The Growth of Technology in Iron- and Steelmaking in the Past and Challenges Ahead*

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I. Preface

When I was asked to present a paper on the occasion of the Annual Meeting of your Institute, I felt myself like a Swiss living in the Alps whom is asked to present a paper in Holland on the subject of building dykes and polders in the sea. In other words: I have such a high respect for the experience and performance of Japanese steelmaking that I do not know what to say here before such a distinguished and experienced gathering. I will, however, try to give some of my personal views in rather general terms on the development of technology over the past decades and on what in my own opinion will be the major points to be faced in the coming two decades. I will limit myself to this period, because looking further, beyond the year 2000, seems to me to be more guessing than predicting. A further limitation I will set myself, is that I will refer mainly to the European scene, because that is where I know best the boundary conditions in which the technology of iron- and steelmaking came to fruition and which boundaries are now going to impose increasing restrictions on the technological development.

II. Past and Present Developments

The history of steelmaking is markedly characterized by the period of 1850~1870 when large-scale liquid steelmaking was invented and industrialized (with which the names of Sir Henry Bessemer, Gilchrist Thomas, Werner Siemens and Pierre Martin are inseparably connected). These events caused the transition from cast iron to steel as the main construction material. The period from about 1875 to 1940 was characterized not so much by new developments as by the slow growth in unit sizes and improved technology in controlling the different processes. This growth in unit size was greatly enhanced by the engineering and manufacturing industries which were able to make bigger castings, more powerful mill drives and presses, larger electric motors, more consistent and better refractories, bigger pipelines and pumps, etc. Since 1945, however, there has been a drastic change in this trend and developments in processes and in unit sizes have come in rapid succession and so in 25 years the picture has changed completely.

It is not my intention to give a survey of the major developments of the last 30 years, because one only

has to stay in Japan for 1 or 2 weeks and visit the major steel-works to see the testimonies of what has been achieved over that period after a war which had devastated to a large extent iron- and steelmaking in Japan. One would not only see 8 completely new integrated steelworks, which did not exist after the war, and 5 steelworks which have been so modernized that their original lay-out can hardly be recognized today; but in addition one would see how much has been done in further developing new processes. Especially for transferring a new process from its initial development into a fully commercial profitmaking installation we all owe a great deal to the Japanese resolution and persistency in bringing this to a successful achievement.

Just for illustration I want to recall the increase of blast-furnace volume from 700 to 5 000 m³, the increase of productivity from 0.7 to 2.5 t/m³ per day, the increase of converter sizes from 60 to 325 tons, the increase of coil weights in the hot strip mill from 12 to 40 tons and as an overall figure the increase of the steel production of one integrated site from 1 or 2 million to over 15 million tons per annum.

In the past, rapid technological developments were induced by great strides in the engineering and manufacturing industries, by better materials (refractories, wear-resisting materials), by better measuring and control techniques, and last but not least, by better understanding of scientific mechanisms, production bottlenecks, reasons for break-downs, etc. All these developments could take place because the market was there; there was an enormous need for steel for private use (*e.g.* cars), public use, and for capital goods for industry and energy supply. Higher standards of living allowed greater consumption of goods and energy and so the rate of development of technology was fast and rapidly brought to fruition.

It is my opinion that we are now seeing a different picture emerge: in a large number of industries (including steel) we see further technological development reaching a number of limits:

- 1) Fundamental technological limits which we are beginning to see more clearly than in the past through our better understanding of processes and products;
- 2) Availability limits of raw materials and energy where scarcity is translated into higher costs; this is not yet the case for iron ore, but is certainly the trend for energy and for some metals;

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- 3) Economical limits which have caused a halt in the ever-increasing size of production units, to which I will return below;
- 4) Market limits which we denote commonly as an economic depression, but which are more a sign of a mature economy in our industrialized and maybe overdeveloped countries (especially those in Northern Europe, North America and Japan);
- 5) Environmental limits which we, as industrialists, are inclined to consider as fashions of young progressive or idealistic people, but which, in fact, are efforts to safeguard the quality of life to which the very same technological progress has made such valuable contributions; and
- 6) Capital limits, because in the many sectors of industry immense sums will be needed to increase or even retain our present level of input of raw materials, energy, *etc.* and to adapt both existing and new installations to the stringent but often also reasonable environmental standards which industry has to meet; the latter will take a large amount out of any capital available for process industries such as steel. Besides this, governments will also compete on the capital market for social projects (*e.g.*, housing, welfare projects) and for infrastructure improvements (such as harbours, public transport).

