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# *Industry as a partner for sustainable development*

## Iron and Steel

International Iron and Steel Institute (IISI)



*Developed through a multi-stakeholder process  
facilitated by:*



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# *Industry as a partner for sustainable development*

## Iron and Steel

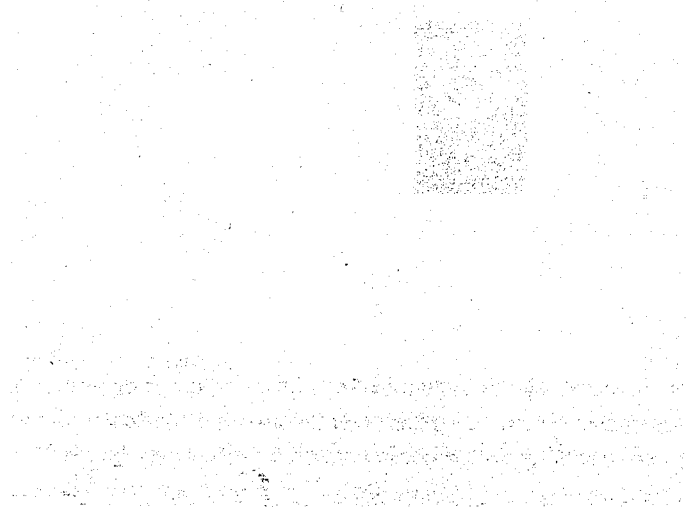
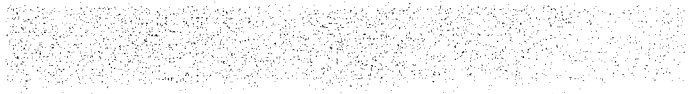
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### Disclaimer

In a multi-stakeholder consultation facilitated by the United Nations Environment Programme, a number of groups (including representatives from non-governmental organisations, labour unions, research institutes and national governments) provided comments on a preliminary draft of this report prepared by the International Iron and Steel Institute (IISI). The report was then revised, benefiting from stakeholder perspectives and input. The views expressed in the report remain those of the authors, and do not necessarily reflect the views of the United Nations Environment Programme or the individuals and organisations that participated in the consultation.



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## Executive summary

The International Iron and Steel Institute (IISI) prepared this report to communicate sustainable development activities of the world steel industry in preparation for the United Nations World Summit on Sustainable Development scheduled for Johannesburg, South Africa. This report forms part of an effort coordinated by the United Nations Environment Programme, Department of Technology, Industry, and Economics, to contribute to the World Summit with a series of sectoral reports whereby international sectoral industry organisations take stock of progress towards sustainable development and outline future challenges. Additional and updated information on sustainable development in the world steel industry will be available through the IISI Web site at <http://www.worldsteel.org>.

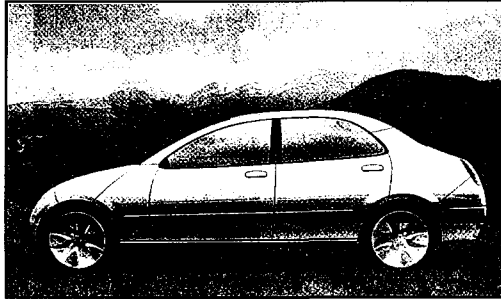
Steel is a material used to build the foundations of society. It is an iron-based material containing low amounts of carbon and alloying elements that can be made into thousands of compositions with exacting properties to meet a wide range of needs. Steel is truly a versatile material. The value of steel produced annually is easily over USD200 billion. Thus steel finds its way into the world economy.

Steel is an essential material for society and an essential material for sustainable development for people to satisfy their needs and aspirations. Steel is a part of people's everyday lives, in both the developed and developing world. It is used in providing transportation such as automobiles and railroads, building shelters from small housing to large multi-family dwellings, delivering energy such as electricity and natural gas, producing food with tools like tractors and hoes, supplying water with pumps and pipelines, and enabling healthcare with medical equipment.

Steel is produced worldwide. Over 96% of world steel production in 2000 was produced in 36 countries. China was the largest steel producing country in 2000 with 127.2 million tonnes. Two other nations produced over 100 million tonnes of steel in 2000 – Japan at 106.4 million tonnes and the United States at 101.5 million tonnes. Together, these three nations account for almost 40% of world steel production. If consideration is extended to the top ten steel producing nations, just over 70% of world steel production is accounted for. The top 20 steel producing nations produced almost 87% of the world's steel in 2000.

While China is the world's largest producer of steel, it is also the world's largest consumer of steel with an apparent consumption of 141.2 million tonnes. The United States ranks as the second largest consumer of steel at 115.0 million tonnes, followed by Japan at 76.1 million tonnes. The top ten nations accounted for almost 69% of steel consumption in 2000, while the top 20 nations made up 83% of world steel consumption.

Looking at the trends in steel consumption, China shows the greatest increase from 1990 to 2000 with an increase of almost 10%. Other countries in Asia accounted for the second largest increase with 5.7%, while the NAFTA trading area demonstrated the third largest increase with 4%. The greatest decrease in steel consumption occurred in the former USSR, registering a 14% decrease.



The world steel industry is characterised by companies that traditionally formed to serve local and national markets, giving rise to a fragmented industry comprised of many companies around the world. The top 20 steel companies account for about 32% of world steel production. In comparison, the top eight vehicle manufacturers account for 67% of world vehicle production while the top three iron ore companies bring about 70% of world iron ore production to market.

In 2002, steel companies are facing their most severe economic challenge in recent history. Earlier this year IISI issued a call for an immediate start of inter-governmental negotiations on steel. A positive response from governments led to the convening of a high level meeting of the OECD in September. Governments from around the world met again in December 2001 to report back on the results of discussions that they have held with their individual industries.

Steel industry leaders recognise that it is their responsibility to improve the financial performance of the industry by implementing the changes in industry structure and behaviour that are required. The now global nature of the steel business requires further urgent and major changes in the size and scope of individual steel enterprises and they need clear support of governments to move quickly in this direction.

The steel industry has engineered a revolution in its performance over the last 20 years. There has been massive investment in new products, new plants and technology and in

new methods of working. The result has been a dramatic improvement in the performance of steel products, and a related reduction in energy use and consumption of raw materials in their manufacture.

Steel products are providing solutions to sustainable development. The ULSAB-AVC (UltraLight Steel AutoBody – Advanced Vehicle Concepts) Programme is a design effort to offer steel solutions to meet society's demands for a safe, affordable, environmentally responsible range of vehicles for the 21st century. ULSAB-AVC, the latest in a series of environmentally-centred initiatives by an international consortium of sheet steel producers, promises that steel can be an environmentally optimal and most affordable material for future generations of vehicles. The programme supports this offer by demonstrating the application of new steels, advanced manufacturing processes, and innovative design concepts.

ULSAB-AVC will present advanced vehicle concepts that help automakers use steel more efficiently and provide a structural platform for achieving:

- anticipated crash safety requirements for 2004;
- significantly improved fuel efficiency and reduced climate change emissions;
- optimised environmental performance regarding emissions, increased resource and energy efficiency and recycling;
- high volume manufacturability at affordable costs.

The steels used for construction have been evolving ever since their initial development in the late-1800s. A steady series of improvements that both enhance and reduce the cost of construction with steel has been achieved. No one area of the world or country is leading this development. It spans from both mature and growing economies; throughout the world, steel is a major



construction material. As we move into the new millennium, the manufacturers of steels for construction continue changing and improving their products to meet the demands for improved material properties.

Steel packaging is a good example of how products can be designed to increase resource and energy efficiency, and reduce their impact on the environment, while delivering the service demanded by society. The mass of a 33cl steel beverage can has decreased over the years, resulting in a can about a quarter of the mass it was 40 year ago. The decrease in mass is enabled by new steelmaking and can-making technologies and by the development of advanced steels that can offer the strength and formability required to make the packaging lightweight.

Steel's distinctive environmental fingerprint has many advantages. More than half of the steel we see around us has already been recycled from scrap. This valuable material – from old cars, buildings, and steel cans, for example – is a powerful energy and resource saver. It takes at least 60% less energy to produce steel from scrap than it does from iron ore. Waste disposal problems are lessened because used steel can be recycled over and over.

Sooner or later, virtually all scrap gets back to the steel mill. Steel's established recycling loop and the ease with which scrap is reclaimed through steel's natural magnetism helps today's designers make end-of-life recycling a vital part of product planning. Steel beverage cans may become new steel in a matter of weeks; cars may take ten to 15 years; buildings and bridges nearly a century. But sooner or later virtually all scrap gets back to the steel mill.

Currently, there are two process routes that dominate global steel manufacturing, although variations and combinations of the two exist. These are the 'integrated' and the 'mini-mill' routes. The key difference between the two is the type of iron bearing feedstock they

consume. In an integrated works this is predominantly iron ore, with a smaller quantity of steel scrap, while a mini-mill produces steel using mainly steel scrap, or increasingly, other sources of metallic iron such as directly reduced iron.

Increased energy and resource efficiency in steel production will bring significant advances in the sustainability of the steel industry. These gains in efficiency result from achievements in optimising current production methods and through the introduction of new technologies.

In the recent IISI study *Energy Use in the Steel Industry*, case histories of four steel product facilities indicated reductions in energy consumption which has been in the order of 25% since the mid-1970s. The report suggests the future may bring energy consumption figures of 12GJ/t of steel, a savings of about 60% from current values, though this is not economically or technically feasible today.

Environmental issues are now so numerous, complex, interconnected and continuously evolving that an ad hoc approach to problem solving is no longer considered effective. A systematic approach to management is required. A formal Environmental Management System (EMS) provides a decision-making structure and action programme to support continuous improvements in environmental performance. The ISO 14001 standard provides a basis for steel companies to have their EMS programmes certified.

The role of the EMS in the iron and steel industry is becoming increasingly significant in customer, supplier, public and regulatory relationships, as the steel product reaches a wider audience through a more informed awareness. EMS, and especially the auditing aspects, is a tool for the industry to control and improve the implemented system, and is widespread in the industry, with 80% of the companies operating one.

Relevant measures of environmental performance include energy efficiency, resource efficiency, and releases to air, water, and ground. It is in this regard that the world steel industry has comprehensive worldwide data in the form of a life cycle inventory (LCI) study. LCI is a quantitative analysis of the inputs (resources and energy) and outputs (products, co-products, emissions) of a product system.

In 1995 IISI undertook the first worldwide LCI study for the steel industry. This study included a 'cradle to gate' analysis of steel production, from the extraction of resources and use of recycled materials through the production of steel products at the steel works gate.

In 2002, IISI will complete its second worldwide LCI study of steel products. Among other uses, the results of this second study can be benchmarked against the first study to gauge changes in energy and resource efficiency and releases to air, water, and ground.

A measure of the impact of steel on the world's social condition is the apparent consumption per capita. This statistic might be considered one indication of a country's prosperity with the notion greater steel consumption per capita is a sign of economic prosperity. The world average for apparent steel consumption per capita in 1999 was 138.2kg.

It can be noted, in general, the more industrialised countries utilised between 250kg and 600kg of steel per person. Countries with developing economies consume less steel per capita, with examples being China at 107kg/capita, Brazil at 99kg/capita and South Africa with 81kg/capita. South Korea and Taiwan, China topped the list, with South Korea registering 757kg/capita while Taiwan, China was at 1,109kg/capita.

The world steel industry has made great strides in sustainable development by providing products and services valued by society, increasing resource and energy efficiency, reducing emissions to air, water and land, adding economic value to the world economy, providing safe and healthy work environments, and being responsible participants in local communities.

Improvement will come largely from the work of the world's steel companies and their collaborative ventures within and external to the industry. Accordingly, companies with regard to their individual circumstances will set priorities for improvement, and where priorities coincide, with their partners and stakeholders.

## Part I: Introduction

### 1.1 The world steel industry

Steel is a material used to build the foundations of society. It is an iron-based material containing low amounts of carbon and alloying elements that can be made into thousands of compositions with exacting properties to meet a wide range of needs. Steel is truly a versatile material.

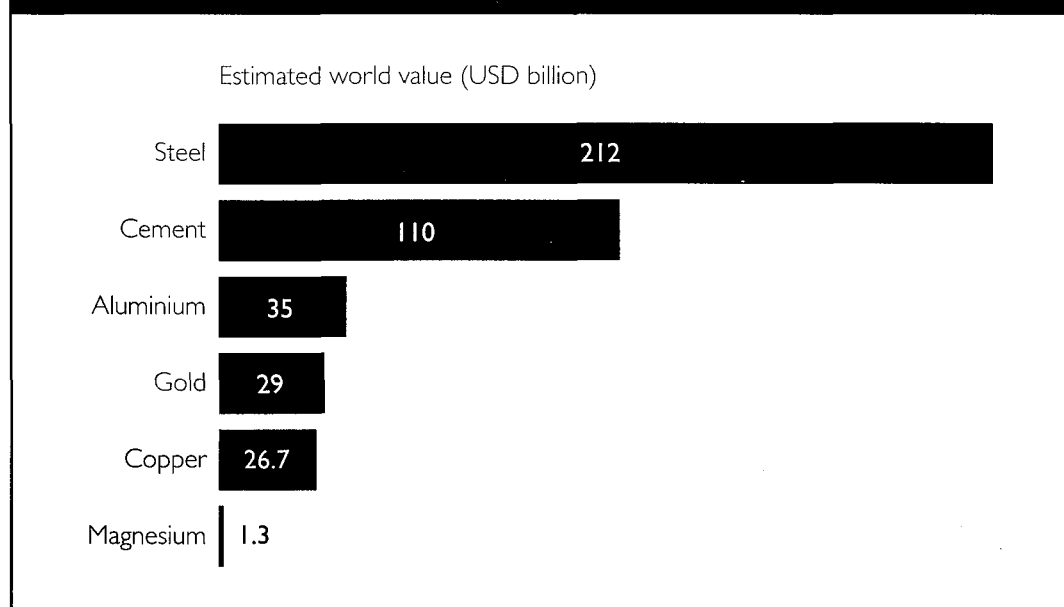
Steel is produced in over 100 countries and its modern age goes back to the 19th century. Technological developments at that time allowed for mass production of steel and opened up new applications like railroads and automobiles. The origins of steel date from 3,000 year ago.

An estimated value<sup>(1)</sup> of steel produced worldwide in 2000 was in excess of USD200 billion. In figure 1, the value of steel and other

materials in common use is presented. Although exact values of the materials produced will change over time as production and prices fluctuate, the relative magnitude of the world's steel output with relation to other materials is apparent.

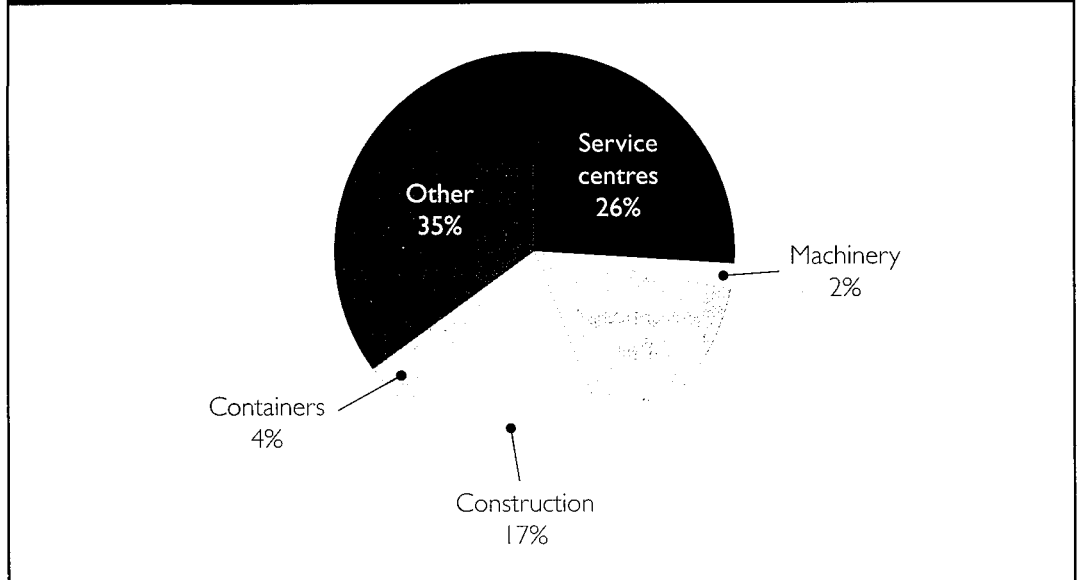
Steel is an essential material for society and an essential material for sustainable development for people to satisfy their needs and aspirations. Steel is a part of people's everyday lives, in both the developed and developing world. Steel is used in providing transportation such as automobiles and railroads, building shelters from small housing to large multifamily dwellings, delivering energy such as electricity and natural gas, producing food with tools like tractors and hoes, supplying water with pumps and pipelines, and enabling healthcare with medical equipment.

