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Community Research

European Steel Technology Platform

Vision 2030

Report of the Group of Personalities

March 2004

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EUROPEAN COMMISSION

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http://www.cordis.lu/coal-steel-rtd/home.html

This brochure has been produced thanks to the contribution of the European Confederation of Iron and Steel Industries (www.eurofer.org)

EUROFER
European Confederation of Iron and Steel Industries

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Forewords

It is a great pleasure for me to present the ideas of the European Steel Technology Platform.

Steel is an important sector for Europe's economy and competitiveness. The European steel industry is a world leader in the production of steel and modern production methods. As underlined by many during the closing ceremony for the European Coal and Steel Community (ECSC) Treaty, the European steel industry has a real competitive advantage compared to its major trading partners because research efforts have been integrated from the start through collaboration and innovative projects.

The ambition of the European steel industry is to meet society's needs and to maintain its global leadership in an increasingly competitive world. This is not possible without increased research efforts. The new Research Fund for Coal and Steel gives an important leverage effect to European steel research. Under the EU's Sixth Framework Programme for Research and Development, several priority areas also provide possibilities for funding relevant research for the steel sector.

But more is needed. At the European Council in Barcelona in March 2002 it was agreed that investment in research should reach 3% of GDP by 2010. The setting-up of pan-European public/private partnerships for technological research and joint initiatives based on the technological platforms concept are a means of increasing investment in research and using the funding in a more efficient and strategic way.

This is why I welcome very much the creation of a Steel Technology Platform. I see this platform as an important vehicle for industrial policy, allowing all stakeholders concerned to set out together a strategic research agenda identifying the technological needs and the ways and means to implement it. The platform should allow for a broad dialogue and the development of a long-term vision within the European Research Area. I am looking forward to seeing in more detail the vision for the steel industry in the roadmap to 2030.

The challenges are well known: the growing impact of globalisation, the matching of steel supply and demand, environmental constraints, changing EU regulatory boundaries, and the impact of EU enlargement.

This paper provides the basic issues for the future. How can more research and innovation meet environmental requirements and, in particular, significantly reduce CO_2 emissions, develop new and cleaner processing methods, and help identify the necessary qualifications and skills of tomorrow's steel workforce.

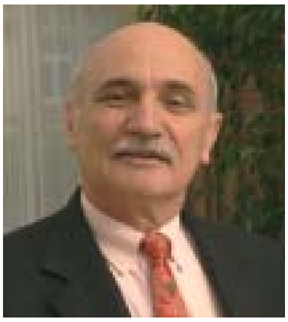
The platform brings together the steel industry, research centres, universities, trades unions and the European Commission as well as the other European institutions and Member States. The dialogue is open to all members of the platform and also to interested partners and experts, according to the evolving priorities.

I am convinced that this platform will enrich the debate and make it possible to coordinate all instruments and available resources, including Community programmes, in order to achieve a critical mass in financial, scientific and technological terms.

I would like to thank the entire group of personalities for this important and timely initiative, and to express my strong commitment to its development. Its success will also depend on the strong involvement and commitment of all stakeholders. I do hope that from now on all resources and ideas regarding steel research issues will converge into and through the platform.

I wish you all a lot of success.

Philippe Busquin
European Commissioner for Research



It gives me great pleasure to add a few introductory remarks to Commissioner Philippe Busquin's message on the occasion of the launch of this European Steel Technology Platform. In my view, it is indeed a major event, bearing witness to the steel sector's commitment to approach the coming decades with determination and enthusiasm. The objective of this platform is to share a common long-term vision. The steel sector provides direct employment for more than 260 000 people in Western Europe, and mobilises many participants across the entire industrial spectrum which embraces suppliers, customers, industrial research centres and universities. In this context, approximately 1 300 000 participants are employed in the automotive and steel construction fields alone.

The celebration of the 50th anniversary of the ECSC Treaty, in Luxembourg on 26 June 2002, was a compelling reminder of the historic role of the European Coal and Steel Community in past decades. The first part of this document recalls the considerable effort that the European steel industry has devoted throughout this period. It attained its world-leading position by showing the way in respect of innovation, restructuring and globalisation strategy, thereby arriving ahead of time in the third millennium.

The Steel Technology Platform is geared to the future. Specifically, it expresses the major ambition of the steel industry looking forward to 2030: the consolidation of undisputed leadership in sustainable development. In this respect, it will have to face up to the well-known challenges of the environment and competitiveness which are described in the following pages, and also to the very rapid emergence of new players such as China. Furthermore, the success of our Community's enlargement into Central Europe will also constitute a compelling objective.

In conjunction with our partners in the steel sector, with national authorities, and with the European Commission, the Steel Technology Platform represents a response to the challenges that lie before us. The European steel industry is grateful to the Commission for offering this exceptional framework for dialogue, a guarantee of future progress and success.

Research initiatives will be used to seek breakthrough technologies and the subsequent promotion of new production processes. For example, steel production will be enhanced through massive reductions in CO_2 emissions and, more generally, the implementation of new process routes for products that will satisfy the constantly evolving needs of European consumers. An important place is also accorded to welfare, human health, safety at work, and continuous training in the workplace. A dynamic image of steel will also be promoted in order to attract young talents.

Finally, it is clear that innovation will be the platform's driving force. It will be far more than a link in the production logistics chain, providing the solutions that are capable of turning the steel sector's ambition into reality, thereby preparing it for future challenges in the medium term. Building on the foundation established by the first European research network created by the ECSC, the Steel Technology Platform will give new impetus to the full spectrum of European research into materials and processes.

For more than 50 years, Europe has been forged in the crucible of the steel industry. Let us all work together to ensure that steel remains an integral part of European development in the coming decades.

Guy Dollé
Chief Executive Officer of Arcelor
President of EUROFER

Group of Personalities

Philippe Busquin

European Commissioner for Research

Guy Dollé

Chief Executive Officer Arcelor

President
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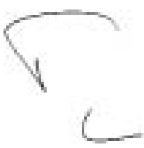

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Chairman of the
Executive Board

ThyssenKrupp Steel

Wolfgang Eder

Deputy Chief Executive
Officer

Voestalpine AG

Table of contents

Ambition

to assume a sustainable and global leadership
in the coming 30 years

Main challenges

- Growing impact of globalisation
- Matching steel supply to demand
- Environmental constraints
- Changing EU regulation
- EU enlargement

Strategic objectives

- Profit trough innovation
- Meet society needs in close partnership with its customers
- Meet environmental requirements
- Attract and secure qualified people

Recommendations

Creation of a European Steel Technology Platform to boost innovation, to develop new breakthrough technologies and steel solutions

Creation of a European Steel Research Advisory Council to select priorities and monitor progress

Development of a strategic research agenda to implement new breakthrough technologies and steel solutions

Executive summary

The European steel industry has a total annual production of approximately 160 million tonnes, and generates €90-100 billion in annual turnover. The industry provides direct employment for more than 250 000 European Union (EU) citizens, and several times this number are employed in the steel processing, using and recycling industries. In addition, steel is a worldwide commodity (global production is more than 900 million tonnes per annum) that is both exported from, and imported into, the EU.

Accordingly, the steel industry is also the origin of millions of other jobs in many other industrial activities. For example, the European constructional steelwork industry and the automotive sector represent 200 000 and 1.1 million jobs* respectively.

Today, the European steel industry exploits the most modern and efficient facilities. This leadership has been achieved after a long process of restructuring and consolidation and now, facing up to globalisation, it's the industry's ambition to maintain this position through the implementation of a sustainable development policy that will meet society's need while remaining competitive.

It will face some important challenges such as competitiveness with emerging countries, the necessity to respond to more demanding markets, and the need to make a clear commitment to saving natural resources to meet exacting environmental regulations, in particular, to significantly reduce CO_2 emissions. These challenges will require determined long-term structured action supported by a coordinated system and the participation of all stakeholders.

In particular, environmental issues and the development of new steel solutions for many applications will necessitate the implementation of new production routes. In this respect, breakthrough technologies will be particularly important and, as a consequence, a large effort in R&D and innovation will be required. The issues of security and competence of human resources must also be developed in parallel with these activities.

Therefore, a "Steel Technology Platform", within the European research framework, is expected to constitute a powerful tool to gather the skills and competence necessary to achieve the ambition of the European steel industry. It would strengthen and broaden the existing European steel research network.

**Estimated data for 2001, sources: ECCS and ACEA*

1. Background and current key features of the steel sector

1.1. Background: the steel industry over the last 50 years

Since the 1950s, the steel industry has played a key role in the process of European integration, actively contributing to its economic development. Indeed, in the second half of the 20th century, steel was by far the single most important material in the reconstruction and rapid economic development of Europe after World War II.

The European Coal and Steel Community (ECSC), which was established in the early 1950s, made a significant contribution to the development of the steel industry during this period. This predecessor of the European Union (EU) created an initial common market among the European countries. It was concerned with a broad range of issues such as market transparency, competition rules, regulations for mergers and acquisitions, as well as social issues like training for employees. It also established a system of corporate funding for research and development (R&D) and initiated a new system of multinational collaborative research which has been one of the most impressive successes in Europe over the last 50 years.

Nowadays, steel stands at the hub of many industrial sectors, such as construction, transportation, packaging and retailing, power generation, mechanical engineering, the chemical industry, home appliance manufacturing and, last but not least, IT infrastructures.

Throughout the last two decades huge changes in all areas of the business were needed and the changes that occurred were very impressive. These changes took place in two periods.

The first one concerned a **radical industrial restructuring** which secured the orderly adaptation of the industry to new market structures. After two oil crises (1974 and 1980), Western economies entered a new economic era which transformed the steel market **from a seller's market into a buyer's market.** This period also marked the end of state interventions in the steel industry and involved a huge restructuring of inefficient steel-making plants leading to a reduction of 45 million tonnes in capacity. It ended in 1993, with the European approval of the last restructuring plans which led to an additional reduction in capacity of 25 million tonnes.

