features of Nucor's success: the so-called "Nucor Style" and its technological edge. Second, we will correlate these strengths with the company's operational effectiveness and then be able to judge the sustainability of those sources of competitive advantage. Finally, we will identify some weaknesses in this model and propose some recommendations based on our analysis.

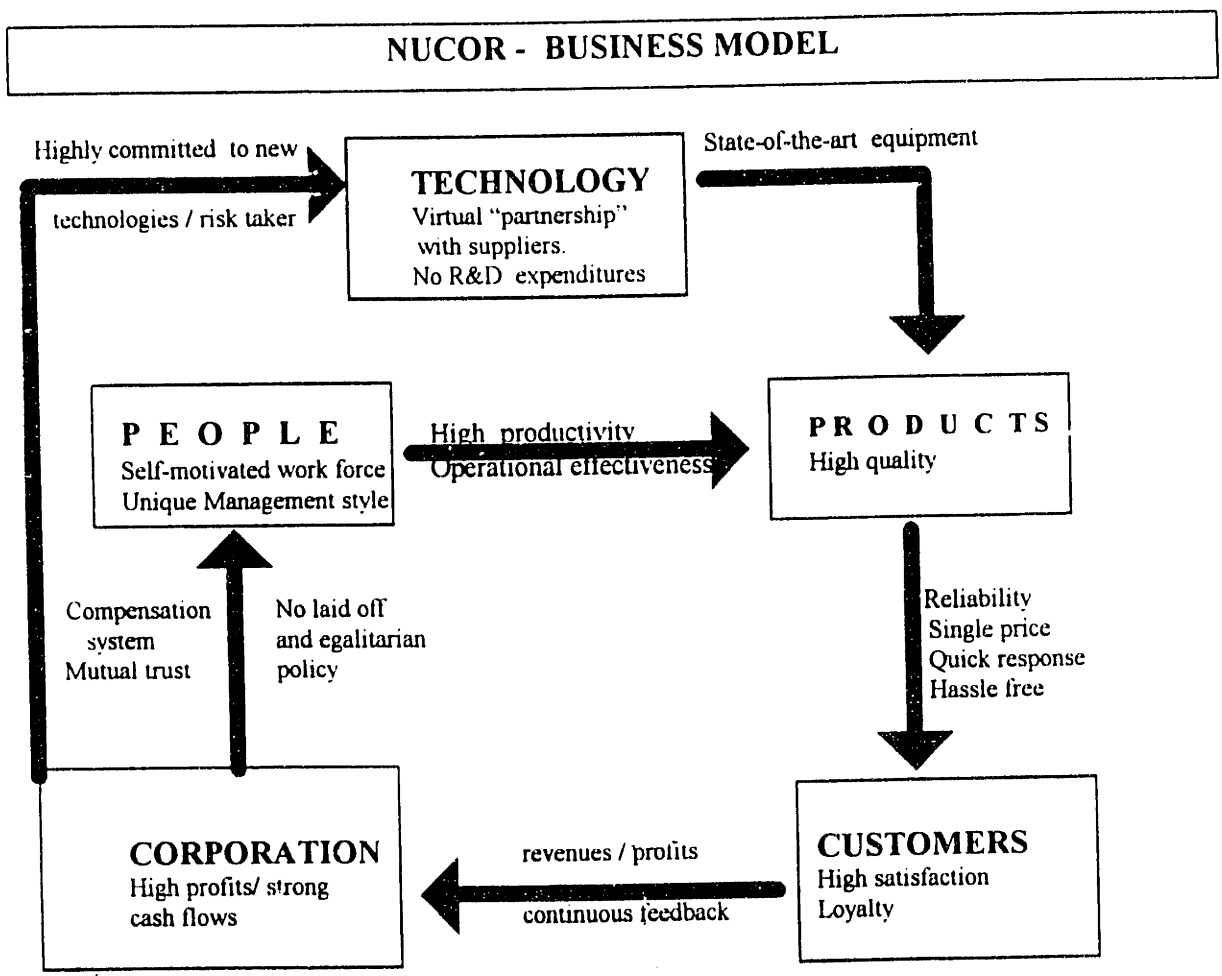
As part of our research, we visited Nucor's headquarters in Charlotte, North Carolina and the Nucor plant in Hickman, Arkansas. During those visits, we obtained some insightful comments about this company from John Correnti, CEO, James Coblin, General Manager Personnel Services, Michael Parrish, Vice President and General Manager of Nucor Steel Division (Hickman), as well as Hickman Plant's Controller, various production managers, supervisors and hourly workers. In addition, we interviewed senior management of Huntco Steel, one of Nucor's most significant customers.

As noted in Chapter Three, Mr. Correnti remarked that in spite of Nucor's state-of-the-art facilities, only 20% of Nucor's success is attributed to technology. The most important driver is the so-called "Nucor Style". However, in our opinion, technology has played an outstanding role in the process of consolidating Nucor into one of the most successful steel producers in the world, and therefore we can assume that both features "technology" and "culture" have contributed equally to their success.

5.1 NUCOR STYLE

In this section, we will analyze the main characteristics of Nucor's style. In Exhibit 5.2, we have summarized our perspective of the business model of Nucor.

Exhibit 5.2



Among the main characteristic of the "Nucor Style", we will discuss decentralization, compensation system, people edge, and management style.

Decentralization

Nucor, with its completely decentralized structure, runs its business through eleven divisions. This decentralization results in a high degree of flexibility, due to the lack of major corporate involvement in the day-to-day business decisions.

As an illustration of this lack of corporate involvement, Mr. Correnti acknowledged that he has rejected some attractive proposals from suppliers; for instance, a supplier of electrodes offered a 30% discount if Nucor decided to purchase this element for all of its divisions (note: electrodes are highly consumed in the EAF process and the offer represented a major saving).

The main reasons for this attitude are, first "do not impose any decision from headquarters" down to divisions which at the end of the day might result in an excuse for an inadequate division performance. Second, this policy allows division managers to deal with suppliers individually, knowing that there is room for discount with this particular supplier. Consequently, the final price reached in each division is pretty close to that offered by the supplier for the entire corporation. This also fosters a spirit of entrepreneurship for those who are running Nucor's divisions.

Coordination at the corporate level is done through Nucor's Central Planning Process. There are three general meetings that take place in February, May and November at headquarters in which all the executives, managers, and division managers discuss

(among other issues) the budget for the next fiscal year, capital expenditures, compensation systems and incentives, and past performance.

Performance-Based Compensation

Nucor pays its employees via a unique performance-related compensation system that rewards goal-oriented employees. All employees are covered under one of four basic compensation plans, each featuring incentives related to meeting specific goals and targets. A complete description of this compensation system is presented in Chapter Eight (Exhibit 8.1).

This compensation system is heavily based on a performance bonus; two-thirds of total salary is incentives. For example, an hourly worker's average base salary is $10 per hour, but after the performance bonus (which could be as much as 200%), the worker earns a total hourly salary of $30. As Mr. Correnti remarked in our visit, the idea behind this system is clear and simple: "SHARE GAIN and SHARE PAIN". When a recession comes, all employees are asked to work less hours and lose their productivity bonus.

This compensation system, together with a no-layoff policy, has allowed Nucor to minimize personnel turnover and increase worker loyalty. As a result of this innovative compensation system, Nucor's workforce is characterized by high motivation, team orientation, and strong commitment to job performance.

Nucor's compensation system is a classic example of an incentive program designed to reward production groups rather than individual workers. Production groups are evaluated by productivity and quality standards and rewarded with weekly bonuses. As mentioned earlier, although Nucor's base wage is significantly lower than wages of other

unionized steel makers, the base salary plus performance incentives typically results in a higher wage.

As a direct consequence of the bonus incentive system, most of the worker's pay is at risk. This system also provides certain flexibility to Nucor since most of its salary expense is tied to the success of the company. Hence, this expense behaves more as a **variable cost**. In addition to these established bonus plans, Nucor periodically issues an extraordinary bonus to all employees, except officers, during times when Nucor is enjoying a particularly strong performance.

Overall, Nucor's incentive compensation programs gives every employee the opportunity to share directly in Nucor's success. This kind of compensation linkage to performance enables the company to align with its strategy, providing strong encouragement for employees to work hard to build a better future for Nucor and themselves.

People Edge

The composition of the workforce and the personnel compensation system are specifically designed to spur productivity. To obtain the desired workforce, Nucor locates its plants in small towns in low-wage rural areas. Nucor believes these rural populations tend to have a stronger work ethic and are mechanically minded. In addition, rural people also tend to be anti-union which is a key tenet of Nucor's management strategy.

Nucor does not have a central personnel department. Instead, each plant hires its own workers. Out of 22 plants, 17 do not have personnel departments. At the headquarters in North Carolina, there is a General Manager of Personnel Services, James Coblin, and his

role is to be a Human Resources consultant, supporting executives managers in all of Nucor's production facilities.

In our visit to Nucor Steel Arkansas, we had the opportunity to talk with hourly employees in the melting area as well as in the rolling area. With regard to unionization, the workers strongly believe that working without union rules makes it easier to achieve a more flexible schedule as well as to perform various tasks. The workers are extremely money-oriented; their main concern is to produce as many good quality tons as possible in order to increase their bonus. They also noted that Nucor's management structure allows them to communicate directly with department managers and general managers without any intermediary such as union representatives.

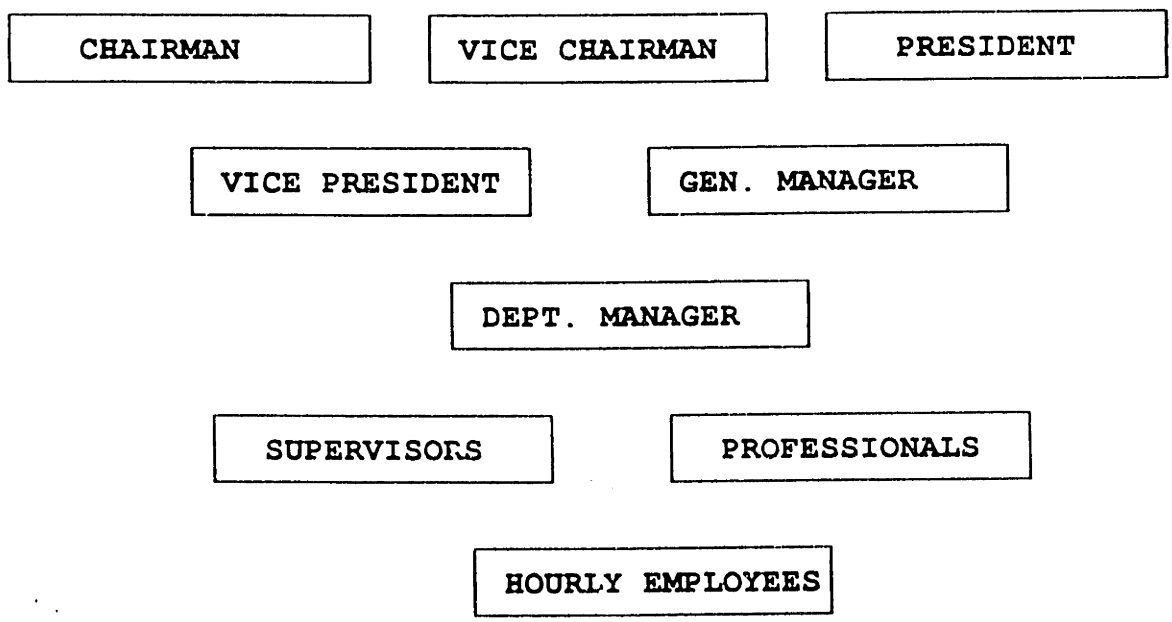
We also interviewed Bob McCracken, the hot mill supervisor, who had previously worked in an integrated mill. It was interesting to see how he compared both styles for a supervisor position. He strongly believes that the role of supervisor in an unionized environment is one of trying to get people to do the job, acting as a "baby-sitter." On the contrary, at Nucor, people are self-motivated, due primarily to the incentive system and the management style. Hence, a supervisor becomes a coach, a planner, a trouble shooter, focusing on improving processes, quality, etc.

Management Style

Nucor is one of the companies that has changed the role of top management. It now focuses less on formal structural design and more on effective management processes. The company is less concerned with controlling employees' behavior and more concerned with developing their capabilities and broadening their perspectives (Bartlett & Ghoshal, 1995).

Nucor is also convinced that **decentralization and few management layers** are critical to operating productively and economically. Nucor has only five layers compared to a dozen at conventional steel manufacturers. The company's philosophy is to decentralize as many decisions as possible down to the next lower layer. The only decisions made at the corporate level involve investment decision-making, organizational changes, and pricing policies. This flat organization also promotes informal communication, teamwork and customer orientation. The following Exhibit 5.3 shows the different management layers in Nucor.

Exhibit 5.3



This streamlined chain of command provides the general managers at each Nucor division with great autonomy in operating the facility as an independent business. One department manager observed that in his scope of activities, he has to recruit and eventually

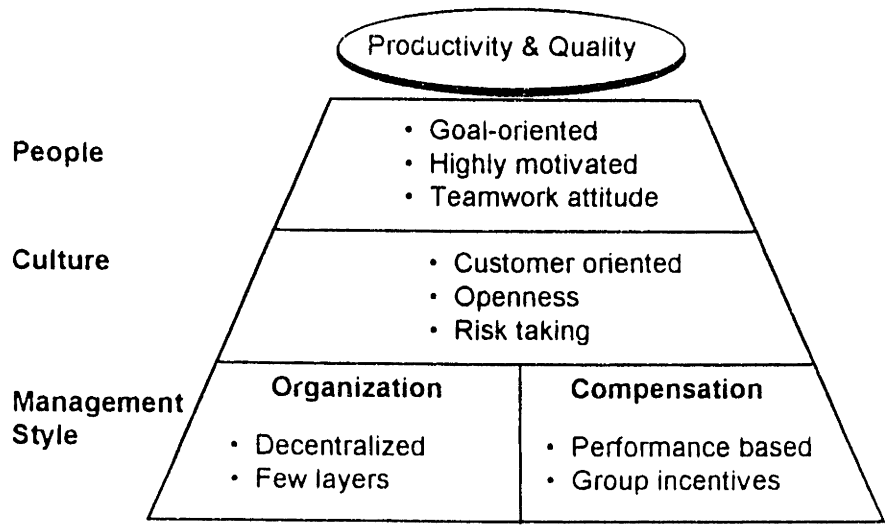
lay off employees, deal with suppliers for new equipment, provide training to supervisors and hourly workers -- all in addition to his own tasks.

According to Mr. Coblin, workers want to work when management and union do not intervene much in the business. Nucor has been able to provide an environment for getting work done without politics, unions, bureaucracy, or the like.

According to Mr.Iverson, Nucor's Chairman, employees at Nucor are concerned about union work rules that might reduce productivity, as has happened in many unionized facilities. They are also "concerned about the union requiring that promotions be based solely on seniority," he said. Rather, they want "the most qualified people put in the positions of authority" and feel that otherwise productivity and their bonuses could be hurt. The union's attempts to organize minimills like Nucor "are directed not toward the empowerment of Nucor employees but toward increasing the power and money of the union," Iverson remarked (Iverson, 1996).

Despite its growth, Nucor has remained a very egalitarian company where there are no company cars or reserved parking places, everyone has the same holiday and vacation benefits, everyone flies coach. Exhibit 5:4 below summarizes Nucor's personnel management system and management style.

Exhibit 5.4



This following set of recommendations for top managers, seem to fit Nucor's management style (Bartlett and Ghoshal, 1995):

- reduce its reliance on strategic planning systems by influencing the organization's direction through the development and deployment of key people;
- lighten the burden of control systems by developing personal values and interpersonal relationships that encourage self-monitoring;
- replace much of its dependence on information systems by developing personal communications with those who have access to vital intelligence and expertise.

Additionally, Nucor's executives reject ostentation and maintain a low profile management style with strong emphasis on expenditure control. Mr. Correnti commented

that in spite of the fact that Nucor is a $3.5 billion company, he wants people to see Nucor as a $300 million company. The company works hard to keep overhead at a minimum and run its facilities with few people. Nucor Arkansas, a 2.2 million tons facility, is run by only 350 employees total. In this plant all the scheduling is done by one person who coordinates sales orders with production availability.

Achieving competitive success through people involves fundamentally altering how corporations think about the workforce and the employment relationship. It means achieving success by working with people, not by replacing them or limiting the scope of their activities (Pfeffer, 1994). Nucor considers its workforce as a source of strategic advantage, not as a cost to be minimized or avoided.

5.2 TECHNOLOGY EDGE

In typically unconventional fashion, Nucor does not allocate any funding or staff for R&D. They consider their core competencies to be operating and constructing new plants rather than developing new steel-making technologies. Nucor considers the development efforts of their capital equipment suppliers as their R&D resources. However, Nucor is very proactive in employing new technology and it hires experts to monitor technical developments in the steel industry.

Nucor was the pioneer in introducing the Compact Strip Production (CSP) technology in the flat segment of the U.S. steel industry. This process involves two major innovations to conventional technology. The first element of CSP is continuous thin-slab

casting. The target is to cast much thinner slabs, 2 inches thick and 54 inches wide, compared to the 10 inch thickness produced by most conventional continuous casters.

The second element of CSP is the coupling of continuous casting with rolling operations. Rather than cooling the thin slabs and then re-heating and roughing them before final hot rolling, Nucor transports red-hot thin slabs directly from the caster to the hot strip mill through a continuous tunnel furnace whose temperature is kept at a constant 2200°F. This prevents temperature gradients within the slabs as they move toward the rolling mill. All intermediate cooling, inspection, and reheating processing steps are eliminated, cutting energy consumption during the rolling process by more than half.

When the slabs reach the hot-strip rolling mill, they are processed through four stands of rollers, each of which reduces the steel's thickness by 50%, until the sheet or strip had reached its final thickness. This hot rolling process is in sharp contrast to conventional finish rolling mill configurations which contain 6 or 7 stands, each capable of reducing the steel's thickness by only 20%.

5.2.1 Impact on Costs

According to Barnett's calculations ("Nucor at a Crossroads", HBS case), Nucor is able to reduce its final operating costs by $40 to $60 per ton compared to estimated production costs at modernized fully integrated mills. At prices of approximately $500 per ton, this represents an additional 8-12% of gross margin.

However, the most striking impact of the CSP process is the reduced investment needed to build a flat rolled minimill. The estimated cost to build a 1 million ton facility is approximately $400 per ton. On the other hand, an efficiently scaled, modernized, integrated mill requires a capital investment of approximately $1200 per ton.

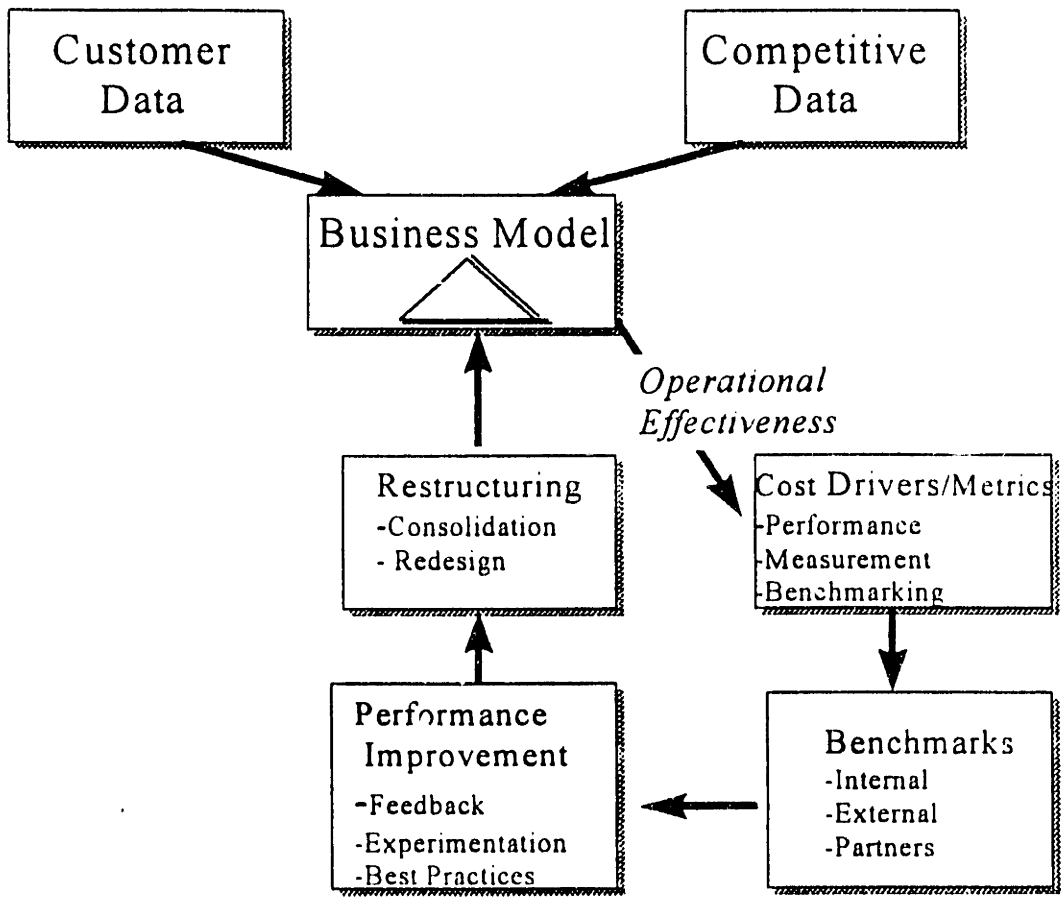
There are two primary reasons why the CSP process enjoys such a striking capital cost advantage over conventional processes. First, since the CSP process relies on scrap steel melted in electric arc furnaces, the massive investment required to install blast furnaces, basic oxygen converters, and coke ovens is unnecessary. Second, since the rolling process does not require re-heating furnaces and roughing stands, and requires four instead of seven finish rolling stands, the hot-strip rolling mill is also considerably less expensive.

