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Iron and steel industry
Contribution to sector report by Brian Cooper

For UNIDO Global Report 1988

Overall outline

1988 saw a record output for the world iron and steel industry with a total output of 780Mt of crude steeel produced, 6% above the figure for the previous year. The growth is attributed to demand from the automotive and construction sectors. This growth was achieved in the western industrialised world, the developing world and in the centrally planned economies, to differing degrees. The Western World experienced a growth of 8.3% to 487.6Mt, with the United States showing a 12.2% increase to 90.8Mt. The European Community output at 137.5Mt was 8.6% above the year earlier figure and the other major contributor to the sector - Japan- produced 105.7Mt, 7.3% above the 1987 result.

The wetern industrialised world recorded a growth of 8.4% above the previous level at 391Mt, but outside these countries growth was less spectacular. The USSR and other East European CMEA member countries increased production to an estimated 226.6Mt representing an increase of only 0.8% , whilst the Peoples Republic of China and other Asian centrally planned economies produced 65.8Mt, 4.8% higher than estimated for 1987.

For countries belonging to the Organisation for Economic Cooperation and Development (OECD), growth was almost 9% overall, and consumption in the OECD area was given as 11%

higher than for the previous year. Indeed demand reached its highest level since 1979.

In the United States, where the steel making industry is entirely privately run, many companies were able to post profits for the first time in a decade. In Australia where the steel industry is dominated by BHP, again a private company, profits were once agin posted after a massive rationalisation programme. In most other countries there is a degree of government involvement in the steelmaking industry, noticeably in Europe, Latin America and , of course, in the centrally planned economies. In Japan the Big Five steelmaking companies have become increasingly diversified and so rely less on steel for their overall performance. However rationalisation plans by these companies in the steel sector have been slowed down as demand was sustained throughout the year and satisfactory figures were recorded generally. In Europe , the EEC 'crisis' regime was finally phased out completely, leaving EEC steelmakers exposed to the realities of free markets. This turned out to be less than terrible since the market conditions were actually bettter suited to a system of no quotas on production levels and enabled steelmakers to increase capacity utilisation and make money on volume.

The other major market economy regions involved in steelmaking are Latin America and South East Asian countries. Latin America recorded a 7% growth in crude steel output completing six years of uninterrupted growth at a cumulative annual rate of 5%, passing from 27Mt in 1980 to 42.4Mt in 1988. Despite this the commercial side of Latin American steelmaking remains decidedly unsatisfactory with low internal prices, insufficient profitability, high indebtedness and interest rates, scarce credit,and (claim the Latin Americans) protectionist policies being pursued by the industrialised countries concerning imports.

The South East Asian growth countries of South Korea and Taiwan have enjoyed government support in the setting up of their steelmaking industries, but have recently made the major companies of Pohang (S. Korea) and China Steel (Taiwan) more self supporting by partially privatising these companies.The other South East Asian countries do not have major iron and steel industries, although Malaysia does produce steel from domestically produced direct reduced iron .

The timing of the buoyant market in Europe was fortunate for the British Steel Corporation which was privatised at the end of last year after having announced record profits. Other European steelmakers are also being removed from governmental control now that Community rules make there little advantage in being shielded from the marketplace with subsidies.There is probably relief from both sides - from the steelmakers since they can now develop their companies along strictly commercial lines without regard to politics, and from the governments since they will no longer have to pour money into the industry when times once again become hard, as it is generally agreed that they will. 1989 is not viewed as being a picnic by steel forecasters. The current market may persist for some time, but it is clear that steel will not continue its present growth rate.

Measurement of production

Traditionally steel production has been measured in terms of crude steel, ie liquid steel which is poured from the furnace or converter plant. This was the way in which individual plants measured production, and not surprisingly these figures were summed up to give a country's output. It has become increasingly recognised that this method is unfair and does not give a true picture of steel production. It might be considered to be tampering with statistics to produce a more palatable result, but the truth is that the nature of steel production is such that crude tonnage is not a fair estimate of the success of the product in the marketplace. The section below on technical developments will help to explain this, but there are two main reasons why this is the case. Liquid steel is not an end product, but only an interim state. What has happened in recent years is that a considerably more efficient way has been found of converting liquid steel into so-called semi-finished steel, ie slabs, blooms and billets, and that is by continuous casting. The introduction of this technology has been estimated to increase yield figures by up to 25%, and so considerably less liquid steel is needed to make the same tonnage of semi-finished steel. The second main reason for the statistical inaccuracy is that steel has been developed as a product into a more competitive,higher strength, better performing material.