The 1990s were also a time of dramatic change for the industry as it came to the end of a cushioned existence in a production structure based largely on protected national markets. During this period, the European steel industry recognised that a permanent effort was critical to maintain and increase its international competitiveness. **A number of companies expanded by merging or forming alliances in the face of narrowing margins:** for example, British Steel, United Kingdom, and Hoogovens, Netherlands; in Germany, Thyssen, Krupp and Hoesch; Usinor, France, (which had earlier merged with Cockerill-Sambre, Belgium, and Eko Stahl, Germany) and Arbed, Luxembourg and Aceralia, Spain. During this period Riva in Italy became a huge pan-European operator. This generated a deep cultural revolution **from a production-oriented to a customer-oriented philosophy which** was necessary to enable the industry to provide its customers with a permanently improved quality of products and services. These changes also contributed to a continuing **adaptation to a global market.**

1.1.1. The steel industry and its commitment to sustainability

The concept of sustainability was first introduced by Mrs. Brundtland in her famous 1987 report, also known as *Our Common Future*, in which she alerted the world to the urgency of making progress toward economic development that could be sustained without depleting natural resources or harming the environment. During the Barcelona summit, the governments of the 15 Member States promoted the concept of "sustainable development" with a view to ensuring a balance between social, economic and environmental aspects in future EU legislation. Industrial sectors – and the steel industry in particular – had been practising the concept since the 1960s at least.

Indeed, under the drivers of mass production, quality control and cost reduction, **technical progress has led to large energy savings and to the systematic use of lean and clean processes.** As a result, energy consumption and CO_2 generation in the European steel industry have decreased by 50% and 60%, respectively, over the past 40 years. Furthermore, this is not simply a reflection of recession in the sector, as the trends in specific values show. Behind these seemingly simple figures there exists a complex set of circumstances where change and modernisation have been carried out in various ways, including the movement from integrated mills to electric arc furnace mills for the manufacture of various types of long products.

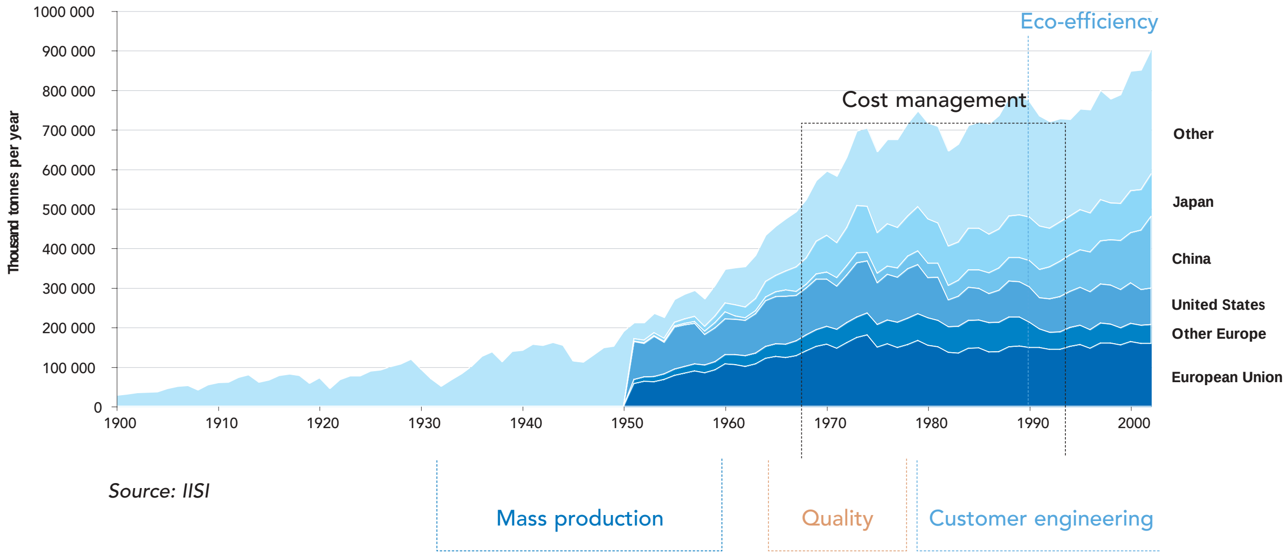
This continuous trend has resulted in very significant progress. Since the beginning of the 1990s, steel-making processes have approached their physical upper limits with respect to energy efficiency.

1.1.2. Creation of a network of collaborative research and development in steel research

During the lifetime of the ECSC, networks of excellence in the core competencies of the steel business were developed between industrial laboratories, governments, academic research centres and public bodies under the umbrella of the EU Institutions. Nowadays, the total network brings together around **8 300 researchers who are collectively engaged in steel research and technological development (RTD) and represent 3.5% of the workforce in the steel industry.**

Since the beginning of the 20th century, and particularly since the end of World War II, steel research and technology have been driven by the following chronological concepts (see Fig. 1):

Fig. 1: World crude steel production 1900-2002



Source: IISI

- The need for mass production during the reconstruction period;

- The need to increase productivity (continuous casting), to improve the quality of products (research carried out on secondary metallurgy, cleanness of steels, etc.) and to decrease the cost of production (thin slab and thin strip casting, etc.);

- Customer engineering and the subsequent need for steel solutions that provide the impetus to develop new steels for specific functionalities (high strength steels, hot dipped galvanised coatings, etc.);

- The need to develop **eco-efficiency and sustainable growth** leading to breakthroughs. Since the 1990s, the European steel industry has been actively working towards those objectives which represent the main challenges today.

1.2. The current key features of the steel industry

The framework in which the EU steel industry now operates is characterised in the main by the following drivers:

- Increased public awareness of environmental issues which have driven industry operations towards environmentally 'friendly' products and technologies;

- The increasing global concentration of client industries;

- Customer requirements which have induced production of innovative quality products in combination with a high '*service*' component offering steel solutions;

- Demand for improved working conditions for steel employees, in return for higher qualifications and productivity;

- The emergence of new competitors to challenge the traditional producers;

- The acceleration in technological change and the permanent cost/price squeeze for steel products;

- The regulatory framework has changed from being mainly sector-oriented into an EU policy applied to the whole of manufacturing industry.

1.2.1. The European steel industry today

The European steel industry produces approximately 160 million tonnes of crude steel per year which represents about 20% of world steel production, with an estimated turnover of €80-90 billion. Its labour force represents about 260 000 people.

Through in-depth restructuring and mergers, production has been concentrated on the most modern and efficient facilities. Competitiveness has been further enhanced through cross-border strategic alliances, especially in the field of high value-added steels, or through consolidation between one or more former European competitors. Productivity has increased by more than 50% in European steel plants over the last ten years (see Fig. 2).

The EU represents the geographical area where the consolidation process, which is still ongoing, has occurred to the largest extent. Nevertheless, compared to other industrial activities (e.g. automotive industry), the steel industry remains a less-concentrated sector (see Fig. 3 and 4).

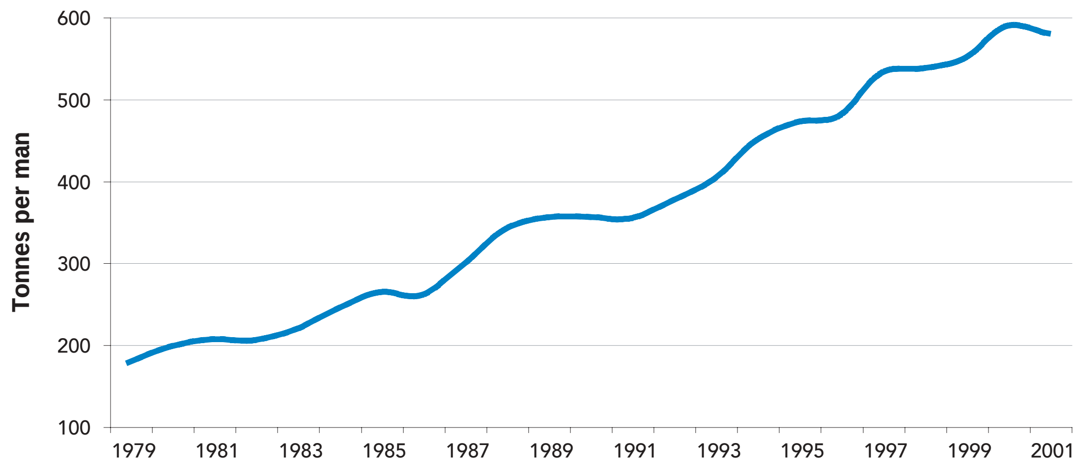
The European steel industry ranks among the best worldwide in terms of manufacturing excellence, equipment performance, product quality, and innovative capacity. This position has been achieved thanks largely to the complex and informal network of individuals and organisations active in the field of R&D.

1.2.2. The steel sector

The steel sector comprises a galaxy of enterprises, large and small, which provide raw materials, energy, support technologies, and which deliver and process steel.