Figure 1: Estimated value of selected materials in 2000



(1) Estimated value as 2000 (primary & secondary) production multiplied by typical 2000.

Figure 2: Steel shipments by market classification for North America in 1999



Source: AISI

### Corus Group plc and the community

Corus Group plc manufactures, processes and distributes steel and aluminium products as well as providing design, technology and consultancy services.

Corus is an integral part of the communities in which it operates. The company actively participates in community initiatives and is committed to making a positive social contribution. We place great emphasis on the contribution we make to a sustainable society and are committed to incorporating the principles of sustainable development into all aspects of our operations.

The breakdown of steel markets is demonstrated in figure 2 with the example of the North American situation in 1999. The largest markets for steel products include service centres, construction, automotive, and containers. Service centres, intermediaries between steel companies and finished product producers, distributing and processing steel to meet specific customer requirements, received 26% of shipments. The second-largest market was construction at 17% followed by automotive at 16%. Containers amounted to 4%, machinery 2%, and all other markets accounted for 35%.

### 1.2 Commitment to sustainable development

The world steel industry is committed to sustainable development. On the world level, the IISI board of directors agreed in 1992 to apply the principles of sustainable development to the steel industry. This direction was reinforced in 2001 when the board of directors agreed to make sustainability one of five key activities for IISI.

On the company level, most steel companies have made a commitment to sustainable development by integrating economic, environmental and social aspects in decision-making, although a survey has not been completed to gauge exact numbers. Indeed, aspiring for good financial returns, protecting the environment and responsibility to people are becoming necessities, not an option, for a successful business.

### 1.3 About this report

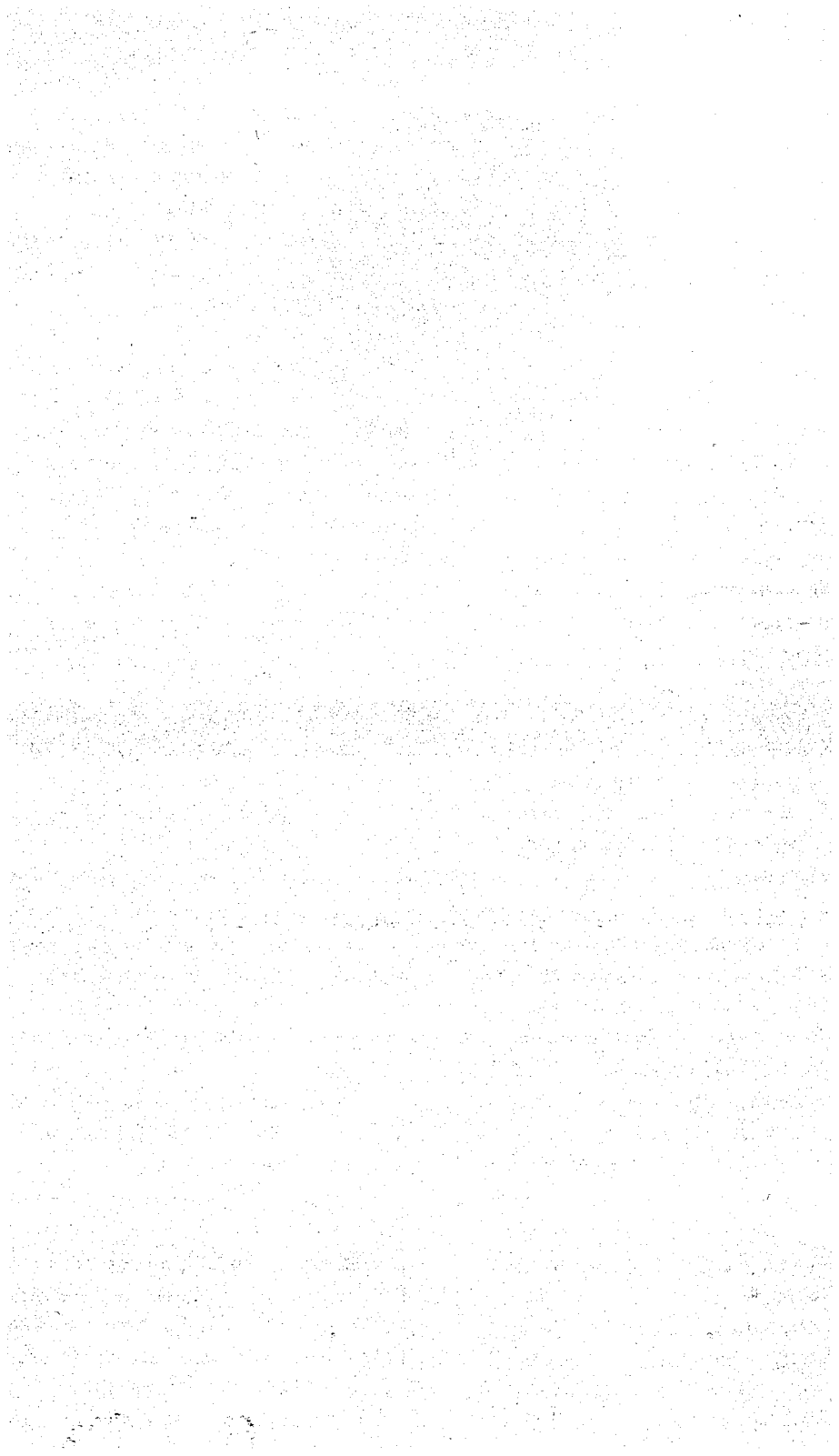
IISI prepared this report to communicate sustainable development activities of the world steel industry in preparation for the United Nations World Summit on Sustainable Development scheduled for 26 August to 4 September 2002 in Johannesburg, South Africa. This report forms part of an effort coordinated by the United Nations Environment Programme, Department of Technology, Industry, and Economics, to contribute to the World Summit with a series of sectoral reports whereby international sectoral industry organisations take stock of progress towards sustainable development and outline future challenges.

IISI is reviewing its sustainable development programme and preparing for new activities. The outcome of this review was not available for publication in this report. Readers are invited to visit the IISI Web site at <http://www.worldsteel.org> to obtain information on continuing sustainable development activities in the world steel industry.

### 1.4 About IISI

Founded in 1967, IISI is a non-profit research organisation whose members are steel-producing companies, national or regional steel federations, and steel research organisations in more than 55 countries. Together the countries in which IISI steel producing member companies are located account for over 76% of total world steel production.

IISI undertakes research into economic, financial, technological, environmental and promotional aspects of world steel and into various raw materials and human resources matters on behalf of its members. It also collects, evaluates and disseminates world steel statistics.



## Part 2: Implementation of the three dimensions of sustainable development

Steel is and will remain the most important engineering and construction material in the modern world. It is used in every aspect of our lives and progress would be impossible without it. Steel plays an essential role in meeting the challenge of sustainable development for the world in the 21st century – improving economic and social welfare without prejudicing the ability of future generations to do the same.

The steel industry has engineered a revolution in its performance over the last 20 years. There has been massive investment in new products, new plants and technology and in new methods of working. The result has been a dramatic improvement in the performance of steel products, and a related reduction in the energy and consumption of raw materials in their manufacture.

Steel is fully recyclable. At the end of their useful life, products containing steel can be converted back into 'new' steel ready for other applications. As a result, steel is one of the world's most recycled materials.

There are thousands of grades of steel. Recent developments have enabled the steel industry's customers to improve their products through better corrosion resistance, reduced weight

and improved energy performance. This improvement is seen through a wide range of products including passenger cars, packaging and construction materials.

The production of steel involves the production of valuable by-products. For example, slags are processed into building materials such as cement and aggregates providing a contribution to the environment by reducing carbon dioxide emissions and the need for new raw materials.

### 2.1 Social dimension

#### 2.1.1 Health and safety

Health and safety in the workplace is of the highest priority to the world steel industry. In 1999, IISI published the report *Accident-Free Steel*. A special working group set up by the IISI Committee on Human Resources at the request of the IISI board of directors prepared this report. It contains advice and recommendations on how to improve steel plant safety based on the experience of senior line managers and safety specialists from IISI member companies around the world. It is addressed to senior management, plant managers, safety managers and other specialist staff in steel companies.

### Tata Steel combines census efforts with AIDS awareness

Tata Steel has found a novel way to combat the spread of AIDS in Jamshedpur (India) through the dissemination of information pertaining to the prevention and spread of HIV/AIDS.

Over 340 employees including 200 teachers and staff of the Education Department began census work on 15 May 2000. During census work they visited houses in Jamshedpur and distributed 48,000 handbills to raise AIDS awareness. The handbills, developed by the AIDS Core Committee, Tata Steel, bear information on AIDS prevention.

Tata Steel remains committed to extending its expertise and experience in encouraging such efforts for the benefit of our community and the nation.

*Accident-Free Steel* identified three components as essential to progress steel plant safety:

1. the condition of the workplace environment,
2. the training and competence of employees,
3. the motivation and behaviour of employees.

The report focuses on the third component. The principal recommendations that appear in the report relate to the elements that are judged essential by all the members of the working group.

1. Substantial commitment and leadership of safety by management – with both hearts and minds.
2. A change in the attitude and behaviour of individuals and working groups with respect to safety in all aspects of our companies.
3. The elimination of a two-tier approach to safety.

For the first element, this requires:

- a strong and visible commitment from the very top of the company and communicated to and shared by all levels of management;
- setting examples, raising standards and implementing them;
- a communication plan and a participatory way of working, which will obtain the commitment to safe working from the maximum number of persons and will confirm that this commitment is real;
- the recognition of best practice in safety and the exchange of these ideas, both within and between companies;
- an organisation's structure appropriate to the problems to be solved, well defined by management and well understood by everyone in the company;
- the setting of ambitious goals for the improvement of safety and the

measurement of progress by the collection of appropriate statistics.

For the second element, attention should be focused on those factors that influence safety behaviour:

- the mechanisms having an influence on behaviour; the triggers that management should develop and the consequences that should be understood by all participants. Management's role is to assure the adoption of those factors that can become the base of further progress;
- The recognition that career development depends on an individual's safety performance;
- putting into practice methods of management that demonstrate that attitude and behaviour to safety is an essential part of the professionalism of everyone, through training programmes, individual interviews, career development, etc;
- the acceptance by everyone of his/her responsibility for their own safety and the safety of others. We do not work alone, but belong to a team.

The third element requires that external contractors working on steel sites should attain the same level of safety as our own employees and use the same methods to achieve this.

### 2.1.2 Community

Every steel company is a member of its community. The involvement of steel companies in their communities encompasses activities such as payment of local taxes, purchasing from local companies, charitable donations, volunteer time, education, medical care, recreation and activities, arts and entertainment, and building of communities. The world steel industry represents a range of company commitment to the community, including in some cases responsibility for all aspects of community development.



### Steel Authority of India (SAIL) socio-economic initiatives

Each plant and unit of SAIL has created around itself a developed community and is responsible for its social welfare, that of the surrounding area, and the environment that it will bequeath to the next generation.

Since the inception, the steel plants built houses, community centres, parks, schools and markets for the employees, their families and others residing nearby. Modern amenities such as electricity, water, sanitation, hospitals, shopping centres, and welfare facilities, comparable to those available in a modern metropolis, were provided.

SAIL has continuously strived to provide the best of education facilities for the children and wards of its employees. Over the years it has opened about 200 schools in the steel townships that employ more than 6,000 teachers and provide modern education to about 122,000 children. Apart from managing its own schools, SAIL also supports other public schools, managed independently, opened primarily to meet the growing demand.

In each of the integrated steel plants, the company manages large hospitals to provide free medical treatment to the employees and their eligible dependants. There are 20 hospitals situated throughout the country having a total of 4,500 beds for the benefit of employees, their dependants and the peripheral population.

One example of a steel company with considerable involvement in its community is the Steel Authority of India (see box above). This company, which is 86% owned by the Government of India, takes responsibility for its community such as the building of housing, provision of hospitals, schools, and recreation facilities.

Saldanha Steel, a South African steel company, plays a role in developing and promoting the culture of entrepreneurship and competitiveness in the community it operates. This initiative not only has a positive impact on the region, but at the same time enhances the company's long-term efficiency. In addition, the company has committed itself to redressing past imbalances in society through providing sound business opportunities to previously disadvantaged businesses and actively supporting and nurturing these businesses.

In doing this, Saldanha Steel subscribes to sound business principles. While the company will ensure equal opportunity, participation and

local community commitment, it will not compromise on price, quality and service. The company strives to develop long-term, mutually beneficial relationships with emerging and established business.

To this end, a business development initiative was established with the overriding objective to create at least 20,000 jobs through outsourcing and new business creation in the first ten years of the plant's existence. In 1997, Saldanha Steel appointed a business development manager, mandated to implement programmes to achieve the company's stated objectives. An enterprise development specialist provides added support.

The initiative aims to promote and support the development of local (South African West Coast) business, provide opportunities for entrepreneurs, create jobs and facilitate empowerment for members of the previously disadvantaged communities in the region.

Another company, United States Steel Corporation, through its United States Steel

**Table 1: Statistics for the city of Pohang, South Korea, from 1968 and 1999**

Pohang statistic	1968	1999
Population	72,000	514,000
Housing supply	55.7% (1975)	84%
Households	13,684	160,059
Running water supply	69%	85.6%
Sewage supply	33% (1975)	63.5%

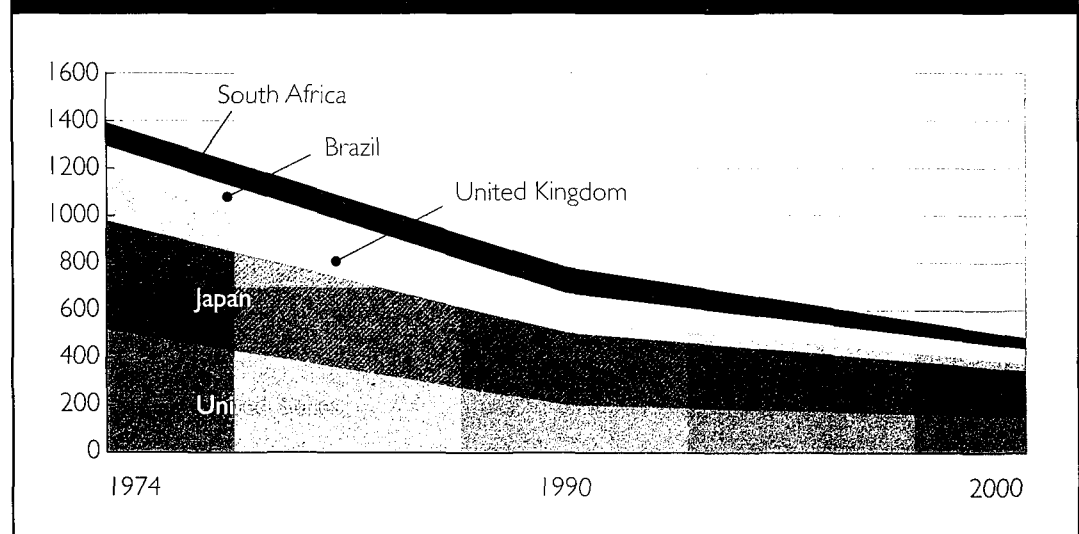
Source: City of Pohang

Foundation, a non-profit membership corporation, provides support in a planned and balanced manner for educational, scientific, charitable, civic, cultural and health needs. Since 1953, the foundation has made grants totalling more than \$270 million.

In South Korea, at the time of POSCO's founding in April 1968, the port city of Pohang had a population of around 72,000. Some three decades later, it has emerged as a strategic industrial centre in south-east Korea with a population of over 510,000 serving the auto, shipbuilding, and heavy industries in Ulsan, the electronics industry in Kumi, the

machinery industry in Changwon, and the major regional cities of Pusan and Taegu.

On 31 December 1972, POSCO relocated its headquarters from Seoul to Pohang, a decision that has significantly contributed to the economic, social, cultural, educational, and infrastructure development of that local community over the years. A prime example of this is the housing scheme. Since the launch of construction of the Pohang Works, POSCO built residential complexes covering over 198 hectares, helping the host city reach a supply ratio of over 85%, a figure far higher than the national average.

**Figure 3: Employment in the steel industry, 1974 and 2000**

Source: IISI

### 2.1.3 Employment

One way the world steel industry contributes to the well being of society is through employment, both directly with steel companies and indirectly with companies providing goods and services to the industry.

Employment in the world steel industry has seen significant change. Figure 3 provides an example of the evolution of employment in the steel industry for five countries; the United States, the United Kingdom, Japan, Brazil and South Africa. The decrease in number of people employed from 1974 to 2000 is 65%.

A key reason for lower employment levels while production of steel continued to expand, is finding more efficient ways to work, such as the widespread adoption of new technologies like continuous casting and computerised process control.