5.3 LINKAGE BETWEEN THE NUCOR STYLE AND OPERATIONAL EFFECTIVENESS

In this section, we will discuss the impact of the various characteristics just discussed on Nucor's operational effectiveness according to the Adaptive Management Framework, which is shown in Exhibit 5.5.

In Exhibit 5.5 we are conveying that operational effectiveness is mainly driven by performance measurement analysis. By having a suitable set of metrics, performing a credible competitive profile analysis, giving feedback to the operational level, and finally modifying existing practices, a company achieves a superior operational effectiveness level.

Exhibit 5.5
Operational effectiveness in the adaptive management framework



This framework also contemplates the dimension of "restructuring" which we understand to be a one-time shot needed to re-shape the business almost completely. Although this restructuring process was not followed by Nucor, most integrated mills have been through a process of business reengineering to evolve a new set of capabilities needed to adapt to the tremendous changes in the industry.

Nucor relies heavily on an evaluation of **costs drivers and metrics**. Its compensation system has been designed to spur productivity, and therefore the entire system

is tied to the achievement of a certain set of performance metrics. One of the main performance drivers is the "Return on assets employed (ROA)", that is evaluated in the process of allocating financial resources as well as in the day-to-day operations. This metric is absolutely critical in an industry like steel that is so capital-intensive. In doing this evaluation, Nucor sets a target of 25% ROA employed that is remarkably large for a steel manufacturer.

In addition, Nucor's officers and division managers evaluate technically the capacity of each major equipment and then set the average rate of performance for that equipment. These production goals are the basis for determining the bonus for hourly workers. Typically, bonuses are based on anticipated production time or tonnage of quality steel produced, depending on the type of facility. This incentive program creates pressure for each individual to perform well and, in some facilities, is tied to attendance and tardiness standards. No bonus is paid if equipment is not operating, thus creating a strong emphasis on maintaining equipment in top operating condition at all times. Maintenance personnel are assigned to each shift, and they participate in the bonus along with the other bonus groups.

Production goals are reset from time to time in order to compensate for the learning curve effect. Therefore, the bonus salary increases continuously with improvement in productivity of each production line. This motivation factor in the workforce enables Nucor to excel in productivity, achieving records of 0.4 mht in Hickman plant in Arkansas. Furthermore, the only things that counts for the bonus is quality tons of steel. This means that if a customer rejects a shipment, the bonus earned in that production order is automatically taken off from the next bonus. This system is designed to increase the

productivity of the firm, but it does not necessarily means just an increase in the number of tons of production. Rather, it is intended to boost the total volume produced and still maintain the required quality.

People at Nucor are constantly exposed to metrics for performance improvement. Each shop-floor operator glances at a computer that instantly indicates the bonus he are getting at the current level of performance. Therefore, a by-product of this compensation system is the fact that most hourly workers understand perfectly the relevant metrics of the firm as well as their contribution to the whole corporation. This is not trivial; on the contrary, we consider this an outstanding tool to "link the strategy of the firm with the execution", which -- as mentioned in Chapter Two -- is one of the main characteristics of the AMF.

Consequently, ***measurement*** is a key component of Nucor's operational effectiveness. At the corporate level, the company approves the performance goals defined by the General Manager of each division. In this process, they identify the contribution of each division to the entire corporation and the impact of the bonus system in the bottom line.

A continuous process of ***benchmarking*** among Nucor's division and with external producers also characterizes this corporation. Information is fully shared among the divisions which allows them to incorporate new operational practices and technologies. Furthermore, a monthly performance report, called the "Smile Report", is distributed to all divisions. In this report, Nucor evaluates its performance through a variety of indicators such as:

- Return on Assets employed (greater than 25%)
- Weeks of production in inventory
- Accounts receivable collection efficiency.

It is called the "Smile Report" since on the right-hand side appears either a happy face with a smile or an unhappy, worried face. These face depends on the accomplishment of the overall target for each division. We understand that this kind of public performance of all divisions helps to compare achievement of goals as well as to encourage competition among them divisions, particularly those divisions that are in the same business.

Bob McCracken, hot mill supervisor, commented about a recent divisional meeting where Nucor Steel (flat producers) from Hickman, Crawfordsville and Berkeley County had a roundtable discussion about what are they working on, what their problems are, what are their successes, sharing equipment performance figures, rejection measures, quality control, etc. They conduct this meeting at least three times a year. This process of internal benchmarking together with experimentation and feedback certainly contributes to a continuous process of performance improvement.

Additionally, there is a continuous process of benchmarking with world-class producers in order to identify possible sources of improvement in any particular area of its business. Exhibit 5.6 illustrates the components of Nucor's operational effectiveness.

Many operationally excellent companies today focus on multiple tangible and intangible costs. Price remains the focus of most operationally excellent companies.[1] This is even more clear in a commodity segment of the steel market.

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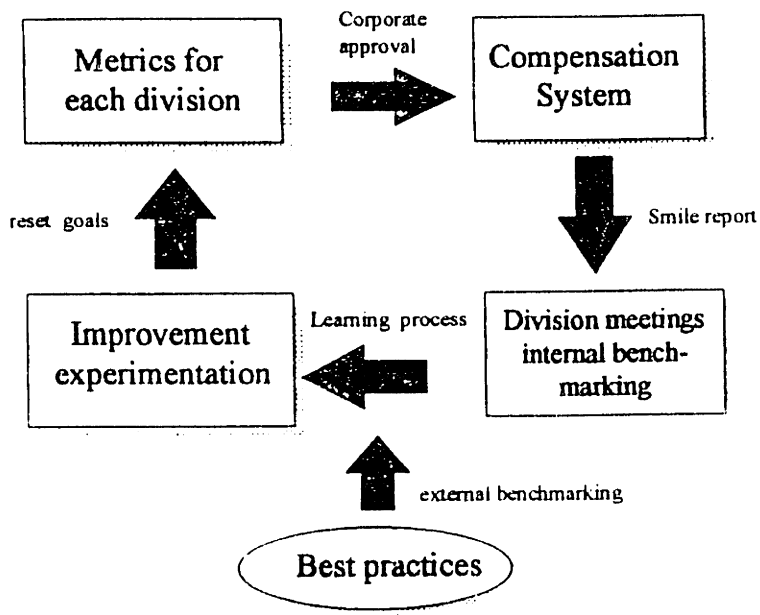
[1] Some of the general features of operational effectiveness were taken from *The Discipline of the Market Leaders*, Tracy and Wiersema, 1995.

Exhibit 5.6

Operational effectiveness at Nucor



Operationally excellent companies obtain their growth in three coordinated ways. They work to assure a **constant, steady volume** of business so as to keep their assets continually working; they find **new ways to use** their existing assets; and they **replicate** their formula in other markets or through expansion in the same business.

Standardized assets and efficient operating procedures are the backbone of every operationally excellent company. The idea is to standardize assets that form the basis for efficient operating procedures. At Nucor, they strive to build new facilities with the same equipment that already runs well in other divisions. By doing this, Nucor is be able not only to do some cross-fertilization at the hourly worker level (which leads to an enormous advantage in terms of learning curve), but also to **benchmark divisions** on a daily basis which ultimately results in extraordinary **feedback** for improving performance.

In order to **replicate** its success in other divisions, Nucor allocates approximately 10% of the total workforce to a new plant from existing facilities already operating under the Nucor philosophy. This cross-fertilization of culture assures a more rapid process of adopting the Nucor style.

Beyond Nucor's style, there are a couple of words that describe well the relationship between workers and management: **mutual trust**. This trust is hard to find in most organizations and it goes beyond the fact of being unionized or not. This kind of trust relies upon the egalitarian system implemented in Nucor. Nucor takes such an egalitarian approach in providing benefits to its employees. Senior executives do not enjoy traditional perquisites such as company cars, corporate jets, executive dining rooms, or executive parking places. In fact, certain benefits such as Nucor's Profit Sharing, Scholarship Program, Employee Stock Purchase Plan, Extraordinary Bonus, and Service Awards Program are not available to Nucor's officers. All employees have the same holidays, vacation schedules, and insurance programs. This equality in benefits is a key ingredient toward fostering the teamwork approach that is an essential part of Nucor's business.

Another element of cost that operationally excellent companies stress is **convenience**, the absence of tangible or intangible costs stemming from annoyance and irritation of customers. Steel customers are looking for the best value as opposed to only the best price. This particular approach means that customer service matters. In order to have the lowest total cost, service must be effortless, flawless, and immediate. In the case of Nucor the company is focused on simplicity in pricing, high quality, reliable delivery, responsive inside and outside sales support, and quick answers to any customer's inquiry. They strive to make hassle-free basic service a key part of their unmatched value proposition.

The management of people is essential in this model. The team is what counts, not the individual. All the performance and incentives are set so they can be achieved in teams. Nucor pays enormous attention to the hiring process in order to obtain good people, not necessarily experienced people. Rather, Nucor looks for highly motivated people who are trainable, they are hired and taught the Nucor way of business. Nucor furnishes the environment that allows them to learn, make decisions, and work on their own. Nucor's management truly believe that when people understand corporate objectives and values, they will be able to gauge their own performance against those goals.

Experimentation is another factor that contributes to Nucor's success. As is the case in almost every learning organization, Nucor's officers encourage workers at any level of the firm to explore new ways of doing things. In this process of experimentation, the openness of managers is essential to ensure that people's suggestions are taken into consideration. Nucor's managers and supervisors rely on innovative suggestion coming from people who operate the equipment. Those workers are very keen to improve equipment performance that will result in an increase of their total salary.

Some of the projects are undertaken individually at the division level, others are undertaken together with other divisions. As an example, in the new steel facility at Berkeley, South Carolina, the hot rolled manager is preparing to incorporate the concept of regular job rotation. In doing so, they try to cut the number of jobs from 9 to 4. If this project is successful, it may spread into other divisions.

Another aspect that facilitates experimentation at Nucor is its flat organization structure. People who have a new idea do not need to seek approval through four or five levels of management. On the contrary, most of the experimentation projects are approved

at the department level. This increases the number of possible trials and, of course, the probability of success.

These unique Nucor characteristics clearly show that this company is an extraordinary example of **OPERATIONAL EFFECTIVENESS**. In the following Exhibit 5.7, we present a set of comparative metrics between Nucor and those who achieve average results in the steel industry. This outstanding performance is primarily due to superb efficiency achieved in its operations.

5.4 SUSTAINABILITY OF THIS MODEL

One answer offered by the emerging capabilities or resource-based theories cites two related sources of sustainable competitive advantage: ***Assets***, the resource endowments the business has accumulated (e.g., investments in the scale, scope, and efficiency of facilities and systems, brand equity, and the consequences of the location of activities for factor costs and government support); and ***capabilities***, the glue that brings these assets together and enables them to be deployed advantageously. Capabilities differ from assets in that they cannot be given a monetary value, as can tangible plant and equipment, and are so deeply embedded in the organizational routines and practices that they cannot be traded or imitated (Dierkx and Cool 1989).

Exhibit 5.7

(%)

Metrics	1993	1994	1995	1996
Return on common shareholders equity				
- Industry	7.1	12.9	14.9	11.1
- Nucor	14.6	22.4	21.9	17.2
Return on Assets				
- Industry	3.0	5.0	6.1	5.2
- Nucor	7.4	11.8	12.8	10.4
Return on sales				
- Industry	2.3	4.1	4.3	3.2
- Nucor	5.5	7.6	7.9	6.9
Return on avg. total capital employed				
- Industry	3.6	7.9	9.3	7.9
- Nucor	9.1	14.6	15.8	12.9
Market to book value				
- Industry	1.7	1.8	1.6	1.7
- Nucor	4.6	4.7	3.6	3.2
Price to net earning multiple				
- Industry	16.9	14.2	11.2	15.2
- Nucor	37.4	21.3	18.2	19.2
Price to EBITDA multiple				
- Industry	6.6	5.7	4.6	4.5
- Nucor	14.6	9.3	8.4	7.7
Cost of equity				
- Industry	12.1	13.7	10.4	10.5
- Nucor	13.6	14.5	9.4	9.4
Sales per employee in $				
- Industry	191.8	195.1	232.9	242.1
- Nucor	382.0	504.3	558.3	568.9
Total debt to total assets				
- Industry	25.0	23.8	24.0	24.0
- Nucor	19.3	8.7	4.7	4.7
Capital expenditures to total sales				
- Industry	3.4	4.9	5.0	4.7
- Nucor	16.2	6.2	7.6	7.5
Coverage ratio				
- Industry	1.6	2.4	3.1	3.2
- Nucor	21.7	35.1	62.5	62.5

Source: Deloitte & Touche

Nucor has clearly developed some capabilities that are embedded in the organization such as management style, self-motivated people, etc. Those capabilities are depicted in Nucor's culture and hence, difficult to replicate. This lack of imitation results in an unequivocal source of sustainability.

As we noted earlier, this model could be replicated in a brand new company but first a location or community must be found whose potential employees with to remain

unattached to unions and who are also trainable. Second, an incentive compensation system must be put in place. Third, resources have to be committed for the new technology and then updated with technological innovations. These three aspects of this model are, to some extent, relatively easy to duplicate.

But the one we consider highly critical is **management style** and the people who occupy the managerial positions. Most of the things that Nucor's management has done are easy to tell but hard to do. How many vice presidents of large corporations can live without a secretary, share a hotel room, and fly coach when traveling for business, call most of their employees by their first name, and bear almost completely the pain of bad years. These characteristics, together with the fact that Nucor has been a first mover in terms of new technology, have resulted in a source of sustainable competitive advantage.

5.5 WEAKNESSES OF THIS MODEL

Although we consider that in general Nucor's model of operational effectiveness is somewhat unique and successful, we do believe there are some weaknesses as well.

We consider the model to be strongly focused on **short-term financial performance** which results in a certain lack of long term strategic objectives. However, Nucor's corporate executives try to bridge this gap through certain goals such as potential market growth domestically and internationally, new technologies, etc. This deficiency in focusing on long-term goals is not uncommon in public companies. Unfortunately, institutional investors tends to base their investment choices on relatively limited information that is

oriented toward predicting near-term price movement. This pervasive short- term vision has a tendency to compel corporations to concentrate mainly on quarterly financial results instead of qualitative assessments of attributes of the workforce, level of technological sophistication, potential improvement in operational practices, etc.

Another weakness of this model is the fact that, in some sense, the ROA compensation system can undermine the competitive edge achieved by the company. To elaborate on this statement, we can see conflict arising from the fact that those people who are paid basically on ROA, can be reluctant to invest in new equipment (increase its assets base) to avoid a salary reduction, particularly during the first years of operation. Nucor has resolved this problem by setting a minimum bonus during the start-up period that can last five years. This bonus assures a reasonably similar compensation to the one that would be achieved without the new equipment. This situation can also be seen in a process of replacing some equipment parts.

Hourly people can react negatively to the idea of new operational practices that will require certain time to run efficiently. They worry about a reduction in their income as a consequence of the introduction of those minor or major changes in existing equipment. Again, this model heavily depends on **people**, therefore firms must make those adjustments in compensation in order to run the business smoothly.

Additionally, the performance goal of ROA is applicable to every single division of Nucor. As a matter of fact, we understand that this **uniform** target is only applicable in a case of similar businesses. This is not the case in Nucor, where there are many completely different businesses such as Vulcraft, Building Systems, Flat steel, bars, etc. and almost none of them has a similar attainable ROA employed.

From our point of view, there are many factors that can contribute to the above-mentioned difference in returns. Among these factors, we would emphasize the degree of competition in each business, distortions between book and real value of fixed assets (amortization system, inflation, etc.), relative position of the division to the entire market, etc. Some divisions may have an ROA that is substantially above target and therefore there is less pressure to improve further. In contrast, those divisions where the standard return of the industry is lower than that required by Nucor, situation becomes one in which it is impossible to accomplish the corporation's goals which lead to frustration and eventually increases personnel turnover.

Therefore, our recommendation is to set the ROA goals according to the standard return in each particular business in which the divisions operate. This would enable Nucor to correctly evaluate the performance of each division.

The third weakness of this model comes from the excessive pressure to keep costs as low as possible and run the business with very few people. This does not invalidate our earlier positive comments about Nucor in this regard. But what we are addressing here is the fact that in cases of extraordinary growth like that of Nucor, companies must make a decision to invest in resources, including hiring more people and developing information systems, at the right time. This timing factor in the decision process is critical to avoid being caught by competitors.

Finally, a more general consideration: this kind of model works best in a growing business, but we would not expect such remarkable success in declining businesses. The reason for this relies upon the fact that this model is based primarily on people who are extremely driven by "money." Therefore, we foresee a strong impact on people's morale

if there is a persistent reduction in the activity level and consequently in their salaries. This reverse effect can destroy much of the value created by the firm in the past. However, it is noteworthy to mention that this reverse effect is highly unlikely to happen at Nucor since its costs structure brings certain flexibility that is difficult to achieve by other producers in the steel industry.

CHAPTER SIX

ADAPTIVE PROCESS - CUSTOMER TARGETING

In this chapter, we will enrich the concept of customer targeting that was previously describe in Chapter Two using contemporary examples in this field from British Steel and LTV Corporation. We will start this chapter with a brief description of the main characteristics of firms following a total customer solution approach, and later we will present the results of our research in the aforementioned companies. Finally, we will discuss the results of a very unique project developed by many important steel producers in the world, the "ultra-light steel auto body" project.

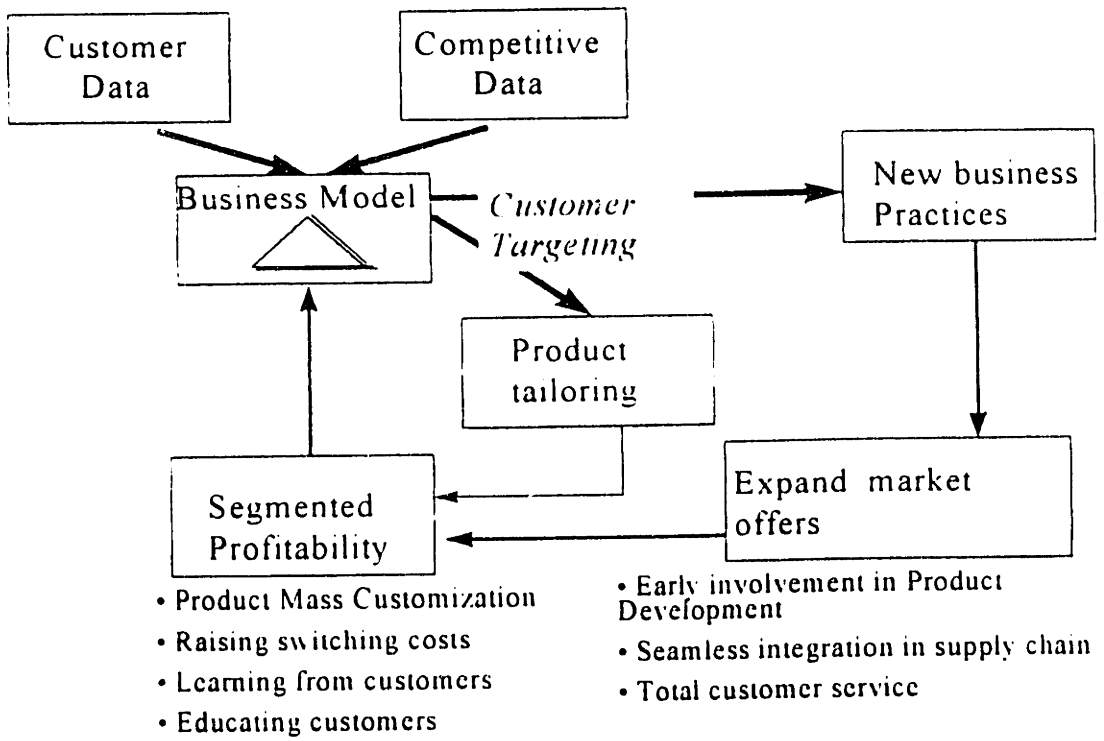
In our research, we conducted interviews at LTV headquarters in Cleveland, Ohio and at the British Steel headquarters in London, England.