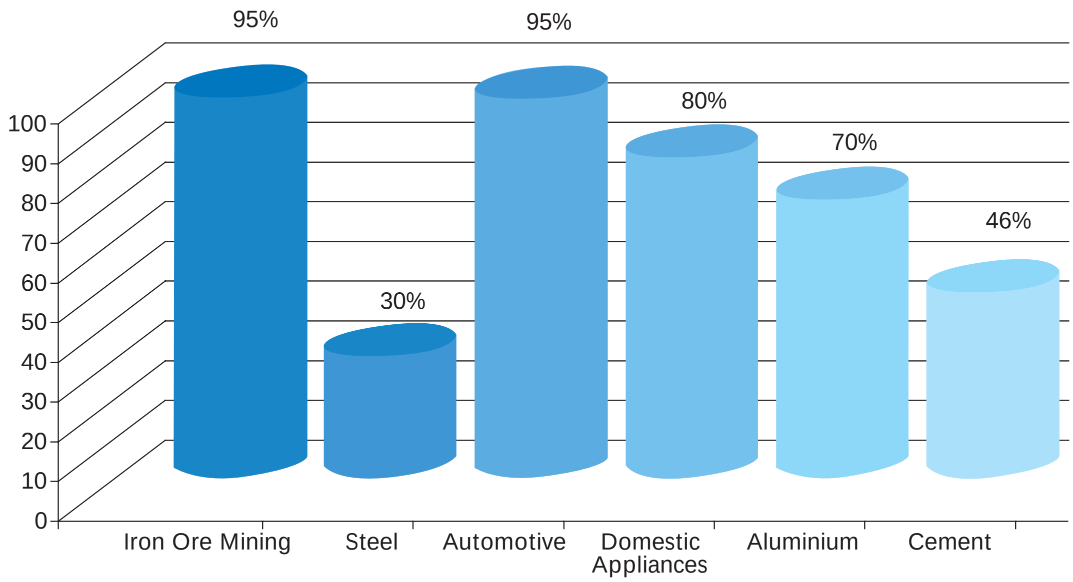
Indeed, around 1 800 European steel **stockholders and steel service centres** are small and

Fig. 2: Steel productivity: output per employee
(average for France, Germany, UK)



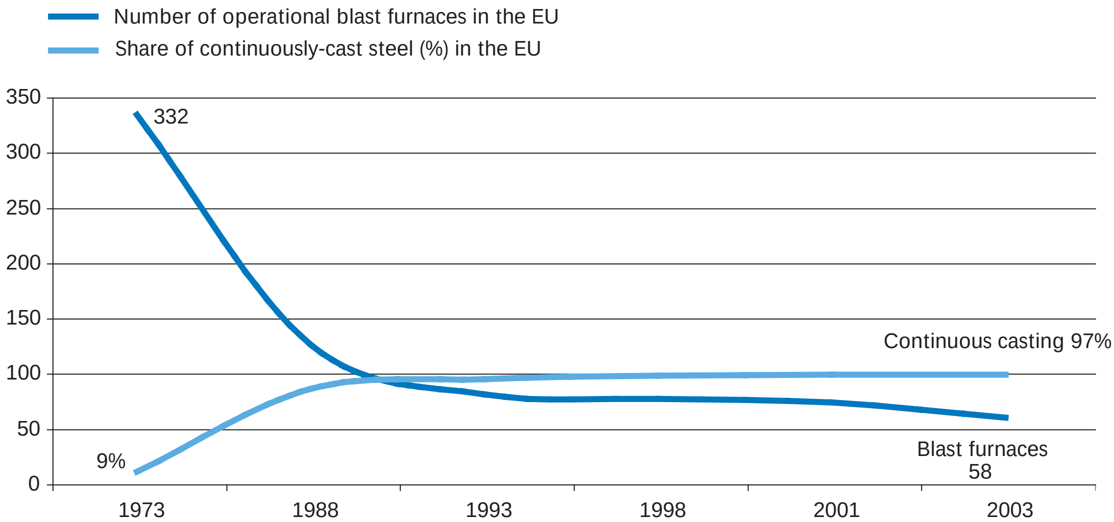
Source: Iron and Steel Statistics Bureau - ISSB

Fig. 3: Concentration of the first ten producers worldwide - % by sector



Source: Arcelor

Fig. 4: Evolution of the steel productivity



Source: European BF Cttee./Arcelor

medium-sized enterprises (SMEs), with about 3 000 installations throughout Europe. Many of them also deal in other materials and industrial goods. In the **downstream primary processing sector**, a substantial part of the steel industry's output is of great significance for many industrial branches. Pipe and tube makers and various companies engaged in cold rolling and drawing number around 3 000 firms, mostly SMEs. **Steel production and products made from steel are thus a major source of employment and wealth creation in the EU.**

In order to maintain a competitive technological edge and to achieve financial returns, **the EU steel industry depends strongly on its ability to innovate**. This is achieved through RTD programmes both at company level and through common research initiatives supported by the European Commission. These common research programmes are funded by both the industry and the Research Fund for Coal and Steel. In addition, research activities in EU RTD Framework Programmes may also contribute to the steel-related sectors.

1.2.3. Technology base for the future

Steel is produced by two different basic technologies. Integrated steelworks produce **crude steel from iron ore and coal via the blast furnace route**. As the result of customers' requirements for high-quality steels, this technology accounts for most of the production of flat products.

The **electric arc furnace route** is less capital intensive and provides greater operational flexibility. Driven by new technological developments, it is now also used for flat steel production. However, in the latter case, either high-quality scrap is required or the use of 'virgin' materials such as sponge iron, and cold or hot metal from blast furnaces.

1.2.4. Customer base

Today, total steel production worldwide is close to 1 000 million tonnes per year.

A broad range of products, if not made entirely from steel, at least include steel, e.g. in machines, buildings, vehicles, tools, etc. With over 2 500 steel varieties and a range of exceptional properties (strength, elasticity, malleability, durability, recyclability, cost/performance ratio, etc.), steel is a modern and extremely versatile material which Europe's major industries cannot do without.

The range of steels is constantly being expanded towards new applications and high value-added special steels. From cars to space rocket engines, from bridges to precision surgical instruments and IT, steel responds to our needs thanks to its exceptional adaptability. **Its ability to be associated with other materials, like aluminium, plastic and cement, makes it increasingly adaptable to new demands and applications.** For example, steel sandwich constructions have enabled significant noise reduction, highly valued by customers, in new cars and domestic appliances. Moreover, zinc coating has increased corrosion resistance considerably to the extent that car manufacturers are now able to offer 12-year warranties against corrosion on their new cars.

1.2.5. Material, energy base and transport infrastructures

The integrated steel industry in the EU depends on overseas suppliers for a substantial part of its raw materials (e.g. iron ore and coking coal). Today, the first three iron ore producers worldwide account for 70% of all shipments.

Ferrous scrap is the principal raw material for electric steel-making and, in order to obtain better quality scrap, initiatives are being taken to improve its collection and recycling. The latter is not only an environmental priority, but is also intrinsically profitable due to energy savings and economies in materials.

In order to extend their raw materials base, and following the drive towards higher value-added products, electric steel producers increasingly combine scrap with sponge iron, hot 'briquetted' iron and/or cold or hot metal from the blast furnace.

A further group of raw materials, essential for the production of special steels, is the ferro-alloys. These materials are largely imported and constitute an important and increasing part of production costs. Long-term supplies must be secured through facilitating market access and increased competition between suppliers.

Electricity and natural gas supplies make up a significant part of steel production costs. Within the EU, electricity and natural gas prices exhibit marked differences, in part because of taxation but also because of different pricing structures and regulation of the supply industries. There may still be room for improvement in that respect.

The steel industry is very transport intensive. After crude oil, iron ore and coal are the most important commodities in the world's sea-borne trade. Moreover, **almost 30% of all finished steel products pass from one country to another worldwide.** Depending upon the steel quality, the distance involved and the means of transportation, transport costs constitute between 5% and 15% of the selling price. Several initiatives have been carried out by the Commission in the field of transportation, particularly by improving transport links between the EU and non-EU countries. However, **an improved and more harmonised regulatory and competitive framework for transport still needs to be achieved for both economic and environmental reasons.** For example, transport costs remain higher in Europe than in other large competing areas such as the United States, where they have decreased by 45% since 1984. In addition, the harmonisation of road transport regulations should be accelerated: this must be done not only within the EU but also with central and eastern European countries which will become part of the EU in 2004.

1.2.6. Financial and economic aspects

The EU steel industry faces competition from producers benefiting from comparative cost advantages (labour, energy, taxation), and/or those faced with less stringent regulations (state aid, environment, etc.). Moreover, cost competitiveness is strongly influenced by ex-change rates.

The investment potential is directly related to profit levels and the overall cost of capital. Particular factors that influence the cost of capital are interest rates, depreciation, taxation and debt/equity levels. The introduction of the euro and the consequent absence of currency risk capital in the euro-zone should **reduce costs and foster the integration of the European financial markets.** As a consequence, the increased size of the capital market and the sharper competition between financial intermediaries should help to reduce the cost of capital, which is still too high for EU steel firms in comparison with some of their competitors in other sectors.

World steel price levels affect the steel industry's ability to capitalise on the fruits of its efficiency efforts, and contribute to the funding of new investments and RTD. In order to reduce the impact of the price competition that characterises the trade in ordinary steels, the EU steel industry is focusing increasingly on the production of steel products tailor-made to the needs of its customers.

1.3. Main challenges to sustainable global competitiveness

1.3.1. The growing impact of globalisation

The globalisation of steel customers results in increased market power, stricter product requirements, and standardisation.

Collaboration with its traditional customers is so deeply rooted that the European steel industry has taken the necessary measures to continue to satisfy their needs in terms of services, quality and prices. Thus, many of the European steel companies have established facilities in other regions of the world or developed strategic alliances worldwide.

Moreover, the trend towards further liberalisation of international steel trade, and thus increased international competition, has manifested itself clearly. The financial and economic crises in several geographical areas have seriously disturbed traditional international trade flows. **The steel industry, faced with this growing impact of globalisation, and to respond to the pressures on its markets, requires that the rules of fair trade be applied and respected worldwide**.

1.3.2. Matching steel supply and demand

Past experience shows that crises in the steel industry usually have their roots in imbalances caused by rapid fluctuations in demand combined with somewhat rigid supply structures and global overcapacity. Fluctuations in demand are related to business cycles but also have structural backgrounds. Economic cycles influence steel demand to a large extent, bearing in mind that steel is used for both consumer and capital goods. In terms of volume, steel demand is expected to increase more outside mature steel markets like the EU, Japan and the US, particularly in favour of Asian and Latin American countries. Indeed, the situation worldwide is very heterogeneous: in 2002, per capita steel consumption was 163 kg for China, 363 kg for Western Europe and 562 kg for Japan. This presupposes a huge potential for growth in China and a potential change in the centre of gravity for steel from Europe to Asia. The main reason for this is the potential demand for steel products, particularly for infrastructure upgrading. In terms of quality, however, the industry expects an important potential for increased demand in highly developed countries (durable consumer products, capital goods) as a result of further product development. It is expected that world steel trade will focus increasingly on higher value-added products.