To build the same structure or component using steel now takes less of the material in weight terms, although the value of the steel may indeed be higher , and probably will be.
In order to get around this problem, which creates a negative impression in the public eye that steel is a dying material, the International Iron and Steel Institute in Brussels has developed a method of recording steel output based on finished steel. Although this may sound simple and obvious , it is far from that, since the finised products from a steel mill differ considerably from one another and it becomes very difficult to compare like with like.The IISI has 44 member countries from which it now obtains these revised statistics, but it is virtually impossible to obtain parallel figures from non-member countries which are largely in the Communist bloc. Nevertheless the overall meassage is that crude steel figures reflect too pessimistic a picture of steel output, and that the liquid steel growth reported in the 1988 figures from nearly all countries represents in fact the overpowering story that steel is not a material of the past, wreathed in the image of a smokestack industry, but that it is a competitive.
modern,developing material which has a real future in a wide range of industry sectors,- notably automotive, where the threat from aluminium and plastics has been long recognised and challenged,- in the construction sector where steel has actually been making major inroads into the market which has ben dominated by reinforced concrete, - and in general

engineering where the properties of steel have long been recognised and never replaced.

What is Steel?

The statistics which make up the larger part of this type of report do not tell a useful story unless the context of the steel industry is understood in some way. Steel is used as a material by all countries, no matter what their state of industrialisation or development is. Yet far from all countries actually produce steel. The steelmaking industry is considered by steelmakers to involve the actual melting of steel, and although many countries would claim a steel industry, in fact they do not all melt steel. They may be involved in rerolling bought-in billet or in processing strip or other semi-finished product. Some statistics include these activities within their definition of steelmaking, but strictly they are not. They may be involved in the steel industry but they do not make steel; they add value to steel which has been purchased from an outside source.This preamble will help to explain the necessity to put the steelmaking processes into perspective.

It is important to understand that steel is in itself a raw material for other industries, and thereby differs from many other industrial sectors. Its consumers are invariably industrial concerns themselves. Individuals do not buy steel as a product, but only things made from steel. So what does the steel industry produce?

It is generally recognised that the steel industry begins with ironmaking and ends with the delivery of so-called long products or flat products to the consumer industry. Long products are sections, bars, rod and rail. Flat products are sheet in the form of strip and plates. Increasingly the makers of flat products have become involved with transforming their plain strip into coated strip of one kind or another as a result of market demand. This can be either metallic or organically coated, the former being galvanised or tinplate, and the latter painted or plastic coated. Much of the investment made by established steelmakers in recent years has been in strip coating lines to match the needs of the automotive industry demanding rust resistant steel for bodyshells and structural components.

The interesting development in actual steelmaking terms has been how these different product lines have polarised steel production technology into two very different and specific channnels. Whilst they inevitably have overlaps, which will be discussed below, it is worth descibing the two main systems since they have distinct regional qualifications.

Process routes

Integrated plants

To produce flat steel the integrated process route is used exclusively. This involves coke and iron ore as the basic raw materials, and the coke itself must be produced from metallurgical coal.Integrated plants are highly capital intensive and are only viable today if built on coastal sites with deep water ports and have annual capacities of 2Mt or over.

Many of the countries with long established steelmaking plants no longer have the domestic raw materials available, and have to import them. The major sources for iron ore today are Australia, Brazil , the Soviet Union and the United States, although the latter two play only a small part in the world iron ore trade. India has extensive reserves but not of high enough quality to meet the exacting standards of many western integrated plants. Sweden has a well established ore mining industry, and whilst is a player on the international scene, concentrates on specialised qualities for the European market. Coal is equally an internationally traded commodity, with Australia being a major supplier again. Metallurgical coal is transformed to coke in coke ovens which may or may not be attached to the ironworks, and is then charged with iron ore and limestone into the blast furnace from which the product is liquid iron, referred to as hot metal. After desulphurisation and dephosphorisation the hot metal is charged into a basic oxygen converter where it is blown with oxygen to remove carbon and produce liquid steel.A typical batch size at this stage is in the order of 300t. In most modern steelplants this liquid steel is now treated at a secondary steelmaking station where it is degassed, refined. stirred and adjusted for temperature prior to casting via continuous casters. It is at this point that the steel first takes its shape, and is cast into either slabs- for rolling into flat products such as wide strip, -

blooms for rolling into rails or heavy sections, -or billets for rolling into rod, bar and light sections. An integrated plant may have all of these facilities, but it is becoming increasingly uncommon for it to have only bloom and billet casting plant. This is because of the competition which has been provided by the second main steelmaking process route, known generally as the minimill.