6.1 THE DIMENSION OF TOTAL CUSTOMER SOLUTIONS

In the process of linking strategy to execution, the Adaptive Management Framework integrates "***granular segmentation***" within each of the adaptive processes. This granular segmentation is a critical factor for simplifying the complexity of the current business environment.

In the following Exhibit 6.1, we present the different sequences of customer targeting as an adaptive process.

Exhibit 6.1
Customer Targeting



Source: Authors' adaptation from AMF

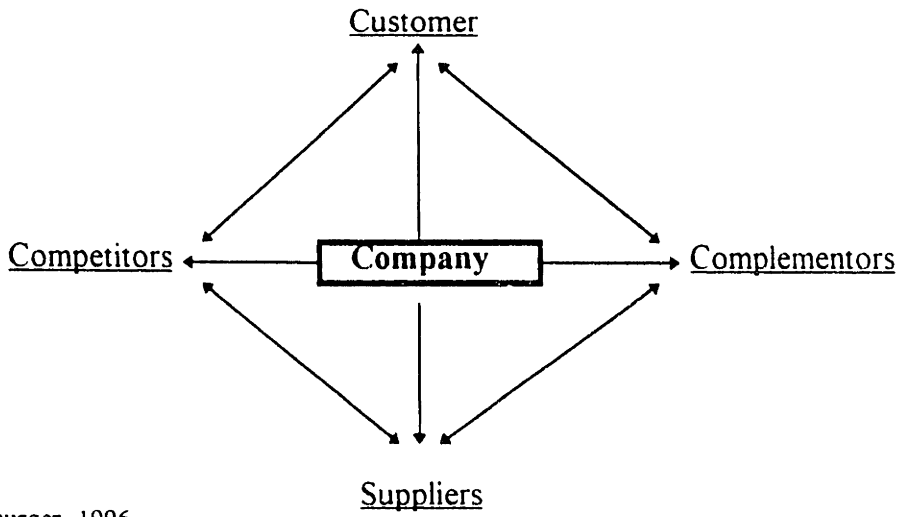
One expression that is commonly used in business today is "***customization***". This relatively new term refers to the specific actions necessary to provide products or services, or a combination of both, that are tailored to customers' needs. This synchronization of effort strives to either reduce customers' costs or improve their competitive position. This new concept contemplates a business environment in which companies work very close to their customers, sometimes even maintaining their own office at the customer base. In this process of ***tailoring products and services***, companies look at their customers in order to

better understand the final use of the product and accordingly to provide the total solution for them.

In this process of searching for excellence in providing customer solutions, firms need to understand the customers' economic drivers. In doing so, firms must identify opportunities that will add value to key customers by ***bundling solutions*** that contribute to either reduce customer costs or increase their profits. Therefore, if firms cannot fully articulate the economic drivers needed to improve performance to their customers, they will not be able to define the right set of solutions.

One of the first steps to fully understanding customers' needs is to focus attention on the customers' value chain, and identify the primary activities, in particular inbound and outbound logistics and operations. Firms must recognize people and companies that are involved in those processes, scrutinize the complete value net (see Exhibit 6.2), and understand how their product is further processed and/or used by their customers. The value net in Exhibit 6.2 includes all the relevant players in a particular business environment. Therefore, companies aiming to provide a total customer solutions must be able to articulate the role of these players as well as identify the impact of their strategic actions in the customers' economics.

Exhibit 6.2
The Value Net



Source: Brandenburger, 1996

When do firms must undertake a total customer solution approach? In order to understand the applicability of this strategy, companies must clearly depict a "Value Orientation Frame" (Whiteley and Hessan, 1996) in which they can define exactly what customers are looking for (see Exhibit 6.3). Companies following the total customer solution must concentrate their efforts on those customers that are more interested in a close relationship, with especial emphasis on those looking for a "truly partnership relation".

Communications occur at many levels and across many functions of the customer and supplier organizations, requiring a high level of internal coordination and a new role for the sales function. When the focus is on transactions, the salesperson is pivotal and the emphasis is on persuading the customer through features, price, terms, and maintaining a presence. The sales function adopts a very different -- and possibly subordinate -- role in a collaborative relationship. It is responsible for coordinating other functions, anticipating needs, demonstrating responsiveness, and building credibility and trust.

Exhibit 6.3
Value Orientation Frame

More Interest in relationship	**Relationship-oriented** - Advice -Knowledge of customer and company -Problem finding and solving -Close working relation	**Partnership-oriented** -Long-term, mutually beneficial partnership (an in-depth relationship and well-managed information)
Less interest in relationship	**Transaction-oriented** -Price -convenience -quality product -product knowledge	**Information-oriented** -Education on products -Information about your business -synthesis of complex information
	Less interest in Information	More interest in information

Source: Whiteley and Hessan, 1996.

Providing total solution does not mean necessarily providing the lowest cost or the best product; it means providing the right product and service to fulfill the customer's needs exactly. This process requires tremendous effort to understand and solve customer problems on an ongoing basis.

To become truly attuned to the customer, a company must offer expertise that drives client performance; a willingness to share the client's risk; and real, meaningful tailoring and customization of products and services, not useless value-added service (Treacy & Wiersema, 1995).

Is your firm capable of providing "total customer solutions"?

The most distinctive features of customer-driven organizations are their ability to sense the market, and customer linking capabilities. A comprehensive change program aimed at enhancing these capabilities includes:

- the diagnosis of current capabilities,
- anticipation of future needs for capabilities,
- bottom-up redesign of underlying processes,
- top-down direction and commitment,
- creative use of information technology,
- continuous monitoring of progress. (Day, 1994)

Once again, people play a key role in the process of linkage with customers. The trend of decentralization and the elimination of layers in organizations have contributed to a closer relationship with clients at different levels in the organization. The concept of horizontal or flat organizations rather than hierarchical organizations has helped to accelerate the process of decision making, providing firms with a flawless organizational device for immediately reacting to customers' requirements. In addition, firms should realize the importance of ***empowerment*** and the crucial role of people at the front line. Those people have to devote a large part of their time to understanding the customer's business and, consequently, to be ready to deliver immediate responses to them. To some extent, those people work as a "consultant", providing advice, recommendations and technical support.

Following a total customer solution brings not only a lock-in situation with some clients but also allows the company to spread the knowledge of each account team throughout the organization. As is the case in many consultant firm, building a knowledge infrastructure is a key decision in the process of leveraging learning within the firm.

Specifically, as we will discuss in later chapters, some steel producers undertake business with a highly demanding automaker sector not because it is a largely profitable segment but because those enormous efforts to provide product and process development can be subsequently spread over the rest of the products, thereby enhancing the market penetration in others segments.

Suppliers must be prepared to develop team-based mechanisms for continually exchanging information about needs, problems, and emerging requirements and then taking action. In a successful collaborative relationship, joint problem solving displaces negotiations. Suppliers must also be prepared to participate in the customer's development processes, even before the product specifications are established. This is also particularly true in the new trend in the steel-auto industry relationships where steelmakers are now involved in the early stage of design, working in teams to achieve a "win-win" solution.

In addition, new management processes are needed for (1) joint production planning and scheduling, (2) management of information system links so each knows the other's requirements and status and orders can be communicated electronically, and (3) mutual commitments to the improvement of quality and reliability.

6.2 LTV CORPORATION: APPLYING THE TOTAL CUSTOMER SOLUTION APPROACH

As noted in Chapter Four, LTV pursues a total customer solution in the high end of the market. During our visit to LTV's headquarters, we interviewed James F. Haeck, Senior Vice President, Commercial; Eric W. Evans, General Manager, Strategic Planning and

Business Development; A. Cole Tremain, Vice President, Industrial Relations and Public Affairs; Frank Altimore, Director of Business Process Re-design Program; George T. Henning, Vice President & Controller; Frank E. Filipovits, General Manager, Human Resources; and Ron Minor, Director of Product Development.

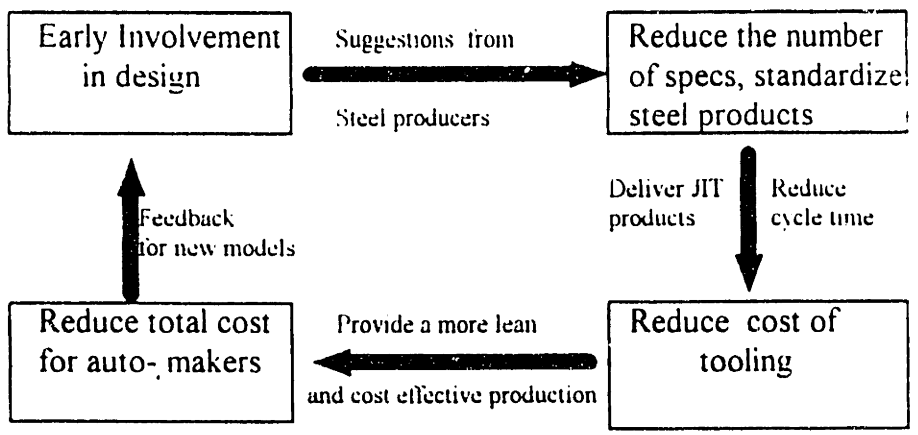
According to Mr. Haeck, LTV is actually involved in a process of providing total customer solutions, particularly to the automotive industry. To achieve this specific capability, the firm has implemented an Automotive Development Group. The group works with auto company engineers in what is called "early involvement" in the process design. The group aims to help auto engineers determine the kind of materials needed, the chemistries involved, and thickness specifications. Along the way, LTV will design and manufacture the parts that exactly fit their requirements at the lowest possible cost.

LTV's entire approach to the automotive industry goes beyond early involvement in the process design. LTV has full-time staff in some of the carmaker's plants since they understand that the customer facility is where they need to work in order to truly develop customer familiarity. In doing so, they will be able to react immediately to any problem that involves the use of steel in the production process.

LTV owns a technology center in Cleveland, about ten miles from its headquarters. This technology center has state-of-the-art equipment as well as a group of research engineers who are working to come up with new lighter, high-strength steels for automakers. LTV has special rooms called green rooms, where engineers can put a fender with special lights and equipment can detect any imperfection that is not captured with the human eye.

These are strong technical relationships with the automotive companies. Such early involvement (EI) (see Exhibit 6.4) means that if LTV receives an order for a part early, the automakers will get back the most cost-effective, dent-resistant, uniform part that can be engineered. Additionally, the tooling will be the most cost-effective, and the launch will be the most trouble-free.

Exhibit 6.4
Cycle of Early Involvement



Source: Authors

The total customer solution approach at LTV means that they want to be viewed by their customers as a problem-solving firm with the capabilities in place needed to become a real partner in the product design. This contemplates the concept of working with the automakers to come up with new uses of materials as oppose to "order taking" in the sense that the automakers would come to LTV and say "we need something different".

This process does not necessarily spur new product development; rather, it serves to enhance the application of the right products to the right solution. As was remarked by Frank Altimore, the current business process redesign is a two-dimension program aimed

at enhancing customer intimacy as well as becoming a low-cost producer. In doing so, they are working mainly to add value to the customers by reducing cycle time, reducing inventory, managing the supply chain more efficiently, reducing the response time to inquiries, etc.

Another aspect of this reengineering process is internal streamlining of processes, internal inventory reduction, and relocation of processes from the standpoint of the cross-functional process view. As an example, the inquiry process in LTV used to take from one day to two weeks and involved fourteen hand-offs among several departments. Now, they are implementing a single point of focus, a kind of "one-stop shopping" where the customer can call and receive an immediate response to any issue, including scheduling an order, quality of the material that was ordered, quantities, credit check, etc. To do that, LTV provides the new customer service representatives with the information technology that supports the needed data to be able to provide an accurate response. This is an example of improvement in the operational effectiveness of the firm rather than a total customer solution. However, we believe it fits in this discussion since it represents a clear change in the mindset of integrated producers toward a more customer-oriented approach.

Another aspect that contributes to the delivery of total customer solutions from LTV is its Technology Center. The Center combines the operations of the Customer Technical Center (CTC), the Product and Process Development Groups, and Development Engineering into a single location. The objective of these groups is to provide timely and effective responses to ever-increasing customer requirements. The groups work cooperatively to identify opportunities for LTV Steel customers to take best advantage of the company's engineered steel products. They also develop and implement new and improved value-

added steel products, and new and improved processes and facilities to produce those value-added products. Many synergistic benefits result from the intermingling of these groups in a single location.

LTV Steel's Research and Development organization has developed tailored products according to individual customers' needs. The most relevant example is the case of the bake-hardenables. Bake-hardenables are an all-new range of drawing-quality (DQ) products that were not available ten years ago, before producers installed vacuum degassing (VD). Today, each bake-hardenable product is tailored to specific bake-hardening requirements.

As the term suggests, bake-hardenable steels become harder, thus more dent-resistant, when the car is baked after painting. This occurs because free carbon in the steel becomes bound up in the steel matrix during the final heat treat; this makes further deformation of the material more difficult. The precise control of carbon and nitrogen in the steel is not possible without VD.

Although Ron Miner recognized these are not really new products or technologies, LTV took advantage of them in targeting a specific customer need. The implementation of vacuum degassing has dramatically changed the qualities of deep-drawing that could be developed. LTV product developers look at those VD products as new products from the point of view of what they can do for their customers.

Some new developments in automotive steels have carried over to other sheet markets. LTV often takes advantage of developments in the automotive area and applies them in the appliance area as well. Many improvements in strength and ductility in automotive steel translates readily to appliances.

Distribution at LTV

Unlike British Steel, LTV does not have its own service centers. The role of service centers is very important in the process of customer targeting since these firms provide further processing, primarily cut to length for end-users. From our point of view, this represent a weakness for LTV that should be addressed in the near future in order to remain as a competitive supplier for the highly demanding auto industry. However, it is noteworthy that LTV's CEO mentioned that downstream integration with service centers is one of the strategic decisions that is currently under consideration.

6.3 BRITISH STEEL: AN ENHANCED VIEW OF CUSTOMER TARGETING

In our visit to British Steel headquarters in London, we interviewed Jeffrey Edington, Director of Technology; E. Denham, Director of Corporate Planning; Paurick Doolan, Director of Suppliers & Transport; A. Morris, Manager of Supplies Planning and Transport; Michael Robson, Director Commercial & International; Andrew Page, Director of Coated Products; and Nick Balliger, Head of Technology Strategy.

In the process of providing total customer solutions, British Steel defines its strategy as two-fold. First, they are pursuing ***early involvement*** in the design of cars, and second, they have been applying the concept of "***supplier-driven partnerships***", in which a large supplier seeks to initiate and establish a partnership-style relationship with much smaller

customers. Additionally, as will be discussed in the next chapter, the core of British Steel's business is Technology.

According to Mr. Edington, the company is "world-competitive on costs, world-competitive on quality, and world-competitive on technology." Thus, the company has gone beyond simply catching up with the competition -- which makes British Steel's prognosis considerably more encouraging.

Approximately 900 people work in R&D, keeping in mind a powerful philosophy: to *develop products with customers*, focused on technology and the marketplace, and to *buy process technology* and get more out of it than anybody else. British Steel is looking for ways in which, working in partnership with customers, it can cut inventory, reduce costs, and improve service in a search for "win-win" solutions

British Steel has established an Automotive Engineering Group to increase the company's support for vehicle and component manufacturers. The group is based in Coventry and initially employed 30 people. According to Dr. Edington, British Steel knows that the car industry is important to it, since that industry represents about 20% of British Steel's total business. They want to be the supplier of choice and therefore its commitment is to continually improve its performance. The Automotive Engineering Group is a key step in achieving this goal.

The automotive engineering group also aims to:

- work with customers to make better use of steel and develop new steels for forthcoming vehicle and components projects;
- research forward-looking technologies to help shape the future of cars;

- develop 5-year and 10-year horizons for British Steel's motor industry materials development program.

Another example of customer targeting by British Steel is the development of ***supplier-driven partnerships***. In recognizing the structural changes occurring within the automotive supply chain which are placing significantly increased responsibilities on its indirect presswork customers, British Steel has taken the strategic decision to develop a partnership program to support them -- a step that could benefit the whole automotive supply chain.[1]

The principal changes occurring in the supply chain of the automotive industry are a reduction in the number of direct suppliers, an increase in work that is outsourced, and the perception that first-tier suppliers need to become system providers, capable of designing and integrating products despite ever-decreasing lead times. Therefore, coordination among participants of the value chain is essential in order to accomplish lean manufacturing. British Steel decided to provide assistance to automotive presswork companies to improve their overall competitiveness and strength. The partnership strategy began with a range of related initiatives which concentrate on commercial and technical support to selected customers, such as:

a) Supplier days
b) Specialist supplier day
c) Finite element analysis
d) Early vendor involvement
e) Support activities.

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[1] Information for portions of this section was excerpted from the *European Journal & Supply Management*, Vol 2, No 4, 1996.

(a) Supplier Days. A separate "Supplier Day" is organized for each individual customer. In this event, the customer (i.e., a presswork firm) outlines its organization as well presents a general discussion of supply chain issues. In addition, the customer takes a tour of the steel production facilities to gain a better understanding of British Steel's current capabilities. The day ends with a round-up session, where follow-up actions are agreed for any specific issue that may have arisen.

(b) Specialist supplier days are arranged with customers in order to cover specific topics of particular interest. This occasion provides a unique opportunity to discuss practical experiences in a particular area.

(c) Finite element analysis (FEA) is a key technology for reducing up-front development costs and lead times with specific reference to material performance in the press, and optimizing material specifications and blank shapes in advance of tool completion.

(d) Early Vendor Involvement. Since experience has shown that up to 80% of the cost of a part is determined by the design, British Steel actively promotes and supports the involvement of the material supplier at the design stage of any part. Part of this process includes the proving and trial of new technologies, such as laser welding and the computerized modeling of parts using FEA.

(e) Support Activities. British Steel also provides advice and support for operational and strategic issues such as cost-down initiatives and supply chain management issues. Among the current areas of focus, we believe some of the more valuable are supply chain mapping, stock reduction, joint cost-down teams, etc.

By working in partnership it is possible to reduce the total inventory held in the chain through a better understanding of the demand pattern. British Steel also pursues the reduction of lead time through implementing pipeline supply arrangements that work on the basis of continuous replenishment. In addition, opportunities exist for material optimization that can have a significant impact on the final product cost.

Hence, this partnership approach tend to provide a "win-win" solution in which British Steel retains existing business and grows with the customer while the presswork firm gains access to a host of technical and commercial resources that would not be cost-effective to duplicate at the company level.

As in every kind of partnership, building trust among the participants is a colossal task that must be undertaken from the outset.

This view of teaming up with customers is certainly a new concept of cooperation among the players of the value chain. As noted earlier, this supplier-driven partnership is a clear example of customer targeting where the purpose is to focus on ***customer economics*** rather than as a simple order-taker. Additionally, the potential for partnership should be viewed not only as a one-to-one relationship between two companies, but as an opportunity for all elements of the supply chain to work together to eliminate waste.

6.4 COOPERATIVE CUSTOMER TARGETING: THE ULTRALIGHT STEEL AUTO BODY PROJECT

The steel industry is developing an unprecedented project which contemplates the development of a very light-weight steel-bodied automobile. The project aims to develop

a lightweight steel car structure that will meet a wide range of performance targets. By reducing the car's weight, less fuel is consumed and less emissions are produced, thereby helping the steel industry maintain its grip on the auto body market against the encroachment of potential lightweight aluminum body competitors. Jointly undertaken by 32 steel companies in 15 countries, the study was conducted by Porsche Engineering Services, Inc., a U.S. unit of Porsche AG.

