SMITH, P. H. Strategic planning parameters for the steel and ferroalloy industries. *INFACON 6. Proceedings of the 6th International Ferroalloys Congress, Cape Town.* Volume 1. Johannesburg, SAIMM, 1992. pp. 13–19.

Strategic Planning Parameters for the Steel and Ferroalloy Industries

P. H. SMITH
Smith, Yuill & Co., Inc., Pittsburgh, USA

Strategic planning is an essential element of successful management. The critical nature of this planning is significantly enhanced in capital-intensive industries such as those producing steel, ferroalloys and non-ferrous metals.

This paper discusses an approach to the forecasting of market-demand trends utilizing the relationship of materials' 'intensity-of-use' in an economy to the gross domestic product of that economy. The paradigm used in the paper is that of the US market for steel.

Introduction

The production of steel in an industrialized and expanding economy has traditionally been regarded as a basic necessity for the continued healthy growth of that economy. In a growing and emerging country, steel, basically as long products*, is consumed in significant quantities; firstly, in civil-engineering projects of the economy, viz roads, bridges, dams, water and sewage plants, buildings, etc., and, secondly, as flat-rolled products for consumer goods such as cars, food and beverage packs, and appliances.

Throughout the Western World, the production of raw steel has peaked, and is declining in most geographical sectors, viz the USA, Canada, Europe, and Japan. Growing economies entering the industrialized phase of their growth are still building steel plants and experiencing expanding demand. The most notable of these is the People's Republic of China, where the demand for steel is still significantly in excess of the domestic production, with imports running in the range of 12-15 million tons† per year.

The purpose of this paper is to examine some of the underlying trends in steel demand and production, and to recognize from those trends their impact upon the strategic and capital planning of various companies, industries, and economies.

Background

For the most part, the general trends and conditions in the industry that are identified in Table I, and the conclusions drawn, are based on American market data[1]. It is hypothesized, and with reason, that the same factors as those affecting the declining demand for steel in the USA are also making an impact on the markets of Canadian, Japanese, and European steel producers. The end-markets of these producers are very similar to those of US producers and, since they are all large exporters to the USA (approximately 18 to 20 million tons per year), the US markets for steel are also their end markets.

A basic factor that has been overlooked by the steel industry's strategic planners is that steel is a mature industry – in fact, very mature — and steel consumption, expressed *per capita* or by some measure of inflation-adjusted gross national product (GNP), is growing more slowly than the GNP. One of the reasons that the USA and other mature industrial countries are experiencing such critical over-capacity is that, in forecasting the future demand and capacity needs, the planners generally used unit growth, i.e. tons, plus an anticipated growth percentage, and overlooked the fact that the amount of steel required to support inflation-adjusted GNP was declining. The planners projected steel growth to be lock-stepped with GNP growth when, in fact, a subtle but slow decoupling was taking place. For example, one study has shown that the finished steel required to support inflation-adjusted unit GNP in the period 1980–1982 was only 70 per cent of that needed in the base period of 1970–1972.

TABLE I
CONDITIONS IN THE STEEL INDUSTRY

- Steel is a mature industry – consumption is growing more slowly than GNP
- Domestic steel production has been declining in this decade
- Major reductions in cost are making steel more competitive with alternative materials, but the future demand for steel is still expected to be relatively flat
- All steel markets are, and will continue to be, highly price competitive

Steel production has been declining in the USA throughout this decade. A sharp peak occurred in the 1972–1974 period, and again in 1979; however, except for the past several years, demand and production have steadily declined in the USA and the balance of the industrialized world.

Throughout the past decade, and even in the late 1970's, major reductions in the cost of production have been achieved by two main thrusts: firstly, through new manning organizations in the steel plants and attendant give-ups and give-backs of benefits and wages and, secondly, by technological advances. A broader application of process technologies, viz continuous casting, ladle metallurgy, the use of computers in process control and production scheduling,

**Long products* refer to bars, rods, beams, structural steel, pipe, tube, wire, rails, and ancillary steel products

†Throughout this paper, *ton* refers to US 2000 pounds

improved materials utilization, and process yield, etc., have all helped reduce costs, and make steel more competitive with substitute materials. Nonetheless, steel demand will remain relatively flat to down in the next decade, and steel pricing will continue to remain very competitive. Even with the mini-boom in steel demand in the USA during 1987–1989, discounts of 20 to 25 per cent from posted list prices have been, and continue to be, very common. It is postulated (in point of fact, even hoped for) that this competitive pressure may well force some producers out of the industry, thus reducing unhealthy price erosion and bringing a better balance to the demand/supply equation.