Minimills

A minimill produces bloom and billet via a very different primary stage. It uses scrap as its main raw material, and melts it in an electric arc furnace, refines it through a secondary steelmaking plant where appropriate and casts again through continuous casters.They are far less capital intensive than integrated plants and would typically have single plant sizes of up to one million tonnes per year capacity. The minis started up competing in the lower end of the market producing reinforcing bar for concrete where quality requirements were low, and scrap was an adequate raw material, and continue to concentrate very successfully in this area. So successful have they been that the integrated plants have been largely squeezed right out of this market sector. They have been built at relatively low capital cost in regions of good scrap availability and have served a localised market. These conditions the integrated plants have found it hard to match, and they have in many cases been forced to abandon the rebar market. In the United States, arguably the most effective market economy in the World, the minimills have made the most significant impact, but in Europe too they have had considerable influence.

It is interesting to note that in those countries where the minimill might have been expected to make a real contribution to national infrastructure, ie where there has been a rapid expansion in building,and low capital availability,n such as in developing nations, it has been unable to capitalise on its advantages since those countries neither had a ready supply of scrap steel or a dependable electricty network - both essential for the successful minimill. This is where the anomalies start to happen. India is a classic case in point. The integrated plants owned by the state have been losing money for years. They have been using out of date plant, resulting in low productivity and poor quality. There has been a demand for rebar and light sections from the building industry, and it might be expected that the minimill formula could have filled a need. Minimills were built in many locations , but they competed for the limited scrap supply which is normally the case in a newly industrialised country, and the power grid was insufficiently reliable to provide the electricity to drive the furnaces. The scrap problem was then met by a new development called direct reduced iron. This is a solid charge material suitable for arc furnaces which is produced from lower grade iron ores and coals (or natural gas). India has large reserves of both low grade ore and coal and so the conditions would seem right for the production of DRI as the feedstock for the arc furnaces.

Unfortunately this simple resolution has not proved to solve the problem in India, as the DR technology has not met the promise of its promoters, and the power problems persist. However in some other countries direct reduced iron has been exploited successfully. In Venezuela, the huge natural gas fields are being exploited to reduce iron ore into DR pellets for export, and in South Africa, coal based DR technology has been refined to the point where it is operating successfully. A very specialised production technique in New Zealand has also proved to be technically feasible, although commercial problems have dogged the new plant of New Zealand Steel.In Europe and the United States DR iron is not produced, and neither is it used in any quantities since scrap is readily available at competitive prices. How long this will remain the case is interesting to speculate, since it is largely an economic arguement for the minimills which raw material they choose to use.

Whilst it is largely an economic arguement it is not exclusively so, since direct reduced iron does have quality advantages over scrap. There is a trend nowadays , especially in the developed countries, for minimills to move up market in their product range, and to enable them to do so they rely on a better quality of feedstock material. This can either be more highly segregated scrap, at an increased cost. or DRI. Indeed one minimill operator in the United States is being watched extremely closely at the moment as he brings on stream the worlds first minimill plant which will make flat products, previously the sole domain of the integrated producers. This plant will be melting scrap in addition to DRI imported from Venezuela.

But it should not be thought that the electric arc furnace route is only used to produce 'basic' steel grades. Indeed this could not be further from the truth, since the very large part of special engineering and tool steel grades plus stainless steels are also produced through the electric route. The reason for this is that the batch sizes tend to be smaller, and the mini concept is able to provide a more flexible service to the customer. In the case of these special grades, scrap selection becomes even more important, and seconday steelmaking, sometimes referred to as ladle metallurgy, is a vital and integral part of the process. Indeed there are also some very specialised remelting techniques used to produce high quality, highly alloyed ingots and billets for special forging applications. This market could not be more different from the rebar market,and yet it is all included blandly in the steel output statistics.

Now that the basic steel producing process have been outlined, ie integrated for flat products, minimill for long products and electric arc furnace for special steels, it is time to realsie that the real situation is not cut and dried. There are many hybrid operations which involve mixtures of technology either to suit local condtions or as a result of historical development. Particularly in the developing countries one sees various hybrid operations. But also in the developing countries are seen the very latest in dedicated integrated and minimill plants, built to incorporate the latest state of the art technology which has been supplied by the traditional steel producing countries such as Japan, West Germany, United Kingdom or the United States.Open hearth furnace are still to be found in many countries, although the western industrialised nations would have to look hard to find one operating.In Eastern European countries and the USSR however, open hearth furnaces still provide up to half of total production.