From the above we may conclude that there will be little chance for a breakthrough or a major development in the technology of iron- and steelmaking in the next two decades, and that further developments will have more the character of refinements in performance resulting in slightly lower cost price and better availability of products and more consistency in their quality and performance.

Let us therefore consider some areas in which technology will be heavily involved, bearing in mind these prevailing limits: there are areas, such as energy and raw materials conservation, where much of the technology to meet many of the likely future challenges already exists, but where its rate of application depends on political and economic factors rather than on technological ones.

There are other areas, such as environmental control and engineering and product improvement, where technological problems are appearing which demand a substantially different approach to that adopted in the last two decades.

Let us now face some of the major challenges which lie ahead of us and for which we have to find solutions either technological or political or economic.

Coke-making

The first one is coke-making. When we look at all the developments which have taken place over the last 30 years, it is somewhat disappointing to see how little has been achieved in the way of coke-making. We still are faced with the conventional discontinuous coke-oven batteries and the only "innovation" we have been able to introduce recently is raising the height of the batteries from 4 to 6 meters and pre-heating or briquetting of coal and dry quenching of

coke. But it still is a capital intensive, sluggish operation, with many environmental problems caused by the numerous doors and other openings and unpleasant to operate in spite of some mechanization and automation. Great efforts have been devoted to alternatives in the way of formed coke or briquettes, but so far none of these has been able to come out of the trial and error period. Over the last few years there is even a decreasing interest in formed coke over the world. The reasons are probably twofold:

(1) For producing good coke out of good metallurgical coals the different formed coke processes do not show sufficient economic justification; their main merit seems to be their ability to make a coke from coals with poor metallurgical properties. However, this is not a great incentive, because there is an abundance of good metallurgical coal, of which still a large percentage (about 45% in the USA and more than 20% in West-Germany) is burnt in power stations and used for industrial steam production.

And even when a steel industry has to import coals from overseas, there will not be much price difference (about 10% on calorific value base) between good metallurgical coal and a coal with poorer coking properties but with still acceptable ash- and sulphur-levels, because of the overriding effect of transport costs (30~40%).

(2) From tests and from theory it seems that formed coke is not giving the same maximum productivity in the blast furnace if it comprises more than 50% of the fuel required. For these reasons one has recently found more indications of using coal to reduce iron ore in a different way and not via the cumbersome and capital-intensive coke-making route. This, however promising it might seem at first glance, has the great drawback of bypassing the blast furnace, which essentially needs coke. The blast furnace, however, has a great number of strong positive points:

- i) high efficiency in fuel and raw materials;
- ii) low capital and low maintenance cost per ton of iron;
- iii) it separates efficiently iron and gangue and can therefore use a great variety of ores.

Its main competitor is the direct reduction furnace, which, when using natural gas, has a good fuel economy, about equal to a modern blast-furnace; it loses its lead when coal has to be gasified for making a clean sulphur free reducing gas. Besides, the direct reduction furnace needs the electric steelmaking furnace, with its inherently high energy consumption and costs. So the direct reduction/electric furnace chain will only be applied in those cases where there are special, economic incentives for it; however, there seems to be a sufficient number of these cases, for the present total tonnage of nearly 7 Mt in 1979 is expected to rise to some 30 Mt in 1985 (world wide).

So all in all, in spite of my aversion to the coke oven battery, it will be there for the two decades to come and many new batteries will have to be built in view of the shortage of modern coking capacity in both Europe and the USA, which will necessarily lead to a substantial activity in renovation of existing batteries.

Fig. 1. Age profile of coking capacity. (Source: IISI)

LD-steelmaking

A second focus of interest is LD-steelmaking. Since it grew up in the early fifties, one has witnessed a fascinating victory over basic Bessemer and open-hearth steelmaking. A number of years ago the blowing of oxygen through the bottom was successfully developed in the OBM or the Q-BOP process, resulting in a world production capacity in 1979 of about 50 Mt (about 8.5% of the world total). This revival of bottom-blowing is most remarkable after many earlier and unsuccessful attempts to improve the yield and the steel quality and to remove environmental drawbacks of the conventional Bessemer process. In the last two years we see a new modification coming to the fore, namely top-blowing combined with bottom-blowing, appearing in a number of different versions. This latest version seems to offer considerable advantages in combining the metallurgical advantages of bottom blowing, namely fast reactions, better mixing of the steel bath, with the more complete combustion of CO above the bath, resulting in higher thermal efficiency and so a higher usage of scrap. As has been reported, scrap usage can be pushed up to 40% and even recently it has been mentioned that by injecting carbon or coal through the bottom together with oxygen, scrap percentages of up to 75% could be preheated and melted into steel. This all shows that we have a highly powerful and flexible tool in the steel converter, be it top-blown or bottom-blown or both.