Geographical Markets

It is not my intention in this paper to examine and/or debate the issues attendant upon steel imports into US markets. However, what I can say, based on personal experience in the industry and competing with steel imports for several decades, is that steel exports to the USA are strongly 'encouraged' by the governments of other countries, and steel imports are more fairly and expeditiously passed through customs barriers into US markets than is the case in the exporters' home markets. 'Encouraged' can also mean subsidized in a plethora of hidden ways in order to generate hard-currency earnings. Furthermore, some countries view access to the American market for their steel as a 'right', not a privilege.

Within the US markets, the major impact of imports is felt in the Pacific Coast and the Gulf Coast/South Central markets; Table II shows the distribution of total steel demand and domestic steel demand. Clearly, the great midwestern markets, bounded by the Alleghenies, the Canadian border, the Rockies, and the mid-South, consume the greatest amount of steel, and are less vulnerable to imports because the Great Lakes freeze over from late November to May and the cost of freight from coastal seaports to midwest destinations is high.

TABLE II
GEOGRAPHIC MARKETS FOR STEEL, %

	Domestic steel	Total steel
North Atlantic	15	15
South Atlantic	7	7
Great Lakes	50	43
South Central	15	18
Plains and Mountains	8	7
Pacific Coast	5	10

Table II also illustrates a point concerning import restrictions. The Pacific Coast market is half imports, mostly from Japan. In 1968, President Johnson arranged the first Voluntary Restraint Arrangement (VRA) on a government-to-government basis with both the Japanese and the Europeans. The Japanese agreed to restrict their exports to no more that 30 per cent of the Pacific Coast market; compliance with this agreement lasted several years and, when substantially breached by the Japanese, was ignored by the governmental authorities in both the USA and Japan. Each subsequent quota agreement, the trigger-pricing mechanisms (TPM) – later VRAs – and product-line limits have generally been abrogated by the foreign producers, with exceptions on certain stainless and specialty steels, and in cases when the US government took appropriate action in order to head off domestic lawsuits against 'dumping', with ensuing countervailing duty penalties.

Distribution of Product Groups

It will be seen from Table III that plain carbon steels still remain the predominant grades within the US markets (slightly over 88 per cent of the total markets), with alloy steels at 10 per cent and stainless steels at 2 per cent accounting for the balance of the demand by chemistry and grade. Carbon steels are those in which the primary alloying elements are carbon and manganese, the 1000 series of steel made to chemistry and strength specifications, and, as resulphurized steels, the 1100 and 1200 series. Alloy steels are those in the 1300 series range and above, according to the designations of the AISI (American Iron and Steel Institute)[2] or SAE (Society for Automotive Engineers), up to the 9400 series.

TABLE III
MAJOR PRODUCT CATEGORIES IN DOMESTIC MILL SHIPMENTS (1985)

Category	Million tons		%	
Semi-finished		1,3		1,8
Heavy products		9,6		13,3
Bar products		12,5		17,3
Pipe and tube		4,0		5,5
Rod and wire		4,0		5,5
Tin-mill products		3,7		5,1
Sheet and strip				
Hot rolled	(13,6)		(18,8)	
Cold rolled	(14,5)		(20,1)	
Coated	(9,1)		(12,6)	
	(37,2)	37,2	(51,5)	51,5
Total		72,3		100
By grade group	%			
Carbon	88			
Alloy	10			
Stainless	2			

Table III shows that the largest product grouping is flat-rolled steels, consisting of hot-rolled, cold-rolled, and coated steels. The product distribution shown in the Table is typical of a mature industrial economy, where consumer products requiring flat-rolled and coated steels provide the greatest demand. In emerging and growing economies, long products, beams, structural steel, bars, rods, and wire would be a much larger fraction of the total product mix. However, when tin-mill products are added to flat-rolled, and, when certain welded pipe and tube products made from flat-rolled steel are added back, it is clear that, from the point of view of a mechanical-conversion process, flat-rolled steels account for well over half of the output.