New technologies

The words 'new technologies' have come to mean electronics, computers and automated systems. Whilst this is relevant to the steel industry, and indeed a vital contributor to high productivity and efficiency, new technology also refers to newly developed processes which are continually under examination. The decade of hard times which the steel industry has recently pulled through provided a much needed stimulus to research and develop new energy saving, environmentally acceptable technologies which are today being put into practice. The result has been that the steel industry has cleaned up its act and become a dynamic market led industry, which is able to respond to customer demand and produce an economically attractive product.

Process control

The introduction of reliable automated process control equipment has had an enormous impact on all stages of the steelmaking process from blast furnace operation right through to rolling mills.Without modern process control equipment other advances would have been impossible, and for the integrated plant in particular the concept of 'hot charging' has now become commonplace in just the last five years. This technique sounds obvious. It is a method of maintaining the heat in the cast slab, bloom or billet, to reduce the energy input at the reheating furnace prior to hot rolling. At the same time it reduces energy consumption, reduces work in progress, speeds production and reduces capital plant requirements. The downside is that it is difficult to manage since it allows for no errors in scheduling and is very demanding on machine reliability. There is no allowance for buffer stocking in theory, although in practice there is always a degree of buffering and an element of reheating.Hot charging itself has degrees of refinement depending on the actual operation, and the ultimate variation is to hot direct charge with no cooling down or reheating allowed at all. This would not be possible without complex central control on all items of equipment throughout the steelplant. The newest integrated plant in the world at Kwangyang in South Korea has been designed for hot direct charging of slabs into the rolling mill. Older plants often have a difficulty with the plant layout, necessitating the transportation of hot slabs over some distance without significant loss of temperature. Nippon Steel in Japan and others have made great advances in this method.

Direct linking

Hot charging is just one form of direct linking. The concept can also be applied to other stages in the steelmaking process, which has always been regarded as a batch process. Today continuous casting is universally applied, and hot linking has joined the caster to the hot mill in a continuous link. Upstream the steelmaking process remains a batch process in the BOS converter, and looks to remain so for the forseeable future. However BOS plants often operate two out of three vessels at a time (with one down for maintenance), and so they can effectively supply a batch-continous flow of steel to the casters. Downstream, however, real progress is being made in the cold mill. Linking of the stages of pickling, cold rolling , anealing, temper rolling and even strip processing such as slitting and shearing is now practised in some European mills. This avoids intermediate decoiling and coiling, saves time and energy and is able to produce a more consistent, and therefore more quality controlled product. The dream of a fully continuous integrated plant may be some years away yet, but the advances of recent years using modern process control equipment lead some to suspect that it is possibe to achieve an automated plant in which the total time to produce strip steel from iron ore is reduced from two or three weeks to just a few hours.

Moving away from coal

The coke ovens have been a cross which integrated plants have had to bear. They are essential in order to run a blast furnace, but they are peripheral, in that they only make the fuel to drive the blast furnace and to reduce the ore.They are expensive, have limited lives and need careful designing to avoid environmental problems.They also need expensive metallurgical coal to convert to coke. Ironmakers have met this problem in three ways;

By developing ways to extend coke oven life using hot refractory repair methods, and thereby reduce the need for new capital investment, and

By developing techniques to reduce the demand for coke in the blast furnace, by using injected granulated or pulverised coal through the blast furnace tuyeres, and

By working on new smelting reduction techniques which use cheaper quality coals and ores to produce hot metal.

The first two methods have become common practice in iron and steelworks in Japan and Western countries, and most of the major companies have been involved to some extent in the third method. To date prototype and pilot plants abound, but only in South Africa has smelting reduction been tried on a commercial scale. Early problems with the plant are now thought to have been overcome, and it is likely that the next year or two will see an acceleration of these process being tried on small commercial scale. This could be of vital interest to developing countries where coal and ore qualities are inadequate to meet the demanding needs of the traditional blast furnace. Capital costs are lower, there is no demand for reliable electricity supply, and product quality should be good. For developed countries where output is high, these smelting reduction technologies are unlikely to meet the huge capacities of blast furnace production, but if they can be scaled up in time to meet the next round of major investment in coke oven facilities, then they will have a promising future. Certainly the industrialised nation steelmakers hope so.

The technique of coal injection is now being widely used, and replacement ratios of up to 120kg per tonne of hot metal have been achieved. The coal is used as a fuel and reducing agent, but has non of the structural properties of the coke in a blast furnace stack, which allows a permeable burden to be maintained. Interestingly, the technique has been developed separately in China, where it is probably more widely used than elsewhere, but other industrialised nations are catching up with significant benefits.