Once one is able by the injection of different fuels and extra oxygen to melt such high percentages of scrap and also possibly sponge iron, one may see the steel converter being in a very competitive situation with respect to the electric furnace. Especially when the latter will be equipped with auxiliary oxygen-fuel burners for the preheating of scrap and also with bottom purging for better mixing, the two processes become extremely close in their performance, both having great flexibility in their use of raw materials and energy. This is a very attractive field for further developments.

A further clear development is to use the steel converter mainly for converting efficiently iron and scrap or ore into steel and using the steel ladle for after-treatment and adjustment of temperature, composition and deoxidation grade. The need for this comes more and more to the front, the more continuous-casting with its stringent requirements for temperature and composition is taking over from ingot casting. A further extension of this idea is to prerefine iron by taking out the silicon and some of the phosphorus and the sulphur as suggested by Mr. Komoda of Kawasaki Steel Corporation at the Metals Society conference in Amsterdam in 1979. In this way the steel converter should hardly need any slag and the conversion into steel could be carried out with even higher efficiency.

All in all we see a whole field of new opportunities opening up around the steel converter not by new breakthroughs but by adaptations which allow us to make better use of raw materials and energy in a very flexible way.

Rolling Mills

A third focus of interest is in the rolling mill area. I do not want to deal with all the developments and refinements in this area because this has been done recently in a comprehensive paper by Hewitt of Davy Loewy at the same Amsterdam conference and also because your Iron and Steel Institute is organizing a comprehensive conference on rolling later in this year, which will be attended by many people from all over the world. There is, however, one aspect I like to deal with as a focus of interest in this area and this is automation.

The progress made in this area over the last 10 years, aided by the introduction of computers, is fascinating, especially in Japan. With the lay-out of new works or new extensions to existing ones, there has been a fine opportunity to come to an integrated set-up of a hierarchy of 4 or 5 levels of computer systems in which the handling of information systems (such as order scheduling) is tied up with process control.

The advent of the cheap micro-processors (the chips) will not essentially change this picture and will in my mind certainly not lead to a completely automated rolling mill. There are a number of points impeding such a route:

(1) A rolling mill is essentially a process shop in which a number of solid units (slabs, coils, bars) are

handled each having certain characteristics and a certain destiny: the essential point for handling these units in an automated way is the availability of sensors and identification tags from which the whole computer network can be fed and which will continue to work properly in the adverse conditions of heat, dust and heavy weights existing in the rolling mill bays.

The availability and reliability of these inputs are essential for an automated system and, if not working at 100%, might ruin the whole beautiful computer system located in air-conditioned rooms. There certainly is a need for developing these inputs further in the coming years.

(2) If the cheap micro-processors will have an impact on steelmaking, it will not so much be in the further automation and control of processes, but more in the handling and feeding-back of all kinds of data and other information in offices like production scheduling, inventory control and cost-accounting; and even secretarial and administrative work will be severely affected by these hard-ware developments.

(3) Another point of concern is the ability of the human mind to come and to stay on "speaking terms" with the computer. By pushing automation further, it is essential to realize that the human brain has enormous versatility whose potential should be utilized fully. Automation, therefore, should not be designed so as to replace human beings because they make errors, but to assist them in doing even better those things that they can do well. I cannot do better than to refer to the document issued recently by the EEC regarding an ergonomic evaluation of a hot-strip mill, in which it is recommended that future automated systems should give the operator:

- i) information which will enable him to understand the actions carried out by the automatic system and also give him a better feel for the process;
- ii) controls which will enable him to operate together with the automatic system and help him to increase its performance.

Of course this can be done only if the operator is properly trained to make use of these possibilities.

It is therefore essential that in any integrated computer system the different subsystems are so designed that in case of failure they can be understood and replaced in their functioning not by just one highly specialized system engineer, but by a range of people including the operator.