The Changing Structure of the Industry

The past decade has seen an acceleration in the rate of change in the structure of the industry, viz from large, integrated plants with ore mines, coal mines, shipping fleets, melt shops, blast furnaces, coke plants, hot mills, cold mills, sheet mills, large research facilities, etc., to smaller, semi-integrated plants. Table IV summarizes some of the key determinants of the typical 'large company' profile. In addition to these, it can also be said that the large companies tend to be more traditional in their approach to managing the business, currently are not innovators, have pyramidic hierarchical organizational structures, and are union-

TABLE IV
STRUCTURE OF 'BIG' STEEL
INDUSTRY (70% OF PRODUCTION)

Typical Company

- Controls raw-material sources (coal, iron ore)
- Operates large, inflexible production units
- Serves large buyers with multiple product lines
- Has facilities that are a mix of older and new equipment
- Competes mainly with other 'big' companies (approximately 10 producers) and imports

Industry Problems

- No growth to help finance modernization
- Very high employment costs
- Competition from foreign producers operating under different economic and political structures
- Cyclical demand
- Excess capacity in place, high cost of exit

Industry Strengths

- High cost of entry for competitors in major product lines (flat-rolled)

TABLE V
STRUCTURE OF 'LITTLE' STEEL
INDUSTRY (30% OF PRODUCTION)

Typical Company

- Uses scrap as its major raw material
- Has a limited product line, serves a regional market
- Concentrates on service: quick delivery (inventory of finished goods)
- Has new facilities, using modern technology
- Has low labour content in costs, high asset utilization

Industry Problems

- Saturation of markets in current product lines
- Vulnerability to scrap-price fluctuations
- Increasing capital costs for modernization and expansion

Industry Strengths

- Low-cost supplier to US market
- Potential for increasing breadth of product lines
- Large US scrap pool and scrap generation

ized by the United Steel Workers of America, with whom they usually enjoy an adversarial 'them or us' working relationship.

In the late 1980s, large companies accounted for about 70 per cent of the steel produced in the USA, and typical companies would be United States Steel, Bethlehem Steel, Armco Steel, LTV (made up of the former Youngstown Sheet & Tube Co., Jones & Laughlin Steel, and Republic Steel), Inland Steel, National Steel (90 per cent owned by Nippon Kokan of Japan), and Wheeling–Pittsburgh Steel. A further distinguishing feature of the large, integrated companies is that they have experienced heavy losses over the past decade (over $10 billion), are losing their market share, and are experiencing both declining capital and R & D development expenditures. They are also closing plants and retrenching capacity.

In contrast, the 'little' steel companies are experiencing positive trends in every area in which the large companies are suffering negative trends. Companies in this group, whose typical profile is shown in Table V, account for 30 per cent of the market, and their market share is growing. These companies tend to have organizational structures of matrix-management style, with few layers of supervision, are not unionized, and have a very cohesive 'can-do' dynamic in their human-relations policies. They are innovative, are spending more heavily on R & D and the upgrading of capital equipment in their plants, and are expanding. They are also fairly profitable, and non-traditional in their approach to problem solving. The pay scales in these companies are 65 to 75 per cent of those of the big steel companies, and the fringe benefits are lower, but profit sharing can, and usually does, give the total take-home pay a very healthy boost. Whereas 'big' steel operates under collective-bargaining labour agreements that are often restrictive and inhibit cost reduction, yield, and quality improvement, the small plants have greater flexibility in their utilization of human skills. 'Big' steel is more autocratic in its management dynamic, which is Theory X style while 'little' steel is Theory Y style, and more consultative and participative in day-to-day management. In 'big' steel, plant employees are identified by a clock number and work on an hourly pay scale; in 'little' steel, plant employees are usually on weekly salary and sign a weekly time-attendance sheet, using their family name.