1.3.3. New EU environmental regulations

As far as environmental policies are concerned, various instruments are being introduced or considered, nationally and at EU level. For the steel industry, initiatives with a potentially significant impact include: integrated pollution prevention and control permits, air quality standards and the Clean Air For Europe programme, new product and waste legislation (such as the end-of-life vehicles directive) and the thematic strategies on natural resources and waste prevention and recycling, as well as new EU legislation on chemicals ('REACH').

Another new piece of EU legislation that is important for the EU steel industry is the greenhouse gas emissions trading scheme which is being introduced in order to implement commitments made by EU Member States in the Kyoto Protocol. Across the whole EU economy the costs for implementing these commitments could be considerable. The risk that European steel producers could see a loss of business to non-EU competitors which are not subject to any CO_2 emissions limitations cannot be neglected.

To maintain its competitiveness, the European steel industry will have to meet the challenging combined targets of both environmental friendliness and economic growth.

1.3.4. EU enlargement

The steel companies in the candidate countries offer several strengths, such as relatively low labour costs and a good level of technical qualification amongst the workforce. Production units would benefit from the implementation of modern production techniques, along with higher energy efficiency, better organisation, and quality and services. This would result in higher productivity levels, better product standards, and much needed environmental improvement.

2. Ambition and long-term vision of the steel sector

The ambition of the European steel industry is to maintain and reinforce a global leadership, which is both sustainable and competitive, given the strong development in other parts of the world, notably Asia. These objectives will be developed around the concepts based on the principles of sustainable growth: profit, partners, planet and people.

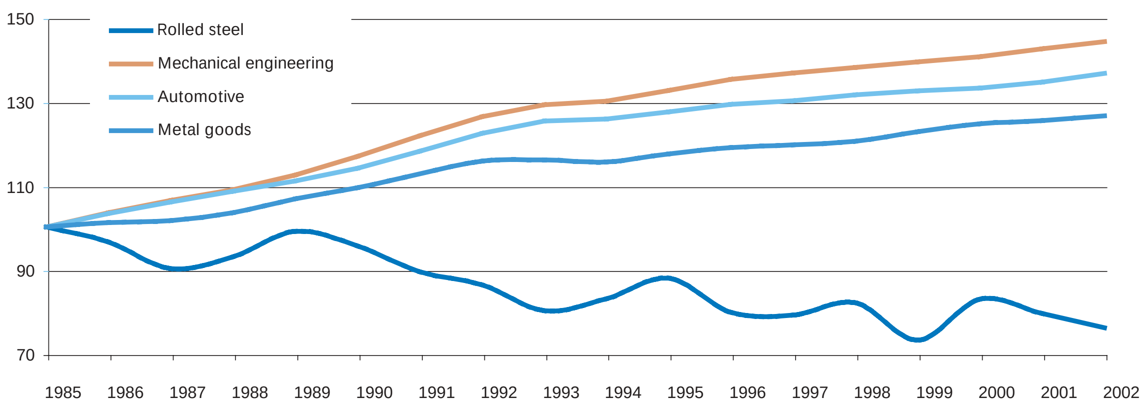
2.1. Profit: Ensuring profit through innovation and new technologies

Strengthening competitiveness is really a major issue for the European steel industry. Despite the closure of uneconomical steel plants, the reduction of excess production capacities, and the regrouping of companies inside large groups was insufficient to prevent the average steel price from dropping by 3% per year. The graph below shows this situation, where higher concentrated sectors, e.g. the automotive sector, are able to determine a more stable course of prices for their products and benefit from a reverse trend (See Fig. 5).

2.1.1. Innovation in new production technologies

Driven by the continuous quest for improved competitiveness, the steel industry, together with the downstream primary processing sector, has recently made large investments in the reduction of production costs. First, advanced computer systems, making extensive use of sophisticated measurement sensors, physical models and methods of artificial intelligence, have been designed and incorporated at all stages of the manufacturing process. Subsequently, significant benefits have been

Fig. 5: Products prices trend of some steel-using sectors in the German market - FRG
(1985 index = 100)



Source: AV Stahl, 2003

obtained with regard to the reliability and robustness of facilities, leading to higher production rates, greater yields as well as better consistency and conformity of the products delivered to the customers. Secondly, solutions have been developed for linking several phases of the production process. The most recent industrial development, the so-called ‘thin slab casting’, is proving to be a great success. Here, a semi-finished product is cast with reduced thickness and sent directly to the hot rolling mill, thereby allowing reduced investment costs, large energy savings and shorter delivery times to be achieved.

Further innovation is currently required by the steel industry to achieve even lower production costs, which implies the **development of new processes that would be much more integrated and flexible than existing ones.** Some breakthrough solutions are already under investigation at present.

Following the successful industrial application of thin slab casting, research projects have been launched with the aim of designing a fully integrated process for casting and rolling hot strip in a single step. The research work led to the development of the ‘thin strip casting’ process which is currently being operated in a few industrial pilot plants for producing stainless steel. Important potential savings in capital and running costs have been demonstrated and further application to conventional mild steels is envisaged. **However, many problems remain to be solved before applying thin strip casting to the mass production of high- quality steel grades such as those used in automobile manufacturing.**

Greater flexibility is needed in the steel production chain of tomorrow to cope with the expanding range of products that will have to be supplied at low cost. Indeed, the demands of society are becoming wider and wider, encompassing applications as diverse as civil engineering, building, car manufacturing, appliances, and cans and containers. In particular, versatility is increasingly being required downstream of the manufacturing process, where the final properties are imparted to the products before delivery to the customers. Specific research activities are currently being conducted in investigating breakthrough concepts in annealing and coating operations.

The huge continuous **annealing** and hot dip galvanising lines in use today are not well suited to frequent changes in strip size or grade because of their high thermal inertia. Consequently, material processed during transient phases is being downgraded. **Much more compact lines with very short response times and extended ranges of capability would fit better, which is precisely the objective of present investigations. New technologies for heating and cooling steel strip in a fast and controllable way are under development. In parallel, intensive metallurgical research is being conducted in order to profit from opportunities presented by new thermal cycles for designing new products, especially for cars.**

In many applications, a **coating** is applied to the steel substrate. The coating is often complex and composed of a layer of zinc for corrosion resistance, an organic layer and/or an outer layer with functional properties. The coating is obtained by processing the strip on several dedicated lines. **A major challenge for the ongoing research work is to bring new processes into operation that are able to deposit several types of top-quality coatings, ideally suited to the specific application of the final product, in multi-purpose compact facilities. To achieve this target and to fulfil environmental obligations, vacuum and plasma technologies are being investigated.**

The fields of annealing and coating are not the only ones where breakthrough processes are under development. These two examples demonstrate the determination of the steel industry to improve its competitiveness by designing new processes that are likely to lead to lower production costs, while better answering the needs of the society. Today, research work on these two examples has reached the laboratory prototype stage, which are expected to lead to commercial application in about 2010. **Very costly developments must still be performed before the construction of industrial pilot plants and final implementation of new solutions for production lines.**

The steel industry has the ambition to strengthen its competitiveness but also to attain improved sustainability. The two examples mentioned in the fields of annealing and coating constitute very valuable contributions with regard to both objectives. However, they only represent a part of the total effort for ensuring sustainable development. This will be undertaken with due regard to offering emerging technologies that are promising from an eco-efficiency point of view and have already been identified.

All these breakthrough approaches require huge amounts of money to be invested in highly risky long-term research projects involving specialists from the industry, research centres and universities, working inside integrated teams.

2.1.2. Strengthening intelligent manufacturing

New technologies are one of the most important ways of covering the technological gap required in process optimisation and increased competitiveness, in line with the objectives of the Lisbon (knowledge-based economy) and Barcelona summits. **Where conventional technologies are mature and robust enough to guarantee stable performance, intelligent manufacturing technology should contribute to developing more flexible production processes.**

New production concepts, such as intelligent manufacturing processes, efficient production and organisation, need to be designed and developed, based on breakthrough organisational, quality and technological improvements, to ensure the evolution of new products, processes and services. The goal is to support the transformation of the European steel industry towards a more knowledge-based and value-added industry with improved competitiveness and sustainability. To this end it is vital to provide industrial systems of the future with the necessary tools for efficient life-cycle design, production, use and recovery, at the same time decreasing internal and external costs and reducing major accident hazards.

Appropriate organisational models and improved knowledge management should support technological developments and innovation routes. Flagship research projects need to be carried out, highlighting the importance of collaboration between research and industry, the major outcome of which would be a framework for 'manufacturing in 2010' based on the substantial involvement of industries.

The steel companies have to face such challenges by using these techniques to deal with the old unsolved necessities and the new needs.

2.1.3. Innovation in products

The utilisation of steel is essential for meeting the future requirements of society and creating new market opportunities. Society is still demanding more from materials to be used in these areas, and the steel sector is continually striving to provide solutions to these new challenges.

In the future it will have to address different needs, in particular the need for more **green products** (reduced energy demand and minimised pollution in production, less material consumption and optimised reuse), by taking new supply- and demand-side initiatives in the context of EU integrated product policy.