## 2.2 Economic dimension

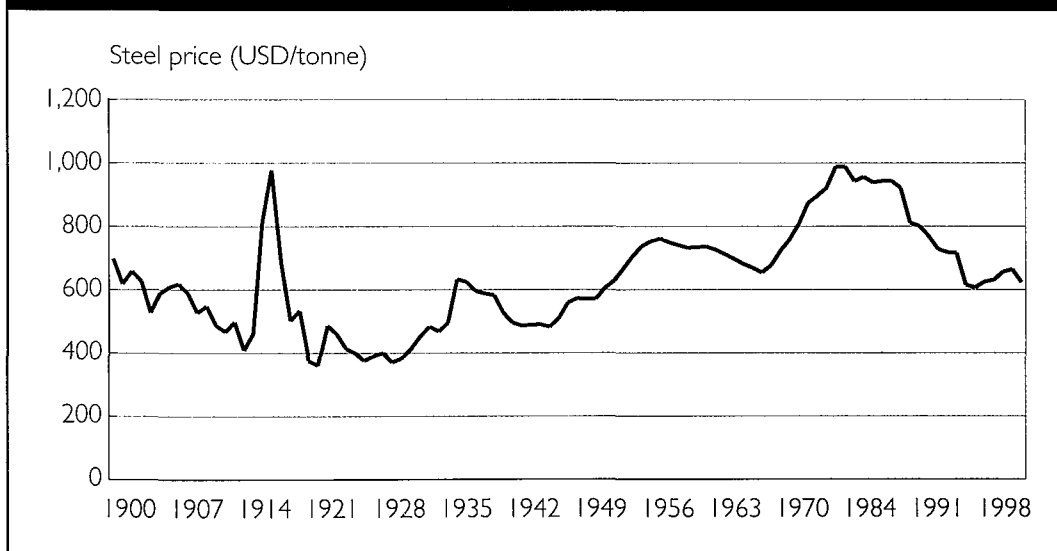
### 2.2.1 Prices and trade

Economic success of the steel industry is a critical requirement for realising sustainable development. The economic performance of the industry today presents its greatest challenge.

The steel industry is experiencing a worldwide downturn in economic performance. Although world steel production is at record levels, the supply exceeds demand and steel prices are down.

A direct consequence of oversupply is low prices for steel products. Figure 4 shows the composite steel price, in constant 1998 USD, over time. This figure clearly demonstrates the price of steel has been steadily diminishing, in real terms, since the early-1980s and is at a level last seen in the mid-1950s.

**Figure 4: Composite steel price in constant 1998 USD**



Source: United States Geological Survey

(2) Based on 199 from BSI.

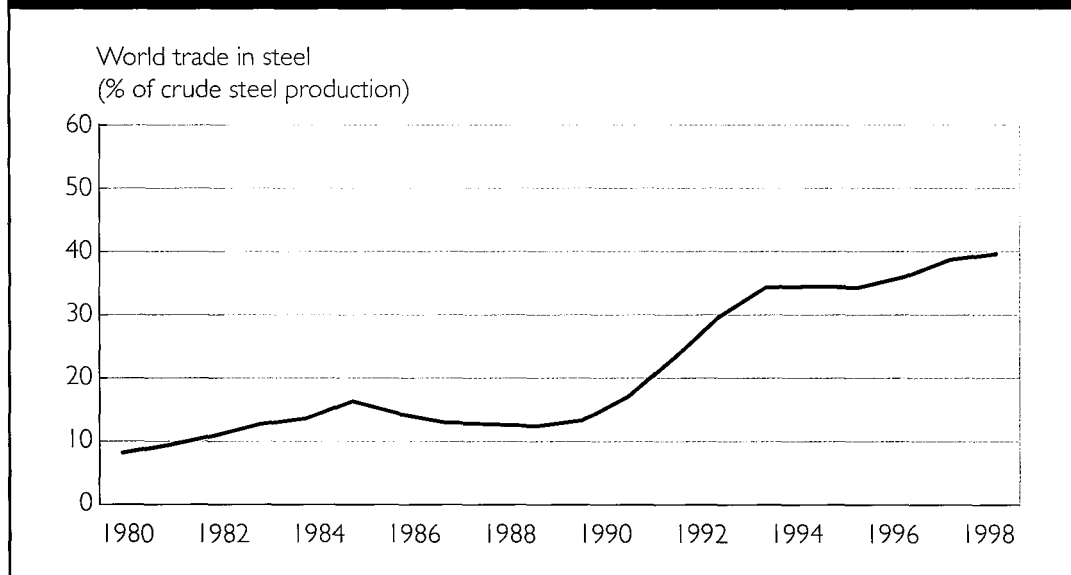
(3) Based on 200 from The International Organisation of M

(4) The steel industry in Australia (2000) p. 13.

Steel companies have traditionally formed to serve local and national markets, giving rise to a fragmented industry comprised of many companies around the world. The top 20 steel companies account for about 32% of world steel production.<sup>(2)</sup> In comparison, the top eight vehicle manufacturers account for 67% of world vehicle production<sup>(3)</sup> while the top three iron ore companies bring about 70% of world iron ore production to market.<sup>(4)</sup>

While the steel industry is fragmented, the market for its products is increasingly becoming global. As evidenced in figure 5, the world trade in steel as a percentage of steel production nearly doubled to 46% since 1980.

**Figure 5: World trade in steel as a percentage of world crude steel production**



Source: IISI

**Table 2: Major steel producing and consuming countries in million tonnes, 2000**

Country	Steel production	Apparent steel consumption
China	127.2	141.2
Japan	106.4	76.1
United States	101.5	115.0
Russia	59.1	23.0
Germany	46.4	36.9
South Korea	43.1	38.5
Ukraine	31.4	9.7
Brazil	27.9	15.8
India	26.9	26.9
Italy	26.7	30.9
France	21.0	17.6
Taiwan, China	16.7	21.1
Canada	16.6	17.5
Spain	15.8	17.5
Mexico	15.7	14.4
United Kingdom	15.2	13.1
Turkey	14.3	12.4
Belgium*	11.6	4.2
Poland	10.5	7.5
<b>World</b>	<b>847.2</b>	<b>768.</b>

\* Consumption includes Luxembourg  
Source: IISI

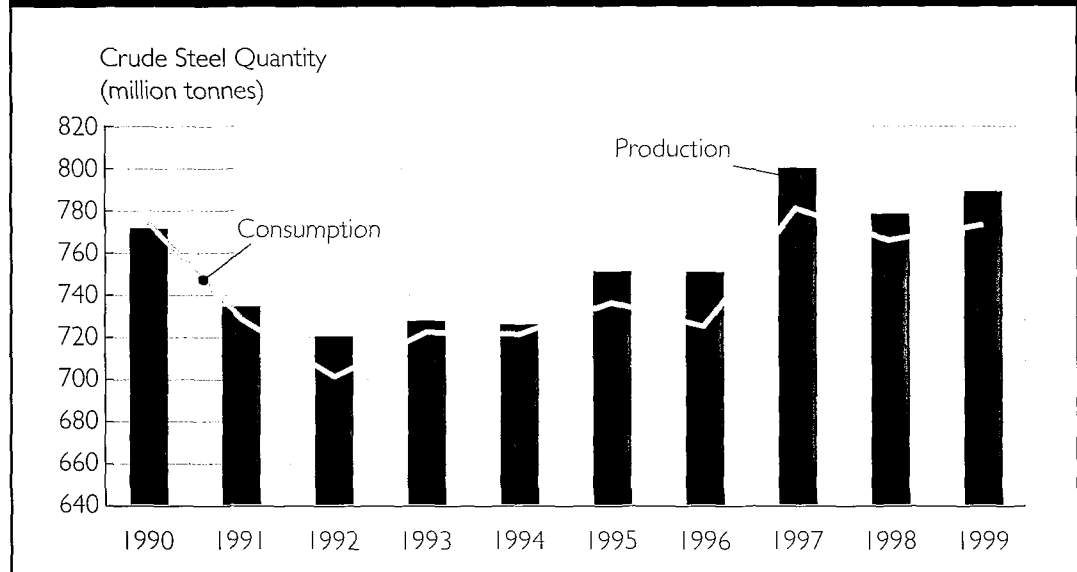
### 2.2.2 Global view of steel production and consumption

Steel is produced Worldwide in the majority of the world's nations, although over 96% of world steel production in 2000 was produced in 36 countries. From table 2 it can be seen that China was the largest steel producing country in 2000 with 127.2 million tonnes. Two other nations produced over 100 million tonnes of steel in 2000, those being Japan at 106.4 million tonnes and the United States at 101.5 million tonnes. Together, these three nations account for almost 40% of world steel production. If consideration is extended to the top ten steel producing nations, just over 70% of world steel production is accounted for. The top 20 steel producing nations produced almost 87% of the world's steel in 2000.

While China is the world's largest producer of steel, it is also the world's largest consumer of steel with an apparent consumption of 141.2 million tonnes. The United States ranks as the second largest consumer of steel at 115.0 million tonnes, followed by Japan at 76.1 million tonnes. The top ten nations accounted for almost 69% of steel consumption in 2000 while the top 20 nations made up 83% of world steel consumption.

The world production of crude steel and apparent consumption of crude steel is presented in figure 6 (see page 20).

**Figure 6: World crude steel production and apparent consumption 1990 to 1999**



Source: IISI

### 2.2.3 Restructuring of steel companies

Three noticeable trends are happening within the world steel industry with respect to steel companies. The first is consolidation, the second is de-mergers, and the third is bankruptcy.

Europe leads the way in consolidating the world steel industry. The world's largest steel company will emerge from the consolidation of Luxembourg's Arbed, France's Usinor, and Spain's Aceralia into a new company called Arcelor. Arcelor will produce some 50 million tonnes of steel per year and have 110,000 employees. Arcelor will be almost double the size, in terms of steel produced, of its nearest competitors, Nippon Steel and POSCO.

In Japan, NKK Corporation and Kawasaki Steel Corporation announced they will merge, first to be joined under a holding company in 2002 and then as a fully integrated business segment of JFE Holding in 2003. The combined crude steel production of these two companies will be about 30 million tonnes per year.

The LMN Group, the world's fourth-largest steelmaker in 2000, worked over the last decade to establish a global network of steelmaking facilities. Notable acquisitions include Inland Steel Company of the United States, Unimetal Group of France, steel production facilities obtained from Thyssen, and the assets of a large steel plant in Kazakhstan.

This consolidation follows recent mergers of British Steel and Koninklijke Hoogovens to form Corus Group plc and the German merger of Thyssen and Fried. Krupp Hoesch-Krupp to form ThyssenKrupp AG. Further consolidation discussions have been made public, notably in the United States and Japan, and it would not be unexpected if the future should bring further mergers of steel companies.

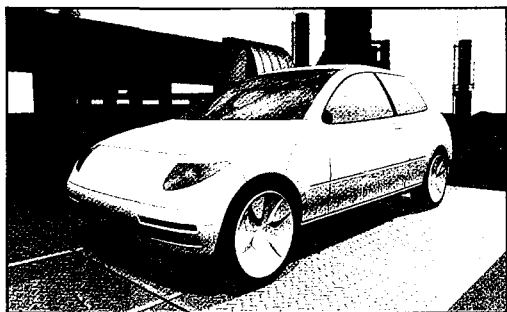
Notable de-mergers that have recently been completed or are about to be completed are occurring around the world. In the United States, United States Steel and Marathon Oil were under the umbrella of USX. Since the

start of 2002, the companies were completely separated with the steel company taking the name United States Steel Corporation and now acting on its own. In South Africa, Iscor was unbundled into two entities, one being steel and retaining the name Iscor Limited, while the mining assets became Kumba Resources. In Australia, BHP Billiton is separating its steel company, BHP Steel, from its remaining resource ventures.

With regard to bankruptcy, in the United States alone, according to the United Steelworkers of America, 29 steel companies with 63,000 employees filed for bankruptcy protection and 11 companies have ceased operations. Among the casualties are the third and fourth largest steel producers in the United States, Bethlehem Steel and LTV Steel. In Canada, the nation's third-largest integrated steel company, Algoma Steel, is also in bankruptcy protection and seeking to reorganise.

## 2.3 Environmental dimension

### 2.3.1 Steel products



#### 2.3.1.1 Automotive

The ULSAB-AVC (UltraLight Steel AutoBody – Advanced Vehicle Concepts) Programme is a design effort to offer steel solutions to meet society's demands for a safe, affordable, environmentally responsible range of vehicles for the 21st century. ULSAB-AVC, the latest in a series of environmentally-centred initiatives by an international consortium of sheet steel producers, offers the promise that steel can be the most environmentally optimal and

affordable material for future generations of vehicles. The programme supports this offer by demonstrating the application of new steels, advanced manufacturing processes, and innovative design concepts.

ULSAB-AVC also provides a steel-based comparison vehicle to dispel the misunderstanding that only more costly, less manufacturable alternative materials can provide the attributes necessary to attain fuel efficiency goals.

ULSAB-AVC takes a holistic approach to the development of a new advanced steel automotive vehicle architecture. The scope of the programme goes beyond the body structure to include closures, suspensions, engine cradle and all structural and safety relevant components.

ULSAB-AVC presents advanced vehicle concepts that help automakers use steel more efficiently and provide a structural platform for achieving:

- anticipated crash safety requirements for 2004;
- significantly improved fuel efficiency;
- optimised environmental performance regarding emissions, source reduction and recycling;
- high volume manufacturability at affordable costs.

The programme commenced in January 1999 with a comprehensive benchmarking of existing vehicle concepts and an investigation of vehicle trends. Targets have been set with reference to the United States government's environmental programme, Partnership for a New Generation of Vehicles (PNGV) and the EU initiative, EUCAR, a stringent CO<sub>2</sub> reduction programme.

The consortium commissioned Porsche Engineering Services (PES) of Troy, Michigan, United States, to undertake the programme. PES will integrate automotive industry

**Table 3: Benefits of breakthrough technologies in steel products**

Breakthrough	Benefit
High strength steels	Lighter, safer, less thirsty cars from thinner, much tougher steels.
Ultra-clean steels (interstitial free)	More luxurious, better styled cars due to easier forming of complex parts.
Bake hardening steels	Self-strengthening steels provide greater safety at less cost.
Advanced coated steels	Improved corrosion resistance for longer lasting cars.

Source: ULSAB-AVC Consortium

feedback and knowledge it acquired in the development of the UltraLight Steel Auto Body (ULSAB) into this new initiative.

The elusive mix of lightness and strength which only modern steel can provide is vital for the driving machine of the future. Entire automobile side panels are now being made in one operation by pre-welding sheets with high-speed lasers prior to forming. By fusing together steels of different thicknesses and qualities, designers can distribute the metal optimally in the body components without sacrificing security levels.

#### **What is the steel autobody?**

The steel autobody is a carefully designed synthesis of components, each tailored to perform a specific function. It provides strength, rigidity, and structural integrity. It ensures passenger security in case of impact. At the same time, it protects the vehicle against the elements and satisfies increasing demands for aesthetics and durability. More than half the steels used in cars today were not available a decade ago.

#### **What do new steels mean to the car buyer?**

New high strength steels, two or three times stronger than their predecessors, mean lighter, more fuel-efficient vehicles. Revolutionary ultra-clean steels that can be shaped more easily are meeting car buyers' demands for increased styling and variety.

Some of the newest steels offer driver and passengers greater protection through their built-in capacity to change properties during processing in the automobile plant. Such steels can be easily formed into the complex parts of the car body. They then undergo a process of self-strengthening which is completed under the heat of the automotive paint line, increasing the strength and dent resistance of the car body by as much as 30%.

#### **How is the autobody is made?**

*Forming (stamping) the various parts of the car body in high speed automated presses.*

Modern versatile steels enable today's fully automated presses to produce up to 15,000 major car body components a day. Outputs of 20,000 are projected. Advanced computer design and analysis make possible lower cost cars by reducing the number of body components and decreasing the need for expensive stamping equipment.

*Assembling the body parts by advanced welding and bonding.*

Using steel's intrinsic electrical properties, modern welding technology fuses automotive components together at rates of seven million spot-welds a day. Lighter, faster robots able to monitor weld quality will increase speed by as much as 30%.

*Painting or applying the complex coating systems that provide beautiful and long lasting finishes.*

The finishes on steel body components are complex systems carefully engineered to provide both beauty and protection. At their base are highly efficient galvanised coatings



with an unusual ability both to create a barrier against corrosive elements and to neutralise them in case of damage.

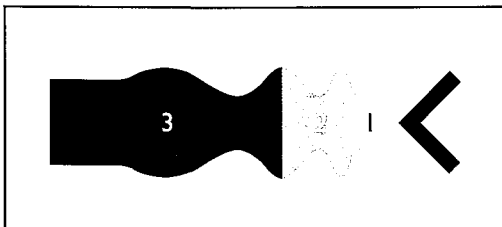
**The steel autobody: why is it safe?**

The designer's concept for each new car model starts with the security cell surrounding the driver and passengers. Occupants are better protected because the carefully engineered safety compartment in new high strength steels is structured to prevent penetration from other parts of the car. Outside the safety cell, the front and rear are designed with built-in crumple zones. On impact, they collapse successively in controlled accordion folds so that energy is absorbed gradually into the whole structure.