Predictably, morale in the small companies is higher than in 'big' steel, and job satisfaction is considerably greater.

Some typical companies in this 'little' steel grouping are Nucor, Chaparral Steel, New Jersey Steel, the Co-Steel Group, and Birmingham Steel. The men who founded and are developing these companies are innovators who have pioneered new technologies: Iverson, Heffernan, Forward, Pasquarelli, and Todd, to name but a few.

Trends in Market Demand

The Arthur D. Little research group of Cambridge, Massachusetts, carried out some pioneering studies of steel demand and consumption at various stages in economic growth and maturation, considering economies in the emerging, industrial, and post-industrial phases. The data from one of those studies have been used in this paper. Recognition of where an economy, or company, is positioned with regard to these longer-term trend lines is critical from the point of view of strategic and facilities planning.

The determinant factors listed in Table VI lead to an intensity-of-use* index, which has a value of 100 for the base year of 1964. Figure 1, which shows the longer-term trend line from 1950 to the early 1980's, shows a 33-year negative trend line of 2,2 per cent. This significant downward trend is not readily recognized when unit tons shipped and traditional economic measures are compared on a year-to-year basis. Figure 2 shows the same trend line but divided into three time periods during which steel's intensity of use has varied significantly. Of more serious note, however, is the fact that the trendline from 1970 onward declines at a faster pace than the long-term trend. It may well be that the flattening of the trend line in the 1960–1969 period resulted from an increased demand for ordnance during the Vietnam War.

Within the traditional steel industry, planners have customarily based their forecasts of steel demand and facilities needs on forecasts of the GNP or gross domestic product (GDP), industrial-demand trend lines, construction and con-

*The selection of the appropriate descriptive term was neither lightly taken nor easily made. Other terms were also considered; after much consideration, 'intensity of use' was chosen. In essence, this describes the efficiency of the utilization of steel in the support of a given level of activity in gross domestic production

TABLE VI
INTENSITY OF USE

- Compares material consumption to measures of economic activity
- Can show trends over time in the importance of a material in the economy
- Can measure relative levels of material use in the economies of different countries
- Can provide indications of trends in the use of different materials in the economy over a given time period
- Can indicate which specific products and which sectors of the economy are changing most in material use relative to the activity in the sector