The member companies of the consortium are:

Argentina: SIDERAR S.A.I.C.; Australia: BHP Steel; Austria: VOEST-ALPINE STAHL LINZ GmbH; Belgium: Cockerill Sambre, S.A., SIDMAR N. V.; Brazil: CSN, USIMINAS (Usinas Siderugicas de Minas Gerais S. A.); Canada: Dofasco Inc., Stelco Inc.; France: SOLLAC (Usinor Sacilor); Germany: Krupp Hoesch Stahl AG / Krupp Hoesch Automotive GmbH, Preussag Stahl AG, Thyssen Stahl AG; India: The Tata Iron and Steel Company Ltd.; Japan: Kawasaki Steel Corporation, Kobe Steel Ltd., Nippon Steel Corporation, NKK Corporation, Sumitomo Metal Industries Ltd.; Korea: Pohang Iron and Steel Co. Ltd. (POSCO); Netherlands: Koninklijke Hoogovens N.V.; Spain: CSI Corporacion Siderurgica; Sweden: SSAB Tunnplat AB; United Kingdom: ***British Steel plc***; United States: AK Steel Corporation, Bethlehem Steel Corporation, Inland Steel Company, ***LTV Steel Company***, National Steel Company, Rouge Steel Company, U. S. Steel Group - USX Corporation, WCI Steel, Inc., Weirton Steel Corporation.

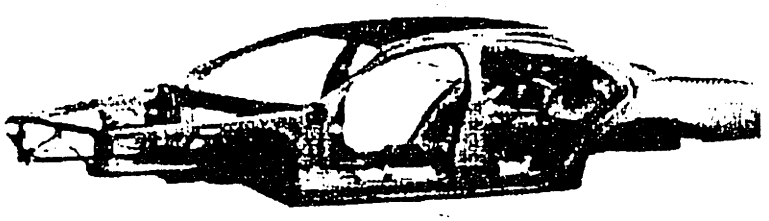
6.4.1 The Challenge of the UltraLight Steel Auto Body Study[2]

The real challenge of reducing vehicular weight to meet stringent regulations as well as customers' performance demands, is to slash weight without sacrificing performance, affordability, recyclability, safety, and durability.

The challenge was to design a very tight, neat package with minimal outer space, maximum inside, usable space, that is comfortable and efficient in performance with all of the nice features consumers want. This approach focused on design, analysis, materials and manufacturing processes.

To accomplish this, seasoned car designer, Porsche Engineering, began with a clean sheet of paper, a luxury most automotive engineers do not enjoy in today's automotive industry. Previous studies to reduce the weight of the automotive steel body have been based on optimizing an existing vehicle. For this project, Porsche Engineering brought together a group of free-thinking, open-minded engineers to design a unique auto body from scratch.

Ultralight steel body - Phase 1



2 Portions of this section were excerpted from IISI, "Ultralight steel auto body", Press Release, 1995.

The first step in the ULSAB program was to define the basic package of the vehicle. Benchmarking and target setting were done by compiling available statistics of world vehicles in the mid-size sedan segment. From these data, Porsche engineers computed a "current reference average," a good representation of the mid-size class. For example, the weight of the current reference average body-in-white is 271 kg.

Forecasting what natural improvements could be accomplished, a "future reference" was computed for mass, torsional, and bending rigidity versus mass, and normal mode frequency. ULSAB strove to exceed a target mass more aggressive than this future reference with a goal of 200 kg, while maintaining rigidity and crash performance.

After defining the baseline unibody (body-in-white), the specs were taken as far as possible to achieve a baseline of 229 kg. Porsche engineers also investigated other approaches including a steel spaceframe and a hydroform intensive body structure that might take advantage of tubular hydroforming technology. The spaceframe was rejected early in the process because it required too many design and package compromises to be mass-efficient. The hydroform intensive body structure incorporated innovative concepts but also fell short of the mass target.

In the end, the ULSAB incorporated select hydroformed parts into a unibody design. The task now became to take the hybrid unibody design and iterate it to improve its efficiency and its performance and to bring the weight down.

Credibility

Credibility was essential to the project, with engineers striving to achieve optimal goals with state-of-the-art and near-term-reach technology and advanced manufacturing processes and materials. Numerous proposals were examined and tested to improve the efficiency of the structure, and an efficient design to gain maximum rigidity out of a given amount of material. If a proposal was tried on the model and improved rigidity dramatically, engineers would re-optimize the structure and remove mass from the model. If it did not, the idea was dropped and replaced with another.

The final model used hydroforming, laser welding, spot welding, tailor-welded blanking, and roll forming -- all technology, manufacturing processes, and materials available in automotive plants today.

In the study, hydroforming was considered for a greater number of major parts of the structure. But, while it was feasible, the team of engineers found it was not practical in a high-volume scenario. So the final model incorporates a smaller number of hydroformed parts.

No Cost Penalties

Carmakers often must pay a premium to achieve less vehicular weight. This study proved just the opposite. The ULSAB actually saves money. Steel is virtually the most inexpensive material available for vehicle manufacturing today. Steel has a proven track record with automakers, being the material of choice for almost a century. And steel is still the only vehicle material that is fully recyclable via a well-established infrastructure. Once the body-in-white weight is reduced, other components that go into a vehicle can be

downsized -- a smaller engine, lighter brakes, suspension, tires and wheels (secondary weight savings).

The result was a body weighing 205 kg but with stiffness well in excess of anything on the road today, with good crash performance in computer simulations. Although this was 5 kg outside the weight target, it was decided that it represented a better overall solution than would be achieved by attempting to shave off the last few kilograms at the expense of rigidity.

This project represents a combination of two adaptive processes, ***innovation*** and ***customer targeting***. New technologies played a critical role in achieving the weight reduction. Consequently, innovation as a means of bringing a new concept to market was certainly emphasized by the steel producers who undertook this project. Furthermore, the goal of this project was to provide a customer solution to the automotive industry that would be benefited by total cost reductions. Additionally, steel producers pursued a clear goal, i.e., to remain as one of the first-tier suppliers to this demanding industry while trying to lock-out their main competitors, plastics and aluminum.

6.5 SUMMARY

This project describes a tremendous transformation in the mindset of steel producers (mainly integrated) who understood the dramatic changes occurring in the industry and were willing to focus their efforts on a ***high-tech-customer-driven*** approach. We recognize that this change of perception on the part of the steel business is an important step toward a

more competitive industry. However, this is only the starting point. Therefore, in Chapter Eight we will recommend a set of actions that steel producers should seriously consider in order to regain strength as an industry and to lead the process of change in an even more competitive environment.

CHAPTER SEVEN

ADAPTIVE PROCESS - INNOVATION

7.1 INTRODUCTION

The purpose of the chapter is to understand how ***Innovation as an Adaptive Process*** will play a major role in the future of the steel industry. Innovation in process development will help to increase Operational Effectiveness, and innovation in product development will help to increase Customer Targeting.

We will show how proposals deriving from the Adaptive Management Framework can be put into practice, and then we will review the basics of innovation in the steel industry. First, we will present innovation as an adaptive process to support product development and then improve total customer solutions and systems lock-in positions. Second, we will comment on fascinating examples of innovations that might give managers an entirely new perspective on finding solutions to these issues. Finally, we will introduce Utterback's (1994) and then Christensen's (1996) views of innovation to provide a framework for innovation in thin-slab technology from the equipment supplier's standpoint and we will depict the struggle to become a dominant designer of this technology.

Although it is widely accepted that technology and strategy must be closely integrated in any business, the examples we will present in this chapter show how increasingly important this linkage will be in the near future of the steel industry. Product

development will be a key in developing a combination of better steels and systems solutions that meet consumer needs. Steel companies must help design their material into consumer products to improve performance, simplify manufacturing, and improve reliability. It is this type of approach that will create demand for industry products and support and maintain industry profitability.

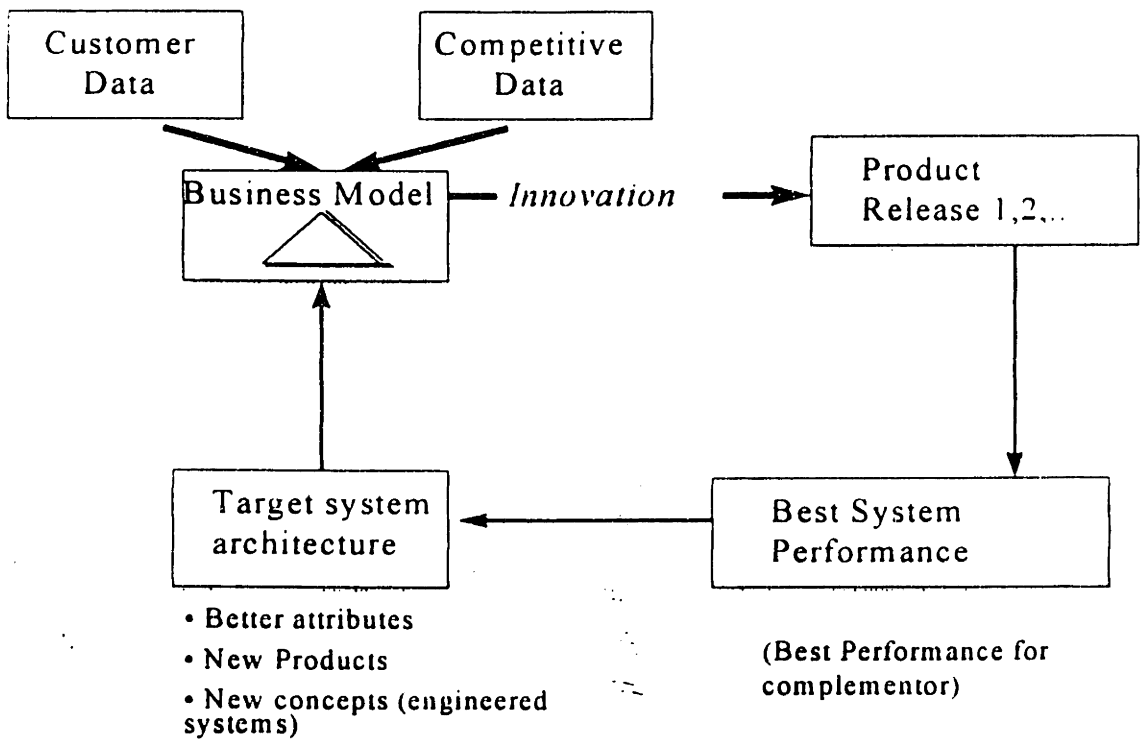
7.2 INNOVATION AS AN ADAPTIVE PROCESS

As we discussed in Chapter One, the steel industry is currently undergoing a fascinating evolution that is equally affecting the processes, products, and steel system itself. This evolution is encouraging the emergence of new standards and new businesses. Steel companies have to monitor these trends and act accordingly to prevent loss of competitiveness. In this section we will explore the most innovative trends in the business, especially what some people in the industry called "engineered systems". Companies such as British Steel and Thyssen want to ensure that steel will continue to be part of the most profitable applications: automobiles, buildings, appliances and containers. We will see how these companies are positioning themselves and how they are investing in R&D in order to achieve that strategic goal.

Independent of the steelmaking technologies a company utilizes, Exhibit 7.1 shows (based on the Adaptive Management Framework view of Innovation) how strategy (i.e., the business model) and execution are linked through innovation. In the short term, new product development is a key to assure any company's competitiveness in an ever-increasing

customer needs scenario. In the long term, managers need to closely screen the evolution of new process technologies as well as invest in new R&D applications that create not only a defense mechanism against potential substitutes but also an increase in systems share (i.e., steel replacing concrete in building construction). We will focus on examples of adaptive processes related to systems because we consider it is the least studied of all that we encountered in our literature research, and because it is one of the main contributions that the Adaptive Management Framework can provide in this field.

Exhibit 7.1
Strategy and Execution: Linked by Innovation



Source: Hax and Wilde, 1996

During our research we had two key interviews that revealed the concept of innovation as seen from a systems perspective. At Arthur D. Little headquarters, John Lichtenstein shared his impressions about Budd Co. as an example of a system coordinator in the automobile industry. When visiting British Steel headquarters we realized that these concepts were not only present in most executives' minds but also in real applications in the building and container industries.

We will begin by summarizing British Steel's rethinking of the industry according to their pioneer, Dr. Jeff Edington, who is Executive Director for Technology. At this point it is noteworthy to mention that other companies like Nippon Steel and Usinor-Sacilor are also examples of excellence in this dimension of strategic vision. But we think one example will suffice to help the reader understand how systems lock-in may be applied in the steel industry. We chose British Steel simply because we thought it would be easier for us to have access to this company.

7.3 NEW THINKING AT BRITISH STEEL

In October 1994, at the annual International Iron and Steel Institute conference, some 350 executives from the world's big steelmakers had the opportunity to view some interesting slides brought along by their colleague, Jeff Edington. In these slides Edington showed conference delegates the wings from a Hawker Harrier jump jet fighter and the tail fin of an Airbus 330.

In both cases, carbon fiber (a composite material that is competing head to head with both steel and aluminum) had replaced aluminum as the material used for construction. Edington's point was that steel, the world's most versatile structural material, has no automatic right to its position in the marketplace. Edington said at that occasion,

> Our product is a low-cost, highly sophisticated material with a lot of development potential left in it. The market is ours to lose. If we lose it, we can only blame ourselves for lack of technical and business creativity and innovation. (*Financial Times*, 10/20/94)

Success in the marketplace is the key measure of the viability of the industry. Steel is a major material in the automotive, construction, packaging, industrial plant and mechanical engineering markets. Development of new steels for all of these markets has been extremely successful. For example, more than half of the steel used in cars built in Europe today was invented in the last five years, according to Edington.

Although British Steel is still undergoing a major mind-set shift from production-led to market-led, we found Edington's concepts had spread into the minds of many of our interviewees. Particularly in our meetings with Edington himself and with Ted Denham, Director of Corporate Planning; Nick Balliger, Head of Technology Strategy; Michael Robson, Director, Commercial & International; and Patrick Doolan, Director, Supplies & Transport.

We will begin by discussing examples of innovation that make British Steel a pioneer in System Lock-in Strategy. We will also comment on Budd Co.'s example in the automobile industry for its relevance to the analysis. Finally, we will provide examples of new technologies that will bring opportunities to create further system lock-ins.

7.3.1 The Building Industry -- Fast Track Slimflor[1]

The building sector is an area where the British Steel Marketing Department has been especially proactive. As a result of World War II, concrete emerged as the dominant material for building, since steel production was totally channeled into military activities. British Steel recognized there was a tremendous opportunity in this market. It also recognized inefficiencies in building the floors in steel buildings, so the company began developing potential new solutions. British Steel grew in market share from 0 in 1970 to more than 60% in 1995 in multi-story building construction, and there are even larger opportunities for expansion into the rest of Europe.

The competing construction materials for commercial and single story industrial buildings are steel and concrete. Over the last decade, competition has been based on a combination of cost and fire resistance and, within the European Union, the steel industry has been most effective in gaining market share in Britain. Here steel costs have been relentlessly driven down to the lowest in Europe.

Competition is now moving toward producing effective and low-cost mechanical and electrical services. Many large buildings are highly serviced with the mechanical and electrical installation accounting for 40% of the cost of an office block and 80% of a laboratory building. This compares with 10% for the building frame, so the basis of steel's contribution must be to offer a low-cost system with services that will have flexible use and easy access for maintenance or modification throughout the life of the building.

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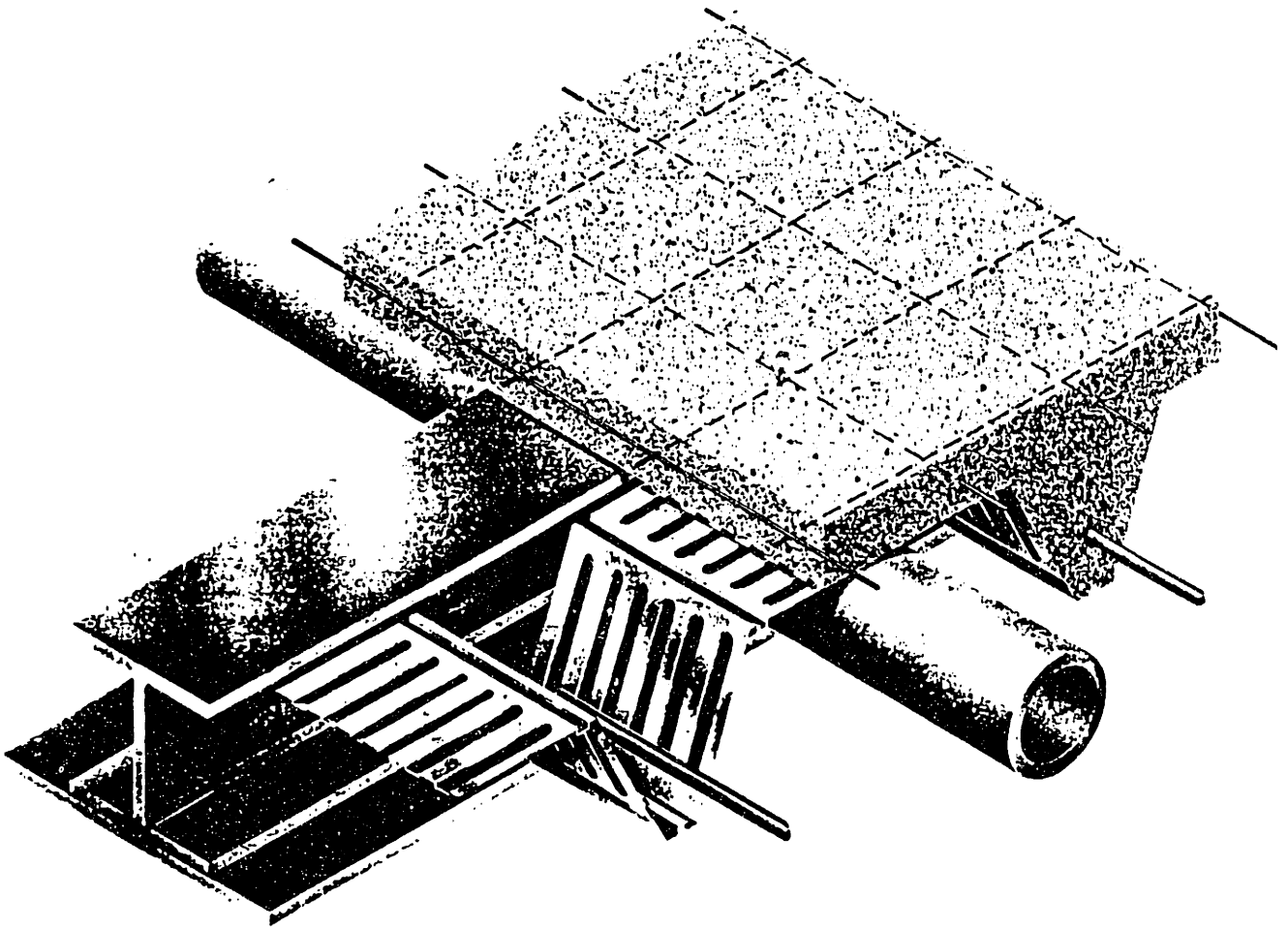
[1] Information for portions of this section was excerpted from Edington, 1995.

British Steel, supported by the Steel Construction Institute, has developed a series of new building systems that address these issues. The design is based on an asymmetric beam that supports a profiled steel deck that incorporates a poured reinforced concrete floor. Services run through a tube which can be directly accessed from the ceiling of the room beneath. The product is known as "Slimflor" (see Exhibit 7.2).

From the consumer's point of view, the system offers several advantages. For example, for the same floor area, the height of the building is 10% less, reducing operating costs for both the mechanical and electrical systems. Furthermore, because there are no

Exhibit 7.2
Fast Track Slimflor



service obstructions so room partitioning can be moved easily to provide maximum flexibility. In addition, easy access to the services ensures less expensive maintenance and upgrading if the building use changes.

Fire tests have shown that protection of the steelwork is not normally required for up to one hour of fire resistance and longer periods can be achieved by protecting only the bottom flange of the asymmetric beam. Approximately 50 buildings with Slimflor have been completed in the last four years.

From a manufacturing point of view, advances include development of a new rolling technique to produce the asymmetric beam as well as innovative assembly techniques that speed construction and increase site safety.

In the future, competition is likely to include ease of dismantling and reuse of the building components at the end of its life. Here steel structures already have an advantage over concrete and will be further enhanced with a modular construction approach.

Other Developments in the Building Industry

Another development is the increasing use of concrete-filled hollow section columns for fire resistance. This enables architects to minimize the number of column and increase usable floor area while providing a slim structure which can be left exposed. Further developments in fire engineering are expected from the BRE Facility at Cardington where a full-scale eight-story building is being tested.