Steel's reliability and the vast database that exists on steel properties make it possible to optimise carbody safety design by simulating impact behaviour on the computer. This way designers can meet carmaker's rigorous performance objectives without lengthy experimentation. Crash management concepts based on steel are proven by long experience – which means added reliability, extra security,

**Steel's inherent safety**

Steel inherently provides a vital security margin in case of collision because of its remarkable ability to deform and harden simultaneously.



The collision forces collapse and then strengthen the impact area: (1) causing the process to be repeated at an adjacent location. (2) The process is repeated over and over; (3) resulting in a progressive collapse of the component and a steady absorption of large amounts of impact energy. At higher impact velocities, the strength of steel

increases without the risk of breakage often associated with other materials.

**The steel autobody: why does it last longer?**

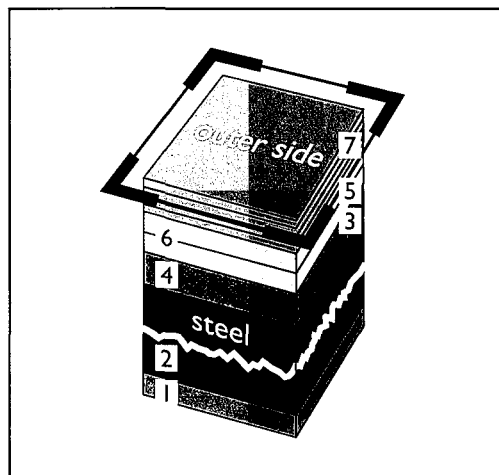
Steel naturally is:

- non-flammable,
- unaffected by ultraviolet radiation,
- not structurally destabilised by humidity,
- dimensionally stable in heat and cold.

Today's corrosion resistant steels are customised to provide one and two-sided protection and to meet different requirements for the surface and underside of the car body. Advanced multi-layer coating systems with a sophisticated outer barrier provide quality finish and a sacrificial undercoating for backup protection. These enable carmakers to custom-design protection and to provide guarantees up to ten years against major types of corrosion.

Anatomy of a modern coating system:

1. metallic undercoating,
2. steel base,
3. adhesion zone: improved interaction and diffusion of iron atoms into coating,
4. alloy coating for barrier and sacrificial protection,
5. metallic barrier coating,
6. organic coating for additional protection,
7. primer and paint layers.



**The steel autobody: why is it beautiful?**

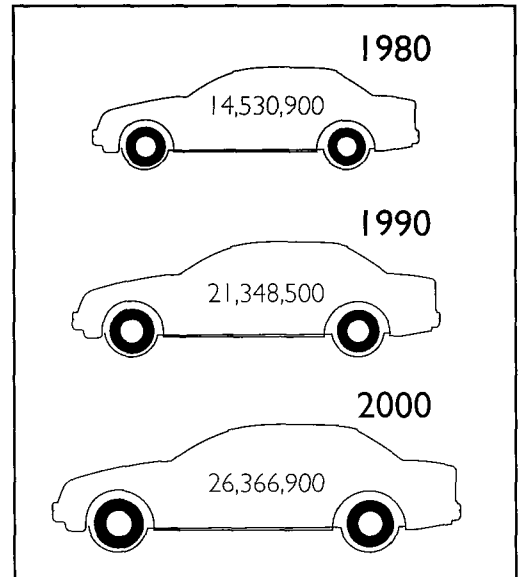
The mirror finish of today's cars starts before the autobody sheets leave the steel plant. High precision finishing techniques emboss microscopic peaks and valleys on the steel surface. Laser and electro-discharge technologies set the height and frequency of these contours so that the highly efficient painting systems produce a surface with undistorted image reflection.

**The steel autobody: why is it recycled?**

Of the 600 materials that make up the modern automobile, steel is the easiest to recycle. The potential savings in terms of the earth's finite resources are important when we remember that 55% to 65% of each car is steel. Recycling the steel from a car is straightforward. Once the car is gutted and drained of fluids, the carcass is shredded and the steel is extracted by magnetic separation. Many of the remaining materials are not as readily recyclable and end up in increasingly scarce landfills or require incineration.

**The steel autobody: how is it recycled?**

More than 26 million cars will be scrapped in the United States, Japan and western Europe in the year 2000 – almost double the number disposed of in 1980. Ninety-five per cent of the steel used in today's cars is recycled routinely. The materials which designers use in cars today will directly reflect their recyclability after the year 2000.

**2.3.1.2 Construction**

Most of the wealth of mankind resides in the constructed environment – and most of the world's output of steel is directed to the construction market. This will not change, even if segments of the world suffer regional and temporary downturns, for construction is tied directly to population growth, to the need for transportation and infrastructure and to the basic need of maintaining and elevating worldwide standards of living.

The steels used for construction have been evolving ever since their initial development in the late-1800s. Continuous improvement in both enhancing and reducing the cost of construction with steel has been achieved. No one area of the world or country is leading this development. It spans both mature and growing economies; throughout the world steel is a major construction material.

One way of identifying these evolutionary changes is to cite some of the construction issues that have been in some way mitigated by new steel developments. Today's construction steels meet stringent requirements for corrosion resistance, high performance and fire protection.

As we move into the next millennium the manufacturers of steels for construction continue changing and improving their products to meet the demands for improved material properties. Furthermore, parallel to the changes being made to steels, many construction materials are increasingly being used in conjunction with one another so as to economically maximise the synergy of each material's assets. Steel is interwoven throughout all these concepts, for steel is the material that gives most other construction materials their strength and ductility, be it for the steels that reinforce concrete or the steels that fasten wood.

#### **Corrosion resistance**

Long considered a serious drawback for steels, corrosion not only reduces steel through loss of material, but is often unaesthetic. However, much has been done to improve steel's corrosion resistance and, in at least one application, to promote the process of surface corrosion.

#### **Rust can be good for steel!**

Known worldwide as weathering steel, this development evolved from a 1933 discovery that steel made from a copper-bearing ore had greater than expected corrosion resistance. In most climatic conditions, the various modern grades of weathering steel develop an adherent layer of corrosion that serves as a partial barrier to further corrosion. Once this occurs, and if the adherence prevents flaking of the corrosion layer, the corrosion process proceeds at a rate that is not structurally detrimental to the capacity of the structure.

First used for railroad cars carrying coal, and now widely applied for fabrication of cargo/freight containers, the evolutionary versions of steel today are important to the unique application of bridge construction. Maintaining paint on a bridge is costly and, over its lifespan, may well cost far more than the original bridge. Use of weathering steels

provides a cost-effective solution; first by the initial savings in paint and, secondly, by the material and environmental savings of not having to repaint a difficult structure.

The use of weathering steels has grown in recent years and will continue to grow in the future. Recent developments have increased levels of strength and facilitated welding processes. It is anticipated that increasing worldwide environmental restrictions of the removal and replacement of paint will further boost the market for these steels in both bridge and building applications.

Resistance to corrosion is also addressed by other developments, principally protective corrosion-resistant barriers. Zinc, tin, lead, chromium and aluminium have served this function for years, but new developments have enhanced their effectiveness. One such improvement has been the addition of various quantities of aluminium to zinc for hot-dipped coatings, creating a product that is a synergistic improvement – the resulting corrosion resistance, for the same thickness of coating, is better than the sum of both protective materials.

Developments in this field, in which other metallic barrier materials are being studied, continue worldwide. The extended life of automobiles, appliances and other capital goods will depend even more on improved corrosion resistance as the tendency toward higher strength, lighter and thinner steels continues.

Paint, both organic and inorganic, is another version of the corrosion-resistant barrier. These products have also undergone major improvements in recent years. One of the more significant is when paint, in multiple coats from primer to topcoat, is applied under controlled conditions to steel in coil form. These paint systems, which then have the adhesion and ductility needed for being formed into final products, provide a high

quality finished surface that eliminates the environmental and workplace hazards of post-fabrication spraying or dipping.

Use of these products will continue to rise, not only because of the better quality of the coated surface, but because environmental restrictions will favour the application of paint in a totally controlled environment.

When an even more durable surface treatment is needed, an alternative to a hot-dipped coating is a heat-cured epoxy coating. Today, worldwide, this product is usually the material specified for environments typified by marine, bridge and highway applications where salt corrosion is anticipated. Its use is growing, particularly to extend the life of concrete in bridge surfaces.

#### **High performance steels**

One of the more recent developments of new constructional steels is a grouping of developments given the broad term high performance. High performance does not necessarily mean higher strength, but rather the improved performance of a number of interrelated variables.

For example, welding is used in most construction fabrication. This can be expensive, not just for the process, but also for the precautions that have to be taken for thick sections and adverse site conditions. Many of the newer construction steels ease the need for these precautions by making it possible to produce high quality welds faster with less effort, with less consideration for pre-heat and post-heat and with less concern about internal cracking.

Ductility is a characteristic that permits steel to elongate without fracture, highly desirable for the process of forming cold steel into shapes and for steel structures that have to resist earthquakes. Special ductile steels have been developed in Japan for earthquake-resistant building construction. In

Luxembourg, steel profiles have been developed for their high degree of ductility, for use in the cold conditions of arctic and offshore construction.

Strength, however, remains one of the key characteristics of high performance steels. Within certain structural limits of deflection, increased strength equates to reduced steel quantities, which in turn may lead to reduced construction cost.

The new high performance steels exhibit a collective mix of improved characteristics that more than compensate for their higher specific cost. They offer opportunities to reduce the finished-project cost by lowering fabrication cost and, by reducing material weight, the costs of shipping and erection, with an end result of improved performance and thereby improved value.

Much of the early research in these products was done for military applications where combinations of reduced weight, higher strength and easier fabrication were more critical than cost. Adapting this technology to construction applications, along with appropriate and essential reductions in material costs, continues to stimulate further development of new steels.

#### **Fire protection**

Since steel was first used as a structural framing material, most regulatory standards have required that it be protected from high-temperature fire. Two options have been commonly used; either thermal insulation to separate the steel from fire or water sprinklers to put the fire out or cool the steel. For nearly a century the standards for fire protection have been based either on tradition or tests in specialised furnaces, practices that often resulted in immoderate protection requirements. As more and more of the world's population moves to ever-expanding urban areas, developers are exploring new avenues for protecting structures and their

occupants, finding new ways to make the fire protection of steel more effective and economical.

The first of these is the transition from expensive real-life testing, to quicker and less expensive calculations using sophisticated computer models. Gradually, as calculation methods are being refined and regulatory authorities become confident in applying them, savings in steel protection can be realised in many ways. More realistic evaluation of fire conditions results in more precise application of protection, allowing for the elimination of excessive protection.

For structures such as those that use an exposed frame as an architectural feature, thermal insulation can be replaced with liquid filling of tubular members. If the members are hydraulically connected and the heated liquid is free to move, the steel frame is able to dissipate its thermal load through convective transfer to other, non-heated segments of the frame.

In another development, a Japanese steel producer has adapted technology developed for steels used in elevated temperature applications to the steels used for building frames; constructional steels have been developed which have superior residual strength characteristics at temperatures above 500°C. While not eliminating the need for fire protection, the special steels for this application require less protection than steels traditionally used.

The total cost of a completed structural frame includes the cost of the steel components, of fabrication, shipping and erection, plus the cost of fire protection. Studies in the United Kingdom have shown that for those cases where fire protection is a significant part of the total cost, it is possible to economically replace protection with additional steel. The concept is that a heavier, structurally over-designed frame can tolerate higher

temperatures. In addition, because of their larger size, heavier frame members heat up less quickly in a fire. The end result is the calculation of cost trade-offs in which more steel may be the route to more economical protection.

To advance the consideration of sustainable development in construction, in May 2002, Luxembourg will host the IISI World Conference 2002 – *Steel in Sustainable Construction*. This conference, which builds upon the success of the 'Steel in Green Building Construction Conference' held in Orlando in 1998, will focus on:

- what sustainable development means for the construction industry,
- raising awareness about sustainable construction and its business benefits,
- how steel construction solutions can contribute to more sustainable development.

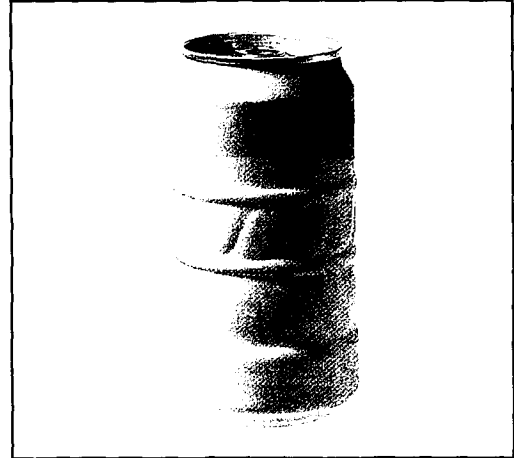
The conference will attract an audience of hundreds of construction professionals, including architects, builders, engineers, and fabricators, to further the cause of implementing the principles of sustainable development in the construction sector. The reader is invited to find more information on the conference Web site at <http://www.sustainablesteel.com>.

### 2.3.1.3 Packaging

Steel is one of the leading materials used for attractive, convenient and cost-effective packaging today. Because they are strong, lightweight, versatile and recyclable, packaging steels are ideal for a wide variety of food, beverage and other packaging applications. In addition, these steels are used in numerous other items ranging from cookware to automotive components to paper clips.

Steel packaging is a good example of how products can be designed to increase resource and energy efficiency, and reduce their impact on the environment, while delivering the service demanded by society. Figure 8 demonstrates how the mass of a 33cl steel

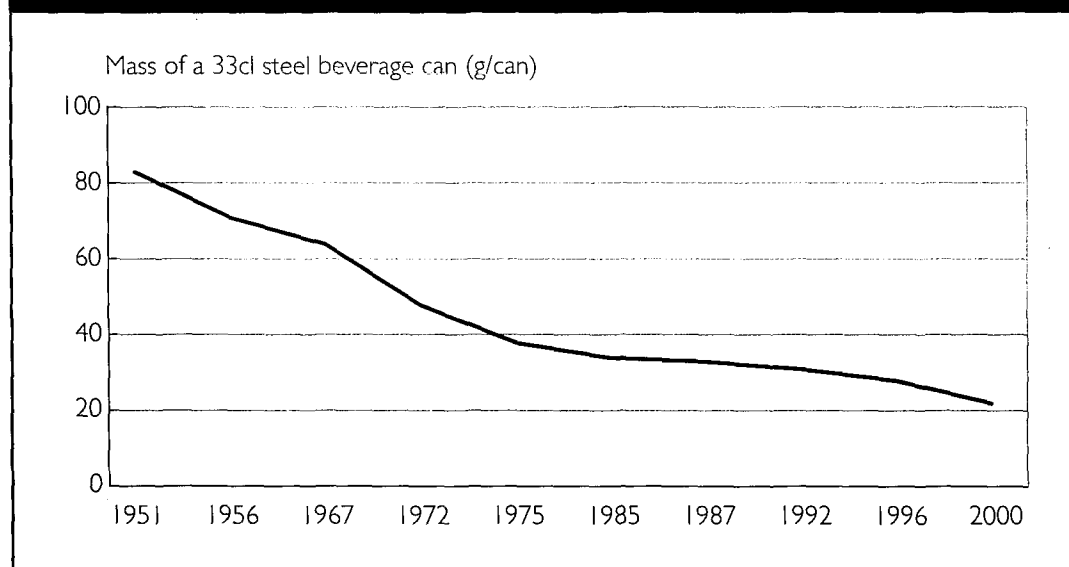
Figure 7: Shaped steel beverage can



Source: APEAL

beverage can has decreased over the years, resulting in a can about a quarter of the mass it was 40 year ago. The decrease in mass is enabled by new steelmaking and can-making technologies and by the development of advanced steels that can offer the strength and formability required to make the packaging lightweight.

Figure 8: Mass of a 33cl steel beverage can



Source: APEAL

The resulting gain in resource and energy efficiency can be seen in the fact it took 38,000 tonnes of tinplated steel to produce one billion cans in 1983. In 2003, it is expected that only 25,600 tonnes of tinplated steel will be needed to produce one billion cans.

### 2.3.2 Steel manufacturing

#### 2.3.2.1 Process description

Currently, there are two process routes that dominate global steel manufacturing, although variations and combinations of the two exist. These are the 'integrated' and the 'mini-mill' routes. The key difference between the two is the type of iron bearing feedstock they consume. In an integrated works this is predominantly iron ore, with a smaller quantity of steel scrap, while a mini-mill produces steel using mainly steel scrap, or increasingly, other sources of metallic iron such as directly reduced iron.

The integrated steelmaker must first make iron and, subsequently, convert this iron to steel. Raw materials for the process include iron ore, coal, limestone, steel scrap, energy and a wide range of other materials in variable quantities such as oil, air, chemicals, refractories, alloys, and water. As the process flowsheet in figure 9 shows (page 30), iron from the blast furnace is converted to steel in the Basic Oxygen Furnace (BOF) and, after casting and solidification, is formed into coil, plate, sections or bars in dedicated rolling mills. The integrated steelmaking route accounts for about 60% of world steel production.