New steelmaking technologies

Pulverised coal also finds increasing application at the steelmaking stage, in converter vessels. electric arc furnaces and in recently developed specialised technologies. It is an energy source which is used to increase the scrap melting potential of converters(which are limited to around 25% scrap under normal conditions), and to reduce electrical energy consumption and electrode wear in arc furnaces. These applications have made technologists realise the possibilities of hybrid systems which rely neither on electricity or on a hot metal supply, and merely inject oxygen, coal and maybe other hydrocarbon fuels in order to provide decarburisation and melting energy in one move. One such system incorporates scrap preheating in addition to further reduce total energy consumption. Once again these steelmaking technologies have a great interest for developing countries which have the required raw materials, since they are flexible in their melting programmes.

The electric arc furnace itself has been the subject of much research and is now a highly tuned primary melting vessel with productivity figures which would have been unheard of just a decade ago. Direct current furnaces and plasma furnaces have been recent interesting ideas which may find success in particular applications. The concept of continuous steelmaking through an electric arc furnace is now in commercial use in the United States, with scrap preheating as an integral part.

Thin slab and strip casting

The impact made by the minimills on the integrated plants has been described above in the long products market. Very recent developments now extend the possibilities for the minimills to further encroach onto the integrateds sector and to produce flat rolled products. This development is known as thin slab or strip casting, and is a technology whereby the casters produce a product which is far nearer to the finished required shape than the traditional casters. Thin slab down to 25mm, and strip down to 3mm is now being cast directly, and the rolling mill requirements have been accordingly reduced. For metallurgical reasons, some rolling is necessary in order to fully exploit the properties of the material, but the traditional and expensive hot mill will no longer be necessary. The massive capital cost involved in building a hot strip mill will be removed and the minis will break into the flats market.They will still have to address the raw material (scrap) quality problem discussed above, but with careful scrap selection and judicious use of DRI this can be overcome. Initially those minis who do try producing flats will not poach on the high quality end of the market, but it is the thin end of the wedge. Integrated plants will also be able to benefit from strip casting technology if speeds can be made sufficiently high. It has take many years for the conventional continuous casters to reach the stage of sophistication, speed and quality production at which they currently operate, and it would be a brave forecaster who would say now that strip or thin slab casting would take over completely, and when.

Environmental control

Environmental control is not strictly new technology, but it is playing an increasingly important role both in developed and newly industrialising countries. Steelmaking has an image of being a dirty industry, but that is now a thing of the past. New steelworks more closely resemble chemical production plants than their older fathers. Up to 20% of total expenditure on a greenfield steelworks is made on environmental control equipment. In many cases there is an energy payback as well, since recovered dusts can be recylced and recovered off-gases are now being used as valuable fuel instead of being flared off as before. On existing plants the problem is more complex since environmental control is viewed as a non-productive expense, but in industrialised countries in particular the legislative requirements are such that a steelmaker can be forced out of business if he does not conform to pollution control regulations. Developing countries often view the problem with a more relaxed approach, which might be interpreted as an irresponsible approach.

Summary

The above should serve to make the reader understand that statistics alone cannot explain what is happening in the steel industry worldwide.The diversity of technologies and the fact that steel is only a raw material for another manufacturer add considerable complication to the interpretation of statistics. However, 1988 was a good year worldwide for steel, but was probably not the beginning of a strong upward trend. Capacity utilisation was high following a decade of rationalisation in the industry and diversification for some of the giants. The achievements of South Korea stand out from the rest, but are seen as part of a burgeoning local economy. China continues to grow strongly, but consumption per capita is still a fraction of that experienced in developed nations. It is bound to continue strongly. Latin America will remain debt ridden and victim to current high interest rates for at least the next year, but steel consumption will probably grow nonetheless. The USA and Western Europe are now in a strong position to meet demand and can produce high quality steel at competitive prices. There will still be further rationalisations and many observers see an increasing internationalisation within Europe, breaking down boundaries, and further increasing competition. The Eastern bloc countries have woken up to the fact that their industries are out of date, unproductive and inefficient, and they are starting out on the long road of which the west has almost reached the end .

END TEXT. TABLES FOLLOW.