In the competition between materials, steel has distinct advantages in terms of its strength, versatility and cost. An **increase in steel's market share can also be achieved by strengthening its integration with other materials** (e.g. sandwich panels), introducing new products like steel-containing composites, use of new bonding technologies, and providing surfaces with new functionalities (e.g. antibacterial properties for the food sector). To develop these products and other new ones coming from new routes to be developed, the interaction with the customer is important. **New alliances between steel producers and customers have to be set up wherein producers and customers share the risks of development.**

Future processes must take account of the demands for new products. However, there will be no new products without suitable new process routes for their manufacture. Consequently, the development of these new manufacturing routes will change the chemical composition of future steels, their cleanness (inclusions, residuals), and other properties such as microstructure and even porosity, etc. significantly. **The development of new processing routes will then create opportunities for new metallurgical processes and new families of products, changing and opening up further the opportunities for new product solutions. Thus, new basic research should be devoted to these topics.**

However, shared knowledge could be a means of reducing costs and further enhancing the standardisation of steel products (e.g. fire resistance in construction). In this respect, the EU could be at the forefront in defining the standardisation of steel products; the development of new steel products should be accompanied by an enhanced production of EU common rules, which could be part of the Platform for a future global initiative.

New product development will be more integrated between marketing, manufacturing, and research and development. The R&D stage will become even more important and costly because of the need to encompass the whole chain from start to finish. However, these steps need time and huge financial resources to progress from laboratory to customer acceptance, via several stages of process and product optimisation. Despite this, time to market must be as short as possible.

2.1.4. Reducing time to market and applying the supply chain concept

Nowadays, *time to market* is generally acknowledged to be a key factor to success in manufacturing companies, and is necessary to complete and to capitalise on the innovation effort. Combinations of factors, such as ever-changing market needs and expectations, tough competition, and emerging technologies among others, continually challenge industrial companies to increase the speed of delivery of new products to the market, to fulfil customer requirements.

Furthermore, **supply chain management** answers the need to reduce *lead time* since it implies the coordination of all companies involved in the delivery of a product (production, distribution, manipulation, storage, and merchandising) and its components.

Indeed, products are rapidly changing from physical tangible objects to include intangible assets related to fulfilling requirements, fitting the right product to the right needs, servicing the product and maintaining it through its life, empowering the user to get the best from it, and finally facilitating end-of-life product retrieval and recovery of resources in an environmentally friendly manner.

Recommendations concerning *Profit*

The European steel industry is prepared to proceed with its move towards global, sustainable and competitive leadership but needs partners and external skills to face the high levels of cost and risk involved in breakthrough innovation and research.

European universities and research centres should increase their input into dedicated research to accelerate this move and make it even more successful, especially with regard to new production technologies.

Simplified and uniform rules and standards are also required for products at EU level.

Research funding should be made available in the form of grants by public authorities (e.g. the European Commission, national or regional authorities). Leverage effects should be helpful to reach a critical financial mass.

Fiscal incentives should also be promoted in order to enhance research activities, facilitating the achievement of Lisbon's objectives.

2.2. Partners: improving the steel sector partnership in modern society

Partnerships developed by the steel industry cover a vast range of industrial sectors, such as raw material, energy and equipment suppliers, transport sectors, manufacturers, customers and recyclers, standardisation bodies as well as national and international authorities and financial institutes.

Almost all European manufacturing sectors are largely based on the utilisation of steel in various forms. **In addition to the automotive and construction sectors**, which are outlined in the following chapters as examples of priorities for the co-operation and partnership of steel with other industries, **important application areas include marine technology, packaging and engineering** which can all benefit from the development of new steel grades and manufacturing technologies. **Shipbuilding, offshore construction as well as oil and gas transport via pipelines** in Arctic or deep sea areas **need collaboration from suitable partners to develop and process the necessary steel grades.** The development of steel plate for use in long-distance, large diameter, sour gas resistant pipelines is being performed in partnership with pipe manufacturers, the oil and gas industry, and testing authorities. The work in this area is aimed at developing the production of high-strength steels with high toughness and good weldability suitable for use in low-temperature and high-pressure conditions.

Equipment manufacturers work in close co-operation with special steel producers. Stainless steel is very often the best value option over the total life of a project or product. **Corrosion resistance, cryogenic properties, easy cleaning ability and aesthetic appearance, strength-to-weight advantage, and fire and heat resistance are unique properties afforded by more than 60 different grades of stainless steel.** The chemical industry and the food-processing sector are dependent on the availability and development of stainless steel. Stainless steel application for structural components is growing and the design for different sizes and shapes is being discussed among structural engineers, architects and building owners.

The European steel sector is constantly addressing the challenge of meeting customers' demands for a broad variety of ever more sophisticated high-performance materials. To meet these needs, a direct partnership between steel producers and their immediate customers is a strong requirement. Such collaborations are major features of new product development in the steel industry and an essential element in the promotion of steel use. In the framework of **future RTD projects, the automotive and the construction sectors are examples to be regarded as priorities.**

2.2.1. Partnership priorities: the automotive sector

Society's needs. Mobility is a basic requirement for people in modern industrial and knowledge-based societies. Mobility of people and goods has contributed greatly to wealth creation and economic prosperity.

Energy consumption in transportation is dominated by road (73%) and air transport (12%). In Europe, individuals spend a significant amount of time in motor cars. The total distance travelled by all road vehicles has tripled over the last three decades. In the EU, the average number of cars per 1 000 people is approaching 500; in Germany, France and Sweden this figure is even higher. Every year 40 000 people are killed in Europe in traffic accidents. Road deaths are still the first cause of mortality among youth aged from 15 to 24 years. New strategies for maintaining mobility and for mitigating the consequences of action programmes will therefore be necessary in future. In this context, **safety of passengers and drivers is increasingly becoming an important priority, as recommended by the EU Commission (a decrease by a factor of 2).**

However, worldwide the transport sector is responsible for about 20% of greenhouse gas (GHG) emissions. A decrease in the specific fuel consumption of cars has been counterbalanced by trends towards bigger cars with high-powered engines, an increase in the number of cars, and fewer passengers per car. In addition to new fuel technologies, new transport concepts and construction methods are required in order to enable reductions in GHG emissions to be achieved despite increasing passenger and goods traffic.

The development of transport modalities and intelligence in transportation systems are essential to provide an infrastructure that can facilitate mobility while minimising energy consumption and emissions, and also reduce car accidents. Steel solutions are central to meeting these requirements and should be considered for future infrastructures as far as traffic control is concerned.

Recent collaborative studies by the steel sector (Ultra Light Steel Auto Body Programme - ULSAB, Ultra Light Steel Auto Suspension Programme - ULSAS, Ultra Light Steel Auto Closure Programme - ULSAC) have demonstrated the capacity to reduce the weight of car bodies, suspensions and closures by around 25%, leading to a decrease in CO_2 emissions in the environment, improved safety, and material recyclability. This has been made possible using new steel products and new steel solutions. These programmes demonstrate the potential of steel as a high-performance material for mass production and for achieving cost advantages with better or equal performance results. **Efforts should be pursued and new steel solutions sought to accompany the evolution of the automotive sector.**

Challenges posed by lightweight construction and improved energy efficiency. The car of the future will have to be more energy efficient, lower in pollutant emissions and simultaneously lighter, safer and quieter. Therefore, the automotive industry is stimulating light construction innovations. However, new energy sources involving hydrogen will be developed, such as fuel cells. It is essential for the steel industry to exploit its material expertise, through material development and component design for use in mass production and, in co-operation with the automotive industry, to achieve further improvements or totally new solutions for vehicle concepts.

In addition, the EU Directive in 2000 on end-of-life vehicles aims to make vehicle dismantling and recycling more environmentally friendly, and sets quantified targets for reuse, recycling and recovery of vehicles and their components.

Future collaboration as a precondition. In future, even earlier and closer collaboration with the automotive industry will be necessary in the areas of materials used (properties), construction (components), and production processes (joining techniques). In order to remain competitive in further developments of technique, design, safety, environmental behaviour and comfort, research activities should be focused on the following topics:

Car body. The construction techniques employed in modern automobiles can basically be divided into three groups:

- Shell designs;
- Space-frame designs;
- Mixed shell/space-frame designs.

New steel grades and more intelligent use of the materials, together with new types of production technologies, are imperative if the car of the future is to combine mobility with sustainable development. Steel designs have great future potential:

- Modern sheet designs can optimise material use, as required to meet strength and stiffness demands;
- A mixed design of spatial grid frames made of closed profiles for the bearing structure of the vehicle body (space-frame) can achieve weight reduction while maintaining the same performance data by optimising hydroforming and tailored-tube production;
- The production of outer skin parts should be developed from high-tensile multi-phase thinner steels (< 0.5 mm). The creation of a new family of lightweight steel grades, facilitating the production of complex, geometrically-demanding components, is a further challenge for the steel sector;
- The use of corrosion-resistant stainless steels in the vehicle body can play a major role in future in forming complex geometries as a result of the good ductility and strength properties of these steels, and the advantages that these qualities bring about;
- New surface technologies could provide scratch-proof and dirt-resistance surfaces. Current techniques can be further developed to reduce the thickness of zinc layers, improving corrosion resistance and laser weldability of the next generation of coated products.

Suspensions. New steels with improved fatigue properties for smaller component sizes (including spring steels), and new forming and processing techniques are at the forefront of future developments.

Drive line and gears. New steels for connecting rods, gear teeth, roller bearings, and drive shafts need to be developed. The applicability of new forming, preparation and processing techniques (including near-net-shape forming and thixo-forming) must be tested.

Engine. New steels for injection systems (raised temperatures and pressures) and for smaller component sizes can be expected to provide improved performance and savings in fuel consumption. New steels require the development of new working methods (particularly drilling).

Complementary measures. Tools with longer operating lives and increased resistance to pressure and temperature changes are consequences of future developments of steel grades in automobile construction.
Measurement of the characteristics of the steels used, such as the modelling of forming behaviour during production of the components, and the simulation of vehicle behaviour are considered to be very important.

Long-term research tasks. High priority should be given to the following topics:
Development of advanced or new lightweight steel grades with high strength and ductility;

- New surface technologies and strip coating processes for integration in conventional metallic coating or coil coating lines;
- New forming technologies for pre-coated or complex parts;
- New joining technologies for tailored products;
- New vehicle systems and steel constructions easy to disassemble;
- Steel solutions to facilitate the use of new energy sources (fuel cells, hydrogen).