Steel is made in an electric arc furnace (EAF) works by melting recycled scrap in an EAF and adjusting the chemical composition of the metal by adding alloying elements, usually in a lower powered ladle furnace (LF). The process flow sheet shown in figure 10 (page 31) indicates that the ironmaking processes, operated on the integrated plant, are not required. Most of the energy for melting comes from electricity, although there is an increasing tendency to replace or supplement electrical energy with oxygen, coal and other fossil fuels injected directly in the EAF.

In addition to steel scrap, metallic substitutes such as direct reduced iron (DRI) are becoming increasingly important where scrap availability is limited, where the impurity content of scrap is high or where a localised raw material resource is available. Downstream process stages, such as casting and reheating and rolling, are similar to those found in the integrated route.

A third steelmaking technology, open hearth furnace steelmaking (OHF), remains in use for about 4% of world crude steel production (figure 11, page 32). Countries where open hearth steelmaking is still employed, based on 2000 data, include Russia, Ukraine, Bosnia-Herzegovina, Czech Republic, Poland, Uzbekistan, Latvia, China, India and Turkey.

Figure 9: Process flow diagram for steel production using the blast furnace route

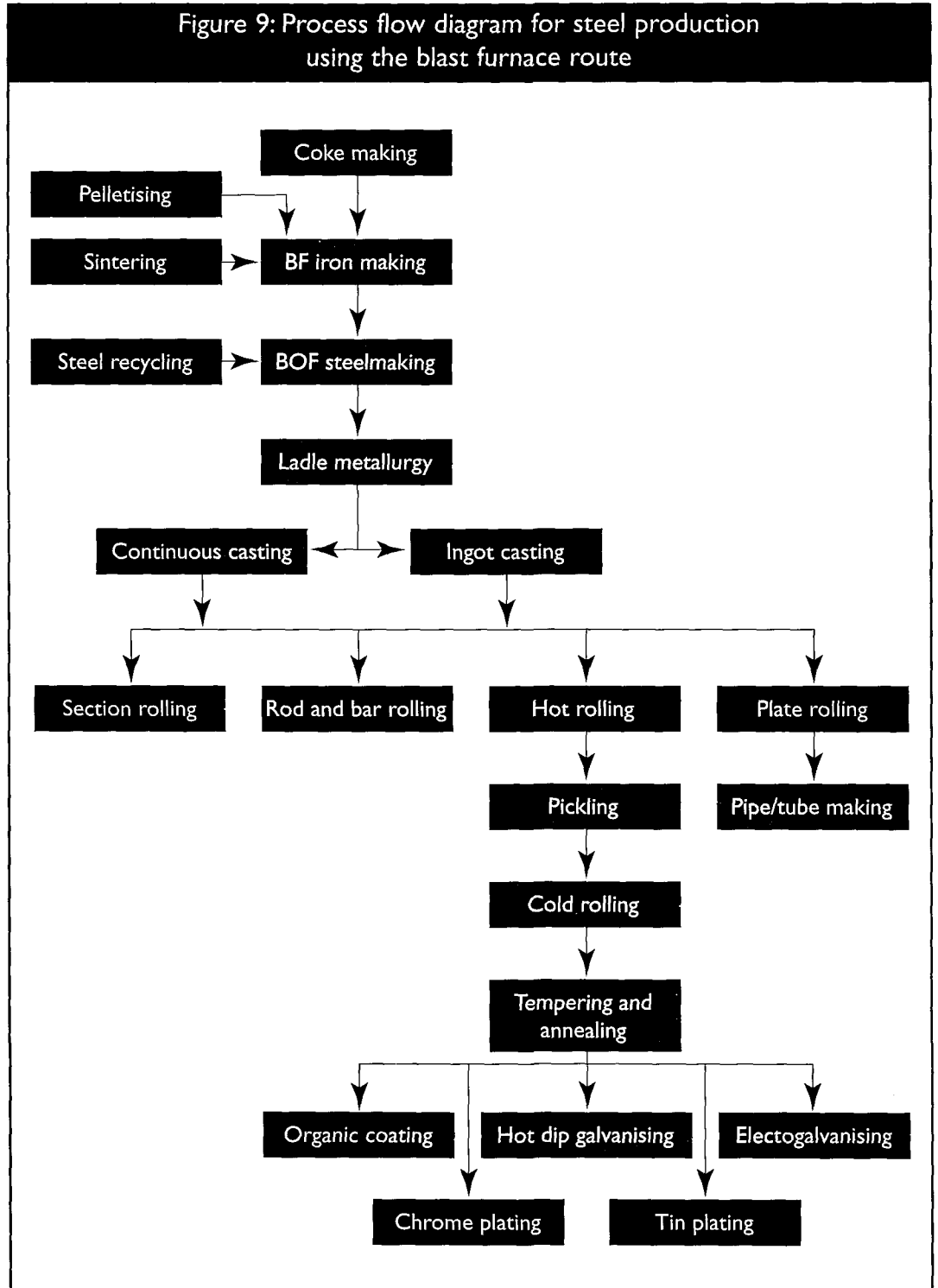




Figure 10: Process flow diagram for steel production using the electric arc furnace (EAF) route

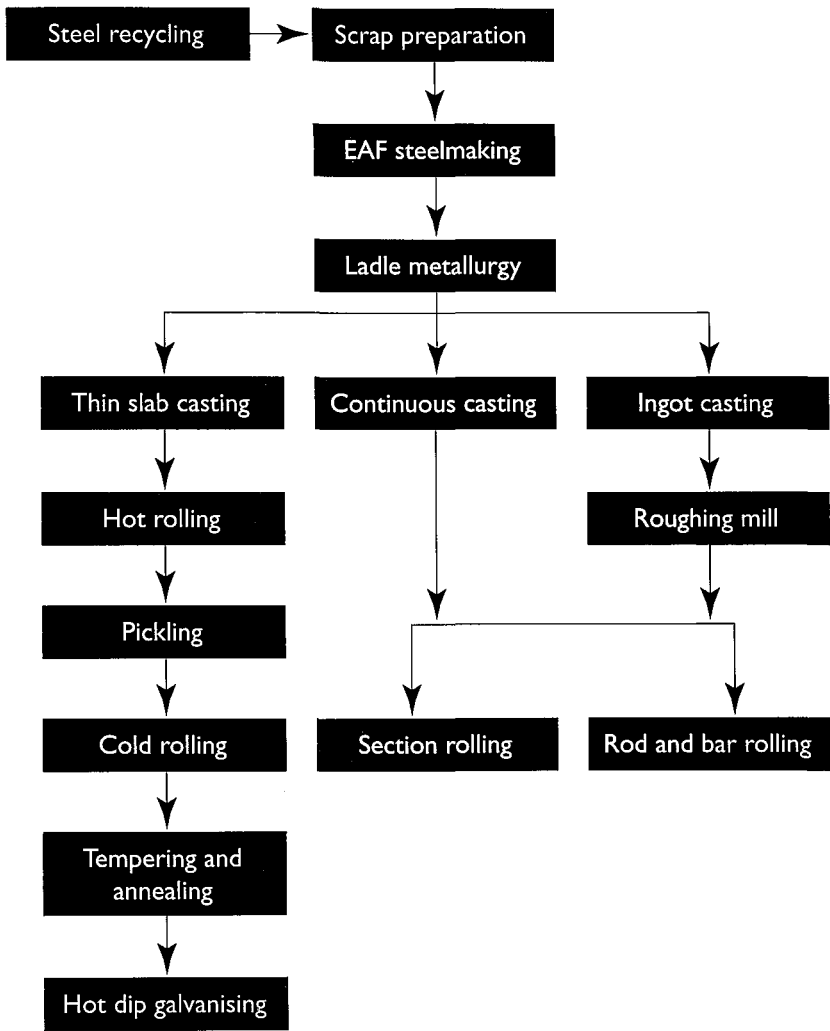
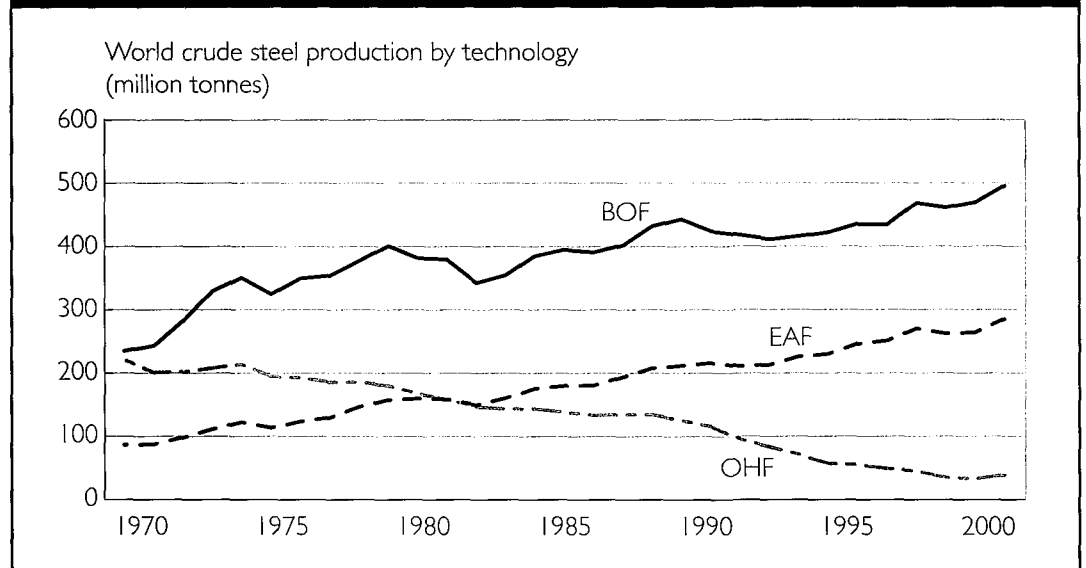


Figure 11: Share of world crude steel production by process technology



Source: IISI

Steel manufacturing operations have the potential to lead to a variety of impacts on the environment. These impacts depend on the process stage, the size and type of operation, the technology employed, the nature and sensitivity of the surrounding environment, and the effectiveness of planning, pollution prevention, mitigation and control techniques adopted. The perceived severity of impacts will be based on value judgements made by society and will be linked to the current status of scientific debate.

Cleaner production is good business, good for government, industry and society at large. The lesson from the past is simple: it is less costly to prevent pollution at source than to clean it up after it has been produced.

Cleaner production may not solve all of the environmental problems at a facility, but it will decrease the reliance on end-of-pipe solutions and will create smaller quantities of less toxic waste requiring treatment and disposal. Cleaner production will reduce workers' exposure to hazardous chemicals and the

potential for accidents that can lead to harm of surrounding areas. Products that are designed and produced with cleaner production in mind are less harmful to the environment and their residuals are less of a burden to waste streams.

As a guide, the application of cleaner production can be subdivided into the following areas:

- change of process or manufacturing technology;
- change of input materials;
- change to the final product;
- reuse of materials on-site, preferably within the process. Off-site recycling is not considered part of cleaner production, although it may bring substantial environmental benefits;
- Improved housekeeping;
- training.

The steel industry in the 1950s and early 1960s was a major source of pollution, particularly air pollution, in the densely

populated areas where production has traditionally been concentrated. Initially, the problem was tackled with the retrofitting of gas and dust collection facilities to existing plants, but this approach was superseded by the replacement of obsolete plants, with newer facilities designed with cleaner production in mind, and the training of personnel to raise awareness of environmental issues. Thus, the improved design, operation, and maintenance of steelworks processes has resulted in a reduction of emissions to air of 50% to 80% over the last 20 years.

### 2.3.2.2 Air pollution prevention

Air pollution remains the most significant environmental issue for steelmaking, but the reduction or prevention of atmospheric emissions is closely linked to energy and resource conservation, as well as waste water management. For example, by-product gases are a valuable fuel source which form an integral part of a steelworks energy balance. However, cleaning systems are required to treat these gases before they can be used and the resulting waste water may contain particulate matter and some heavy metals or organic pollutants, cyanide, ammonia, and other species. In addition, iron containing dusts and sludges may also be collected.

Thus, by reducing emissions to air of by-product gases a steelworks can benefit from the flexibility of a captive energy resource, reducing energy consumption, and the availability of iron-containing materials that might be returned to the process, reducing resource consumption. Recirculating systems can be employed ensuring that the water is used effectively within the process and, with careful management of the necessary system bleeds, process water might be downgraded to less critical applications, thus minimising the overall water demand of the steelworks.

If prevention at source is not possible, emissions should be captured as close as possible to the point at which they are

generated. Hoods and enclosures are widely used, incorporating carefully designed ductwork to prevent dust drop out, blockage, or excessive erosion, and, once captured, the offgas is cleaned prior to discharge.

There are four main types of gas cleaning device including:

- fabric filters, which have been adapted for use at high gas volumes and temperatures, with variable dust size and dust loadings and under acid and alkaline conditions. Filters are used primarily to capture dust and fume and are routinely integrated into materials handling systems, the blast furnace, BOF and EAF steelmaking plant and rolling mills;
- electrostatic precipitators (ESPs), which apply an electrical charge to the particles of dust, causing them to attach to oppositely charged plates. Again, ESPs are used primarily to capture dust and fume and are routinely integrated into coke ovens (tar separators), sinter and pellet plant, BOF and EAF steelmaking plant;
- wet scrubbers, which wash the offgas with a stream of water droplets. The pollutant laden water is collected, cleaned of solids and dissolved substances and then recycled back to the scrubber. These systems can be used to capture a wider range of pollutants including dust, fume, acid gases, acid aerosols etc. and may be incorporated into lime production plant, coke ovens, sinter and pellet plant, BOF steelmaking, pickling and coating operations;
- dry cyclones, which accelerate the offgas within a cyclone to remove particulate with a centrifugal action. Cyclones can only remove particulate and, because they operate at a lower efficiency than the other systems discussed, particularly where fine material is present, they are not now widely applied. Examples include the application of these systems on the sinter plant main waste gas, although this is not recommended, and on the sinter cooler gas.

### Emissions abatement in coking works in Poland

A cleaner production assessment of the coking plants in the Zabrze Coking Works, Poland, was carried out to establish the sources of emitted pollution. Implementation of cleaner production technology for the coke gas cooling system resulted in the following:

- reduced hydrogen cyanide emissions by 91%,
- reduced benzene emissions by 88%,
- reduced toluene emissions by 89%,
- reduced xylene emissions by 88%,
- reduced hydrogen sulphide emissions by 85%.

The payback period of the capital investment was one month.

The best technology for a particular application will be dependent on the type of emission to be abated and on local circumstances. For example, electrostatic precipitators use less energy than the other methods, but are unsuited to highly resistive dusts. Wet scrubbers are suitable for treating saturated gases but require water pollution control facilities to clean the water. Fabric filters provide high cleaning efficiency, but can operate over only a limited range of temperature and moisture conditions.

#### 2.3.2.3 Water and waste water management

The total water requirement of the iron- and steelmaking processes is of the order 100-200 m<sup>3</sup> per tonne of product supplied, primarily, by integrated recycling systems. From the viewpoint of pollutant control a high recycling

ratio is preferred, however, factors such as build-up of hardness and conductivity require that an optimum recycling ratio is determined from a total water system analysis.

Table 4 illustrates a comparison between the intake water requirements of a once-through system and a system involving extensive recirculation in a typical integrated works. The extensive recirculation in indirect and direct cooling systems reduces the total water intake to 2.4% of the requirement of the once through system.

Sources of waste water include that resulting from direct and indirect cooling, gas cleaning, scale breaking, pickling, washing and rinsing operations and rainfall runoff such as from raw material stockpiles, roads, and building roofs.

**Table 4: Intake water requirements for a four million T/y crude steel integrated works**

Water use	Quality	Water intake			
		Once through		Extensive recirculation	
		m <sup>3</sup> /minute	% of total	m <sup>3</sup> /minute	% of total
Indirect cooling	General	675	70.7	7.4	32
Direct cooling	General	265	27.8	6.2	26.8
Process water	Low grade	7.7	0.8	5.1	22.1
Potable	High	1.5	0.2	1.5	6.5
<b>Total</b>		<b>954</b>	<b>100</b>	<b>23.1</b>	<b>100</b>

Source: IISI

Direct cooling involves the open spraying of water onto steel or equipment and is most commonly used for cooling hot steel leading to contamination with millscale and equipment oil. Water used for indirect cooling is contained in a closed system and is far less prone to contamination, however, some water must be removed from the circuit to prevent excessive water hardness and build-up of suspended solids.

When direct and indirect cooling systems are used together, the water removed from the indirect circuit can often be used as make-up water for the direct cooling system, although some intermediate cooling may be required. Similarly, although a waste water treatment plant and pumping system can render waste water reusable, the use of poor quality water in critical areas may cause product degradation and equipment deterioration. As such, waste water may be best suited for quality insensitive applications such as dampening of raw material stockpiles or road washing.