LIST OF TABLES

1988 output of major steel producing countries (Mt)

E - Estimated *Source: IISI*	1988	1987	1986	1985	1984	1983	1982	1988/1987 % change
1 USSR	164.0 E	161.9	160.5	154.7	154.2	152.5	147.2	1.3
2 Japan	105.7	98.5	98.3	105.3	105.6	97.2	99.5	7.3
3 USA	90.8	80.9	74.0	80.1	83.9	76.8	67.7	12.2
4 China	59.0 E	56.0	51.9	46.7	43.3	40.0	37.2	5.3
5 FRG	41.0	36.2	37.1	40.5	39.4	35.7	35.9	13.1
6 Brazil	24.6	22.2	21.2	20.5	18.4	14.7	13.0	10.7
7 Italy	23.7	22.8	23.0	23.9	24.1	21.8	24.0	3.7
8 Rep of Korea	19.1	16.8	14.6	13.5	13.0	11.9	11.8	13.9
9 UK	19.0	17.4	14.7	15.7	13.5	15.0	13.7	9.1
10 France	19.0	17.7	17.9	18.8	19.0	17.6	18.4	7.4
11 Poland	17.0 E	17.1	17.1	16.1	16.5	16.2	14.8	-0.8
12 Czechoslovakia	15.4 E	15.4	15.1	15.0	14.8	15.0	15.0	-0.1
13 Canada	15.2	14.7	14.1	14.6	14.7	12.8	11.9	3.0
14 Romania	15.0 E	15.0	14.3	13.8	14.4	12.6	13.1	0.3
15 India	14.2	13.1	12.2	11.9	10.5	10.2	11.0	8.4
16 Spain	11.7	11.8	11.9	14.2	13.5	13.0	13.2	-1.1
17 Belgium	11.2	9.8	9.7	10.7	11.3	10.2	10.0	14.4
18 South Africa	8.8	8.7	8.9	8.5	7.7	7.2	8.3	0.3
19 Taiwan (ROC)	8.3 E	5.8	5.5	5.2	5.0	5.0	4.2	43.6
20 German DR	8.3 E	8.2	8.0	7.9	7.6	7.2	7.2	0.1
21 Turkey	8.0 E	7.0	5.9	4.9	4.3	3.8	3.2	13.7
22 Mexico	7.8	7.6	7.2	7.3	7.5	6.9	7.1	2.9
23 DPR Korea (E)	6.8 E	6.7	6.6	6.5	6.5	6.1	5.8	0.3
24 Australia	6.3	6.1	6.7	6.6	6.3	5.7	6.4	3.3
25 Netherlands	5.5	5.1	5.3	5.5	5.7	4.5	4.4	9.1
26 Sweden	4.8	4.6	4.7	4.8	4.7	4.2	3.9	4.0
27 Austria	4.6 E	4.3	4.3	4.7	4.9	4.4	4.3	6.2
28 Yugoslavia	4.5 E	4.4	4.5	4.5	4.2	4.1	3.8	2.4
29 Luxembourg	3.7	3.3	3.7	3.9	4.0	3.3	3.5	10.8
30 Argentina	3.6	3.6	3.2	2.9	2.6	2.9	2.9	0.3
31 Venezuela	3.6 E	3.7	3.4	3.1	2.8	2.3	2.3	-3.0
32 Hungary	3.5 E	3.6	3.7	3.7	3.8	3.6	3.7	-3.4
33 Bulgaria	3.0 E	3.0	2.9	2.9	2.9	2.8	2.6	-1.4
34 Finland	2.8	2.7	2.6	2.5	2.6	2.4	2.4	4.7
Other countries	20.7	19.9	18.3	17.5	17.5	14.2	12.9	4.3
World total	780.0	735.9	713.1	719.0	711.0	664.1	645.8	6.0

World crude steel production summary, 1988 (Mt)

Source: IISI	1988	1987	1986	1985	1984	1983	1982	1988/1987 % change
Industrial countries	391.0	360.7	352.1	374.2	375.6	343.8	338.3	8.4
of which:	90.8	80.9	74.0	80.1	83.9	76.8	67.7	12.2
Japan	105.7	98.5	98.3	105.3	105.6	97.2	99.5	7.3
EC (12)	137.5	126.7	125.8	135.7	134.4	123.2	125.1	8.6
Developing countries	96.6	87.7	80.5	77.0	70.9	63.8	60.8	10.2
Total Western World	487.6	448.4	432.6	451.3	446.5	407.6	399.1	8.8
USSR & other CMEA	226.6	224.8	222.1	214.5	214.6	210.4	203.8	0.8
China & other Asian countries	65.8	62.8	58.5	53.2	49.8	46.1	43.0	4.8
Total CPE's	292.4	287.5	280.6	267.7	264.4	256.5	246.7	1.7
World total	780.0	735.9	713.1	719.0	711.0	664.1	645.8	6.0

Western World excludes Centrally Planned Economies (CPE's). Developing countries include Latin America, Africa (excluding South Africa), the Middle East and Asia (excluding Japan and Asian CPEs). Industrial Countries comprise Western Europe, United States, Canada, Japan, South Africa, Australia and New Zealand.