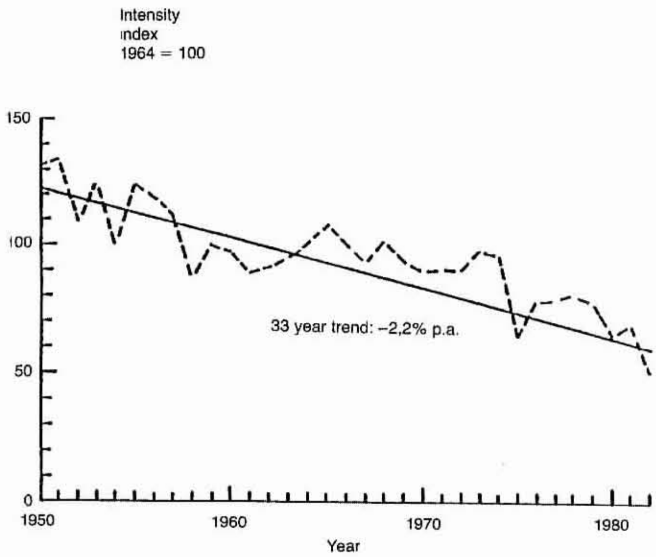

FIGURE 1. Intensity of steel use in the USA 1950 – 1982

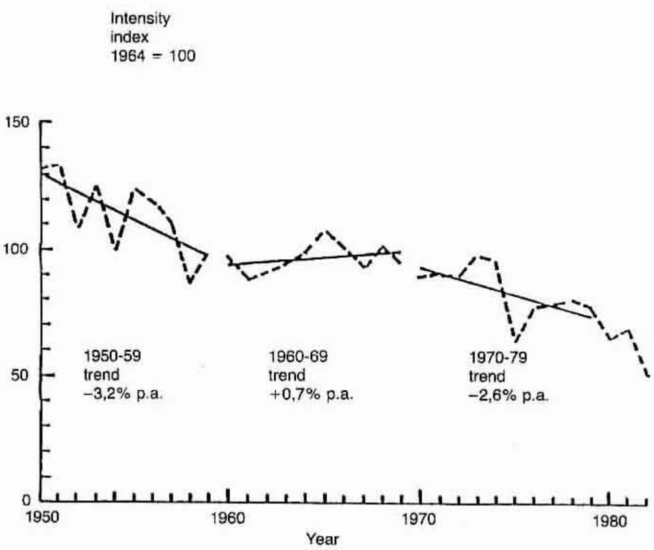

FIGURE 2. Intensity of steel use divided into three decades

sumer demand, etc. However, within these trend lines, subtle shifts of market demand have resulted from the downsizing of cars, materials substitution, slowdown in plant building, improved quality within steel-making and ensuing fabrication processes, improved strength-to-mass ratios through alloying, and so on. Taken singly, these shifts are often masked, subtle, and difficult to identify, but the cumulative and compound effect is quite significant, as Figures 1 and 2 show. As a result, facilities planning in the steel industry, which relied upon the traditional approach of economic determinants, led to significant excess capacity, both in the USA and world-wide. Excess plant capacity in the USA is in the 25 to 30 per cent range; similarly, the Organization for Economic Cooperation and Development, (OECD) recently reported its estimate of world excess capacity to be about 20 per cent.

A useful illustration of how the intensity-of-use index for steel has declined in the automobile markets is shown in Table VII. A comparison of the amount of steel used in an automobile between 1977 and 1985 shows the dual effect of both substitution and improvement in the strength-to-mass efficiency in steel usage. As a result, close to one-third of a ton less steel is used per automobile and, in a year in which 10 to 12 million domestic automobiles and light trucks are produced, 3 to 4 million tons less steel are consumed. When to this loss is added the steel imported via foreign-made cars, trucks, and parts, the impact is very significant. Coincident with these trends in market demand, there has been a gradual and steadily efficient improvement in the use of steel. Within the distribution chain, the increased handling of steel by distributors or warehouses (Table VIII), now up to 25 per cent of the market, has meant a reduction in the loss in yield from scrappage at the warehouse customers' plants. Another trend of considerable significance has been the demands upon the steel industry by automobile and appliance manufacturers to have their shipments manufactured to within one-half to two-thirds of the published product tolerances – a move that also improves the yield and reduces the consumption of steel.

TABLE VII
AUTOMOBILE MATERIALS – CHANGES AFFECTING STEEL MASS (1977–1985)

	Pounds	
Steel mass per vehicle, 1977	2 315	
Less:		
Parts converted to aluminium	10	
Parts converted to plastics	25	
Loss to competitive materials	35	5%
Less:		
Parts eliminated, or reduced in size but still made of steel	620	95%
Total mass reduction of steel	655	100%
Steel mass per vehicle, 1985	1 660	

TABLE VIII
PRINCIPAL MARKETS FOR STEEL

Customer industry	% of domestic steel	Major products purchased
Distributors	25	All products
Automotive	20	Sheet and strip Special quality bars
Construction	15	Structural shapes Rebars Plates
Machinery and equipment	10	All products
Containers	5	Sheet
Steel production	8	Semi-finished sheet
Appliances	2	Sheet
Other/not specified	15	–

Technical Developments

While the US industry in general has tended to reduce expenditures on R & D over the past decade, a number of companies, particularly the smaller innovative ones, have been stepping up their R & D activities. During the expansion of 1945–1975, the research, pilot-plant, and in-plant developmental activities of the industry leaders were outstanding, and produced significant results. Today, those efforts are virtually non-existent, with the possible exception of Inland Steel, and now the 'big' industry is living on purchased technology and its own aging and depleting technological 'bank account'. To keep this in perspective, however, several points can be made, viz that significant major shifts in technical emphasis have also occurred. Firstly, while de-emphasizing or discontinuing internal R & D and pilot-plant efforts, major companies have initiated multi-sponsor projects under the aegis of external research entities, for example Carnegie–Mellon University and The Massachusetts Institute of Technology. Secondly, engineering groups have become more innovative, and have taken R & D activity from the companies (and universities) to engineering facilities for refinement and scale-up. This latter trend has been of considerable assistance to the small companies in particular. The newer technical innovations, such as horizontal casting and thin-strip casting, are coming from the smaller companies, and the results appear significant. The increased implementation of thin-strip casting will further improve the yield and usage efficiency, and will again cause a reduction in the amount of steel needed to support a unit of GNP.