A major bonus offered by steel is its post-construction flexibility. Sections can be measured to confirm capacities and easily strengthened, added to, or cut to suit new requirements or refurbishment. Long clear spans that provide more flexibility in internal layouts can be achieved economically.

Structural hollow sections (SHS) allow architects and engineers to express the structural frame freely, frequently in combination with glass. Site connections in SHS are made easier -- and neater -- by the Flowdrill thermal drilling and roll tapping system which facilitates direct site bolting into the SHS and cuts out shop-welded cleats.

Another major development with tremendous potential is Double Skin Composite Construction, which consists of two steel plates held apart and filled with concrete. A continuing high level of capital investment by British Steel and UK steel fabricators has produced a modern, computer-integrated industry. Just-In-Time manufacturing techniques contribute to even faster construction of the steel structure.

New forms of construction, as yet unimagined, may develop in the years ahead. But steel is a dynamic material and making it available in every possible way, continues to be reflected throughout the industry, which means that structural steel will have a major role to play well into the new millennium.

7.4 THYSSEN/BUDD AUTOMOTIVE[2]

Because of the huge buying power that automakers exert, the automotive sector is the segment where steelmakers need to put most of their efforts. This pressure can, and should, lead to continuous product innovation. As we saw in the previous chapter most of these innovations are in the shape of product tailoring. What is not so common is innovation in the shape of systems solutions. When creating its Automotive Group, British

[2] Information for portions of this section was excerpted from *American Metal Market*, 1996.

Steel internally set a short-term objective to develop effective and efficient solutions for carmaking applications. However, the company also set a long-term strategic goal to be a system provider in the automotive sector. Furthermore, the UK-based company understood they will need to acquire expertise in other materials such as plastic, composites, and even aluminum.

As a result of our meetings with John Lichtenstein, he suggested that we look at Thyssen/Budd Automotive as an example of a company that combines different materials to deliver system solutions.

Thyssen's automotive marketing is focused along the lines of cooperation as demonstrated by a now year-old program combining the forces of Budd Co. in the U.S. with several units of Thyssen Industrie in Germany. At the Frankfurt International Auto Show in September 1995, the company introduced that form of cooperation as the creation of a "virtual company" intended to coordinate the automotive marketing efforts of all three Thyssen business sectors -- capital and manufactured products, trading and services, and steel -- which are involved in automotive markets.

The "alliance" called Thyssen/Budd Automotive includes:

- Budd Co., a maker of stamping and frame products plastic products, cast products and other manufactured products, accounting for $1.6 billion of the new unit's $2.8 billion in sales in 19930-94;
- Thyssen Guss AG, Mulheim, Germany, a maker of castings and other automotive components;
- Thyssen Umformtechnik GmbH, Remscheid, Germany, a maker of precision-forged machine parts and sheet-metal formed parts; and

- Nothelfer, which makes bodies, chassis, powertrain parts, and special tooling.

In 1993-94, Thyssen/Budd Automotive accounted for 63% of Thyssen's sales to the automotive industry, with 22% coming from Thyssen Stahl AG and 15% coming from other companies, including Thyssen Handelsunion AG and other Thyssen Industrie AG units.

The strategic formation of Thyssen/Budd Automotive is intended to integrate the expertise accumulated at The Budd Company and within the Thyssen Group. More important, the unit aims to establish systems capability, integrate engineering capacities, and improve the company's competitive position in the auto industry.

Thyssen/Budd Automotive's product emphasis is on steel stampings and assemblies for bodies and chassis; sheet molding compound plastic body parts, cast parts such as crankshafts, powertrains, and suspension components in iron and aluminum; and forgings such as crankshafts and transmission parts. This unit is also seamlessly integrated with customers since Thyssen/Budd Automotive's specialties is also involved in simultaneous engineering.

Thyssen/Budd Automotive integrates all of the automotive vendor operations concentrating on expertise in components, assemblies, product and process development, because these are decisive in planning new models by automotive manufacturers.

The group of Thyssen/Budd companies is now in a position to apply their combined experience to meet their customers' needs on a global basis. The multi-media research, design, and process knowledge of the group of Thyssen/Budd companies aids automotive customers in developing higher-quality, fuel-efficient vehicles. So far, Thyssen/Budd Automotive seems to be oriented to provide systems to their increasingly demanding

customers. It is still too early to see how much further they will push their strategic thinking, as British Steel has already done, toward a system lock-in strategy.

7.5 THE CONTAINER INDUSTRY AND BEVERAGE CANS[3]

Packaging is a $570 billion industry worldwide and the European Union accounts for around $170 billion. Of the materials used in consumer packaging, metals account for 28%; paper and cardboard, 28%; plastics, 30%, and glass 14% (Edington, 1995). Steel competes in the rigid packaging sector along with glass, aluminum, and plastics, and for some products, such as food cans, steel essentially has all of the market. About 16% of the $160 billion worth of metal beverage cans sold worldwide annually are made of steel. Steel has captured 55% of the drink can market in Europe and its share has been rising. However, in others, notably beverage containers, competition is extremely fierce and is based on cost and transport efficiency (the weight of the can) as well as its recyclability or re-usability. This is now moving toward differentiation that is visible on the shelf in supermarkets and so includes decoration, texture, end design, and shape.

In 1992 three major European tinplate manufacturers, British Steel, Rasselstein, and Hoogovens, began to a joint design project together with CarnaudMetalBox (now part of Crown Cork and Seal), a global can manufacturer. The objective was to reduce both the cost and weight of the can as well as to introduce a new, visibly different can end.

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3 Information for portions of this section was excerpted from Edington, 1995; Acher, 1996; and Nutting, 1996.

Consequently, like ULSAB, the design activity involved both product performance and manufacturability.

Cost and weight reduction involve reducing the thickness of the feedstock and modifying the manufacturing process. The bodies of two-piece beverage cans are manufactured by a process of drawing and wall-ironing (DWI) which involves several operations. First, cups are drawn from discs cut from a continuously fed coil of steel which are then subsequently redrawn and ironed in three steps to produce a shell that is the full height of the can. The process is very fast; each bodymaking machine operates at a rate of 250+ units/min. The lightweight can body necessitated the development of a new superclean steel, new lubricants, and design of a new DWI tool.

The first phase of the project resulted in reducing the weight of a 330 ml. can from 28g to 22g by reducing the thickness of the strip feedstock from 0.27 mm to 0.22 mm. This product is now on the market and steelmakers say that further "lightweighting" will ensure that the steel can will be the packaging choice of the future since further developments to reduce the weight to 18g are underway. (Note: an aluminum can weighs just over 11 grams.)

To differentiate the steel can, a new can end design in steel has been developed that looks different and is both easier to open and provides evidence if the product has been tampered. This "Ecotop" was originally designed by BHP and American Can but has been further developed by the consortium. It features two small buttons; pressing the smaller button releases the internal pressure, and pressing the larger button enables the drink to be poured. Both buttons stay attached to the end by a small metal hinge that remains after pressing. For this reason the metal is almost completely punctured around the periphery of

each button and only a small hinge remains. As a consequence, sharp edges around the apertures are completely eliminated. A plastisol sealant is used with any one of several different aperture designs to ensure that tampering produces an unacceptably flat drink. Combined with the lightweight body, the end is now in the Sainsbury Supermarket line under the name of "Gio" soft drinks in the UK.

Exhibit 7.3
"Gio" Soft Drink Container

This product development has contributed to increased market share for steel in Britain. In mid-1995, a number of leading brands announced a move to steel cans, reversing the earlier trend toward aluminum.

We believe that in British Steel's strategic thinking of moving toward a system lock-in strategy, there are three elements that are crucial:

1) to jointly design with customers new steel that meets customers' ever-increasing requirements;

2) to jointly invest with customers in their manufacturing lines transformation in order to adapt them to produce steel instead of aluminum; and

3) to design a customer-focused supply chain able to quickly respond to changes in label design (e.g., to help with advertising of hot sports events).

British Steel continues to work with beverage and soft-drink manufacturers across Europe, including European steelmakers Hoogovens, Rasselstein Hoesch and Sollac, to develop what they have dubbed the "Ultimate Can".

Further Improvement in Canmaking

Steelmakers must consider the container segment strategic since beverages companies have begun to explore the use of shaped cans as a means of "adding value" to their drinks, foregoing the complete emphasis on low cost. The move followed the fantastic success in 1994 of Coke's 20 oz. PET plastic bottles that were shaped like the old-fashioned,

distinctive contour glass bottles first launched in 1916 and registered as a U.S. trademark in 1977.

A prototype steel can developed by Coke was test marketed in Germany and Southeast Asia in 1994 and 1995. It was based on technology that has been used for making reformed or shaped food and beer cans for more than a decade. The new types of containers add value to the product and differentiate the company from its competition.

There is little that is new in the technology of making shaped cans. A variety of techniques, including high-pressure air, hydraulics, explosives and mechanical systems have been used to make shaped food cans in a number of markets. The difference with drinks cans is that they are much lighter and therefore more delicate, and the production processes are much faster.

Companies such as Crown Cork & Seal of the U.S. (the biggest canmaking company in the world), France's Pechiney (the biggest maker of drinks cans worldwide), and Alcoa (the world's biggest aluminum supplier), have all come up with proposals for high-speed manufacturing of contour cans. They see it as a matter of survival, even though such cans might form only a small sector of the overall market.

It is likely that a steel container could provide a better answer. Sollac, the French steel company that is part of Usinor Sacilor, has shown Coke its prototypes of cans using special steels designed for reforming. These low-carbon steels are ductile for forming, yet harden during manufacturing so they can resist the rigors of filling and distribution.

As can be seen, there is a lot of room for steelmakers to develop a system lock-in strategy in the container segment. In order to do so, steel companies need to think in terms

of the entire supply chain, and not merely in terms of the product manufactured at the mill site.

7.6 NEW PRODUCT TECHNOLOGIES[4]

Automotive applications keep improving and new and fascinating technologies continue to appear, increasing opportunities for steelmakers. We will mention two of them, Tailor-welded blanks and Hydroforming.

Tailor-welded blanks involves "tailoring" the blank so that the best attributes of steel (i.e., gauge, strength, coating, etc.) are located precisely where they are needed within the part. The benefits of tailor-welded blanks include weight reduction, i.e., putting thickness and strength only where they are needed and removing thickness or strength where they are not needed; lower manufacturing/labor costs; reduced design and development time; less material; better utilization of steel; fewer parts; fewer dies/ assembly tooling/stamping operations; fewer spot welds; improved dimensional quality; improved structural integrity; and improved safety.

A mushrooming technology, **hydroforming** is a process that starts with a straight or bent, welded, round tube that is placed into a forming die. The tube is then filled with fluid at sufficient pressure to force the tube to conform to the shape of the die cavity. As recently as fifteen years ago, it is estimated that less than 10% of steel in the typical North

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4 Information for portions of this section was excerpted from "American Iron and Steel Institute," Automotive Applications, (http://www.autosteel.org)

American-built family vehicle was tubular in form. Today those figures are closer to 15-16%, with standard- and intermediate-size vans, sport utility vehicles, pickup trucks, and rear-wheel-drive cars having the most content.

Use of hydroformed tubing results in part integration, reduced tooling cost, improved dimensional accuracy, less or negligible die wear, improved dimensional repeatability, elimination of weld flanges, reduced weight, and increased strength and stiffness.

Hydroformed tubing is ideal for car sub-frames, structural parts such as engine cradles, radiator surround/support, lower and upper longitudinal body rails, instrument panel support beams, steering column energy absorption bellows, D-pillars for station wagons, and various body cross members.

7.7 INNOVATIONS IN PROCESS DEVELOPMENT

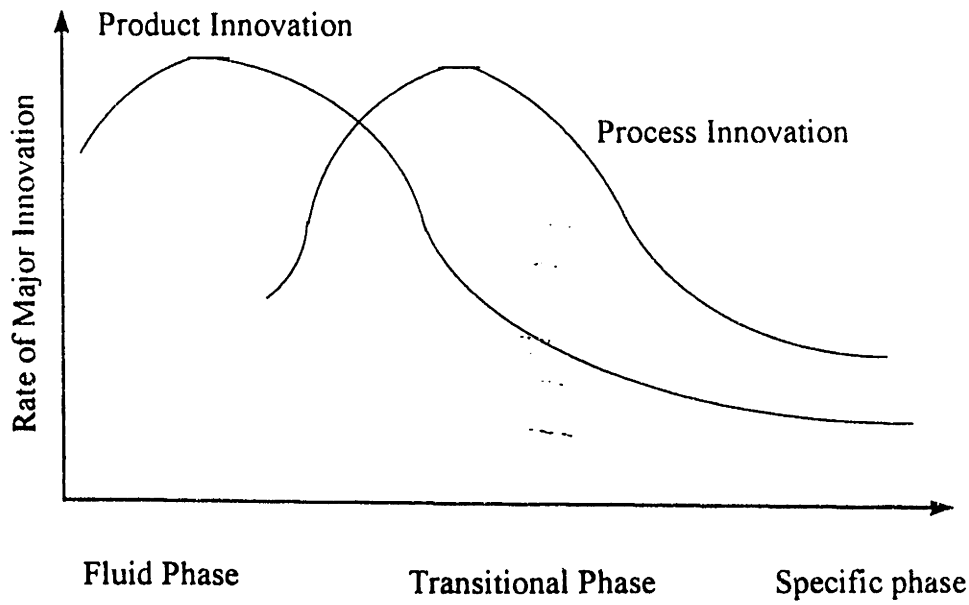
This section analyzes innovation in thin-slab technology, based on the views of Utterback (1994) and Christensen (1996). It is noteworthy to mention that from the equipment supplier's viewpoint, this chapter should be viewed as "product innovation". From the steel companies' standpoint, we should refer to this as "innovation in process". This clarification is important because it means that in our Adaptive Management Framework analysis, this type of technological innovation will primarily help steel companies to gain competitive advantage in operational effectiveness and to a lesser extent in customer targeting. Customer targeting should be the result of efforts put in product

development, which in turns relies on the metallurgical core expertise embedded in the organization.

7.7.1 The Utterback/Abernathy Model

Utterback and Abernathy (1994) developed a model that attempts to capture the interaction of technological change, organizations, and the competitive marketplace (see Exhibit 7.4). It describes how changes in product and process innovation and in organizational structure occur in patterns that are observable across industries and sectors.

Exhibit 7.4
The Dynamics of Innovation



Source: Utterback, 1994.

The model might be summarized thus far as exhibiting interdependent rates of product and process innovation over time, and these in turn are linked to important transformations in the characteristics of product, process, competition, and organization. These relationships are combined in Exhibit 7.4.

This model refers to developmental phases as a matter of analytical convenience. The phases are here called fluid, transitional, and specific. Because this is a dynamic model, these phases are associated with both the rate of innovation and the underlying dimensions of product, process, competition, and organization. In effect, these phases slice the model a different way, each cutting across those dimensions. Exhibit 7.5 shows the main characteristics governing each development phase.

Exhibit 7.5
Characteristics of Each Phase

Product	From high variety, to dominant design, to incremental innovation on standardized products.
Process	Manufacturing progresses from heavy reliance on skilled labor and general-purpose equipment to specialized equipment tended by low-skilled labor.
Organization	From entrepreneurial *organic* firm to hierarchical mechanistic firm with defined tasks and procedures and few rewards for radical innovation.
Market	From fragmented and unstable with diverse products and rapid feedback to commodity-like with largely undifferentiated products.
Competition	From many small firms with unique products to an oligopoly of firms with similar products.

Utterback described and tested his model, in both product and process innovation, in a number of industries. The patterns depicted by Utterback are repeated wave of innovation after wave of innovation. In the case of the steel industry, this model used to work well mainly because of the slow technological evolution that characterized the industry for years. Transitions from Open Hearth (1868) to Basic Oxygen Furnace (1960s) and from

Ingot Casting to Continuous Casting were clearly separated for long periods. This is not happening any more. Minimill technology has evolved from an unproven concept to an increasingly adopted technology in steel sheet making in less than a decade. As a result of the introduction of minimills, the steel industry has gone back to a transitional phase where it is still unclear what the new dominant design will be.

At present there are two established process routes to make steel, the blast furnace (BF) which produces liquid iron for refining to steel in the basic oxygen furnace (BOF), and the electric arc furnace (EAF) which remelts in-plant arising and collected merchant scrap. Although Thin-Slab seems to become the new standard, new waves of innovation are appearing here and there. New designs are rapidly evolving (i.e., ISP, Conroll, and Sumitomo) challenging SMS Schloeman-Siemag's Compact Strip Technology (CSP), widely acclaimed after implementation by Nucor. Furthermore, even before that a dominant design has appeared in thin-slab technology, and new processes are under evaluation to ultimately replace it (i.e., strip casting and spray forming). Ironmaking technology is no less dynamic than steelmaking; the evolution of both processes has accelerated dramatically as a consequence of Nucor's entrance in the flat rolled market with the CSP technology (Demidchuk, 1996).

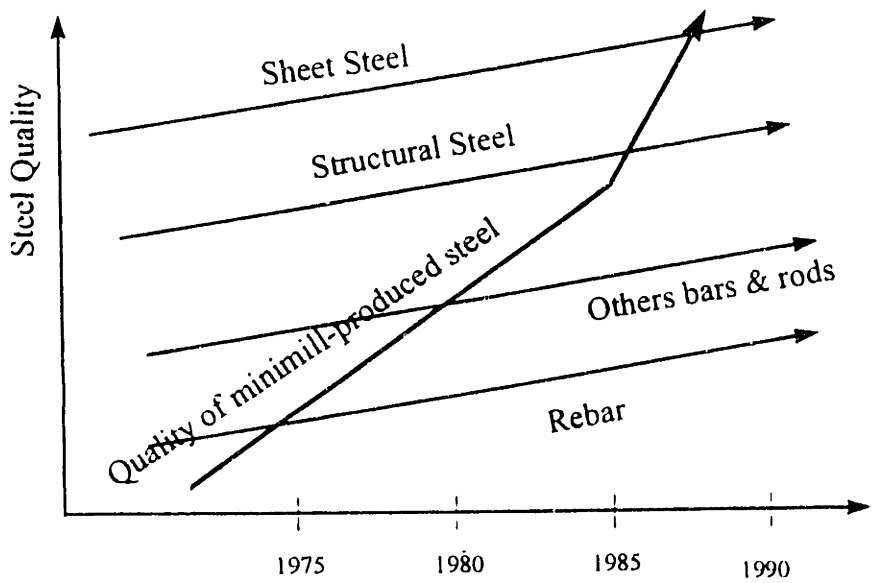
7.7.2 Christensten's Model

In his theory of Disruptive Technologies, Clayton Christensen (1996) studied how major innovations that aim to change the same architectural technology emerged after being

first commercialized in remote or emerging markets. Christensen's research gives numerous examples involving different businesses such as RISC microprocessors, desktop copiers, personal computers, portable computers, athletic footwear, etc. In the case of the steel industry, the invading minimill technology started eroding market share from the integrated mills at the low end (especially in the construction segment) and now is challenging the medium end in non-exposed auto body applications (see Exhibit 7.6).

Exhibit 7.6

The invasion of disruptive steel minimill technology into progressively more sophisticated steel markets



Source: Christensen, 1996.

New improvements in minimill technology can be expected from a better steel metallurgical composition, either through elimination of impurities present in scrap or through the diffusion of alternatives to scrap that feed electric furnaces (DRI, Iron Carbide, Corex, etc.). It is widely accepted that there is still room for improvement in steelmaking

based on EOF. Therefore minimill penetration into the high end will occur sooner or later. In the short term, minimills are also expected to replace cold-rolled steel with thin gauge hot-rolled steel for certain lower-end applications. Integrated mills do not cold-roll such gauges because is inefficient in terms of productivity (speed is constant in rolling mills).

The success of the technology itself attracts new entrants that are willing to invest in process technology in order to expand the applicability of the existing minimill scope. Equipment manufacturing companies such as Danielli, Mannesmann, Sumitomo, and SMS are working primarily focused on improving minimill technology. Integrated mills have already started to invest in minimills. LTV, British Steel, Sumitomo, Acme steel, Arvedi are companies that have already started to invest in the technology.

7.8 STRIVING FOR THE DOMINANT DESIGN[5]

As we saw in Chapter Five, SMS was the first company to commercialize its compact rolling mill process (CSP). In this process, the caster produces a slab about 50 mm (2 inches) thick. One of the breakthroughs by SMS was the design of a funnel-shaped mold which accommodated the submerged entry nozzle and allowed a much higher casting speed.