Recommendations concerning *Partners*

The automotive sector

The steel sector, in close co-operation with the automotive sector, should continue to develop steel solutions for the car of the future, including traffic modality and transport control.

The main objective is to maintain individual mobility for citizens, satisfying the needs of sustainability by the design of lightweight steel parts (because of increasingly large and powerful cars) for lower energy consumption, including new solutions for improving safety, primarily, but also durability, comfort, ease of car disassembly to facilitate recycling and, last but not least, the use of new energy sources.

2.2.2. Partnership priorities: the construction sector

Steel is one of the most important construction materials. Almost half of the steel produced is used for construction purposes. New applications for steel can be found through the development of new grades, building components and systems, composite structures, and construction technologies.

From the construction sector’s point of view, the prevailing future trends, society's needs, environmental concerns, and the threat of global warming can be classified in the following different groups:

- Urbanisation development in the EU continues its trend, bringing infrastructure opportunities (e.g. hospitals, schools, transport, etc.) that have key relevance for construction;
- Existing building stock is ageing and needs service, repair, renovation and refurbishment. Inhabitants are also ageing, which means, for example, that in multi-storey buildings stairways do not provide sufficient access but elevators are needed. Greater adaptability is needed in apartments as a result of the changing needs of smaller families;

- With increasing energy prices, more attention will be devoted to reducing use of energy in heating and air-conditioning in both the home and industry, by utilising new construction techniques/designs to reduce heat loss and/or the need for cooling buildings. Less energy will be used in production and less waste will be generated in construction. Noise and dust must be minimised during construction and better sound insulation is needed in urban areas. Sustainability issues drive the steel construction sector to develop and design new products according to new regulations;
- The ever-increasing capacity of information and communication technology offers a powerful tool for innovative product development and the realisation of construction projects. Multiple individuals, functions and, increasingly, even separate companies can contribute to any given concept.
- The development of steel solutions to improve safety in building construction areas and reduce both costs and construction time. Safety should be improved by exchanging best practices in the safe erection of buildings;
- Reduction in the consumption of non-renewable materials.

The direct partnership with customers is the tool through which the steel industry will meet the needs of consumers. In order to respond to these needs, three kinds of actions should be developed:

Effective implementation and dissemination of the results achieved in the joint projects and adoption of best construction practices. Steel's market share varies from country to country and is very dependent on the type of construction. Steel has always been present in heavy infrastructure, bridges, pipelines and high-rise buildings. However, in small houses and in some civil engineering structures, such as pilings and foundations, market share remains low compared to its potential. **The development and implementation of standards at EU level, especially Eurocodes and reference standards, are key issues for the use of steel.**

Technical and scientific development of materials and products, including composite structures, and development of new products, new construction systems, production and construction processes and more efficient control of the supply chain. Product development is already focused on the evolution of standardised products and mass customised production systems. However, further innovations will be carried out to develop new steel grades with improved corrosion resistance and fire safety, new technical solutions for combining steel with other materials, and associated innovative design features. This would offer new potential for a healthier lifestyle, such as the minimisation of noise and vibrations, improvement in thermal insulation systems, and the capacity to integrate alternative energy systems. Finally, the development of new assembly processes would contribute to reductions in on-site construction costs.

Initiatives to carry out integrated programmes incorporating the different sectors involved. ULSAB, ULSAC and ULSAS programmes could represent a model to be followed.

Recommendations concerning *Partners*

The construction sector

The following RTD activities are recommended:

- Development of new solutions for the use of steel in residential constructions, single family housing, multi-storey apartment buildings;
- Development of new solutions for the use of steel in renovation of existing buildings;
- Development projects to increase the use of steel in the above-mentioned applications, especially in those countries where the knowledge of its potential is less developed;
- Research activities providing new scientific knowledge;
- Development of new standards;
- Exchanging best practices, especially to increase safety in construction.

2.3. Planet: improving environmental aspects

2.3.1. The greenhouse gas challenge

Over the last 50 years, the concentration of CO_2 in the atmosphere increased from 280 ppm to today's level of 360 ppm. There is a growing consensus that this change is linked to anthropogenic activities. According to reports from the International Panel on Climate Change, this phenomenon will lead to a worldwide rise in temperature by 1.4 to 5.2°C by the end of this century. Many countries in the world decided to take action in accordance with the Kyoto Protocol. One of the measures taken by the EU to respect the Kyoto commitments is to create an emission-trading market for certain industrial activities, including steel-making.

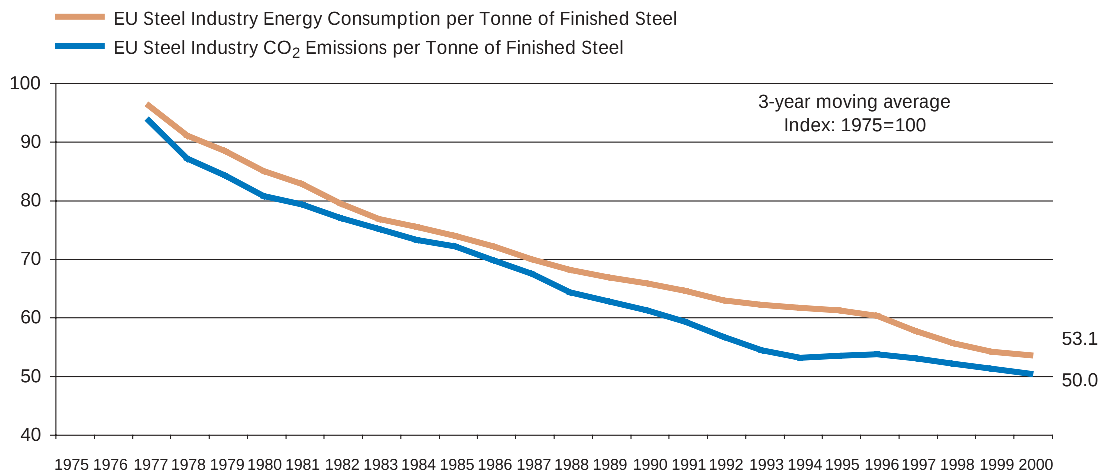
The steel industry is in a special situation as regards this issue. Over the last 50 years, there has been important and systematic progress in steel-making resulting in the halving of the CO_2 emissions per tonne of steel produced. This was achieved largely due to the reduction of coke consumption in blast furnaces and the increased availability of scrap to be recycled either in basic oxygen furnaces or mainly in electric arc furnaces. **The steel industry still represents an important share of the European anthropogenic CO_2 emissions (6%), and therefore remains a sector of specific importance (See Fig. 6).**

Further major improvements in integrated steel-making (blast furnace) cannot to be expected. In the integrated steel-making route, coke and coal are not primarily fossil fuels but are reducing agents that cannot be replaced currently under economically viable conditions. Today, about 1.8 tonnes of CO_2 are emitted per tonne of steel, which represents almost the theoretical limit for the process.

Therefore, to make meaningful progress in the reduction of CO_2 emissions a new approach and breakthrough technologies for reduction of iron ore are required. The development of such a process is essential to keep the performance of the sector in line with the environmental needs of our society.

Looking for breakthrough technology: Ultra Low CO_2 Mitigation (ULCOS). To respond to the challenge of lowering CO_2 emissions in the steel industry, breakthrough technologies need

Fig. 6: Progress in steel-making in terms of reduction of both CO_2 emissions and energy consumption



Source: Eurostat

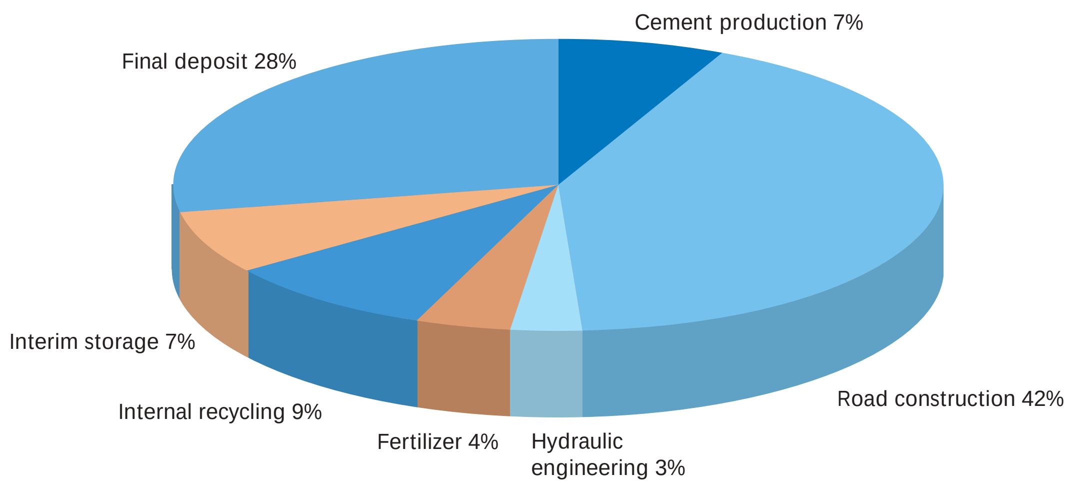
to be developed. This idea has led to the creation of the ULCOS study group, which submitted a proposal for research funding in this area to the European Commission. In the first phase, the ULCOS project will evaluate every reasonable proposal on CO_2 emission reduction using a standardised methodology. This concerns carbon-based technologies with or without subsequent sequestration, technologies that would require cheap and plentiful electricity or hydrogen, biomass, etc. The most promising technologies will then be studied in detail and tested on a pilot scale. Finally, full-scale demonstrations of appropriate technologies will be tested. The results of this work should redirect the investments in steel-making in the post-Kyoto era.