This will be greatly facilitated by the higher level of programming languages which are now developed and under further development: the advent of more powerful and cheaper memories will also facilitate this, but it remains essential to give great attention to the compatibility of the human mind and the computer systems, not primarily for economical reasons, but essentially for the benefit of the human being, who wants an occupation in life which will satisfy his primary aims of self-fulfillment.

So for the further progress of automation in the process industries, it will be necessary to look more and more after social and psychological aspects too.

There is one further point of interest I like to men-

tion in connection with rolling mills and this is renovation of existing mills. With the present slow growth of the steel production in the industrialized countries, there will be a great need for adapting and modernizing existing mills in order to make these more competitive and to allow them to make their products up to the quality standards offered by modern mills and required by the market. A good example of this is the renovation of the No. 1, 56" wide, hot strip mill of my company Hoogovens at IJmuiden, which mill dates from 1952; it will shortly be outfitted with a coil-box as designed by Stelco Canada (Fig. 2). By doing so it is possible to bring the coil weight from 7 kg/mm width up to 16, which figure is essentially a market requirement; the coil-box will also avoid the inherent temperature drop (or run-down) from head to tail of the strip by reversing head and tail ends (Fig. 2(a)).

The major expenditure in such a renovation is, however, not the coil-box itself, but the furnaces which have to be completely rebuilt for the longer slabs and also the new heavier coilers. But in itself the coil-box is an elegant and daring solution as much for renovating older mills as for shortening the length and so for cutting costs of a new mill lay-out. In the coming years many such renovations of existing mills will take place, especially in Europe and the USA, which will also lead to the introduction of better controls for

Fig. 2. Coilbox from Stelco.

Fig. 2(a). Temperature distribution over the length of the strip with and without coilbox.

width, thickness, flatness, temperature and surface conditions, all essential to satisfy present-day market requirements.

III. Impact from Outside

Energy

When talking about the challenges ahead of us, it is unavoidable to speak about energy. I hesitate, however, to deal with this subject at some length, because so much has been said already (nearly every day I would say) that it is impossible to bring forward any aspect in this matter, which has not been dealt with earlier already many times. Besides, The Metals Society together with the Technisch-wissenschaftlicher Verein "Eisenhütte Oesterreich", is organizing a conference on the subject of energy-conscious iron- and steelmaking at Leoben in two weeks from now: all aspects of energy availability and energy saving will be reviewed and discussed there.

One of the outstanding points for the coming decades is not so much the energy scarcity (there is plenty of coal and even of natural gas in reserve), but more the price, which gives us great concern.

It is well-known that costs of energy (including coal) take a share of about 25% in the total costs of steelmaking. A doubling of this price, as we have seen over the last two years, has a heavy impact on steel prices; it is, therefore, no wonder that numerous studies have been done on the relative energy content of different, competing materials such as steel, aluminum, polymers and concrete. These studies, more generally indicated as energy accounting, are difficult to interpret for two reasons:

(1) The energy needed for making a material is one thing (even an important one), but for the user many more factors play a vital role in their mutual competition, such as level and consistency of mechanical and chemical properties. This makes a comparison between competing materials on a volume or

weight base doubtful; this matter is much more complex.

(2) It is difficult to give a correct definition of energy content of a material, because of different uncertain factors, such as costs of mining and transportation and the value to be given to used material and scrap.

So, although the energy content of a material is important, its value should not be overstressed.

When talking about energy and the present high level of energy costs since 1973, I prefer to consider the present situation as a more balanced one than the good old 1960s. If one compares energy prices on a long time scale with the cost of living in The Netherlands one sees that in 1974~1978 we were back to the same relationship as existed around 1950, which probably is the same situation as we had in the 1930s (Fig. 3). In the 1960s, however, we had abnormally low-priced energy because of the tremendously large finds in the Middle East in the early 1950s, which led to abnormally low price levels, and consumption rates of energy so high as to be completely out of proportion to our overall consumption pattern. Since 1978, however, we have seen a second explosion of oil prices which is now by far overtaking the price of consumer goods. It is impossible to predict to which situation this will lead us, but in the 1980s we certainly will enter a period in which energy prices will be more and more determined by national policies and less by economy and availability. The steel industry is, by its nature of being largely coal-based, in a rather favourable position.