Waste water treatment involves a combination of physical, chemical and biological processes. Each waste water stream normally undergoes an initial treatment close to its source, perhaps to remove gross solids and oil, before being sent to a secondary treatment system. Some sites also use municipal waste water treatment systems to complement internal secondary systems.

There are several basic treatments, applied at most steelworks, that are capable of removing the great majority (by mass) of waterborne pollutants prior to discharge and others, applied as necessary, to remove trace pollutants. These include:

for the removal of solids:

- settling basins, which are a simple, low maintenance means of removing solid particles from liquid by gravity. After a preliminary stage of chemical coagulation

and precipitation using aluminium or a polymeric flocculent, the velocity of the waste water stream is reduced as it passes into a large volume basin where settling occurs. Sufficient retention time and regular sludge removal are important factors that determine the success of this method;

- clarifiers, which are more effective than settling basins for the removal of suspended solids, require less space and provide for centralised sludge collection. Conventional clarifiers consist of a circular or rectangular tank with either a mechanical sludge collection device or a sloping funnel shaped bottom into which sludge collects. Advanced clarifier designs using slanted tubes or inclined plates may be used for pre-screening coarse materials that could clog the system. Chemical aids can be used to enhance solids removal, although chemical pre-treatment and sludge removal systems both require regular maintenance;
- filtration is a highly reliable method of waste water treatment, capable of removing suspended solids and unwanted odours and colour. The advantages of filtration are the low solids concentration that can be achieved, low investment and operating costs, modest land requirements and low levels of chemical discharge. Some pre-treatment may be necessary if the solids level is greater than 100mg/L. Several types of filter and filter media are used, such as the pressure type or gravity types, operating with single, dual or mixed filter media. The most important variable in filter design is the width and depth of the media, although particle density, size distribution and chemical composition are also important in terms of media selection. The media selected depends on the filtration rate and may consist of sand, diatomaceous earth, walnut shells or, for concentrations below 5mg/L solids, anthracite. All filters require regular back washing to prevent accumulation of solids in the filter bed.

For the removal of oil:

- skimming, which can be used to remove floating oil and grease from the water surface. Skimming efficiency depends on the density of the floated material and the retention time for phase separation, which varies from one to 15 minutes. Dispersed or emulsified oil cannot be removed by skimming. Skimming is often used as a pre-treatment to improve the performance of subsequent downstream treatments;
- filtration is an effective means of removing oil from water. Problems are only encountered when high oil concentrations contact the filter bed directly, although this can be avoided if appropriate pre-treatments are applied;
- flotation, in which air bubbles attach to the oil particles that then rise to the surface and can be skimmed off. The principal advantage of flotation over sedimentation is that very small particles can be removed more completely and in a shorter time. Various types of flotation are possible. For example, air may be injected while the liquid is under pressure, the bubbles being released when the pressure is reduced (dissolved air flotation). Aeration may take place at atmospheric pressure (air flotation) or the water may be saturated with air at atmospheric pressure and a vacuum applied to release the bubbles (vacuum flotation). In all cases, chemicals for flocculation and coagulation are usually added before flotation;
- coalescing filters, which agglomerate small oil particles thus enhancing the rate at which oil rise to the surface of waste water. The filter media is made up of plastic chips that have the correct surface properties to attract oil particles from the waste water stream allowing agglomeration and release.

For the removal of metals and inorganics:

- chemical precipitation is a process by which metals in solution can be removed using alkaline compounds, such as lime or

sodium hydroxide, followed by sedimentation, clarification and filtration. Lime also precipitates phosphates as insoluble calcium phosphates and fluorides as calcium fluoride. Sodium sulphide allows for the removal of metals by the precipitation of insoluble metal sulphides and calcium carbonate and carbon dioxide can remove metals as carbonates. Lime is widely used in the steel industry, as this technique operates under ambient conditions, has relatively cheap and available raw materials and is easily automated. Although the process produces clean water, it also generates a metal bearing sludge that should be recycled or disposed of in a safe manner, such as in a well designed landfill.

For the removal of organics:

- biological treatment is used to coagulate and remove soluble organics and may be based on the activated sludge system or, less frequently, other systems such as rotating biological discs, which are under test by the steel industry. The activated sludge process works by stabilising waste water using micro organisms in an aerobic environment, achieved by diffused or mechanical aeration of the waste water in an aeration tank. There is a constant bleed from the aeration tank to the settling tank that allows for the separation of the biological mass from the waste water, after which the waste water is sufficiently clean for discharge. Some systems may also incorporate an anaerobic stage to enhance the removal of nitrogen from the system. Following separation, the majority of the biological mass is returned to the aeration tank, but a small portion is removed and disposed of or recycled to the coking plant. The system is generally insensitive to normal fluctuations in hydraulic and pollutant loading, although certain pollutants, for example ammonia at high concentrations and heavy metals, can be extremely toxic to the micro organisms in

the system. Temperature will also influence the metabolic activity of the microbiological population, gas transfer rates and the settling characteristics of the biological solids. The method incurs relatively low capital and operating costs and is widely used in the industry for coke plant waste water treatment;

- carbon adsorption with activated carbon is an extremely efficient method for removing organics from waste water. In general, less soluble and relatively small organic molecules are most easily adsorbed by carbon, including most aromatic compounds, chlorinated non-aromatics, phenol, pesticides, and high molecular weight hydrocarbons. The adsorption process is reversible, allowing the used carbon to be regenerated by the application of steam or a solvent. Heating materials such as almond, coconut, walnut husks and coal produces activated carbon. The process relies on the large internal surface area of activated carbon for efficient adsorption (500 to 1,500m<sup>2</sup>/g). The major benefits of carbon treatment are its applicability to a wide variety of organics and its high removal efficiency. The system is compact and insensitive to wide variations in concentration and flow rate, but due to the relatively high capital and operating costs its use is restricted to the final treatment of coke plant effluents, where particularly stringent legislation applies.

For the removal of trace pollutants:

- technologies such as ion exchange and membrane separation have been developed and applied when fresh water is in particular short supply. The ion exchange process removes contaminant cations and anions using synthetic resins or by adsorption on to activated alumina. Since most ion exchange reactions are reversible, the medium can be reused many times before it must ultimately be replaced due to irreversible fouling. The main application

area for the ion exchange process in the steel works is in the preparation of indirect cooling water for use in boilers. There are many alternative membrane processes such as reverse osmosis, electro dialysis, ultra filtration and nano filtration. Membrane processes are usually used for desalination and for removal of specific ions that are difficult to remove by other means. Many attempts have also been made to apply membrane processes to the reuse of waste water.

#### 2.3.2.4 Energy conservation

The steel industry is a major user of energy. In Japan, steel accounts for 10% of total energy consumption and in Germany for 5.7%. However, indicative of many national industries, the energy consumed in the German industry to make one tonne of steel has fallen significantly from 29 GJ/tonne, in 1960, to about 22 GJ/tonne in 1989. This has been achieved by concentrating production at a smaller number of sites and increasing capacity of the process units, made possible by the introduction of technologies such as the back pressure blast furnace and oxygen steelmaking. Thus, the number of blast furnaces and steel plants has been reduced over time to one quarter and one-fifth of their previous number respectively.

About 95% of an integrated works' energy input comes from solid fuel, primarily coal, 3% to 4% from gaseous fuels, and 1% to 2% from liquid fuels. However, approximately three-quarters of the energy content of coal is consumed in the reduction reaction that converts iron ore to iron in the blast furnace. The remainder provides heat at the sinter and coking plants and, in the form of by-product gas, to the various downstream process stages.

The quantities of liquid and gaseous fuels used alongside the by-product gases in the downstream process stages depends on the overall works energy balance. Thus, by-product gases from the coke oven, blast furnace and

steelmaking typically contribute 40% to total energy and are used either as a direct fuel substitute or for the internal generation of electricity. The efficient utilisation of these internally generated energy sources is critical to the overall energy efficiency of a works, requiring that the complex relationships between the different generating and consuming facilities are understood.

#### 2.3.2.5 Resource conservation

When iron ore is converted into finished steel products, some iron units are 'lost' in the processes that are inevitably less than 100% efficient. Thus, the production of one tonne of steel in an integrated plant requires several times that quantity of raw materials.

A measure of the efficiency of individual or groups of processes is the yield, defined as the quantity of material leaving a process expressed as a fraction of the material entering, or the mass of product divided by the crude steel necessary to make that product. While the phrase 'yield loss' is widely used, its literal translation is misleading because the majority of the material comprising the 'loss' can often be recycled as feed to an earlier process stage.

Yield losses occur at all the main process stages, from material handling through iron- and steelmaking to the subsequent operations of casting, rolling and coating. Some loss is inevitable, although studies revealing the wide variation in yield performance between countries suggest that not all producers have implemented best technology and methods. For example, an IISI global survey showed that between 1961 and 1987 yields for hot rolled products in Japan rose from 77% to over 85%, while yields for the same process during this period in the former USSR remained static at around 70%. Table 5 shows the range of yields being achieved by steelmakers for the major processes in 1991.

As indicated above, scrap steel can be 100% recycled back into the process route and in tonnage terms is the world's most recycled material. Actual scrap recycling rates of over 80% are achieved on a world basis and over 40% of all steel is manufactured using processes that consume scrap as the primary input material (for example the EAF and open hearth). Scrap use is also an essential aspect of steelmaking BOF process that requires about 10% to 30% of scrap as a feed material to operate correctly. As such, steel scrap is a

**Table 5: Range of yields for processes and products**

Process	Range of yields (%)
BOF steelmaking	86.0 - 95.0
EAF steelmaking	85.0 - 92.5
Slab concast	84.9 - 98.0
Bloom concast	82.3 - 97.6
Billet concast	76.7 - 99.0
Hot rolled coil	84.5 - 98.8
Cold rolled coil	82.4 - 93.8
Tinplate	83.4 - 97.3
Plate	74.1 - 94.8
Sections	78.4 - 97.5
Wire rod	88.0 - 98.6
Straight bar	85.5 - 97.3



valuable and necessary raw material, and one that is returned to the steelmaker through a sophisticated and often independent recycling infrastructure.

The technology for steel recycling is well proven and based on the magnetic properties of iron and steel for its separation from non-metallic/nonferrous contaminants. In addition, scrap processing technologies involving the shredding and subsequent separation of scrap components have resulted in an increase in the recyclability of products as diverse as automobiles and beverage cans.

Obviously, the EAF producers have always sourced the majority of their scrap feed from external sources, but increasingly the integrated producer is having to do the same as the quantity of internally generated scrap is falling as yields improve. For example, in Germany the introduction of continuous casting has cut the quantity of in-plant generated scrap by two thirds.

By recycling nearly 300 million tonnes of scrap each year (not including internally generated scrap), the steel industry:

- does not have to extract 475 million tonnes of natural iron bearing ore,
- saves energy equivalent of 160 million tonnes of hard coal,
- avoids the emission of 470 million tonnes of carbon dioxide.

While the large quantities of by-products and wastes associated with the production of iron and steel have been progressively declining over the past 30 years, responsible management of both types of material remains an important and challenging task. If internally generated scrap is counted as a by-product, the industry currently recycles about 90% of all its by-products and wastes. Blast furnace slag accounts for 54% by volume of all integrated site by-products. The remainder made up of steelmaking slag (21%), special slags from pre-treatments (6%) and construction and refractory wastes such as used furnace lining bricks (7%).

Particulate matter and sludge from operations such as gas scrubbing have increased over the last ten years and account for 7% of the total. Other materials include coarse scale (the oxidised skin on hot steel surfaces) and millscale that, together, account for about 5% of total by-products and wastes.

Although the industry successfully recycles or reuses a large proportion of the wastes and by-products arising from the steelmaking process, there are still major efforts to valorise the more difficult materials. This effort will bring both environmental and economic benefits.

The following text is extremely faint and illegible due to low contrast and poor scan quality. It appears to be a multi-paragraph document, possibly a report or a letter, but the specific content cannot be discerned. The text is organized into several distinct blocks, likely representing paragraphs or sections of a document. The overall appearance is that of a scanned document where the original text has been lost or is too light to be captured accurately.

## Part 3: Means of implementation

### 3.1 Strategies

#### 3.1.1 Management systems

Environmental issues are now so numerous, complex, interconnected and continuously evolving that an ad hoc approach to problem solving is no longer considered effective. A systematic approach to management is required. A formal environmental management system (EMS) provides a decision-making structure and action programme to support continuous improvement in environmental performance. The ISO 14001 standard provides a basis for steel companies to have their EMS programmes certified.

A survey of EMS programmes was completed by IISI in 2000. The study looked at the current status of environmental management systems in the iron and steel industry with an aim to benchmark the current development, and offer a best practice for those companies about to undertake the implementation of a system. A special questionnaire was circulated to the members of IISI's Committee on Environment.

The role of EMS in the iron and steel industry is becoming increasingly significant in customer, supplier, public and regulatory relationships, as the steel product reaches a wider audience through a more informed awareness. EMS, and especially the auditing aspects, are a tool for the industry to control and improve the implemented system, and are widespread in the industry, with 80% of the companies operating one.

The 30 companies responding to this survey represent 24% of the total world production of steel in 1999, (~187 Mt), and cover mainly the integrated works, therefore the EAF operators, and particularly stainless steel and special steels, are under-represented. Regional variations are found to be slight, mainly due to the number of responses in each region making sound statistical comparisons difficult. Differences were apparent between integrated and EAF works, however larger numbers of EAF responses are required to allow a more significant comparison. The results and following analysis should be considered with these points in mind.

In terms of the EMS in place, only 37% are certified to international standards, however, the certification process is not considered an obstacle to gaining the standard, instead a lack of resources is to blame (manpower for the larger operators, and financial for the smaller (generally EAF) operators). 50% of those systems uncertified intend to certify them to ISO or other standards.

The application of the EMS is most common at the highest level of the company, but there is a significant regional variation between Europe and South America, where six out of ten companies in South America have their system at company level, compared with only one out of ten in Europe – the systems are generally spread throughout the company. Europe also has the highest number of companies not operating an EMS.

### Baoshan Iron and Steel Co. Certified to ISO 14001

Shanghai Baosteel Group Corporation (SBGC) pays great attention to environmental protection. Baoshan Iron & Steel Co., a company of SBGC, is the first to obtain the environmental certificate of ISO 14001 among the metallurgical enterprises in China. Its green coverage in plant area is up to 38.12%, which makes its air quality the same level as that in national scenery spots.

The automotive sector, of all the sectors indicated by the companies as the area from which most revenue is received, showed the lowest degree of EMS implementation. The customer and regulatory pressures experienced in iron and steel industry – particularly in this sector – make this result surprising.

The companies indicated that in 72% of the cases, products were included in the EMS, however in terms of the supplier, 53% indicated that they have requirements as part of the EMS.

In terms of auditing, 77% of companies carry out internal audits, with a spread at the various company levels, and are generally once a year in frequency. Average sizes of the audit teams are three to four people, with the average number of days a year for the audits being 31, 44, 51, and 14 for the company, site, business unit, and production unit respectively. The average number of auditors per company is 24, with the average proportion that are accredited at 20%. Only one company (Europe) has only external auditors.

Environmental performance is considered the most important factor for reducing air and water pollution and recycling waste. Performance targets are generally reviewed every year. The reasons for revision of the targets are mainly 'relevant regulations', followed by the environmental impacts of various aspects of the process. Checking the targets takes place widely across all companies, and at all levels, particularly on an annual and monthly basis. On the whole, the head of the

particular company level establishes the targets, but the share evens out at the business unit and production unit level where other managers and most likely, environmental personnel, are involved.

### 3.1.2 Product stewardship

Steel's distinctive environmental fingerprint has many advantages. More than half of the steel we see around us has already been recycled from scrap. This valuable material – from old cars, buildings, and steel cans, for example – is a powerful energy and resource saver. It takes at least 60% less energy to produce steel from scrap than it does from iron ore. Waste disposal problems are lessened because used steel can be recycled over and over. Sooner or later, virtually all scrap gets back to the steel mill.

Steel's established recycling loop and the ease with which scrap is reclaimed through steel's natural magnetism helps today's designers make end-of-life recycling a vital part of product planning. Steel beverage cans may become new steel in a matter of weeks; cars may take ten to 15 years; buildings and bridges nearly a century. But sooner or later virtually all scrap gets back to the steel mill.

Steel is the world's most versatile material to recycle. Other less flexible materials must be recycled back to their original uses. But once recycled, steel can hop from one product to another without losing its quality. Steel from cans, for instance, can as easily turn up in precision blades for turbines or super strong suspension cables.

## New steel casting technology

Nucor Corporation<sup>(tm)</sup> is constructing the first commercial Castrip<sup>(tm)</sup> facility in Crawfordsville, Indiana, (United States), to produce thin-strip sheet steel. Strip casting involves the direct casting of molten steel into final shape and thickness without further hot or cold rolling, allowing lower investment and operating costs, reduced energy consumption and smaller scale plants than can be economically built with current technology. The facility is expected to be operational in 2002 and have a production capability of up to 500,000 tonnes per year of hot rolled coil.