Besides the casters at the three Nucor plants (Crawfordsville, Hickman, and Berkeley), SMS has thin-slab casters in operation at Acme Steel in Riverdale, Illinois, Steel Dynamics in Butler, Indiana, Gallatin Steel in Kentucky, Hylsa in Monterey, Mexico, and

[5] Information for this section was excerpted from *World Steel Dynamics*, 1997.

Hanbo Steel in Korea. Other orders in the works include Nippon Denro Ispat in India, Aceria Compacta Bizkaia in Spain, NSM Chonburi in Thailand and ASM in Malaysia.

Although SMS is still the dominant supplier of thin-slab casting machines, other equipment manufacturers are beginning to have significant successes and they are challenging SMS's emergence as the dominant design depicted in Utterback's model. These alternative suppliers include:

- Mannesmann Demag's In-lin Strip Production (ISP) process. It casts a 60 mm thick slab which is reduced in-line in two stages: first, the slab is reduced to 40 mm by soft reduction by a set of rolls located below the mold, then the fully solidified slab is reduced to 15 mm by three shaping stands. The goal is to produce hot-rolled coil down to a thickness of 0.7 mm. A recent evolution in the process is the introduction of a rectangular mold which is said to improve surface quality. Other improvements include new very high pressure descaling technology.
- Voest-Alpine's CONROLL process casts a 75 to 125 mm slab through a straight mold and is not reduced further in the caster. The process has been tested primarily for the production of stainless steels at Avesta Sheffield in Sweden. The process has been installed at the Armco plant in Mansfield, Ohio, which casts a 3-5" slab at a rate of 3.8 net tons per minute. The slab passes through a walking beam furnace, which provides a one-hour buffer capacity, directly into the existing hot strip mill consisting of a roughing stand and six finishing stands.

- Danielli's thin slab caster casts slabs 30 to 140 mm thick through a lens-shaped curved mold. Casting speed can vary from 0.5 to 6 meters per minute. Nucor at Hickman has experimented with a Danielli caster, including the implementation of Danielli's soft shell slab reduction technology. Algoma Steel in Canada is installing a Danielli-designed thin-slab caster directly linked to a hot strip mill. A two-strand caster will produce slabs that are 70 mm (2.75") thick and 1600 mm (63") wide. Liquid core reduction will be utilized. The slabs will pass through a tunnel heating furnace and a single-pass rougher before being transferred to a six-stand finishing mill, a laminar cooling table and down coilers. Gauges down to a thickness of 1.0 mm (0.04") are possible.
- The Tippins-Samsung process (TSP) consists of a two-stand reversing hot strip mill, with coil-heating furnaces at both ends of the mill, that is tied to a caster producing a slab that is 3-6" thick. The advantage of the thicker slab is the ability to make coiled plate up to 120" wide. The typical width for hot-rolled band is 68". Capacity can range from 1.0 to 2.0 mtpy. Surface quality is good because of the slow casting speed. This also allows the production of a wide range of carbons and peritectic grades. Tippins hopes to finalize an order from Nova Hut in the Czech Republic in early 1998. The company also has a technology exchange agreement with IPSCO which is significant. The TSP process appears to have quite low capital costs (under $300 million for the complete facility) because the hot strip mill has only two stands. This also makes the plant more compact, which saves on

infrastructure. The facility has considerable flexibility to produce a wide range of coiled sheet and plate products that are high in quality which makes it well suited to be the only flat-rolling mill in a smaller developing country.

- Japanese equipment makers Sumitomo Metals, Sumitomo Heavy Industries and Mitsubishi Heavy Industries are offering a thin slab configuration that will be used at the new Trico venture in Alabama. The plant consists of two DC-EAFs with twin electrodes, two ladle metallurgy stations and two single-strand continuous casters. The slabs will be cut to a thickness of 90 mm (3.5") and reduced while there is still a liquid core to 70 mm (2.76"). The slabs are placed in a tunnel furnace which feeds a hot strip mill two roughing stands and five finishing stands. The product will be up to 65" wide. The objective is to roll some of the bands down to a thickness of 1.0 mm (0.04"). The plant will start up in the first quarter of 1997. The goal is to produce hot-rolled band at low cost and of the highest quality.
- A new technology under development is known as the Ultra Thin Hot Strip (UTHP) process. It involves the casting of a 90 mm (3.5") thick slab which is then rolled down to 4 mm by a planetary high reduction mill, followed by a four-stand finishing mill. The final strip is expected to be less than 1 mm thick, with a minimum of 0.7 mm. The companies behind this technology are Mannesman Demag and Chaparral Steel. The technology is expected to be installed at a new 600,000 tpy mill at Natsteel in Singapore.

The caster described above is based on oscillating molds to move the slab along. Another type of caster is belt casters in which a cooling belt moves along at the same speed

as the slab. The Hazlett caster, which has had some success in casting aluminum, is of this type of design. A new version in being developed by Kawasaki Steel and Hitachi. This caster can produce a 30 mm thick slab at speeds of 10 to 12.5 meters per minute, which is directly rolled without reheating. This concept is more revolutionary than the oscillating mold design.

7.9 SUMMARY

Although the idea of "***steel inside***" which we introduced in Chapter One seems to be very bold, we can see very important companies in the industry intending to position themselves in a Systems Lock-in strategy. In some ways, what companies like British Steel and Thyssen are really pursuing is coordinating a big piece of the automotive supply chain -- a move that would completely change the transaction power balance. Whether these companies will be successful in combining materials to deliver systems is not clear. These companies are committed to eliminating bottlenecks in the use of steel as Intel does to enhance the consumption of microprocessors.

In the case of Intel, eliminating bottlenecks refers to the forward push to develop complementary products (i.e., DRAMS, software) in order to allow the applicability of newer and more powerful microprocessors that Intel is continuously designing. Similarly, in the case of steel producers, bottleneck elimination means to help customers design newer products (i.e., Slimfor, shaped cans, entire systems for carmaking) and where to apply newer and more sophisticated steel products.

The Fast Track Slimflor can be defined as a virtual system since it is composed of parts manufactured in different British Steel divisions. At present a customer has to buy each piece from the corresponding division. The next step for British Steel is to assemble the whole set and to market it as a real system.

The case of the beverage container is a lesson in how complementors, in this case the same competitors (steelmakers) and customers (container manufacturers) create a system that is coordinated by the steel company that not only develops the steel to make it happen but also finances customer line modifications.

The strategic alliance of Thyssen/Budd proves that systems supplier will be increasingly a part of the future automotive supply chain. However, new challenges to expertise in the combination of different materials may be critical to success when the automakers decide to fully outsource the sub-assembly of vehicles. Budd seems to have started working in that direction and many other companies will follow their lead.

New technologies such as tailor-welded blanks and hydroforming will enhance opportunities for steelmakers to maintain themselves as a key part of the supply chain. And from the equipment suppliers' side, new developments in casting will allow steel manufacturers to increase operational effectiveness, reinforcing competitiveness.

CHAPTER EIGHT

CONCLUSIONS AND RECOMMENDATIONS

8.1 INTRODUCTION

In this chapter we will present our set of conclusions and recommendations for steel firms in today's competitive environment. First, we will start with the introduction of a high-level casual loop that can predict the evolution in competition between minimills and integrated mills. We believe this casual loop will help our readers gather the concepts introduced in the previous chapters as well as identify how the AMF contributes to strategic thinking in the steel industry.

Second, we will go back to the ideas of strategic inflection point when introducing the concept of "Industry in Transition". This model was originally developed by Hax and will be correlated with research done by John Lichtenstein, Resource Industries' Director at Arthur D. Little.

Third, we will sum up the strategic position of the three companies we have researched. By reviewing each company's strategy, we will show the importance of the linking between strategy and execution.

Finally, we will present our recommendations in three critical aspects: technology management, knowledge-based management, and compensation system.

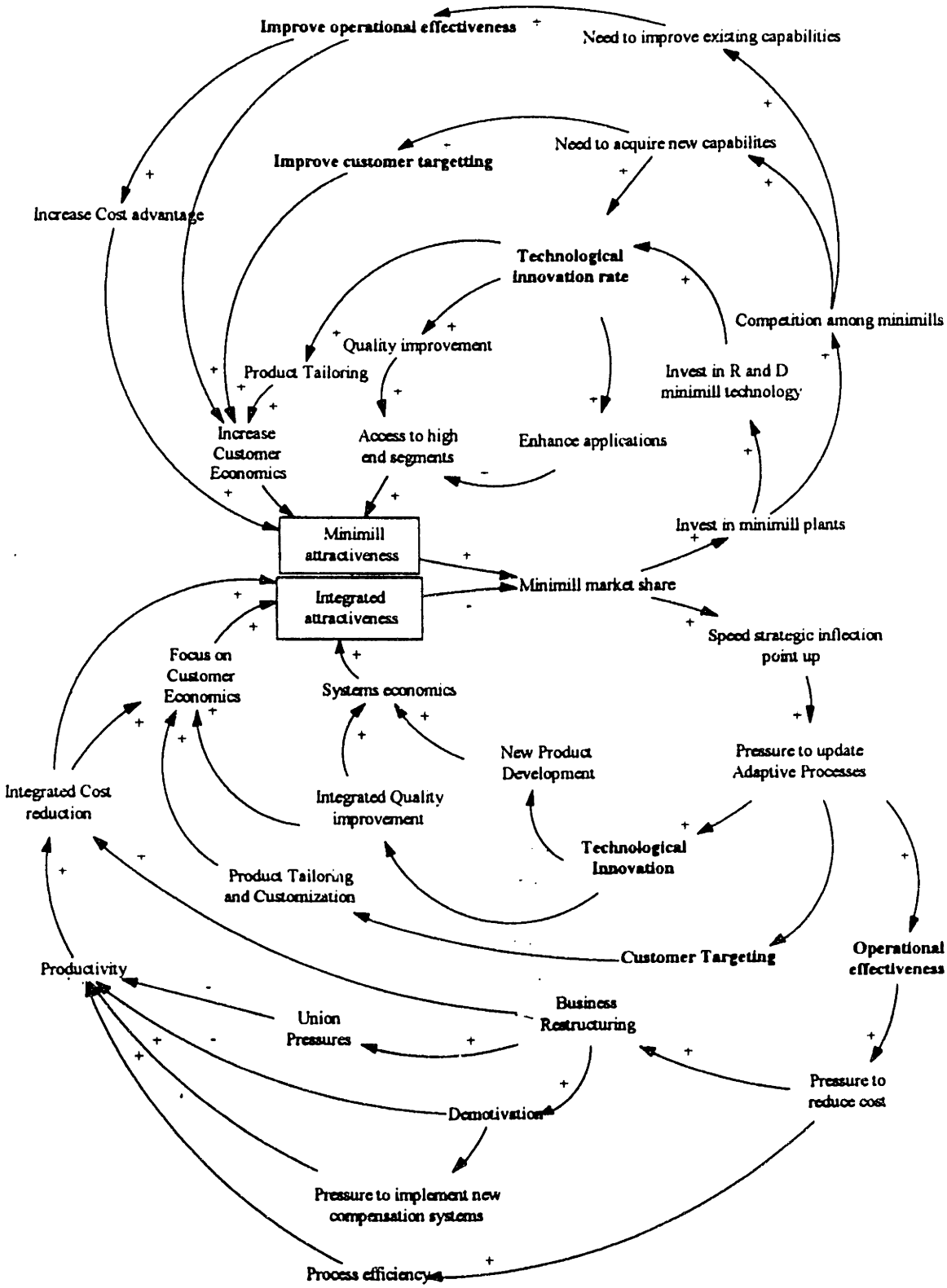
8.2 ADAPTIVE MANAGEMENT FRAMEWORK DYNAMICS IN THE STEEL INDUSTRY - CASUAL LOOP

The casual loop shown in Exhibit 8.1 reflects the dynamic underlying the competition between minimills and integrated mills, and explain how players in the industry will continue to change strategic positions. The dichotomy between integrated mills and minimills must be understood in the current state of the industry, generally speaking, as a synonym of Total Customer Solutions/Best Product (Low Cost). Based on our research in the field, we have created a casual loop that reflects, from our perspective, the evolution of the steel industry in the next decade.

The core of the casual loop is the varying degree of attractiveness between minimills and integrated mills. Starting from minimill products attractiveness, we will analyze the critical factors that contribute to reshaping the role of the main players in this industry. We will emphasize the applicability of the Adaptive Management Framework as a powerful strategic tool in the process of business reconfiguration.

This high-level casual loop is divided in upper and lower sub-loops, each showing the strategic dynamics of minimills and integrated mills, respectively. The speed of evolution embedded in each sub-loop differs enormously, primarily as a consequence of the magnitude of the drivers that affect each sub-loop. The upper loop main driver (minimills' attractiveness) represents the growth in market share through potential penetration in new segments of the markets resulting from continuous R&D investments in minimill technology. The lower loop (integrated mills' attractiveness) is driven by tremendous efforts to improve operational effectiveness to retain their market share.

Exhibit 8.1
Competition in the Steel Industry: Causal Loop



Upper sub-loop - Minimills attractiveness

Technological change has accelerated dramatically since the introduction of the first minimill in 1988. Based on a huge cost advantage in manufacturing and capital, minimills started gaining market share in the low-end of the market at expense of integrated mills and foreign producers. This was originally the main factor for minimills to gain attractiveness in the steel industry.

Minimill technology attractiveness led to massive investment in new electric furnace-based flat-rolled minimills. Installed capacity is expected to increase from 2.0 million tons in 1993 to 20.0 million tons by the year 2000 in the U.S. This capacity will represent around 40% of the flat-rolled segment. With more minimills in construction, naturally more and more equipment manufacturers start to **invest in R&D in minimill technology**, which in turn creates more applications and enhances process efficiency, reduces costs and improves quality. These three elements -- applicability, cost and quality -- act as reinforcing loops that enhance minimill attractiveness.

Since minimills has been traditionally fed with scrap, this incoming capacity will result in a pressure to increase the price of scrap. However, pressures on scrap price will simultaneously encourage minimill producers and equipment suppliers to further develop new steel scrap substitutes. Additionally, according to Utterback's model, new designs (i.e., Danielli, Mannesmann, Sumitomo) have been and will continue to enter the scene to challenge the original SMS technology; consequently, a dominant design has not emerged yet.

New minimill capacity will take additional market share from integrated companies. As minimills become dominant players in every segment of the market, there will be a **shift**

in the scope of competition from integrated/minimills to minimill/minimill. This situation will force minimills to redefine their strategies and, hence, to acquire new capabilities. At the time, as they redefine strategy they should contemplate the Adaptive Management Framework as a tool that helps to select the appropriate adaptive process to support that strategy. As was extensively discussed in previous chapters, these adaptive processes are operational effectiveness, customer targeting and innovation.

Competition among minimills will fuel ***operational effectiveness***. This adaptive process will bring better technologies and practices that, together with flatter organizational structures, create the strongest minimill attractiveness reinforcing loop.

In terms of the new capabilities, the first Adaptive Process that minimills should develop is ***Customer Targeting***. With more minimill firms competing for a certain segment, each individual company should aim to improve Customer Economics — gaining new capabilities in product development and implementing new business practices that allow them to gain in customer intimacy. Practices such as product tailoring and integration into customers' supply chain -- first begun with the automotive industry and now spreading to the other segments -- should be adopted by minimills. Acquiring these capabilities does not necessarily mean for minimills to physically integrate downstream. They can pursue customer intimacy through strategic alliances with re-processors and service centers to focus on final customer needs.

Additionally, minimills must hire people with a strong expertise in technical support. Information technology will also play a critical role in enabling companies to coordinate the whole system (minimill, re-processors, end users) externally through tools like EDI, as well as internally via e-mail, intranet, etc.

A second crucial aspect for minimills to acquire is **Technological Innovation** in both product and process development. The challenges minimills will face in pursuing market expansion are to develop new applications and to keep improving quality. While the latter event is foreseeable in the near future as a result of the existing process improvement programs carried on in most minimills, the former seems to be more remote. In fact, new applications development requires key expertise in the metallurgical process which involves the longest delay for minimill attractiveness to improve. More specifically thin-slab technology needs for improvement in flow mold control and practices to get a clean steel.

Minimills will not be able to catch up in the near future with the level of knowledge that integrated firms already have in marketing practices and product development. There are several ways for minimills to shorten this time, among them: getting core expertise in the form of technical assistance from integrated firms and increasing liaisons with universities as some have already begun (e.g., Carnegie-Mellon, British Columbia, etc.).

Lower Sub-loop - Integrated Attractiveness

As noted earlier, the attractiveness of integrated mills was seriously hurt by the introduction of minimills into the flat segment of the market in 1988. This phenomenon accelerated the process of losing market share to minimills that began in the late 1960s. Consequently, some integrated steel producers reacted to this 10X force by reshaping their business almost entirely. Nowadays, some integrated mills are pretty much competitive in terms of cost structures compared to minimills. However, they are still far behind in terms

of achieving excellence in operational effectiveness as described in Chapter Five (the Nucor case).

These progressive changes must continue, pushing toward an **update of the adaptive processes** followed by these producers. Some integrated mills have developed a set of capabilities that facilitates the reinforcement of this sub-loop, such as customization, process and product development, marketing, etc. Hence, those firms must be rather focused primarily on "**operational effectiveness**".

As illustrated in the casual loop, the basis of the change in their businesses is driven by reduction in costs. Depending on the depth of the changes already taken by each firm, further changes will be either radical or incremental. Radical change implies ***business restructuring***, in which firms undertake a serious transformation in the way they conduct businesses. This process leads in most cases to a "downsizing", with a massive elimination of jobs and the shutdown of obsolete production lines. Additionally, firms must pursue the outsourcing of non-core competencies in order to remain focused on the activities in which they excel.

However, searching for this kind of radical change does not assure an immediate result or accomplishment of goals. The overwhelming majority of integrated mills have to conduct this demanding business by reengineering in an unionized environment. This is one of the main features that characterizes the aforementioned differences in the speed of changes in this loop compared to the upper loop. Our understanding is that although possible, undertaking such enormous transformation in their business is a colossal task for senior managers.

We are truly convinced that once again people play an outstanding role in this process of major change. Thus, the impact of downsizing on the motivation of the workforce is a situation that must be carefully considered and thoroughly understood by managers and unions. Periods of confrontation, strikes, and demotivation of employees all contribute to reducing the speed of changes and therefore the process of regaining competitiveness becomes longer than expected. Once again, we do not mean that this is an impossible task; rather, we have tried to describe the main factors that in the short run negatively affect the process of re-shaping the business.

Another important aspect of this transformation is the idea of incorporating variable remuneration, as is the case with Nucor, in an attempt to spur productivity and strengthen the morale of the workforce. In our research, we observed that LTV and British Steel offered 15-23% of salary tied to profit sharing or productivity bonuses. Although far from the level of compensation incentive offered at Nucor, those firms commented about the necessity of focusing even more on this aspect of their business. We will elaborate on this issue later in this chapter.

Integrated mills need to reduce the number of layers in their organization structure. In this process of transformation from the old-style hierarchies to a new type of horizontal/ flat organization, mills must also accommodate their management structure to one needed in a more decentralized environment. Additionally, the process of trimming layers will end up with an expansion in the span of control.

In addition to restructuring their business, integrated mills must follow the search for process improvement. In an attempt to catch up with the advantage that thin-slab technology has over integrated technology -- this advantage resides in the elimination of the

work-in-process between the continuous caster and the hot-rolling mill -- some integrated companies (i.e., Nippon Steel, LTV, Posco, etc.) have introduced different techniques of direct-charge that reduce energy consumption, increase productivity, and eliminate many job positions of people engaged in handling semi-finished products. Research and development, as well as new technologies brought by equipment supplier, are also essential in this state of transformation. As we remarked in Chapters Six and Seven, integrated steel mills are prone to invest in new technologies in order to regain attractiveness vis-à-vis minimills.

Certainly, most of the aforementioned changes are aimed at spurring productivity and reducing costs. These two factors will in turn increase the attractiveness of integrated mills through a twofold strategy: on one hand, allowing them to be more competitive in the low end of the market with better costs structures; on the other hand, enabling them to focus more on the customers' economics through a more efficient and quick response to customer needs.

Additionally, integrated mills must continue focusing on providing total customer solutions via a reinforcing loop in the adaptive process of ***customer targeting.*** As was noted in Chapter Six, integrated mills have indeed undertaken the process of searching for customer intimacy. Actually, they are fully prepared to support customers with very sophisticated technologies and services that are aimed at providing an unmatched value-added product. Advanced ladle and vacuum processing allows metallurgists to develop newer and better applications for steel. This set of capabilities is a very important weapon to prevent minimills from penetrating into highly demanding segments of the market.