In addition I may say one word about nuclear steelmaking, because as a member of the European Nuclear Steelmaking Club I know how much attention is given to this subject in Japan by ERANS. Irrespective of the political issues behind nuclear energy, it is my own feeling that the thermal energy released in a high temperature reactor might well be used for gasification of coal or oil to make reducing

Fig. 3. Development of consumer prices and energy prices in The Netherlands. (1950=100%)

gas or even hydrogen, but that it is undesirable to couple a nuclear reactor directly or indirectly with a direct reduction furnace: the tuning of these complicated systems both from capacity and from safety point of view seems to me to offer nearly insurmountable risks. I therefore hold that up to the year 2000 the steel industry might only make use of nuclear energy in an indirect way, *i.e.*, *via* electric power. Even coal gasification *via* nuclear energy will probably come well after the next two decades.

Environment

This is an area which only began to show a significant development in the last decade and is one which will require considerable action in the future.

Increasing environmental demands and laws necessitate more research and engineering in this field. I will limit myself to mentioning just a few examples of problems which have to be solved.

One is the problem of sludges or dusts which are caught by washers, cyclones, bag filters, and electrostatic precipitators used in cleaning exhaust and waste gases produced in blast furnaces and steelworks and also the air around these units in the working bays (the so-called secondary cleaning-systems). The gases can be cleaned to a sufficient degree, but what is to be done with the sludges and dusts collected? They usually contain not only iron oxides and gangue materials, but also compounds of a variety of heavy metals, coming mainly from the ores used, but some of them, like zinc, mainly from the scrap used in steel-making. Generally, the percentage of each of these elements is too low to make concentration economically or even technically feasible and dumping is no permanent solution.

One approach might be to work up these sludges and dusts into bricks or other building materials, for which they would be bonded in an insoluble matrix: there is, however, a limit to which the construction industries could use this waste not only from the steel, but also from many other process industries.

Another problem is the ever-increasing refinement in the environmental standards which industries have to meet, coming from the correct insight that more factors are spoiling our environment than just SO_2 and NO_x .

This, however, puts rather a load on the steel industry to determine by measurement and analysis the sources of certain contaminants; and, even more difficult, what technology or method can be applied to prevent the appearance in the environment in such minute concentrations—often in parts per billion—of certain organic compounds, such as may be produced in the coke-making process. In the steel industry we are working with natural materials (coal, ores, stone, fuel) which by their very nature contain of course a great variety of elements and compounds, also poisonous ones.

It is clear that an increasing proportion of research and engineering activities will be needed to measure properly the emissions of a multitude of compounds from a great number of sources, to determine their

impact on the environment, to lower these emissions to acceptable limits, and to recycle the residues properly or to dump them in some way acceptable to community. All these activities will add considerably to the cost of steel for which there is no other justification than that, if steel is to continue its role as a major material supplier, they just have to be done.

A third area of great activity is noise abatement. Steelmaking and especially rolling is producing high levels of high pitch noise; increasingly noise levels acceptable for surrounding domestic areas are being lowered to 45 dB(A) and even lower in some cases. This asks for expensive measures in buildings, chimneys and installations, which can amount to multiples of 10 million dollars per site.

Two important comments must be associated with these environmental developments: the first is that the steel industry is going to spend considerable sums of money on research, capital investment, and operational costs in this area. Recently a study by Arthur D. Little has pointed out that US steel industry might need to spend 15~20% of its total capital investment in environmental measures and that this will result in about 10% of their operational costs being spent in running costs of environmental equipments. The steel industry will therefore expect that the laws and standards which it has to meet, will be applied on an international scale, otherwise unfair competition will arise. The EEC in Brussels is active in this field, but there is still much room for improvement in the harmonization of international rules.

The second comment is that increasingly extra energy is needed in order to clean the environment. In a recent study in my company an attempt has been made to put figures to this statement and the result is shown in Fig. 4. In a comparative study in Europe it is shown that about 10% of the total power consumption in a steelworks is needed for environmental equipment, half of which is used in fans for cleaning the air in BF- and LD-bays.

This shows clearly that the ever-increasing demands for cleaner air will require a disproportionate increase in energy in the form of power; this clearly goes against the pressure to save energy: optimization of these conflicting demands must clearly be part of

Fig. 4. Energy consumption for dust extraction.

governmental policy and priorities.