The basic dynamic of the process-improvement efforts throughout the industry is summarized in Table IX. All the companies, large and small, are concentrating their efforts in these various areas to differing degrees, and the ultimate financial survival of each entity will depend upon the success of their achievements in these areas.

TABLE IX
RECENT TECHNICAL DEVELOPMENTS IN STEEL

- Basic thrusts of technical efforts
  1. Reduce costs of production
     - Improve yields
     - Increase asset utilization
  2. Reduce costs (prices) to users
     - Reduce rejections
     - Tailor products for specific uses
     - Achieve required properties at lower manufacturing cost

'There are no steel-mill products where the cost of production is not ultimately critical to the producer's success.'

Trends in the Demand for Steel and Other Metals

The subtle shift in declining use of steel in the USA in earlier years was largely unrecognized while unit production was climbing. The question will naturally be asked, 'Is this trend going on only in the United States?' The answer is a clear and unequivocal 'No'; it is happening in the other major industrialized economies, too. Figure 3 shows the trends of declining intensity of steel use in the major steel-producing countries from the early 1970's to the early 1980's, and these declines are actually steeper than those in the USA in certain cases. Of course, the growth rates shown for South Korea and Taiwan partially mirror the declines in the other areas, since Korean exports to these markets have substituted for domestic production. It is interesting to note the Japanese decline, which has to be viewed in the light of Japan's position as a 'superpower' in steel in the late 1960's and 1970's; even today, half of the American imports of steel are Japanese, and Japanese steel exports in the form of consumer durables, cars, etc., around the world are by no means insignificant. The retrenchment of production capacity in Japan has been massive — and the capacity is not yet totally in balance with the demand. *It will be however;* MITI, the Japanese Ministry for International Trade & Industry, will see to that! The efficacy of the Japanese approach is shown by the fact that, while the industrialized world's steel industry is in decline and largely unprofitable, the Japanese industry is operating at very high levels, *and* profitably too.

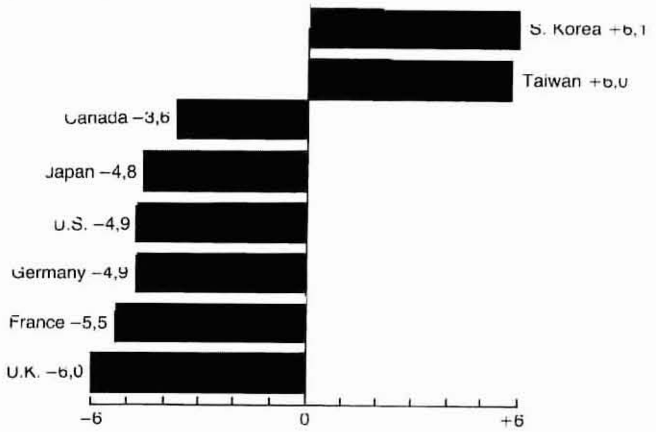

FIGURE 3. Changes in the intensity of steel usage in various nations, early 1970's to early 1980's, in percentages per annum

It is interesting to study the shift in the intensity of steel consumption in the decade 1973–1982, and observe how it has affected product sectors within the industry. In Figure 4, it will be noted that, while the GNP grew in that period and the traditionally steel-consuming sectors grew similarly, many of the large-tonnage sectors of the steel markets did not keep pace with this growth. The apparent growth in pipe and tube is an aberration because of the inclusion in