2.3.2. Towards zero waste

It is estimated that steel-making activities in Europe produce about 80 million tonnes annually, equivalent to half of the European steel production of by-products and waste, of which 10 million tonnes is waste for disposal. **This waste of resources and land area are not sustainable and must be reduced in the future.**

The analysis of waste for disposal shows that 80% consists of slag and iron-bearing dusts and sludges which can be transformed into raw materials for other users or usable products. For example, blast furnace slag (about 30 million tonnes of which is produced per year) is used as a hydraulic binder. This slag is custom-made, according to the content and physical properties required by the customer, to serve as raw material for road construction, or cement manufacture, replacing Portland clinker. **Its use avoids the mining of minerals and contributes to the conservation of natural resources.** In addition, a valuable and often indispensable product is manufactured avoiding not only the excavation of lime clay and other raw materials but also the use of energy and emissions of CO_2 in the clinker process. **For other types of slag, especially those from steel-making, different treatments and applications should be further developed and implemented. This should be done in compliance with meaningful standards to ensure possible and known applications. In this context, the aid of government regulators might be welcome to promote the recycling of products rather than to quarry and treat new mineral products. At the same time, a market is to be developed to commercialise these products (See Fig. 7).**

Fig. 7: Steelslag in the EU: breakdown by using sectors (year 2000)



Source: Euroslag

At present, the recyclability of many iron-bearing process dusts or sludges is limited by their fine particle size, the presence of hazardous elements or compounds, or other chemical/physical properties. Various technologies have been developed (e.g. Oxicup, RHF furnace, Shaft Furnace), or are under development (e.g. Primus, hydrometallurgy), to separate iron from other undesired elements and, at the same time, to ensure that the remaining non-ferrous fraction is returned to non-ferrous recycling streams. The development of such technologies should be encouraged in the future.

2.3.3. Energy effectiveness

Even though the European steel industry has drastically decreased its specific CO_2 emissions over recent decades, breakthrough technologies are needed in the long term. Progress already made is mainly the result of improved energy efficiency in the steel-making process. Indeed, the development of continuous casting, increased recycling of scrap, development of RTD activities on the optimisation of the processes, and the development of computer-controlled systems, have all contributed to reduced energy consumption in some energy-intensive stages.

The current status of steel-making processes in Europe is that they are rather close to their optimum, taking into account techno-economic conditions. Gross energy consumption by European production units can often be considered as a benchmark, but the net energy consumption can be lower in some countries receiving incentives from higher energy costs.

Additional energy recovery could result from the implementation of coke dry quenching which remains a significant source of potential savings. Another existing technique for coke making is coal preheating which is widely developed in Japan but not used in Europe. Obstacles to the development of these techniques in the EU are not only due to meteorological and/or economic conditions, but also to the effects on the quality of dry-quenched coke. To become viable, more research initiatives should be carried out in this field.

However, the steel-making process involves a number of heating and cooling operations which generate low-grade heat. **Optimal energy recovery from these processes would require the development of new techniques adapted to low-temperature and continuous operation.** Such techniques, when developed, would be useful for other processes as well as steel-making (e.g. cooling of sintered products, combustion fumes, steel castings, etc.).

2.3.4. Improving material yield

A global improvement in all aspects of production activities, and hence an enhancement of the overall social relevance of these activities, has been achieved by increasing the useful output of the production.

Over the last 30 years, the material efficiency of steel production in Europe has increased markedly. Thirty years ago, 1 000 tonnes of liquid/melted steel were needed to produce 700 tonnes of finished products, whereas today, with the same quantity of liquid steel, the output is 900 tonnes.

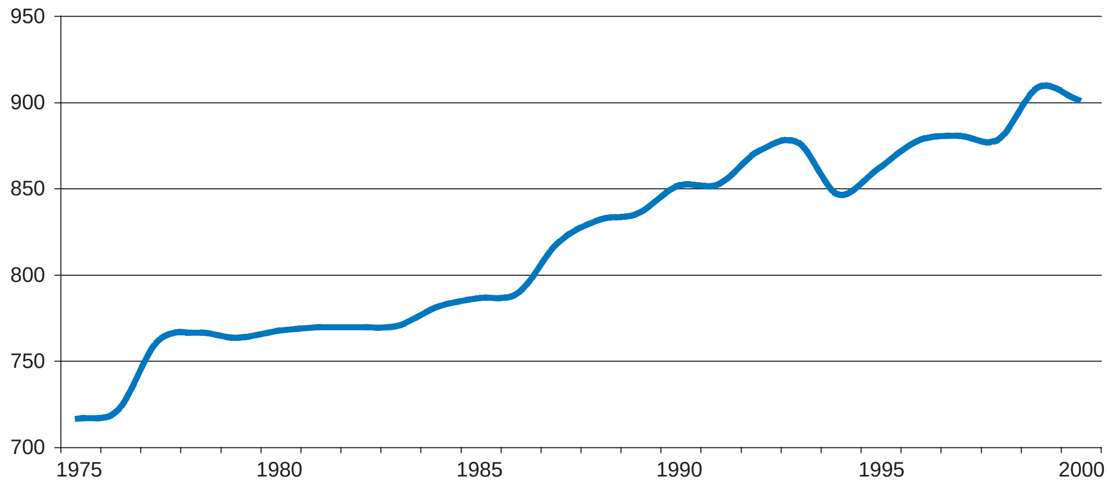
This evolution must continue, even in the face of a diminishing margin for improvement, and the actual progress should be measured (See Fig. 8).

The indication of weight is no longer a measure of the utility of the product in many applications. Thanks to the development of high-strength steels, the mean thickness of steel has decreased. However, for an increasing number of applications, the surface area or length has become a better measure of quantity than weight.

2.3.5. Assessing the advantages of steel applications

Steel products today are becoming more and more sophisticated. **High-strength steels** allow for the production of lighter and lighter applications, which **contribute to savings in energy consumption** (e.g. in transportation systems).

Fig. 8: Kg finished products/tonne crude steel



Source: VDEh

Galvanising and other **corrosion protection systems** extend the life span of the manufactured goods **and strongly reduce the use of natural resources.**

Steel is 100% recyclable and can be recycled infinitely without losing its properties, whatever its use or destination. Moreover, because of its unique magnetic properties, steel is easily separated from other materials. This is a clear advantage over many other materials. **In this context, the steel sector proposes to improve further the recycling of steel from products on the market such as furniture.** In order to facilitate collection, these products must be designed for the easy dismantling and separation of all steel components.

These and other advantages need to be rigorously quantified in order to **design** and develop more **environmentally friendly products.** The steel industry was acting as a pioneer when it charged the International Iron and Steel Institute (IISI) to establish an international methodology for carrying out life-cycle inventories of its products. **This first step needs to be improved and developed in the near future, and it is extremely important that this is achieved within the European context, through a common initiative supported by the European Commission.**

2.3.6. Developing design tools for better environmental performance

To allow for a really comprehensive evaluation of all the advantages and disadvantages when selecting materials for specific applications, a universally accepted methodology, capable of taking into account all relevant aspects of the life cycle of the material, is a major prerequisite. Ultimately, such a scheme will be indispensable in the selection of materials in a quantifiable and objective way, and should be developed at a European/international level.

No single expert, producer or institute will be able to present a suitable solution. **An intensive wide-ranging approach to data collection, verification, and methodology development will be required. This will involve the entire production chain, the user, and the recycling industry.**

2.3.7. Reducing the impact of production

The large volume of materials and the power consumed in the processes make production a source of important emissions and sometimes pollution. Significant progress has already been achieved by the steel industry in the abatement of a number of emissions. However, the sector's biggest challenge, as regards acceptance by neighbouring communities, remains the way in which it will be able to further improve material and energetic emissions to the air in particular.

Every regulatory initiative towards improving the air quality affects the sector. Further technological efforts are therefore desirable and may also be addressed.

Recommendations concerning *Planet*

- Resources should be made available to develop new technologies in order to reduce greenhouses gas emissions in a drastic way;
- Incentives to reach the 'zero waste' concept (recycling and reuse) should be promoted;
- The environmental burden of producing and using high volumes of products and semi products needs to be assessed with the view to being managed;
- A European/international methodology for the LCA (Life Cycle Assessment) Inventory of products should be established and applied in order to optimise design decisions;
- Design tools have to be developed.

2.4. People: attract and secure human resources and skills

2.4.1. Health and safety

Both the image of the steel industry and the quality of steel products are strictly connected to the quality of the working environment and workplaces. The improvement in safety has resulted from long-term activities based on social research that addressed issues related to health and safety of the people in conditions within the working environment.

Accident statistics show that the European steel industry is among the safest worldwide. Nevertheless, **the elimination of fatalities and further improvements towards 'zero accidents' are the major priorities (See Fig. 9).**

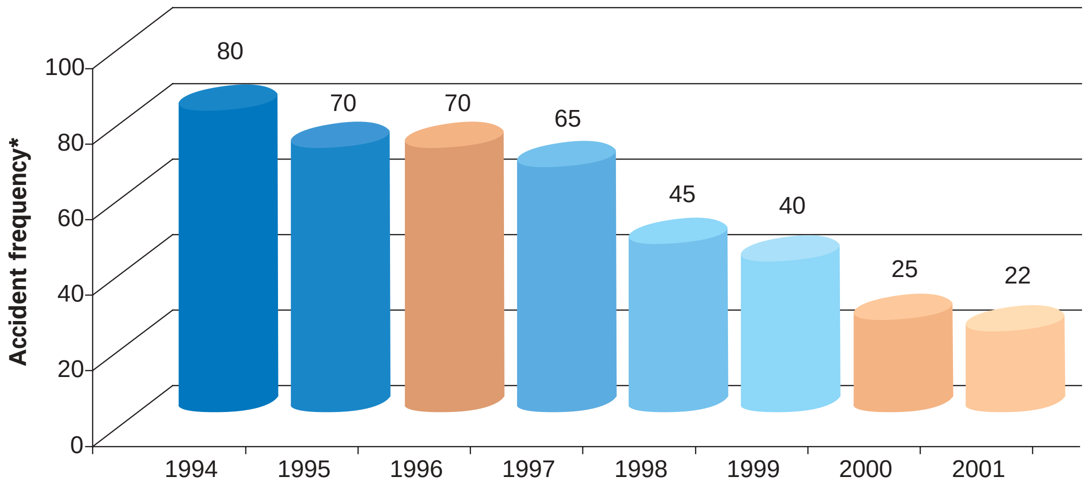
2.4.2. Human resource management in the steel industry

In a global economy in which various industrial sectors are interdependent, and under pressures generated by the imperative needs of reinforcing competitiveness and creating employment, special consideration should be given to the **conventional forms of organisation of work, the methods of people management, their skills and continuous training, and governance employed by companies and public authorities.**

The **macroeconomic changes** over the last 20-30 years have resulted in a move from manufacturing industries to the service sector, from occupations requiring relatively modest educational levels to those with higher education and training. At an **industrial level**, employment has been characterised by its rationalisation and the introduction of new technologies (See Fig. 10).