Certainly, the marketing capability of these producers is overwhelming superior to that those of minimills. However, as we recommended in the upper loops, minimills will

be turning their business model toward greater customer orientation, hence bringing more competition into the high end of the market. This potentially aggressive move by minimills will result, once again, in re-invention of the business of integrated mills. At this point, integrated producers will be challenged to incorporate new concepts into their business models via innovation.

This adaptive process, as was discussed in Chapter Seven, is intended to develop a new philosophy of doing business through incorporating ***complementors***. In contrast to minimills, integrated mills have been able to achieve a remarkable level of cooperation among them in order to regain part of the market share lost in the last decade. Examples of this cooperation are the exchange of technologies and knowledge of process and product development, joint ventures, coordinated projects such as the Ultralight steel auto body project, etc. However, it is noteworthy to mention that those producers have not yet developed core expertise in materials such as glass, plastic, aluminum, etc., that enable them to strategically reposition as system providers.

More and more, integrated steel producer must focus on delivering a product that contemplates not only the manufacturing of steel but also stamping, assembling some parts of cars, etc. One example could be the coordination of activities among steel, glass and plastic producers in an attempt to provide the entire door of a car for the automotive industry. Although this proposal might sound strange, we have to go back a couple of decades and see that some processes made by automakers at that time, such as painting of parts, is made today by steel producers. Therefore, we strongly believe that this new concept can provide integrated steel producers with a valuable alternative to venture into the future. Only those with the capacity to foresee this change, such as Dr. Jeff Edington

at British Steel, can lead the process of unprecedented change in the entire steel industry. Clearly, the winners in this process will be the ones that can coordinate the entire system, as in the case of Microsoft and Intel in the high tech industry.

This new concept of converging toward a ***system provider*** position can only be undertaken today by integrated mills since they have developed the capabilities needed to coordinate the entire system. The search for the excellence in this new concept is aimed to increase the value of the firm via a incremental ***bonding.*** There are different stages of bonding starting with a dominant design with first mover advantage, passing through ***customer lock-in*** via customer learning, and finally achieving a ***competitive lock-out*** through a seamless relationship with the distribution channels and suppliers.

The accomplishment of this ***Systems Lock-in*** position in the Adaptive Management Framework will certainly increase the attractiveness of integrated mills. Nonetheless, in a 20-year timeframe, we forecast the death of many integrated mills due to difference in the speed of change as well as pressures for environmental compliance in many developed countries. Therefore, as we suggested in Chapter Six, integrated mills producers (British Steel and LTV in Trico) have already begun to test new minimills' technologies as a way of anticipating the inevitable extinction of conventional iron and steel-making processes.

In the next section, we will discuss how this transformation will take place as well as the new kind of corporations that will prevail in this industry.

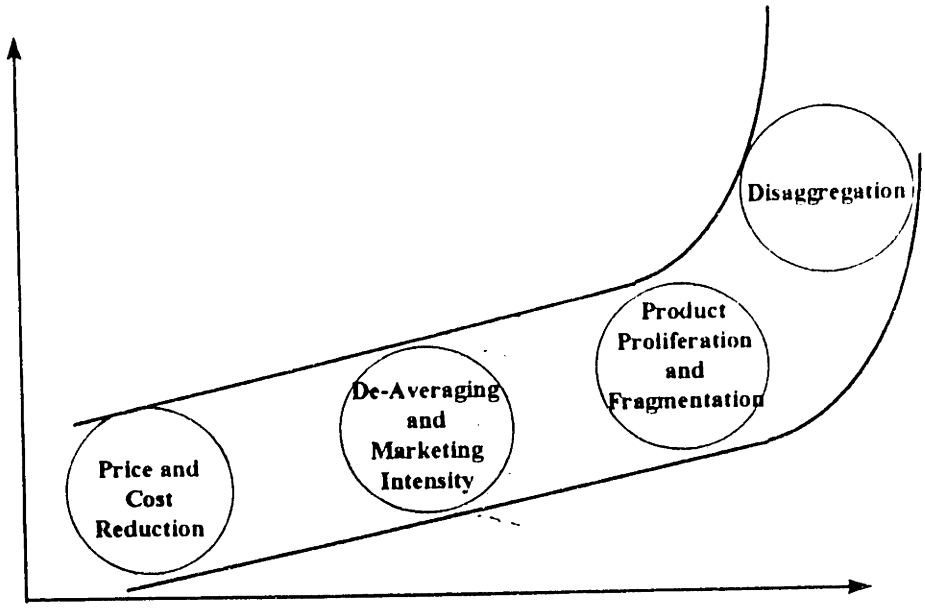
8.3 INDUSTRIES IN TRANSITION

Hax's view of "Industry in Transition" reflects exactly the result predicted by the above- mentioned causal loop and complements it with other facts we introduced in this thesis. By cross-checking Hax's theory with facts presented by one of the most renowned consultants in the industry, John Lichtenstein, we can offer some explanations for the current industry dynamics.

Going back to Utterback's model, he suggests that at the so-called "specific stage" of the industry tends to be commodity-like, with well-established processes and standardized products and an oligopoly of firms with similar products competing mainly based on price. This used to be the old U.S. steel industry before the emergence of minimills, and we can take it as the starting point either for the casual loop depicted in Exhibit 8.1, or in Exhibit 8.2 shown in this section. Different waves of innovation are uninterruptedly entering into the scene creating a continuum and causing the steel industry to be permanently in transition. With dominant designs appearing successively, competition would be based on cost, forcing companies to differentiate. Differentiation brings ***segmentation*** and ***product proliferation***. With minimills gaining attractiveness, there will be more plants of smaller scale that will take the place of less efficient and larger size integrated plants. ***Fragmentation*** is already occurring in the U.S. steel industry, according to Lichtenstein views (Lichtenstein, 1996). In 1980 there were eleven companies producing light flat roll sheet in the United States; in 1990, there were 16; and by 2000, there will be 22 flat roll companies. In 20 years the industry will have doubled in size, at least in terms of the number of players with their fingers on the pricing button.

The transformation of the industry with smaller companies, more distributed, requiring different raw materials, will witness the birth of new business and industries. These new businesses may be new companies developing new technologies, new companies producing new raw materials, new minimills focusing on new products, relocation of service centers and re-processors to be closer of new suppliers. **Disaggregation** will be the result of new economics along the value chain. Companies like Ispat, Nucor, Iron Carbide and Cliffs, are already repositioning themselves in the business, supplying raw materials to the new minimills and avoiding to some extent downward integration.

Exhibit 8.2
Industries in Transition



Source: Hax and Wilde, 1996.

Let us explain these transitions in detail.

First Phase: Price and Cost Reduction

As a result of the entrance of minimills, there was a cost reduction and an excess of capacity; these two factors led to a stronger price reduction. This forced integrated mills to push down costs by restructuring and by being more efficient. As it was insufficient to equalize themselves with minimill costs, some integrated mills repositioned themselves to target the higher end of the market, and others decided to carry on all kind of projects with the final goal of improving their operational practices even more to compete against minimills in the low-end.

Second Phase: De-averaging and Market Intensity

Those integrated mills that restructured to compete in the low-end have paid the price for their mistake by closing down many of their facilities. The integrated mills that understood how to position in the new environment did so by innovating their customer linkages in a number of ways. Customization, product tailoring, supply-chain integration and early involvement in customers' product design are the different ways that producers followed to retain customers. This Customer Targeting enhancement led to de-averaging -- an analysis of profitability by customer segment -- and Marketing Intensity.

Third Phase: Product Proliferation and Fragmentation

Product proliferation is the result of R&D expenditures in both product tailoring and the search for systems solutions. Excelling in applied research, some integrated mills, like

LTV, have taken advantage of the benefits of the vacuum degassing process. As mentioned earlier, fragmentation is the result of new capacity entering in smaller chunks and bigger facilities closing down.

Fourth Phase: Disaggregation

As a consequence of the difference in returns along the value chain, together with environmental pressures, disaggregation is an increasing trend in the industry. LTV, like many other manufacturers, has focused on flat rolled products, closing long products facilities. Additionally, due to environmental pressures, many companies will eliminate their existing coke batteries and will increase Pulverized Coal Injection techniques.

Conclusion

Our casual loop helps to understand the dynamics of the competition and how companies will keep refocusing each of their adaptive processes. And we have also seen how the competitive environment will keep changing following Hax's model of "Industries in Transition".

It has been clearly stated that technology will keep driving the dynamics of the industry. We also believe it will be a sort of convergence to a new type of mill. With smaller size, leaner practices, highly motivated people and retaining its capabilities in R&D, integrated mills will look very much like minimills, and some authors have started to call these new companies mini-grated mills.

On the other hand, as noted earlier, minimills will start to compete with other minimills, and most of them will be forced to add new elements to their low-cost strategies

supported by excellent operational effectiveness processes. Some minimills, encouraged by either the evolution in technology that will enable them to penetrate the high-end, or the necessity to gain market share, will shift their strategy from Best Product (low cost) to Total Customer. This change is much more than rhetorical; it means steel companies must make a choice – choose a strategy -- and consequently develop a suitable set of elements to support the strategy they have chosen. Even more importantly, they must understanding that strategy is also dynamics, and they should continuously update their adaptive processes in order to support it.

8.4 EMPHASIS ON STRATEGY LINKED TO EXECUTION

Nucor, LTV and British Steel have clearly chosen different strategic approaches. These companies understand that each strategy needs to be supported, among other factors, by different sets of technology, organization structure, compensation system and performance measurement. In Chapter Four we defined the strategy followed by each of the companies in our research; and in Chapters Five, Six, and Seven we presented different companies as examples of excelling in applying different Adaptive Processes. There was indeed a connection between the chosen strategy and the way they perform the required Adaptive Processes to support it. Here we will sum up how by choosing different ways of doing activities, they have defended their competitive position over time.

8.4.1 Nucor

Beginning with Nucor, we see that the company purposefully chose to position itself as a Best Product Producer. In Nucor's case being in this position means having the lowest cost and very good quality. It is also true that Nucor achieves this position only in the low-end of the market. According to Mr. Correnti at Nucor, this is not by chance; on the contrary, it is a choice. Nucor deliberately decided not to serve the automotive segment, and this choice fits perfectly with the set of elements in Nucor's strategy. First, since it is not in the automotive business Nucor does not need the usually heavy structures that this market segment involves. Second, the Compact Strip Production technology -- capable of achieving only commercial steel grades so far -- allows Nucor to compete in the segments (re-processors, service centers, constructions) that fit with Nucor's strategy. These segments are low technical-assistance intensive and they usually need massive quantities of a restricted scope of grades.

To maximize costs, Nucor decided to focus its key indicators on productivity (measured as quality tons per hour). Hiring young, rural, money-hunger people, Nucor achieves a tremendously motivated, productive workforce. Its employees' motivation is what drives productivity up, not the classical top-down pressure in execution found in most traditional companies.

A lean structure; a powerful motivating compensation system; a technology that more than satisfy the requirements of the segments where Nucor competes; and a location that enables the company to hire rural "mechanically minded" and "anti-union" people, are the elements of Nucor's outstanding strategy.

8.4.2 LTV

LTV's Total Customer Solutions position is mainly supported by a reasonable degree of Operational Effectiveness but mainly by a clear vision of excelling in Customer Targeting. Because of its location, near the heart of the automotive industry, LTV naturally appears as a strong candidate for taking the bulk of the supply to that industry. A market-oriented structure, still in the process of re-engineering, and a world-class technology, allows LTV to reach its goals.

LTV's state-of-the-art and multi-purpose equipment that includes ladle metallurgy/ vacuum degassing facilities, a Direct Hot Charge Complex (at the Cleveland works), and all the range of coating lines, are also key to offering customized products according to individual customer needs and to achieving lower costs in the high end of the market.

8.4.3 British Steel

British Steel is also focused on Total Customer Solutions. However, they have a strategic vision of Systems Lock-in that is pushed forward at the board level. British Steel does not miss the fact that to be competitive they have to be very good in operational effectiveness -- this is a given. The company achieves the lowest labor cost in Europe thanks in part to Margaret Thatcher's labor reforms in 1980, and partly because of the continuous search for traditional ways to improve productivity, including technical assistance from Nippon Steel.

Because of its organization in Business Units, British Steel has a remarkable market-oriented structure. The company also pays attention to always putting forward a single corporate face to every customer; consequently, different Business Units may take the lead in developments that involves different groups of customers.

What makes British Steel different from LTV and Nucor is the huge amount of investment in R&D (1% of total revenues) on basic research.

8.5 RECOMMENDATIONS

In this section we will propose a set of guidelines that complements the ones mentioned earlier in this thesis such as decentralization, horizontal organization, customization, early involvement in the design with automotive producers, system providers, etc. These recommendations are aimed at serving as useful tools for becoming a competitive player in today's business. Even though most of these concepts have become buzzwords of the 1990s, we strongly believe that they are still valid as a source of competitive advantage. Overall, our comments will apply to any industry; some are specific to the special nature of transformation in the steel industry that we have just noted in the previous section.

In making these recommendations, we will concentrate primarily on the following drivers of success:

A. Technology Management

B. Learning organizations and Knowledge Based Management

C. Compensation systems and Teamwork as the basis of performance measurement.

A. Technology Management

Recognize steel has become a highly dynamic technology

Because technical change has accelerated so much, strategists and technologists need to carefully screen the evolution of technology. And because renovation and purchase of equipment is a long-term decision, it is important to make the right choice every time the decision process comes along. However, it is equally important to see when new technologies are threatening a company's current position and realize that these decisions may have to be made earlier .

The integrated mill sector in the United States seeks the bulk of the capital savings they need in coke-making and iron-making operations. With increasing environmental pressures and the price of coke rising, many major steel plants have installed Pulverized Coal Injection (PCI) into blast furnaces as a partial substitute for coke. A few use natural gas for the same purpose. Because of the need for greater efficiency in blast furnaces, companies are also focusing attention on the efficiency of oxygen use so that combining coal injection and large amounts of oxygen can further diminish the need for coke. Simultaneously, companies will seek processes that eliminate the need for cokemaking. One such process, Corex, is commercially available now, and several other processes are currently under development and likely to become commercially viable in ten to twenty years.

Similar patterns are characteristic of steelmaking operations especially with regard to gaining flexibility in the mix of inputs used (e.g., virgin iron versus scrap metal in the charge). In addition to improved efficiency in continuous casting, as we commented earlier on direct charge operations, thin-slab or mid-thickness casters could be used.

With incoming minimill capacity adding more pressure on steel scrap price and with increasing need for getting clean steel, the minimill sector in the U.S. will pushed forward the developing of steel scrap substitutes. Adding some form of reduced ore, such as DRI, HBI, or pig iron, dilutes the impurities in obsolete scrap and results in the steel chemistries required for flat-rolled products. The same result can be achieved by mixing liquid hot metal with scrap.

Choose the technology that fits the strategy

Many companies seem to be trapped by the thought that Nucor's strategy is the best. They fail to see that Nucor's strategy is different. A company that needs to serve the automotive industry, for example, needs a very different set of technologies than a company that only targets the less-complicated segments of re-processors and service centers.

Companies that target the high-end of the market cannot utilize minimill technology so far. This segment requires high levels of product quality, including unique attributes such as surface quality, internal cleanliness and formability. These define steel's fitness of use in specific (and demanding) applications. High standards of product quality are expected, which require the highest levels of production standards. This assures minimal rejections of the steel once it is received by the customer. This segment is quite customer-specific and requires services by the steel mill that include inventory programs, just-in-time

delivery systems, ordering and shipping flexibility, product design and development assistance, coordination of business systems including electronic data exchanges, bar coding and order-cycle procedures.

In many of these markets, the cost of steel is a relatively small percentage of the total cost of the steel buyer's finished product. To these customers, the steel supplier is chosen and measured primarily on the value of the total package of services, products, and capabilities it offers. The relationships between the steel mills and these customers are long-term and extensive.

Minimills seeking access to this market must be willing to slow down production lines at times, incur extra expense for inspection and service, boost the size of their metallurgical staff, and increase costs in other ways. We think that Nucor may choose not to invest in these capabilities nor may other minimill competitors. The reason is simply that they may choose to continue with their established positions in the Best Product position (Low Cost) rather than shift to a Total Customer Solutions position, and consequently they will not need to acquire the expertise that is needed to compete in the high-end of the market.

Thus, technology in its broad sense must fit the strategy that the company has chosen.

B. Learning Organizations and Knowledge-Based Management

Nowadays, organizations need to leverage corporate resources to maintain competitive position and the key part played by people in this process in terms of their ***intellectual*** contribution rather than exclusively from ***physical*** effort. Actually, this

transformation is absolutely critical even for firms that compete in an intensive physical assets business such as steel. Accordingly, firms must develop learning processes at all levels on the assumption that the ability of the firm to learn faster than its competitors may be its only form of sustainable competitive advantage.

Peter Senge, who popularized learning organizations in his book *The Fifth Discipline* (1990), commented that people in organizations are learning all the time, organizations are not. In today's business environment, leveraging an organization's institutional knowledge is not simply a business advantage, it is a business imperative. Those companies that develop best practices for managing knowledge capital will be the ones that ride this competitive wave.

Leveraging knowledge can lead to a multitude of business benefits, including faster ***innovation*** of new products, reduced duplication of efforts, savings in research and development costs, and enhanced employee satisfaction. For most companies, the central issue is not creating organizational knowledge. Instead, it is figuring out how to more effectively capture and share the knowledge that already exists within the organization but which is locked within a department, a division, or even within the minds of individual workers.

The challenge for management is to create a climate which encourages this open sharing of knowledge and particularly the practice of learning through experimentation in a receptive environment. This process has to be encouraged across hierarchical levels and organizational boundaries. A learning culture encourages responsible risk-taking on the part of individuals and groups, it fosters reflections, open discussion and debate about experience

and it is willing to acknowledge mistakes but at the same time individuals are prepared to take away the lessons from them.

Even though information technology (IT) is consider a perfect tool for enabling knowledge management, we consider that the most important device for allowing learning to happen remain in executives and senior managers' willingness to undertake the necessary processes and systems for making knowledge management successful. Without true commitment and support from top executives regarding the strategic role of learning for growth, knowledge sharing within the organization will never take place. Therefore, IT alone is not sufficient in order to succeed in the process of become a genuine "learning organization". Our assertion is based upon the fact that at most times, managers are reluctant to spend time on this process since they may consider it a waste of time. Nonetheless, we are truly convinced that the leverage of intangible corporate resources will provide in most cases a unique source of competitive advantage. The resource allocation to knowledge management should be viewed as an investment in the future of the organization.

More and more, we see that customers are becoming highly sophisticated and they are demanding a kind of value proposition that was unimaginable a couple of years ago. Therefore, organizations have to be able to respond accordingly, with a very innovative proposition. Actually, firms nowadays are behaving in some sense as a "consultant", analyzing and solving problems and coming with innovative approach. This new approach is basically a reinforcement of the concept of knowledge-intensive business rather than the old fashion tangible-intensive approach.

As we noted earlier the first step is the full involvement of top executives in the appraisal of usefulness of this knowledge management. In the second step, top executives must design or re-design the organizational structure of the firm in order to allow the learning to happen. Firms' ability and willingness to improve its organizational structures around knowledge, willingness to work to develop a knowledge-sharing culture, and use of knowledge sharing technologies are the key drivers in order to implement knowledge-based management. Knowledge must be quickly created, captured, and transferred across internal boundaries in order to increase the pace of innovation.

As we presented in the casual loop, innovation plays a critical role in the process of gaining attractiveness for both integrated and minimills. This innovation must include not only product development but also process development. Learning through experience that takes place during production must be fully captured and shared it with equipment supplier in order to come up with new technologies that helps in the process of becoming a truly first mover firm in the industry. Although the innovation process is very important in the production area, we understand that learning must take place in each corner of the organization. Therefore, we encourage firms in the steel industry to put together a system of knowledge sharing in which people from any division within the organization can access to ***"best practices"*** in order to apply them to his/her problems.

Let us present the following example. The accounting department and marketing have very few attributes in common; however, both must understand customers' needs. In the case of marketing, this department must undertake certain procedures in order to better serve its customers' need. Therefore, learning from each customer account can be spread over other accounts. This is the first step in sharing knowledge, yet other sectors or

divisions of the organization can benefit from this learning as well. In our case, accounting, which may be seen as a service center of information from internal (division managers, senior executives, etc.) and external (public in general) purposes, may learn from this practice of understanding customers' needs and therefore provide a more customized service to its end-users such as a tailor-made report for a particular purpose. Hence, we advocate the elimination of boundaries within the organization as well as the institutionalization of knowledge-based management as a tool for continuous improvement and innovation.