Crude steel production by main geographic region
(million tonnes)

Region	1988	1987	% change
Western Europe	163.3	151.3	+ 7.9
Eastern Europe	223.6	224.4	- 0.4
Total Europe	386.9	375.7	+ 3.0
North America	105.2	95.0	+10.7
Latin America	42.8	40.0	+ 7.0
Far East	220.5	204.1	+ 8.0
Oceania	6.4	6.5	- 1.5
Africa	11.4	11.2	+ 1.8
Middle East	5.5	5.0	+10.0
	778.7	737.5	+ 5.6

UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

OECD figures

	Crude steel production			Apparent steel consumption		
	1987 mln. tonnes	1988/87 estimated change in %	1989/88 expected change in %	1987 mln. tonnes ingot equiv.	1988/87 estimated change in %	1989/88 expected change in %
EC(12)	125.98	+ 9	- 2	117.95	+ 9	-2
Other W.Europe	24.69	+ 7		26.32	+ 6	
USA	80.88	+14	- 6	111.52	+ 8	-6
Canada	14.74	0	+ 2	14.64	+ 7	-6
Australia + New Zealand	6.47	- 2.5		6.93	+ 2	
Japan	98.51	+ 7.3		88.27	+15.8	-3.5
OECD	351.27	+ 8.7		365.64	+11	-3.5
Austria	4.30	+ 5	+ 1	2.55	+ 9	0
Switzerland	0.87	+11		2.71	+ 1.3	
Finland	2.67	+ 4	+ 2	2.17	+ 8	+3
Norway	0.84	+ 5	-20	1.36	- 5	-5
Sweden	4.60	+ 4	- 2	4.08	+ 8	-1
Turkey	7.04			8.85		
Yugoslavia	4.37	+ 2		4.60		
Australia	6.06	- 5.7	+10.8	6.02	+ 5.4	
New Zealand	0.41	+46		0.92	-24	

	Imports of steel mill products			Exports of steel mill products		
	1987 mln. tonnes	1988/87 estimated change in %	1989/88 expected change in %	1987 mln. tonnes	1988/87 estimated change in %	1989/88 expected change in %
EC(12)	10.56	+ 1		30.57	- 1	
Other W.Europe	12.21	+ 8		13.61	+ 10	
USA	18.10	+ 8	- 7	1.04	+ 65	+25
Canada	2.74	+17.5	-25	3.79	- 10	+ 4
Australia + New Zealand	1.44	+19		1.46	- 14	
Japan	4.97	+50		25.12	- 6.9	
OECD	50.02	+11.5		75.59	- 1	
Austria	1.16	+11		3.06	+ 4	
Switzerland	2.16	+ 5		0.86	+ 30	
Finland	0.81	+ 7	+ 1	1.53	+ 7	+ 1
Norway	1.10	- 5	+ 5	0.76	+ 5	- 5
Sweden	1.94	+ 7	- 4	2.86	+ 6	- 7
Turkey	3.46			2.81		
Yugoslavia	1.58			1.73		
Australia	0.91	+44.7		1.32	- 29.2	- 4.9
New Zealand	0.53	-25		0.14	+ 130	

Source: IISI

World Steel Trade by Area, 1986

million metric product tons

Destination \ Exporting region	EEC	Other Western Europe	North America	Latin America	Africa	Middle East	Japan	Other Asia	Oceania	USSR & Eastern Europe	Total Imports
EEC	34.9	5.5	0.2	1.1	0.5	–	0.5	0.2	–	3.2	46.1
Other Western Europe	6.4	1.6	–	0.4	0.5	–	0.2	–	–	2.1	11.2
North America	6.8	1.1	3.7	2.4	0.5	–	4.3	2.1	0.2	0.3	21.4
Latin America	1.8	0.1	0.3	1.0	0.1	–	0.3	0.1	–	0.1	3.8
Africa	2.9	0.2	–	0.2	1.5	–	0.5	–	–	0.6	5.9
Middle East	1.8	1.7	–	0.3	0.1	0.6	2.1	0.9	0.1	0.1	7.7
Japan	0.1	0.2	–	0.7	0.1	–	–	2.0	–	0.2	3.3
Other Asia	2.3	0.2	0.4	1.2	0.1	–	9.1	1.7	0.5	1.3	16.8
Oceania	0.1	–	–	–	–	–	0.7	0.2	0.1	–	1.1
China & DPR Korea	2.9	0.6	0.1	2.0	0.1	–	8.5	0.9	0.5	3.4	19.0
USSR & Eastern Europe	6.2	0.9	–	0.2	–	–	2.5	–	..	10.0	19.8
Total Exports	66.2	12.1	4.7	9.5	3.5	0.6	28.7	8.1	1.4	21.3	156.1