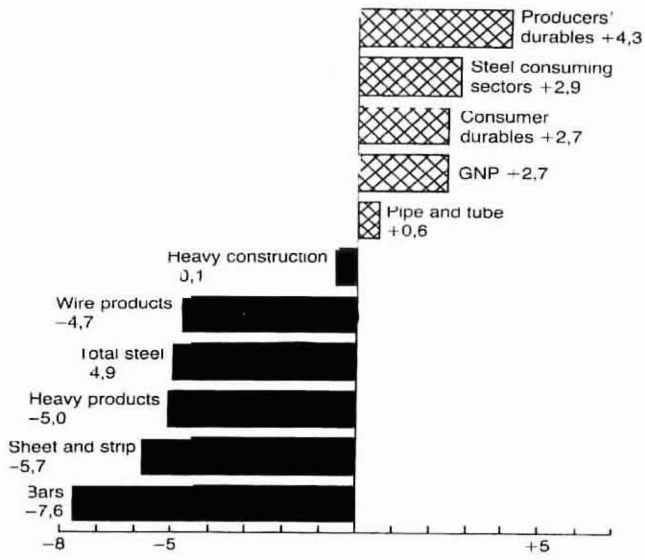

FIGURE 4. Economic growth and steel intensity use, 1973–1982

this period of the surge in oil and gas activity in the late 1970's following the upheaval in Iran. The oil-and-gas activity bubble collapsed in early 1982, and excess inventories in pipe and tube have plagued the market throughout this decade. Figure 5 reflects similar data.

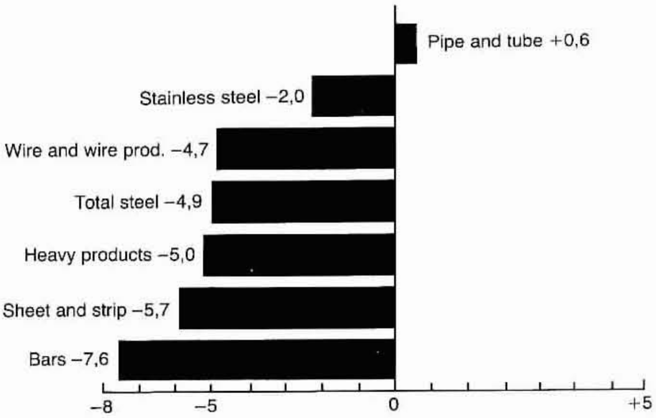

FIGURE 5. Changes in steel intensity 1973–1982 by product category

The question may well be asked, 'Is steel the only metal affected by this gradual but inexorable shift in intensity of use?'. Figure 6 compares the change in the intensity of steel usage with that of other frequently used industrial metals and, clearly, the trend applies to a broader spectrum than steel alone. It should be noted, however, that the data for steel and aluminium have to be viewed in the context of aluminium's steady erosion of steel's markets, particularly in the beverage-container market and in certain automotive applications.

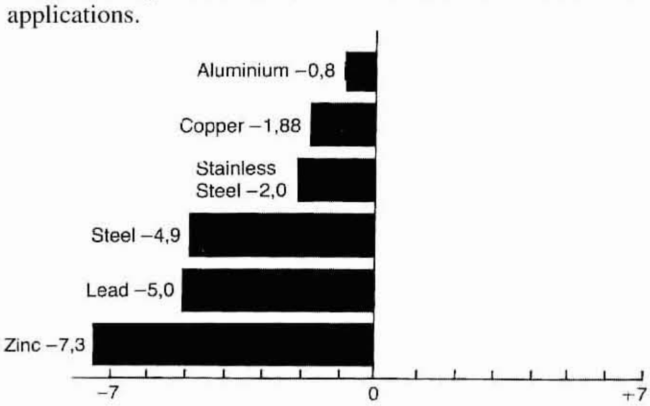

FIGURE 6. Changes in material intensity 1973–1982, in percentages per annum

Collateral Planning Factors

Recognizing, then, these trends and their impact upon the steel and non-ferrous industries, it is appropriate for us to turn to the collateral impacts upon the market sectors to which 'steel' is a *key* market. These would be industries such as capital machinery, ceramics and refractories, alloying supplies, and operating service support. This paper will focus on alloy supply and, while these views are primarily based upon American markets, they apply equally well to steel markets worldwide.