Every year steelmakers recycle nearly 385 million tonnes of steel. This is equivalent to more than 1,055,000 tonnes each day, 44,000 tonnes each hour, and 12 tonnes each second. In the 60 seconds it has taken you to scan this page, steelmakers around the world recycled more than 700 tonnes of steel.

### 3.1.3 Steel production

Increased energy and resource efficiency in steel production will bring significant advances in the sustainability of the steel industry. These gains in efficiency result from achievements in optimising current production methods and from the introduction of new technologies.

In the recent IISI study *Energy Use in the Steel Industry*, case studies of four steel product facilities indicated reductions in energy consumption has been in the order of 25% since the mid-1970s. The report suggests the future may bring energy consumption figures of 12GJ/t of steel, a savings of about 60% from current values, although this is not economically or technically feasible today.

One focus of technology development is steel strip casting. Strip casting involves the direct casting of molten steel into solid strip steel, bypassing the need for hot and cold rolling to obtain the final shape and thickness. The introduction of this technology will reduce energy demand to 0.2GJ/t, or a reduction of 81% to 89% compared with conventional casting and hot rolling technologies.<sup>(5)</sup> Strip casting is expected to also have lower capital and operating costs and result in steel products with new metallurgical properties.

### 3.1.4 Economics

Earlier this year IISI issued a call for an immediate start of inter-governmental negotiations on steel. A positive response from governments led to the convening of a high level meeting at the OECD in September. Governments from around the world met again in December 2001 to report back on

the results of discussions that they have held with their individual industries.

Steel industry leaders recognise that it is their responsibility to improve the financial performance of the industry by implementing the changes in industry structure and behaviour that are required. The now global nature of the steel business requires further urgent and major changes in the size and scope of individual steel enterprises and they need clear support of governments to move quickly in this direction.

The board of directors restated that decisions to close steel plants and to invest in new capacity is the responsibility of individual steel enterprises. There are, however, important areas where governments can help the industry. These are:

- assistance with the past and present social and environmental problems associated with the permanent closure of plants;
- the elimination of all state aid and subsidies which help to maintain existing plants;
- the elimination of state aid or state guaranteed loans for new capacity;
- support for an open and fair trading system in steel rather than self-sufficiency;
- competition policies based on global rather than national or regional competition criteria to allow the international consolidations and alliances required;
- support for the provision of faster, more transparent information on trade, shipments, price, inventories and capacities.

## 3.2 Measures

At the time of writing this report, there are no agreed measures of sustainable development for the world steel industry. Indeed, this situation is not unique to the steel industry, or for that matter to industry, government and civil society. However, as part of its current sustainable development programme, IISI will consider measures, or indicators, of sustainable

(5) Wechsler, Richard L. "The Status of Twin-Roll Casting Technology Compared with Conventional Top Rolling." *ISIJ Conference Series* 1: 35. October 2001.

development that might be recommended to the world steel industry and tracked on a worldwide basis.

For this report, the measures of implementation of sustainable development are divided into measures of environmental performance, measures of social performance, and measures of economic performance. Examples of the world steel industry's performance are presented.

### 3.2.1 Measures of environmental performance

Relevant measures of environmental performance include energy efficiency, resource efficiency, and releases to air, water, and ground. It is in this regard that the world steel industry has comprehensive worldwide data in the form of a life cycle inventory (LCI) study. LCI is a quantitative analysis of the inputs (resources and energy) and outputs (products, co-products, emissions) of a product system. For more information on life cycle assessment, and life cycle inventory, the reader is referred to the ISO 14040, ISO 14041, ISO 14042, and ISO 14043 standards.

In 1995 IISI undertook the first worldwide LCI study for the steel industry. This study included a 'cradle to gate' analysis of steel production, from the extraction of resources and use of recycled materials through the production of steel products at the steel works gate. The results for hot rolled coil are presented in table 6 (opposite), where the hot rolled coil here is steel continuously cast at an integrated steel plant and rolled to reduce thickness (and elongate the continuously cast steel slab into strip) in the hot strip mill. It can be noted these results are derived from a survey of steel works around the world, and these results in particular, represent a global average of 1994-1995 data from some 25 sites.

Interpreting the LCI results for resource and energy efficiency, it can be said to produce 1kg of hot rolled coil at an integrated works, we

would expect the average resource consumption to include 0.59kg of coal, 1.4kg of iron ore, 0.14kg of steel scrap, and 12L of fresh water. In terms of energy consumption, a total energy of 24.8MJ is required, of which most can be classified as non-renewable fuel energy.

Producing 1kg of hot rolled coil results in emissions to air, water and land as well. Emissions to air include 1,911g of carbon dioxide, 2.2g of nitrogen oxides, 1.5g of particulates, and 2.2g of sulphur oxides. Emissions to water include 0.3g of chlorides, 0.05g of nitrogen and 0.2g of suspended matter.

The total waste generated from producing 1kg of hot rolled coil amounts to 0.2kg.

An example of the LCI results for producing 1kg of rebar/wire rod/engineering steel from the electric arc furnace processing route is given in table 7. As described earlier in this report, electric arc furnace steelmaking uses recycled steel as its main source of iron. Electric arc furnace steelmaking and integrated steelmaking (using iron ore and recycled steel) have a symbiotic relationship as integrated steelmaking does not consume the world supply of recycled steel while electric arc furnace steelmaking requires a supply of recycled steel that would be limited without new steel being made.

As with the results for hot rolled coil from integrated steelmaking, the results for rebar/wire rod/engineering steel are based on 1994-1995 data.

To produce 1kg of rebar/wire rod/engineering steel, considering 'cradle to gate' and a global average of surveyed sites, it can be seen that the largest resource requirement is 1.07kg of recycled steel, followed by 0.075kg of limestone, 0.075kg of coal, 0.0583kg of oil and 0.0556kg of natural gas. About 7.2L of fresh water is required. The total energy requirement is 11.8MJ.

**Table 6: LCI results for 1kg of hot rolled steel coil (global average)**

Inputs:	Major Articles*	Units	Average
(r) Coal		kg	0.589
(r) Dolomite (CaCO3.MgCO3)		kg	0.0250
(r) Iron (Fe, ore)		kg	1.43
(r) Limestone (CaCO3)		kg	-0.0077
(r) Natural Gas		kg	0.0402
(r) Oil		kg	0.0469
(r) Zinc (Zn, ore)		kg	0.0000
Ferrous Scraps (net)		kg	0.135
Fresh Water (total)		litre	12.0

Outputs:	Major Articles*	Units	Average
(a) Carbon Dioxide (CO2, fossil and mineral)		g	1911
(a) Carbon Monoxide (CO)		g	26.4
(a) Nitrogen Oxides (NOx as NO2)		g	2.18
(a) Particulates (total)		g	1.46
(a) Sulphur Oxides (SOx as SO2)		g	2.19
(w) Ammonia (NH4+, NH3, as N)		g	0.1043
(w) Chlorides (Cl-)		g	0.30
(w) Chromium (Cr III, Cr VI)		g	2.00E-05
(w) COD (Chemical Oxygen Demand)		g	0.188
(w) Cyanides (CN-)		g	1.05E-03
(w) Fluorides (F-)		g	0.0209
(w) Iron (Fe++, Fe3+)		g	1.44E-02
(w) Lead (Pb++, Pb4+)		g	1.28E-04
(w) Nickel (Ni++, Ni3+)		g	9.34E-05
(w) Nitrogen (total except ammonia, as N)		g	0.0492
(w) Phenol (C6H6O)		g	5.20E-03
(w) Phosphates (PO4 3-, HPO4--, H2PO4-, H3PO4, as P)		g	-1.72E-03
(w) Phosphorus (total except phosphates, as P)		g	6.73E-04
(w) Sulphides (S--)		g	0.131
(w) Suspended Matter (unspecified)		g	0.188
(w) Water		litre	8.31
(w) Zinc (Zn++)		g	2.90E-03
Non Allocated By-products (total)		kg	0.0584
Waste (total)		kg	0.204

Energy Reminders:	Major Articles*	Units	Average
Total Primary Energy		MJ	24.8
Non Renewable Energy		MJ	24.5
Renewable Energy		MJ	0.352
Fuel Energy		MJ	24.7
Feedstock Energy		MJ	0.126

(r): Raw material in ground  
 (a): Airborne emissions  
 (w): Water in ground  
 \* As indicated by the sign in the column  
 (a) and (w) are in g and (r) is in kg

Table 7: LCI results for 1kg of rebar/wire rod/engineering (global average)

Inputs:	Major Articles*	Units	Average
(r) Coal		kg	0.0750
(r) Dolomite (CaCO <sub>3</sub> .MgCO <sub>3</sub> )		kg	8.09E-04
(r) Iron (Fe, ore)		kg	-0.0101
(r) Limestone (CaCO <sub>3</sub> )		kg	0.0750
(r) Natural Gas		kg	0.0556
(r) Oil		kg	0.0583
(r) Zinc (Zn, ore)		kg	-3.63E-03
Ferrous Scraps (net)		kg	1.068
Fresh Water (total)		litre	7.19

Outputs:	Major Articles*	Units	Average
(a) Carbon Dioxide (CO <sub>2</sub> , fossil and mineral)		g	558
(a) Carbon Monoxide (CO)		g	2.37
(a) Nitrogen Oxides (NO <sub>x</sub> as NO <sub>2</sub> )		g	1.53
(a) Particulates (total)		g	0.213
(a) Sulphur Oxides (SO <sub>x</sub> as SO <sub>2</sub> )		g	1.98
(w) Ammonia (NH <sub>4</sub> <sup>+</sup> , NH <sub>3</sub> , as N)		g	-7.85E-04
(w) Chlorides (Cl <sup>-</sup> )		g	0.287
(w) Chromium (Cr III, Cr VI)		g	2.79E-05
(w) COD (Chemical Oxygen Demand)		g	0.0314
(w) Cyanides (CN <sup>-</sup> )		g	2.52E-06
(w) Fluorides (F <sup>-</sup> )		g	0.0177
(w) Iron (Fe <sup>++</sup> , Fe <sup>3+</sup> )		g	1.45E-03
(w) Lead (Pb <sup>++</sup> , Pb <sup>4+</sup> )		g	9.22E-05
(w) Nickel (Ni <sup>++</sup> , Ni <sup>3+</sup> )		g	6.88E-05
(w) Nitrogen (total except ammonia, as N)		g	-1.13E-03
(w) Phenol (C <sub>6</sub> H <sub>6</sub> O)		g	3.08E-05
(w) Phosphates (PO <sub>4</sub> <sup>3-</sup> , HPO <sub>4</sub> <sup>-</sup> , H <sub>2</sub> PO <sub>4</sub> <sup>-</sup> , H <sub>3</sub> PO <sub>4</sub> , as P)		g	8.00E-03
(w) Phosphorus (total except phosphates, as P)		g	0.0650
(w) Sulphides (S <sup>-</sup> )		g	-1.83E-04
(w) Suspended Matter (unspecified)		g	0.0319
(w) Water		litre	5.87
(w) Zinc (Zn <sup>++</sup> )		g	1.93E-04
Non Allocated By-products (total)		kg	0.118
Waste (total)		kg	0.0558

Energy Reminders:	Major Articles*	Units	Average
Total Primary Energy		MJ	11.8
Non Renewable Energy		MJ	10.9
Renewable Energy		MJ	0.93
Fuel Energy		MJ	11.3
Feedstock Energy		MJ	0.57



For air emissions, 558g of carbon dioxide is emitted, 1.98g of sulphur oxides, 1.53g of nitrogen oxides, and 0.2g of particulate. Emissions to water include 0.287g of chlorides, 0.065g of phosphorus, and 0.032g of suspended matter.

The total waste generated is 0.06kg for 1kg of rebar/wire rod/engineering steel.

In interpreting these results, it is important to keep in mind that the inputs and outputs do not all occur at the steel works site. As the LCI results are 'cradle to gate', the results presented here include inputs and outputs from upstream processes, such as iron ore mining, coal mining, oil production and electricity generation. In fact, the inputs and outputs are related to locations around the world and to varying times as well.

In 2002, IISI will complete its second worldwide LCI study of steel products. Among other uses, the results of this second study can be benchmarked against the first study to

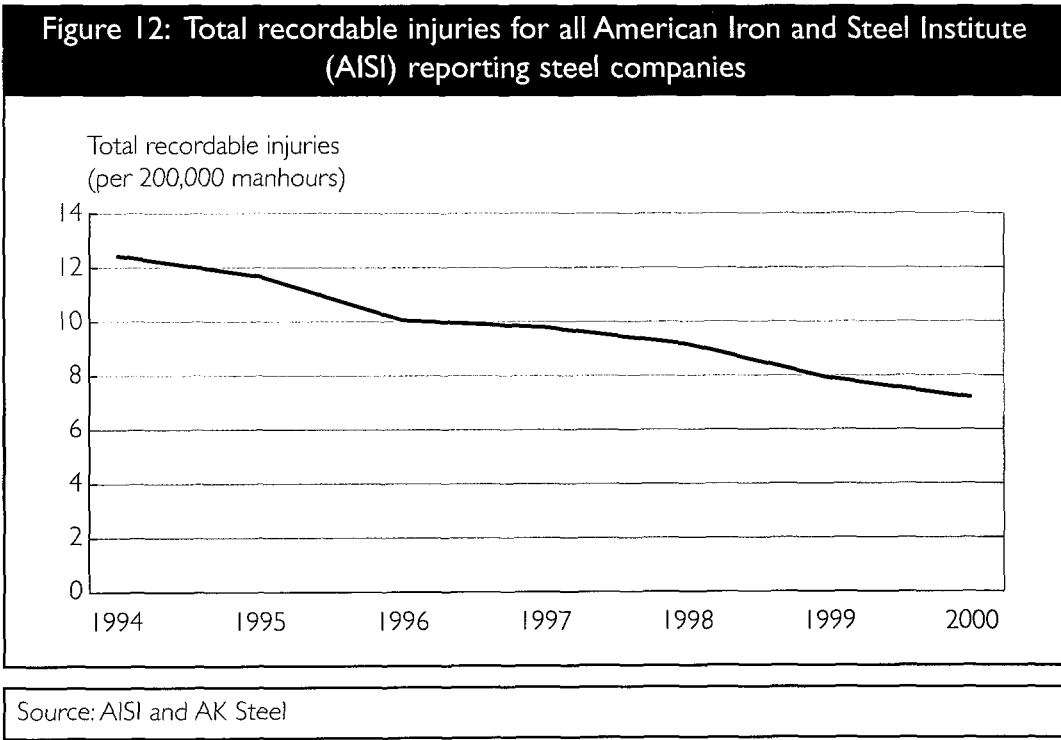
gauge changes in energy and resource efficiency and releases to air, water, and ground.

More information on the IISI LCI work can be found at the IISI Web site <http://www.worldsteel.org>.

### 3.2.2 Measures of social performance

One measure of the world steel industry's social performance is health and safety of people employed in the steel industry. Currently, compiled statistics for the world industry are not available, though this is an action under investigation by IISI.

Though worldwide data on health and safety is not available, some regional data is presented here. In figure 12, the total recordable injuries of reporting steel companies belonging to the American Iron and Steel Institute (AISI) are given for 1994 through 2000. The total recordable injury rate, per 200,000 manhours, decreased 36% from 1994 to 2000.



A measure of the impact of steel on the world's social condition is the apparent consumption per capita. This statistic might be considered one indication of a country's prosperity with the notion that greater steel consumption per capita is a sign of economic prosperity. Table 8 gives the per capita apparent steel consumption for selected countries for the year 1999. The world average for apparent steel consumption per capita is 138.2kg.

It can be noted in general that more industrialised countries utilised between 250kg and 600kg of steel per person. Developing countries use less steel per capita, with examples being China at 107kg/capita, Brazil at 99kg/capita and South Africa with 81kg/capita. South Korea and Taiwan, China top the list. South Korea registers 757kg/capita, while Taiwan, China tops the list at 1,109 kg/capita.

### 3.2.3 Measures of economic performance

Two measures of economic performance are revenue and income. Table 9 (page 50) provides the revenue and income for 19 of the 20 largest steel producers in the world

based on the latest available annual results. It can be seen that 14 of the 19 listed companies posted a profit, although for some companies posting a profit their income as a percentage of revenue is quite low and unattractive to the financial community when compared with investment opportunities in other industries. The companies listed include six based in the EU, four based in Japan, three based in the United States, two based in Russia, and one each based in China, Taiwan, China, India, and South Korea.

When reading table 9 one has to bear in mind that accounting practices differ around the world and between companies. It is not necessarily reliable to compare the results of companies operating in different jurisdictions. Additionally, some of the listed companies operate businesses in addition to steel manufacturing and the results of these businesses are included in the parent company results. As a further caveat, some companies have significant state ownership, while others have no state ownership. The intent of presenting the results is to provide a broad, and admittedly insufficient, indication of the financial health of the world steel industry.