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The Major Exporters and Importers of Steel, 1986

million metric tons

Rank	Total Exports		Rank	Total Imports	
1	Japan	28.7	1	United States	19.0
2	FR Germany	18.7	2	China	18.5
3	Belgium-Luxemburg	11.8	3	FR Germany	12.9
4	France	10.9	4	USSR (E)	9.0
5	Italy	7.3	5	France	8.0
6	Brazil	6.2	6	Italy	7.0
7	Republic of Korea	5.9	7	German Dem. Rep.	5.1
8	USSR (E)	5.5	8	United Kingdom	4.2
9	United Kingdom	5.3	9	Netherlands	4.2
10	Netherlands	5.2	10	Belgium/Luxemburg	3.4
11	Spain	5.2	11	Japan	3.3
12	German Dem. Rep.	4.3	12	Republic of Korea	2.9
13	Czechoslovakia	4.0	13	Spain	2.6
14	Canada	3.8	14	Canada	2.4
15	South Africa	3.2	15	Iran	2.3
16	Romania	3.1	16	Turkey	2.2
17	Sweden	2.9	17	Switzerland	2.1
18	Austria	2.8	18	Taiwan (ROC)	1.9
19	Turkey	2.6	19	Sweden	1.8
20	Poland	2.2	20	Hong Kong	1.8

Rank	Net Exports (exports - imports)		Rank	Net Imports (imports - exports)	
1	Japan	25.4	1	China	18.3
2	Belgium/Luxemburg	8.4	2	United States	18.0
3	FR of Germany	5.8	3	USSR (E)	3.5
4	Brazil	5.6	4	Iran	2.3
5	Czechoslovakia	3.1	5	India	2.0
6	South Africa	3.1	6	Hong Kong	2.0
7	Republic of Korea	3.0	7	Nigeria	1.5
8	France	2.9	8	Saudi Arabia	1.5
9	Spain	2.6	9	Thailand	1.5
10	Romania	2.3	10	Singapore	1.3
11	Austria	1.6	11	Indonesia	1.2
12	Canada	1.4	12	Malaysia	1.2

Source: IISI

Apparent Steel Consumption, 1981 to 1987

million metric tons crude steel equivalent

[illegible]	1981	1982	1983	1984	1985	1986	1987
[illegible]	72.3	70.0	66.3	73.9	74.0	71.0	76.7
[illegible]	109.0	101.7	99.4	102.7	101.7	103.6	104.1
[illegible] Western Europe	20.7	20.8	21.0	22.0	21.9	22.7	25.2
United States	128.2	92.1	96.0	114.6	109.3	99.0	103.3
Canada	14.4	10.2	11.1	13.3	13.4	12.5	13.7
South Africa	6.6	5.8	5.3	5.7	5.0	5.1	5.2
Oceania	7.4	6.5	5.8	6.8	6.7	6.7	6.5
Total industrialised countries	358.6	307.1	304.9	339.0	332.0	320.6	334.7
Latin America	35.5	30.8	23.9	27.2	27.7	30.3	31.5
Africa except South Africa	13.3	11.9	9.9	9.8	11.2	8.6	11.0
Middle East	14.6	18.2	20.3	17.9	17.5	14.1	16.0
Asia except Japan, China, DPR Korea	43.2	44.8	46.0	47.8	51.6	52.3	58.3
Total developing countries	106.8	105.7	100.1	102.7	108.0	105.3	116.8
Total Western World	465.4	412.8	405.0	441.7	440.0	425.9	451.5
[illegible] and [illegible] Europe	205.1	203.8	208.5	210.4	211.2	218.0	220.0
[illegible]	[illegible]	48.1	57.0	63.9	79.0	84.0	82.0
[illegible] economies	250.4	251.9	265.5	274.3	290.2	302.0	302.0
[illegible] World	715.8	664.7	670.5	716.0	730.2	727.9	753.5
[illegible]located	−8.0	−19.1	−6.7	−5.5	−9.4	−12.1	−16.0
World crude steel production	707.8	645.6	663.8	710.5	720.8	715.8	737.5