The standard ferro-alloy families are as follows:

Standard ferromanganese	Ferrovanadium
Medium-carbon ferromanganese	Ferroboron
Low-carbon ferromanganese	Ferrocalcium
Low-phosphorus ferromanganese	Ferrotitanium
Ferrochromium	Ferroaluminium
Ferrocolumbium	Ferrozirconium
Ferrosilicon	Ferromolybdenum
Ferromanganese silicon	Ferrotungsten
Silicomanganese	Ferromischmetal.

The complexity and sophistication of the various qualities and grades of steel produced change as the market matures, and thus the gradual shift from long products to high-quality coated flat products and more complex alloy steels will inevitably change the demand for ferroalloys and other alloying elements. A steel plant making reinforcing bars, structural steel, rods, standard plates, etc. will not be a purchaser of a broad range of alloys; manganese in some form will be the key alloy, coupled with some form of silicon. In contrast, an integrated steel mill serving broad industrial markets such as the automotive, aircraft and aerospace, capital goods, consumer durables, oil-country goods, etc., will be a consumer of a *very* broad range of ferroalloys.

This factor can be seen in more detail from a brief review of the AISI or SAE steel classifications. As the number designation climbs and the steel grade becomes more complex metallurgically, the alloy needs grow accordingly.

Grade	**Alloy requirement**
1000, 1100, 1200 Series	Mn and Si
1300 Series	Mn and Si
4000 Series	Mn, Si, and Mo
4100 Series	Mn, Si, Cr, and Mo
4300 Series	Mn, Si, Cr, Ni, and Mo
4600 Series	Mn, Si, Ni, and Mo
4700 Series	Mn, Si, Ni, Cr, and Mo
4800 Series	Mn, Si, Ni, and Mo
5100 Series	Mn, Si, and Cr
5200 Series	Mn, Si, and Cr
6150 Series	Mn, Si, Cr, and Va
8600 Series	Mn, Si, Ni, Cr, and Mo
8700 Series	Mn, Si, Ni, Cr, and Mo
8800 Series	Mn, Si, Ni, Cr, and Mo
9259 Series	Mn, Si, and Cr
9260 Series	Mn and Si.

To these standard steel-alloy series can be added the boron- and vanadium-treated steels, the 1500 steels, and the H-band steels; for these, the alloy requirements are similar to those listed.

From available market-research data, and a knowledge of the market segments to which each of these steels are sold, it is relatively easy to forecast the changing demands for alloys as the markets mature and become more sophisticated. For example, as automobiles became smaller and somewhat lighter, the performance characteristics were enhanced, and it was predictable that strength-to-mass ratios for automotive steels would climb. More sophisticated alloys would therefore be required and, in turn, a different alloy mix. Nonetheless, the trend in the intensity of use of steel has in turn had a profound impact on changes in the demand for ferroalloys.

Summary

In summary, the approach from the viewpoint of intensity of use in relation to economic activity, rather than units produced, provides a sounder interrelationship measure for the projection of future demand for these metals. Failure to recognize these trends within these industries has led to over-capacity, price deterioration, financial disintermediation and, eventually, to rationalization and then renewed financial health.

Strategic planning must also recognize that significant increases in capital investment will be required to sustain the more sophisticated market demand reflected in the intensity-of-use trends. As we look forward to the installation and production use of the advanced technology required now in the industry – desulphurization stations for blast-furnace hot metal, ladle metallurgy, alloy-injection systems, advanced vacuum degassing for the removal of both gas and non-metallics, continuous-variable crown control (cvcc) for crown and gauge control, high-speed continuous cleaning and annealing, quality-assurance and process-control computers, etc., to name just a few of the 'musts' – the capital requirements mount appreciably.

This paper has sought to show how such trends in the intensity of use have impacted on the steel and non-ferrous industries, and, to some extent, on the suppliers to the steel industry.

References

1. *Annual statistical reports*, American Iron and Steel Institute, and *US annual statistical abstracts*, Washington, D.C.
2. *Steel product manuals*, American Iron and Steel Institute, Washington, D.C.