Skills and knowledge requirements have risen continuously. This includes not only the knowledge of technical processes, but also the ability for analysis and an improved capacity to work in a team. Related to this is the rapidly changing world of work, driven by computerisation and

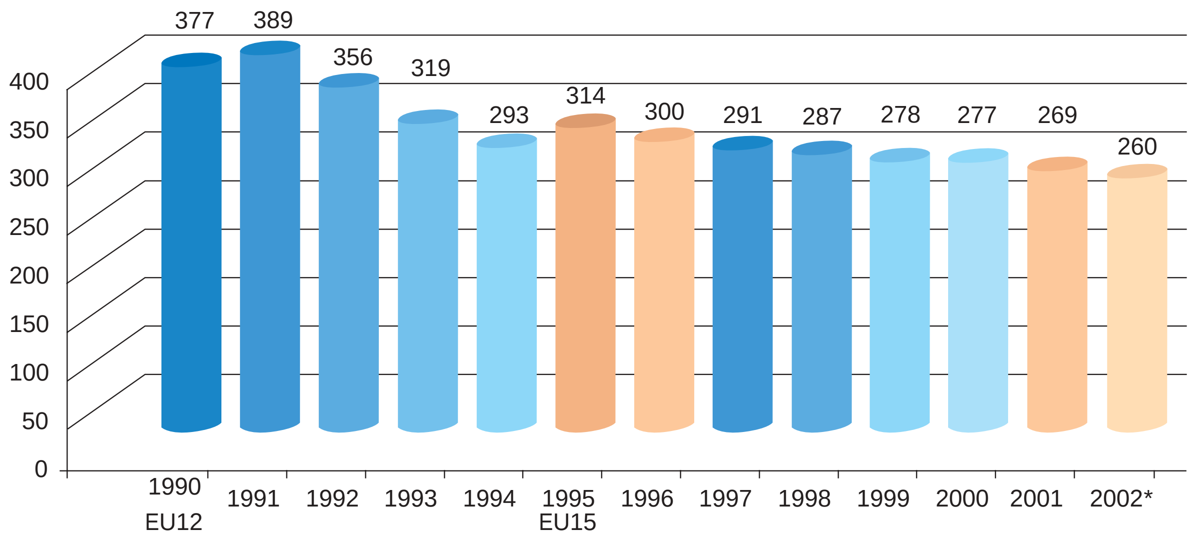
Fig. 9: Accident frequency values in some European steel plants



**Number of accidents causing at least 24 hrs disability over 1 million working hours*

Source: VDEh

Fig. 10: EU steel industry labour force (in thousand)



**Provisional data*

Source: Eurostat/National Steel Associations information technologies. **Hence, a continuous training process and the establishment of 'best practice' education and training arrangements are necessary to adapt the workforce skills to these changes.**

2.4.3. How to attract qualified people

As far as new human resources are concerned, the modern steel industry does not require a monothematic specialisation but a solid technical and scientific base. Following the dominance in demand for highly educated people and the reduced number of young graduate engineers, physicists and chemists, the steel industry is being increasingly threatened by the ever decreasing possibility to employ suitably qualified people and to motivate students who are more attracted by finance and business careers. This is a general need across the European steel industry.

To attract highly qualified staff, the steel industry has committed itself **to intensifying its contacts with universities and research institutes, demonstrating its characteristics of safety, durability and environmental performance in relation to high-technology, in other words the development of a *steel culture*. These values should be shown through specific actions such as advertisements, image and awareness campaigns.**

Development of young staff working in the steel industry is also essential. The ECSC experience showed the importance of co-operation and the development of extended networks at a European level. **Masters degrees in metal sciences should be promoted and tailored towards both modern and future steel industry needs.**

A European 'mastership' programme could be organised in order to transfer updated knowledge on metals science both to young graduate engineers, already working in the European steel companies, and to students at university. The ongoing experience of the **Eurosteelmaster**, which conveys speakers from universities, European institutions, steel companies and research centres, **can be used as the basis for a more complete high-level course.**

In this respect, a transition is required from purely technical activities, to activities requiring an economic intelligence within the company, analyses of its performances, knowledge of the markets, and a high level of management skills. Accordingly, within the scheme of continuous training, the new concept of a new business school should be implemented.

2.4.4. Demand for highly skilled educated people

To meet new needs, the demand for people with higher education qualifications will continue to increase in the coming years and should continue to rise in the future. These difficulties are further exacerbated by the present age distribution in most European steel companies. The distribution shows, in fact, a higher density of older people; as a consequence, a considerable number of employees will retire and leave the industry in the next few years. This situation could become an emergency if not faced in time with the appropriate strategies and measures. **Specific programmes for experienced people over 50 years old have been organised by some steel companies in Europe, with a degree of success, which is encouraging for a similar approach on a larger scale.**

2.4.5. Continuous training

The rapid technological changes in the steel industry raise questions about the adaptability of its labour force. **The current exchange of best practices between steel companies will continue to be implemented.**

The existing committees made up of steel industry and trade union representatives can contribute positively to this training effort.

However, in this dynamic vision of modernisation of human resources, **the Unions have a key role to play, helping to drive all the workers involved to match their aptitudes and capacities to the needs identified by the companies.**

Recommendations concerning *People*

- Improvement of work safety conditions;
- Exchange of practices in view of the 'zero accident' target;
- Close relationships with a network of top level universities taking initiatives to attract the best students in the steel industry; disseminate a *steel culture*;
- Support and development of training at European level; support EUROMASTER initiative.

3. Organisation of the European Steel Technology Platform

3.1. Developing a closer European partnership in RTD to gather a critical mass

It is proposed to build upon the positive experience of co-operative research gained by the European steel industry under the ECSC treaty, which led to the first Excellence Network in the EU. **It is intended to further integrate and broaden its RTD partnership in order to reach the critical mass required to meet the challenges of the long-term ambition.**

Indeed, in order to achieve these long-term objectives, the steel industry needs to broaden its skills and further develop its competence base. This is required in particular with respect to the development of breakthrough technologies to achieve post-Kyoto agreements and to boost innovation to propose new steel solutions to customers, especially those in the automotive and construction sectors. It is envisaged that closer relationships with both suppliers and consumers (the end users) would increase the cross-fertilisation of vertical skills within the supply chain.

These activities should be carried out through participation in European RTD programmes, such as the Framework Programmes, national and even regional programmes.

3.2. Creation of a European RTD Steel Technology Platform – key participants

The creation of a European Steel Technology Platform would constitute a powerful tool to acquire the necessary skills to achieve the ambitions of the European steel sector.

It should comprise:

- The major steel companies, and the whole European steel industry represented by EUROFER;
- The steel research centres;
- Industrial stakeholders linked to the priorities of the Platform, e.g. suppliers and engineering companies, representatives of automotive and building sectors;
- Universities through a European network;
- The European Commission;
- Representatives of national EU governments;
- Representatives of the trades unions and/or the Consultative Committee for Industrial Change (CCIC).

However, because of the open structure of the Platform, additional partners could be integrated into the organisation, according to the evolution of the priorities.

3.3. Governing bodies

Two committees are proposed to steer the Platform: a steering committee and a support committee.

The European Steel Research Advisory Council
Its mission should be to:

- Define long-term priorities for RTD within the steel sector;
- Decide strategic RTD actions to support innovation;
- Set up a strategic research agenda;
- Monitor and coordinate long-term actions.

In order to create an efficient and flexible body, as recommended both by the European Commission and the decision-makers for the steel industry, this Advisory Council should comprise a limited number of high-level personalities (15/17), appropriately balanced.

The Advisory Council Support Group
The size and composition of this body would also be defined according to the technical priorities of the Platform. However, it should include: steel industry R&D managers, representatives of the participants in the technical platform, and representatives from the European Commission services.

3.4. Implementation of the enlarged partnership

The governing bodies should be operational early in 2004, immediately after the official launch of the Technology Platform. Their first task would be to identify an initial set of priority actions and to prepare a detailed strategic research agenda for more long-term actions. This should be achieved before the end of 2004.

European Commission

European Steel Technology Platform - Vision 2030

Luxembourg: Office for Official Publications of the European Communities

2004 — 35 pp. — 21.0 x 29.7 cm

ISBN 92-894-5036-3

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KI-58-04-433-EN-C

This report sets out the ambition and the long-term vision of the European steel sector by 2030: to assume sustainable and global leadership in the coming years. It identifies the main challenges and the strategic research objectives facing the European steel industry. It presents recommendations for the creation of a European steel technology platform to boost innovation, as well as develop breakthrough technologies and new steel solutions. This report was initiated by Commissioner Philippe Busquin, in association with the European steel industry and other stakeholders. It is an important step towards opening and broadening dialogue.

Printed by OIB

Publications Office
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ISBN 92-894-5036-3

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