Working Conditions

Now the steel industry is giving so much attention to environmental conditions in order to make the living conditions around steelworks and heavy industries more agreeable, it is increasingly becoming evident that the industry has to give an equally great attention to how to attract people to working in a heavy industry like a steelworks. Of course working conditions have been greatly improved over the last 25 years by technology, by mechanization (continuous rolling mill *versus* a hand operated reversing mill), by new processes (LD *versus* open-hearth steelmaking), by remote control (locomotives, cranes, cold mills, *etc.*), but in Europe it is getting increasingly difficult to motivate people to come and work in heavy industries.

This is a very complex phenomenon in which many factors have an influence of which I quote only a few: the resistance to working on night-shifts and on Sundays, the working conditions in an industry as compared with the much improved living conditions at home, the desire to work in smaller groups each with their own clear responsibilities, the wish to see a direct recognition (not only financial rewards) of ones efforts, *etc.*

This I feel brings about a new challenge to our industries, which will require great efforts on our side from the technological, social and economic point of view. In Europe it is clear that in spite of an official unemployment figure of 4~6% of the working population, the steel industry is unable to fill its vacancies properly, especially for skilled labour and shift operators. In our talking about the challenges ahead, this is one of prime importance for the survival of the industry. It is also possible to frame it in different words: in the past the developments took place by technology push. Every technical development could be realized adequately because there was a fast-growing market caused by sufficient purchasing power in the community. Now we are entering a decade, in which technology will lose its prime role in our industries and we will have to face a much more complicated pattern of economic, political and social factors. Only those industries will be able to survive whose management and communication structure will be able to balance properly those often conflicting issues.

IV. Summary

I would now like to summarize my presentation in a few words. After a period of slower growth in technology in the period 1875 till 1945 we have seen an explosion of developments since then, namely an ever-growing size of process units, better efficiency in energy and raw materials and much better control of process characteristics and so of product properties, all resulting in a wide-spread use of steel, because of its stable price structure and more consistent properties for the consumer. Technological and scientific developments will not stop, however, because

they are activities inherent to the human mind. But in the period to come, where we will see slower economic growth and less industrial expansion, we will see new challenges ahead for science and technology, different from the ones we had before.

One thing is further savings of energy and I want to mention here, with great respect, what has been done in Japan by the many *jishu kanri* in every works unit.

Another important issue for the coming years will be making more use of abundant coal supplies. A prime challenge is solving the still remaining environmental problems of emissions in air and water and in noise, furthermore re-adaptation of existing mills and construction of smaller and more flexible rolling mills to meet more specific quality requirements of customers; all will ask for considerable activities in research and engineering for finding solutions to these challenges. Above all, however, we as industrialists are facing the challenge of reshaping our industries into a position where they can be considered as an integral part of our human existence, both to work for and to live with. Industrial expansion and our ever-growing desire for consumer goods have put a severe load on natural resources and on the condition of nature around us. Both in Japan and in Holland, with their dense populations and high level of welfare, one can clearly see the problems connected with these developments. Pessimists even prophesy that if we go on in this same way, the human race will only live for another two or three generations and then will disappear like so many other living creatures which have disappeared from the earth because they could not adapt themselves to changing living conditions. I strongly believe, however, that our ingenuity and technology can be put to work to meet these threats, once we want to see clearly the signs ahead of us and show our will to act accordingly and, especially in the rich countries, reduce our aims for ever better and more goods. The steel industry, to speak more specifically, has because of its size and impacts on the economy a major role to play in this. We all can contribute to this and one way of doing so is by pointing out continuously the problems and challenges ahead of us in international conferences and by information exchange.

Traditionally the steel industry has shown a very intensive exchange of information, which does not easily find its parallel in other industries. It is my feeling that this is a most important feature which has promoted substantially the technical developments in this field and at the same time has greatly contributed to personal friendships and ties all over the world. This is not only of great value in our mutual appreciation and world-wide understanding of each others positions, but I feel it can also be of immense value in finding solutions to the challenges ahead of us, which we are all facing, maybe in different degrees and priorities.

It is my personal conviction that the learned societies like The Iron and Steel Institute of Japan and also The Metals Society and many other societies can

be highly instrumental in achieving this; and therefore, I attribute great value to every activity of these Institutes to promote international information exchange. I sincerely hope that the 1980's will be a decade in which this is further developed and pro-

moted to the benefit not only of the steel industries, but more so of the people working in it and the world as a whole, which will need steel for many centuries to come.