Ideas carry maximum impact when they are shared broadly rather than held in a few hands. A variety of mechanisms spur this process, including written, oral, and visual reports, site visits and tours, personnel rotation programs, education and training programs, and standardization programs. In addition to that, highly decentralized companies with relatively flat organizational structures may be very good at fostering innovation and bottom-up idea generation as it was the case of Nucor presented in Chapter Five. Additionally, the compensation system is a very effective complementor in the process of encouraging innovation. We will discuss this aspect later in this section.

One of the champions in this field in the steel industry is Chaparral Steel, which changed its pay structure in 1986-87 to reward accumulation of skills in addition to performance. More than industry experience, the company looks for potential, learning ability, enthusiasm, a conscientious attitude toward work, and a enthusiasm for the job. Chaparral has an absentee rate that is about one-quarter of the National Association of Manufacturers industry average. Chaparral Steel sends its first-line supervisors on sabbaticals around the globe, where they visit academic and industry leaders, develop an understanding of new work practices and technologies, then bring what they have learned

back to the company and apply it to daily operations. In large part as a result of these initiatives, Chaparral is one of the five lowest-cost steel plants in the world.

C. Compensation Incentives and Teamwork

In this section we will present compensation systems as a powerful tool for linking strategy with execution. As was referred in Chapter Five, Nucor's compensation system was clearly designed to spur productivity. This compensation system has an enormous impact in the motivation of the workforce which in turn is the key factor of success of this corporation. Our purpose is to describe different compensation systems that may be undertaken by firms in order to provide a more flexible cost structure, an even more alignment of strategy with execution as well as a device to motive people. Most of these pay strategies should not be considered an all-or-nothing approach; on the contrary, we encourage the pursuit of a pay strategy, even a combination of some of them, that highly correlates with the strategy of the firm in order to create value for the organization.

In the process of implementing new pay strategies, firms must fully understand how this innovative pay systems work, they must also comprehend how these systems can provide a source of alignment to the overall strategy and finally, they must champion in communicating the new strategies in order to achieve the intended results while avoiding the unintended consequences.

Pay Strategies

Perhaps the best way to begin learning about specific pay strategies and tactics that are gaining popularity in the workplace is to look at how compensation has begun to evolve

with work cultures -- albeit at a much slower pace. Therefore, we will present very briefly the traditional approach that is still in place in many steel firms around the world. Under this system, people are paid primarily through base salaries that were mainly determined by the specific features of the job, the need to maintain a competitive benchmark with those paid by other employers in the marketplace, industry or region, etc. (Flannery, et al., 1996).

Nowadays, many employers have begun searching for new compensation solutions in order to help drive and support their strategies in terms of quality, customer service, innovation, learning, productivity, teamwork, economic value added (EVA), etc. The shift has been particularly toward performance-based VARIABLE pay strategies. One of the most clear examples of this transformation is Nucor's compensation system that contemplates almost two-thirds of salaries as a variable component that is tied, among other drivers, to the number of tons produced and ROA. In addition to that, this system is a team-based pay in which the performance of the teams is what actually counts, in contrast to the traditional individual merit system. Although labor cost is becoming less important in the cost structure of steel firms, we consider that compensation systems like Nucor's provides an enormous flexibility to the firm. Furthermore, linking pay system to Return on Assets -- at divisional, departmental and staff level -- is critical in the steel industry that is highly assets intensive. A very desirable by-product of this compensation system is that people become fully aware of the main indicators of the firm which eventually results in an easier way to explain changes in goals that are the basis of this performance system.

In our research, we perceived a trend toward a more variable approach, albeit in an embryonic stage, from integrated mills. LTV has approximately 14-16% of its pay tied to productivity and profit-sharing programs. In 1980, British Steel started paying up to 23%

of workers' salaries tied to overall quality tonnage produced by the company. The compensation system in the British company evolved from a general incentive applied independent of individual performance to a system that fully considers business units and departmental performance. Nowadays, British Steel pays up to 23% variable compensation; however, due to the method used in bonus calculation, there is a substantial difference in terms of workers' motivation and goals orientation from the method they used previously.

This trend is very important to follow and see how this changes are implemented in an unionized environment. However, this is yet not enough to have a real impact in the entire business and in the motivation of the workforce, hence we encourage managers to fortify this trend in a more substantial share of the total pay system. Once again, the success in the implementation of this kind of incentives must rely upon the concept of "Mutual Trust" among managers, unions and workers. Without this pre-requisite, we really doubt about the effectiveness of the system.

Firms undertaking a reengineering/restructuring approach transforming functional method to a more streamline process specific approach, may find appropriate to apply a pay system based on skills. By paying employees for the acquisition of the skills needed in the new organization, the firm can reduce or even eliminate their natural resistance to change. This approach is particularly useful for integrated mills that are in a continuous search for operational improvement through radical changes in the performance of activities. Lack of incentives together with the inability to communicate properly the objectives of the reengineering process have contributed to an astonishing rate of failure in their implementation.

Those aforementioned pay systems are tied primarily to short-term goals, hence we encourage firms to complement these approaches with long-term incentives such as stock options. Although extensively used at the senior level, long-term incentive pay systems are hardly ever seen at lower levels of organizations.

Teamwork and performance measurements as the basis for pay strategies

Team-based compensation has steadily become more popular among corporations in United States in the last decade. As we analyzed in Chapter Five, Nucor's compensation system (explained in Exhibit 8.1 of this chapter) was based on team performance rather than individual accomplishments. We also noted that team-based compensation puts extraordinary pressure on team members to perform accordingly to the goals set by the corporation. Members of each team become self-motivated and are responsible for making the adjustments needed in case of under-performance among any participants. As was explained in Chapter Five, workers at Nucor go directly to supervisors in order to make them aware of the misbehavior of any party in their team that might affect the overall performance of the team and therefore reduce their salaries. Workers will not accept new members who, after a reasonable training, do not perform according to the standards of the team. Thus, supervisors, department managers, and divisions managers do not need to look over the shoulders of each worker; on the contrary, once the goals are set, each team takes care of its own tasks.

Although this team-based performance is not applicable to any activity in organization, there are many functions/processes that can be the base for this approach. Among these activities, we consider noteworthy to mention, production, product and process

development, inbound and outbound logistics, administrative works, etc. In the case of production activities, firms can either define teams of workers that concentrate in a particular part of the production process such as rolling, melting, etc. or the entire production line breaking down the shift in two or three teams depending on the number of workers employ in this process. The basis of compensation in this case can be, as in Nucor's example, the number of quality tons produced in a particular production line.

Our next recommendation is based on the set of performance measurement that firms must consider in order to pursue different strategies. We consider that financial indicators are very important from an investor perspective, however, organizations must follow a set of financial and non-financial indicators that represent more specifically the current positioning of the firm.

Therefore, we suggest using the **Balanced Scorecard** (Kaplan & Norton, 1996) as a supplemented traditional financial measures with criteria that measured performance from three additional perspectives - those of customers, internal business processes, and learning and growth. It therefore enabled companies to track financial results while simultaneously monitoring progress in building the capabilities and acquiring the intangible assets needed for growth. The purpose of this section is not to analyze deeply the Balanced Scorecard concept; rather, we want to mention it as a powerful tool that contributes to linking short and long-term strategic objectives with a set of performance goal that can be the basis of the pay system selected by corporations.

As we presented in our casual loop, minimills and integrated mill must pursue different strategies in order to gain/regain attractiveness. For instance, as competition among minimills becomes more severe, those firms must pursue to develop some

capabilities such as a more customer oriented approach. In this case, they should adjust, Nucor in particular, their compensation system toward some measurements that reflect value added in the customers' economics. Additionally, they also must pursue reward innovation as a source of becoming more proactive toward a total customer solution approach. As it was noted earlier, Chaparral Steel contemplates in this performance base for compensation the learning/innovation that takes place in the organization at worker levels. In the case of integrated, they must focus their attention on performance base that includes internal business process. In doing so, they will be able to excel in operational effectiveness that in turn will contribute to reduce the gap in cost with minimills.

As a conclusion, firms must recognize the impact of compensation systems in the execution of their strategies and more importantly in the morale of their workers. We do not mean that compensation systems can provide a source of competitive advantage, rather we conclude that, as in the case of Nucor, the pay strategy can contribute to develop a cultural environment that eventually is much more difficult to imitate. In addition, firms must make a choice among the different sets of parameters that have to be taken into consideration as the basis of salary-pay. Those choices must be tied to each of the dimension of the strategic positioning, best product, total customer solutions and system lock-in that the firm is pursuing.

Exhibit 8.3
Nucor's compensation system:

This compensation system is based on four different incentive plans. These incentives plans are:

1. Production Incentive Plan

Employees involved directly in manufacturing are paid weekly bonuses on the basis of the production of their work groups, which range from 20 to 40 workers each. Most Nucor employees are covered under this system. Typically, these bonuses are based upon anticipated production time or tonnage of "QUALITY" steel produced, depending upon the type of facility. The formulas for determining the bonus are non-discretionary, based upon established production goals. This plan creates pressure for each individual to perform well and, in some facilities, is tied to attendance and tardiness standards. No bonus is paid if equipment is not operating, thus creating a strong emphasis on maintaining equipment in top operational condition at all times. Maintenance personnel are assigned to each shift, and they participate in the bonus along with the other bonus groups. Production supervisors are also a part of the bonus group and receive the same bonus as the employees they supervise. In general, the Production Incentive bonus can average 80 -150% of the base wage.

2. Department Manager Incentive Plan

Nucor Department Managers earn incentive bonuses paid annually based primarily upon the return on assets of their facility. Nucor pays no discretionary bonuses. All facilities have a common and clear goal since Department Manager bonuses are based upon written plans that are easy to understand. These bonuses can be as much as 82% of base salary.

3. Non-Production and Non-Department Manager Incentive Plan

This bonus is paid to all employees not on the Production Incentive Plan or the Department Manager Incentive Plan. Its participants include accountants, engineers, secretaries, clerks, receptionists or any one of a broad number of different employee classifications. The bonus is based primarily upon each facility's return on assets The bonus is based on a written plan that is clear, easy to understand and accessible to employees. Every month each operation receives a report showing on a year-to-date basis

Exhibit 8.3
(continued)

their return on assets. This chart is posted in the employee cafeteria or break area together with the chart showing the bonus payout. The chart keeps employees appraised of their expected bonus levels throughout the year. This bonus can total over 25% of salary.

4. Senior Officers Incentive Plan

Nucor senior officers do not have employment contracts. They receive no profit sharing, pension, discretionary bonuses nor retirement plans. Their base salaries are set at less than what executives receive in comparable companies. Senior officers have only one compensation system. A significant part of each senior officer's compensation is based upon Nucor's return on stockholder's equity, above certain minimum earnings. A portion of pre-tax earnings is placed into a pool that is divided among the officers in bonuses that are about 60% stock and 40% cash. If Nucor does well, the officer's compensation is well above average, as much as several times base salary. If Nucor does poorly, the officer's compensation is only base salary and, therefore significantly below the average pay for this type of responsibility.

An augmentation aspect of Nucor's benefit program is its commitment to education for children of Nucor employees. The Nucor Scholarship Program provides four-year scholarships for children of Nucor employees pursuing higher education or vocational training past high school. The program pays up to $2,200 annually for each qualified student. Last year, Nucor spent approximately $ 1.3 million in this program. Nucor maintains a Profit Sharing Plan for employees below the officer level. Employees make no contributions to this plan. A minimum of 10% of Nucor's pre-tax earnings is contributed to the Profit Sharing Plan each year. Of this amount approximately 15 to 20% is paid to employees in March of the following year as cash profit sharing. The remainder is placed in trust and allocated to employees based upon their earnings as a percent of the total earnings paid throughout Nucor. Employees become fully vested in their portion of the Profit Sharing Trust after seven full years of service. Profit Sharing Trust funds are paid to employees when they retire, or terminate employment with Nucor. Nucor also offers employees a chance to invest in their future with a Monthly Stock Purchase Plan featuring a 10% Nucor matching contribution; and a 401(k) Retirement Savings Plan including a matching contribution ranging from 5% to 25% of the employee's contribution based upon Nucor's return on shareholder's equity.

BIBLIOGRAPHY

Acher, J., "Light-weight steel beverage can challenges rivals," *The Reuter European Business Report*, October 1996.

American Metal Market, "Thyssen weighs its role in automotive market," November, 19___.

American Iron and Steel Institute, "Automotive Applications". Http:// www.autosteel.org/

Bankers Trust Research, 1996.

Barnett, D. Steel Survival Strategies XI, June 1996

Bartlett, C. and Ghoshal,S. "Changing the role of Top Management: Beyond System to People", Harvard Business Review, May/June, 1995.

Bartlett, C. and Ghoshal,S. "Changing the role of Top Management: Beyond Structure to Processes", Harvard Business Review, January/February, 1995.

Bartlett, C. and Ghoshal, S., "Changing the Role of Top Management: Beyond Strategy to Purpose", Harvard Business Review, November/December, 1994.

Birchall, D. and Lyons, L. *Creating Tomorrow's Organizations*. Cambridge: Pitman Publishing, 1995.

Bradenburger, A. and Nabeluff, B. *Co-Opetition*. New York: Doubleday, 1996.

Brimacombe, J. and Samaresekera, I. "The Challenge of Thin Slab Casting". Paper presented at The Ethem Turkdogan Symposium, University of British Columbia, May 15-17, 1994, Pittsburgh, Pennsylvania.

Butterworth, C., "Supplier-Driven Partnership", *European Journal & Supply Management*, Vol. 2, No. 4, 1996.

Camp, R. *Benchmarking: The Search for Industry Best Practices that Lead to Superior Performance*. Quality Press, 1989.

Champy, J. *Reengineering Management: The Mandate for New Leadership*. New York: HarperCollins, 1995.

Christensen, C., "The Opportunity and Threat of Disruptive Technologies". Class presentation, Management of Technology Program, October, 1996.

BIBLIOGRAPHY
(continued)

Clark, K. and Fujimoto, T. *Product Development Performance: Strategy, Organization and Management in the World Auto Industry.* Cambridge: HBS Press, 1991.

Coblin, J., General Manager, Personnel Services, Nucor Steel, Charlotte, NC. Personal Interview, January, 1997.

Cooper, R., et al. *Implementing Activity-Bsed Cost Management: Moving from Analysis to Action.* Institute of Management Accountants, Montvale, NJ, 1992.

Cooper, R. and Kaplan, R., "Measure the Costs Right: Make the Right Decisions," *Harvard Business Review*, September/October, 1988.

Correnti, J., CEO, Nucor Steel, Charlotte, NC. Personal Interview, January, 1997.

Davenport, T. *Process Innovation.* Cambridge: HBS Press, 1993.

Day, G., "The Capabilities of Market-driven Organizations", *Journal of Marketing*, Fall 1994.

Day, G. *Marketing Driven Strategy: Processes for Creating Value.* New York: The Free Press, 1990.

Demidchuk, R., "Steelmaking: Technological Dynamics". Unpublished Master's, MIT Sloan School of Management, June 1996.

Edington, J., Executive Director, Technology, British Steel plc. Personal Interview, February 1997.

Edington, J. "The New World of Steel", 43rd Hatfield Memorial Lecture, London, December 1995.

Flannery, I, et al. *People, Performance and Pay.* New York: The Free Press, 1996.

Flemings, M. "Continuous Casting". Notes for MIT Engineering School class, 3.185, Fall 1996.

Foster, R. *Innovation: The Attacker's Advantage.* Summit Books, 1986.

Goold, M. with Quinn, J.J. *Strategic Control: Milestones for Long-Term Performance.* Cambridge: Pitman Publishing.

BIBLIOGRAPHY
(continued)

Grove, A. *Only the Paranoid Survive.* New York: Doubleday, 1996.

Hamel, G. and Prahalad, C.K. *Competing for the Future.* Cambridge: HBS Books, 1994.

Hammer, M. *Beyond Reengineering.* New York: HarperBusiness, 1996.

Hammer, M. and Champy, J. *Reengineering the Corporation.* New York: Harper, 1993.

Hammer, M. and Stanton, S. *The Reengineering Revolution: A Handbook.* New York: HarperBusiness, 1995.

Hayes, R., Pisano, G., and Upton, D. *Strategic Operations: Competing Through Capabilities.* New York: The Free Press, 1996.

Hayes, R., Wheelwright, S., and Clark, K. *Dynamic Manufacturing: Creating the Learning Organization.* New York: The Free Press, 1988.

Heskett, J., Sasser, W.E., and Hart, C. *Service Breakthroughs: Changing the Rules of the Game.* New York: The Free Press, 1990.

Hogan, W.T. *Steel in the 21st Century.* Boston: Lexington Books, 1994.

Hope, T. and Hope, J. Transforming the Bottom Line. Cambridge: HBS Press.

IISI, "Ultralight steel auto body", press release -Set. 6 1995

Imai, M. *Kaizen: The Key to Japan's Competitive Success.* New York: McGraw-Hill, 1996.

Iverson, K., Paper presented at Steel Survival Strategies XI conference, June 1996

Kaplan, R. and Norton, D., "Using the Balanced Scorecard as a Strategic Management System," *Harvard Business Review*, January/February, 1996.

Kaplan, R. and Norton, D., "The balanced Scorecard: Measures That Drive Performance", *Harvard Business Review*, January/February, 1992.

Kaplan, R. and Norton, D. *The Balanced Scorecard.* Cambridge: HBS Press, 1996.

Kaydos, L. *Measuring, Managing, and Maximizing Performance.* Productivity Press, 1991.

BIBLIOGRAPHY
(continued)

Kotler, P. *Marketing Management: Analysis, Planning, Implementation, and Control.* New Jersey: Prentice Hall, 1997.

Kotter, J.P. Leading Change. Cambridge: HBS Press.

Leibfried, K. and McNair, C. *Benchmarking: A Tool for Continuous Improvement.* New York: Harper Collins, 1992.

Lichtenstein, J.., "The Future Profile of the Iron and Steel Industry". Presentation at ILAFA 37, October 1996.

Lichtenstein, John, Director of Metals and Resources, Arthur D. Little. Personal Interview, February and April, 1997.

Lichtenstein, J. "The future profile of the Iron and Steel Industry". Presented to ILAFA 37, Monterrey, October 1996b.

Lichtenstein, J., Arthur D. Little. "Steel Survival Strategies XI", Conference Proceedings, June 18-19, 1996a.

Martin, D., "The Evolution of New Steels", *Iron Age*, January, 1997.

Moore, G. *Inside the Tornado.* New York: HarperBusiness, 1995.

Nucor at a Crossroads, Harvard Business School Case No. 9-793-039. May 1993.

Nutting, J., "The shape of tins to come: Novel contours would add value to drink cans", *Financial Times*, December 1996.

Parrish, M., Vice President and General Manager of Nucor Steel Division (Hickman), Arkansas. Personal Interview, January, 1997.

Pfeffer, M. *Competitive Advantage Through People.* Cambridge: HBS Press, 1994.

Pine, B.J. *Mass Customization: The New Frontier in Business Competition.* Cambridge: HBS Press, 1993.

Pisano, G. The Development Factory: Unlocking the Potential of Process Innovation. Cambridge: HBS Press.

Porter, M. *Competitive Strategy.* New York: The Free Press, 1980.

BIBLIOGRAPHY
(continued)

Prudential Securities INC, company report, December 1996.

Salomon Brothers, UK and European Steel, October 1996.

Senge, P. *The Fifth Discipline.* New York: Doubleday, 1990.

Singer, L., Lynch, G., and Holowaty, M., "Dinosaurs on the lake? Steel in the next decade," *Indiana Business Review*, April 1993.

Szekely, J. and Trapaga, G. "Metallurgical Plant and Technology International", April 1994. Some perspectives on new steelmaking technologies.

Tracy, M. and Wiersma, F. *The Discipline of Market Leaders.* Reading, MA: Addison Wesley, 1995.

Ulrich, D. Human Resource Champions. Cambridge: HBS Press.

Utterback, J., *Mastering the Dynamics of Innovation.* Cambridge: HBS Press, 1994.

von Hippel, E., *The Sources of Innovation.* Oxford: Oxford University Press, 1988.

Wheelwright, S. and Clark, K. *Revolutionizing Product Development: Quantum Leaps in Speed, Efficiency and Quality.* New York: The Free Press, 1992.

Whiteley, R. *The Customer-Driven Company.* Reading, MA: Addison Wesley, 1991.

Whiteley, R. and Hessan, D. *Customer centered growth.* Reading, MA: Addison Wesley, 1996.

Womack, J., Jones, D., and Roos, D. *The Machine That Changed the World.* Rawson Associates, 1990.