### Nothing will ever matter more to us

AK Steel, headquartered in Middletown, Ohio (United States), is one of the nation's leaders in creating and maintaining a safety culture throughout the company. Besides its comprehensive workplace safety programmes, the company emphasises its safety performance in its annual reports to stakeholders and other public reports. AK Steel's safety programme has three major elements: a complete management commitment to safety, a strong employee and contractor safety programme and extensive employee participation in the most comprehensive safety training and awareness programmes in the steel industry. AK Steel's total recordable injuries in 2000 was 1.43 per 200,000 manhours, compared with 7.90, the average of all AISI reporting steel companies.

**Table 8: Apparent steel consumption per capita for selected countries**

Country	Apparent steel consumption per capita (kg crude steel, 1999)
Taiwan, China	1,109.1
South Korea	756.7
Canada	604.4
Japan	557.3
Italy	552.3
Austria	537.7
Spain	469.3
Germany	468.7
United States	458.0
France	325.5
United Kingdom	265.9
Poland	204.6
Turkey	188.8
Russia	132.6
Mexico	122.5
China	107.6
Brazil	99.4
South Africa	80.9
Ukraine	61.4
India	30.1
<b>World</b>	<b>138.2</b>

Source: IISI

**Table 9: Revenue and income for the top steel producing companies.**

Company	Reporting Period (year end)	Revenue (million USD)	Income (million USD)
Arbed S.A. <sup>(1)</sup>	12/2000	13,372	418
Bethlehem Steel Corporation	12/2000	4,197	-118
China Steel Corporation	12/2000	3,044	562
Corus Group plc	12/2000	17,491	-2,017
Ispat International N.V.	12/2000	5,097	99
Kawasaki Steel Corporation	03/2001	10,414	-144
Magnitogorsk Iron and Steel Works	12/2000	1,520	447
Nippon Steel Corporation	03/2001	21,772	210
NKK Corporation	03/2001	14,148	768
Nucor Corporation	12/2000	4,586	311
Pohang Iron and Steel Co., Ltd	12/2000	10,873	1,289
Riva Group	12/2000	4,415	256
SeverStal	12/2000	2,073	453
Shanghai Boasteel Group Corporation	12/2000	8,228	187
Steel Authority of India	03/2001	3,639	-156
Sumitomo Metal Industries	03/2001	11,855	46
ThyssenKrupp AG	09/2000	32,710	463
United States Steel Corporation	12/2000	6,132	-21
Usinor Group <sup>(1)</sup>	12/2000	14,814	775

Source: Hoovers Online and company annual reports

## Part 4: Future challenges and goals

### 4.1 Priorities for improvement and future work programme

The world steel industry has made great strides in sustainable development by providing products and services valued by society, increasing resource and energy efficiency, reducing emissions to air, water and land, adding economic value to the world economy, providing safe and healthy work environments, and being responsible participants in local communities. Even with the tremendous amount of work that has been done, there still remain opportunities for improvement in the performance of the world steel industry in all three aspects of sustainable development; economic, environmental and social.

Improvement will come largely from the work of the world's steel companies and their collaborative ventures within and outside the industry. Accordingly, companies with regard to their individual circumstances will set priorities for improvement, and where priorities coincide, with their partners and stakeholders.

Some priorities being considered, in no particular order, include:

- financial sustainability of steel companies. Sound financial health of companies, and the industry as a whole, is a fundamental requirement for sustainable development;
- co-operation with governments to address overcapacity and international trade;
- new steelmaking technologies to increase the resource and energy efficiency of steel manufacturing;
- development of new steels and processes to meet customer needs for affordable, safe, strong, and versatile materials that also respect the environment;
- development of measures to gauge progress with sustainable development;

- education, training, and benchmarking to build capability with respect to sustainable development;
- health and safety of workers;
- community development;
- reduction of releases to the environment, including gases leading to climate change;
- communicate sustainable development activities of the world steel industry.

At its 9 December 2001 meeting, the board of directors of IISI, consisting of about 60 chief executive officers of steel companies from around the world, renewed its support for sustainable development by declaring it to be one of IISI's core objectives. The board of directors provided IISI with a mandate to provide leadership for the world steel industry regarding sustainable development. In practice, it means incorporating sustainable development into the work of the IISI, supporting those steel companies already active in sustainable development, and helping to build capabilities in those companies less familiar with sustainable development.

To this end, a steering group has been working to prepare recommendations to meet the challenge set forth by the board of directors. The recommendations will be presented to the spring 2002 meeting of the board and, if approved, will form the basis of a concerted effort by the world steel industry to forward sustainable development on a collective basis. Apart from the IISI initiative, individual steel companies and regional steel organisations will continue existing, and initiate, sustainable development activities.

## Annexe 1: IISI policy statement on environmental principles

### Foreword

The board of directors of the International Iron and Steel Institute (IISI) approved this new statement on the Environment at its meeting in London on 13 April 1992. The steel industry is proud of its achievements on environmental protection over the last 20 years since the first IISI Statement on the Environment was published in 1972. This new statement underlines the priority which steel continues to give to sustainable development and sets out the principles that lead to environmental excellence in the operation of our industry.

Brian Loton, chairman IISI 1991-1992  
Chairman, BHP, Melbourne, Australia

### Preamble

The member companies of the IISI have long recognised their responsibility to conduct production operations in a manner that protect the environment and contributes towards the objectives of sustainable development - a concept that involves meeting the needs of the present compromising the ability of future generations to meet their own needs. The first IISI Statement on the Environment was published in 1972. Since then much has been accomplished. It is estimated that in the last decade, over 10% of the total expenditure by the steel industry has been on environmental control - a sum of close to USD20,000 million on protection of the environment.

Steel as a material has also made a major contribution to sustainable development in the construction of environmental protection systems, infrastructure and energy conservation systems. Steel products are 'environmentally friendly' and are not only

compatible with, but also critical to, the success of sustainable development. On average, about 40% of all steel produced is sourced from steel scrap. Steel uses less energy per tonne to produce than many competitive materials.

Environmental protection initiatives and improvements will continue to be a major element of iron and steel operations for the foreseeable future. Sustainable development is a complex subject that involves not only environmental protection, but also issues such as economic prosperity, population growth and poverty. Relative priorities and relationships must be established if progress continues.

### Statement of policy

The member companies of IISI are committed to providing leadership in achieving a high standard of environmental care while contributing to the needs and prosperity of society through the production of steel.

### Principles

IISI believes that environmental excellence is furthered by the following principles:

#### 1 Sustainable development

*Apply the principle of sustainable development to the steel industry.*

This involves working together to take a long-term global view of environment, economy and social integration. These principles should be incorporated into business decision making at all levels and throughout the live cycle of the process and products. Sustainable development should be seen as an opportunity as well as a challenge. IISI recognises that different countries and steel firms are evolving towards these goals in different ways.

#### 2 Decision making

*Incorporate sound science, risk assessment and cost/benefit analysis to establish priorities and standards for continuous and fundamental improvement that are equitable reasonable and to identify the most cost-effective application of resources.*

These principles apply to internal decision making as well as public policy and legislation.

### **3 Environmental protection**

*Support efforts to conserve and improve the quality of the environment by recognising environment management as among the highest corporate priorities and a key element of sustainable development.*

This includes the creation and support of an internal organisation to integrate effective environmental policies, programmes and practices into each business actually as an essential element of sound management.

### **4 Environmental management systems**

*Incorporate innovative and progressive environmental management systems to minimise environmental impact.*

Examples include safe and responsible life cycle management of chemicals and processes, environmental impact assessment planning for new processes, best management practices, assessment of environmental performance, emergency response planning and product stewardship.

### **5 Environmental technologies**

*Design, operate and maintain facilities and equipment to minimise environmental impact.*

This includes incorporating reasonable measures for pollution prevention at the source through process or raw material changes, incorporating cleaner technologies, and using all reasonable care to control discharges. Environmental considerations should be an integral part of the research, development and design stages through to recycling of used products and ultimately decommissioning of facilities.

### **6 Resource management**

*Incorporate the fundamentals of efficient resource conservation and waste reduction, reuse, recycle and recovery into all elements of operations and products.*

Examples include scrap recycling, slag and oxide reuse and recycle, coke by-product

reuse and material and energy conservation through yield improvements.

### **7 Energy management**

*Conserve and make the most efficient use of energy to reduce the production of greenhouse and acid gases and thereby improve the environment.*

Although the mechanisms and impact of global warming are not yet confirmed or clear, prudent and reasonable conservation measures can be taken now based upon cost reductions and resource conservation.

### **8 Education, training and information**

*Develop and promote mutual understanding through education, training and information for stakeholders, including directors, management, supervisors, employees, contractors, shareholders, suppliers, customers, government and the community.*

These measures should be appropriate to the needs and responsibilities of the stakeholders. This should be open, positive, proactive and incorporate a long-term global view.

### **9 Research, innovation and technical cooperation**

*Support research, innovation and technical cooperation that will result in continuous improvement, technical breakthroughs and technologies.*

This development should be seen as an opportunity to transfer technology to other firms and countries to further environmental and economic improvement on a global basis.

### **10 Government requirements**

*Co-operate with government in a responsible manner and contribute to the development of cost-effective legislation and regulations that are based upon sound science, technical possibilities and the true environmental and economic priorities of the global community.*

Environment regulations require a balancing of social, economic and environmental goals. The health and environmental risks addressed by proposed regulations must be carefully

quantified and then properly evaluated by comparison with other natural and man-made risks. The resolution of economic and social conditions among nations including the use of economic instruments should be consistent with equity and harmonisation of their environmental requirements. International co-operation and consensus is important and necessary for successful implementation. IISI supports, in concept, the International Chamber of Commerce Business Charter for Sustainable Development and the ICC Environmental Guidelines for World Industry. Many individual steel companies have endorsed the Charter:

## Annexe 2: IISI policy statement on climate change

The steel industry's position on the UNFCCC:

1. The steel industry is committed to incorporating the principles of sustainable development into all aspects of its operations and supports efforts to safeguard and improve the environment (see IISI Statement on the Environment, IISI, Brussels, 1992).
2. The steel industry understands that the present state of knowledge and uncertainty about the relationship between carbon dioxide levels and climate change argues for caution in the short term while further research is undertaken. Policy measures should be flexible and based on sound and rigorous scientific knowledge.
3. A global problem requires a global approach and should involve all countries. A carbon tax or other measures in some countries, but not in others, will distort international trade and paradoxically could lead to greater production of steel in countries with a higher level of carbon dioxide emissions. The steel industry supports consideration of the use of flexible mechanisms such as the principles of joint implementation, clean development mechanisms and emissions trading proposed by the Kyoto Protocol. The steel industry will work to help develop the use of these mechanisms in a practical and positive way.



4. Measures that involve taxes on carbon dioxide emissions from the steel industry would not result in any significant reduction, but instead, in draining the financial resources of the sector; they would impact negatively on the industry's investment programme and research and development which represent the best way for the industry to meet the challenge of sustainable development in the longer term.
5. Policy for the steel industry should focus on voluntary programmes and incentives to encourage greater energy conservation and efficiency and recognition of the international nature of the steel business. Voluntary action is effective because the industry can develop and take measures that are both cost-effective and take account of trends in technology. The industry seeks an active role in the dialogue between governments and industry, which is essential for the development of a viable long-term strategy addressing the issue of climate change.

## Annexe 3: IISI policy statement on Life Cycle Assessment

### General remarks

Life Cycle Assessment (LCA) is one of the tools increasingly being used to consider the environmental issues associated with the production, use, disposal and recycling of products, including the materials from which they are made. An LCA is generally recognised to consist of four phases – the establishment of the goals and scope of the assessment, the drawing up of an inventory of the input of materials and energy and the output of emissions for each stage of the product life cycle, an assessment of the impact on the environment, and the identification of actions for improvement.

The techniques of LCA are in a very early stage of development as a science. The results are often sensitive to the exact assumptions made. Environmental priorities and issues differ in different societies and therefore the analysis is specific in both location and time. There is a danger in reducing complex issues to simplistic and partial analysis. Unfortunately many of the LCA studies published to date do not pass reasonable criteria of objectivity.

LCA can be used to identify priorities for improvements in process operations and product design and development, working closely with customers. The present state of the art and the sensitivity of results to subjective assumptions demand extreme caution when using LCA to compare the impact on the environment of alternative materials.

The steel industry is committed to the concept of sustainable development. This is illustrated by the IISI Statement on the Environment, which states that the highest

standards of environmental care require that the principle of sustainable development is incorporated into all aspects of the management of our industry. It is therefore essential that LCA studies should be correctly placed in the broader context of sustainable development.

To avoid the value of LCA being undermined, the steel industry has been very careful in its use – both in the undertaking of studies and in the publication and interpretation of data and results. A set of practical guidelines has been drawn up which the IISI board of directors commends to all those undertaking or using LCA for the purposes outlined above.

Practical guidelines for those undertaking or using LCA:

1. Maintain the highest standards in both the undertaking of LCA studies and their disclosure to both internal and external audiences.
2. Seek to place LCA within its broader context of sustainable development, recognising that this requires that due weight must also be given to the impact on human health and safety, welfare, biodiversity, the impact on individual ecosystems, the length of a product's life and its recyclability, and the sustainable use of natural resources.
3. Support efforts to develop a consistent, rigorous and transparent methodology for LCA to enable society to make informed choices on the environmental impact of products and processes.
4. Support the collection and dissemination of data on the use and reuse of materials, and the environmental effects resulting from their production.
5. Publish data clearly in a form that allows the user to clearly identify the key assumptions made and the sensitivity to those assumptions.
6. Avoid the selective disclosure of results or the use of data out of its original context.
7. Avoid the mixing of product comparisons based on actual current practice with those based on optimal performance at some future date.
8. Avoid claims of superior impact on the environment where the differences between materials are likely to be within the margin of error of the key assumptions.
9. Support the development of standards for LCA, including the work of the International Organisation for Standardisation (ISO).

## UNEP contribution to the World Summit on Sustainable Development

The mission of the United Nations Environment Programme (UNEP) is to provide leadership and encourage partnerships in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations. The UNEP Division of Technology, Industry and Economics (DTIE) contributes to the UNEP mission by encouraging decision-makers in government, business, and industry develop and adopt policies, strategies and practices that are cleaner and safer; make efficient use of natural resources, ensure adequate management of chemicals, incorporate environmental costs, and reduce pollution and risks for humans and the environment.

This report is part of a series facilitated by UNEP DTIE as a contribution to the World Summit on Sustainable Development. UNEP DTIE provided a report outline based on Agenda 21 to interested industrial sectors and co-ordinated a consultation process with relevant stakeholders. In turn, participating industry sectors committed themselves to producing an honest account of performance against sustainability goals.

The full set of reports is available from UNEP DTIE's web site (<http://www.uneptie.org/wssd/>), which gives further details on the process and the organisations that made it possible. The following is a list of related outputs from this process, all of which are available from UNEP both in electronic version and hardcopy:

- industry sectoral reports, including
  - accounting
  - advertising
  - aluminium
  - automotive
  - aviation
  - chemicals
  - coal
  - construction
  - consulting engineering
  - electricity
  - fertilizer
  - finance and insurance
  - food and drink
  - information and communications technology
  - iron and steel
  - oil and gas
  - railways
  - refrigeration
  - road transport
  - tourism
  - waste management
  - water management
- a compilation of executive summaries of the industry sectoral reports above;
- an overview report by UNEP DTIE;
- a CD-ROM including all of the above documents.

UNEP DTIE is also contributing the following additional products:

- a joint WBCSD/WRI/UNEP publication entitled *Tomorrow's Markets: Global Trends and Their Implications for Business*, presenting the imperative for sustainable business practices;
- a joint WB/UNEP report on innovative finance for sustainability, which highlights new and effective financial mechanisms to address pressing environmental, social and developmental issues;
- two extraordinary issues of UNEP DTIE's quarterly *Industry and Environment* review, addressing key regional industry issues and the broader sustainable development agenda.

More generally, UNEP will be contributing to the World Summit on Sustainable Development with various other products, including:

- the Global Environmental Outlook 3 (GEO 3), UNEP's third state of the environment assessment report;
- a special issue of UNEP's *Our Planet* magazine for World Environment Day, with a focus on the International Year of Mountains;
- the UNEP photobook *Focus on Your World*, with the best images from the Third International Photographic Competition on the Environment.

# Sustainability profile of the Iron and Steel industry

## • Achievements

- Dramatically reduced releases to the environment from steel manufacturing operations, including a reduction of air emissions by up to 80% over the last 20 years.
- Introduced new production technologies and steel products to meet demanding applications, including advanced lightweight steel automobiles, that contribute to a more sustainable society.

## • Unfinished business

- Continued improvement in steel production technologies and development of new products and services to meet evolving societal needs.
- Continued integration of economic, environmental, and social sustainability throughout the world steel industry.

## • Future challenges and possible commitments

- Operation of the world steel industry in an increasingly globalised economy, particularly the economic success of companies.
- Social change, including employment and community development, as the world steel industry transforms.

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