Long Term Trends in the Production and Consumption of Ferro Alloy Metals

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Mr. Chairman, ladies and gentleman may I begin by thanking the organising committee of ABRAFE for this opportunity to address such a distinguished audience in this very beautifyl city of Rio de Janeiro, to which this is my first visit.

The ferro-alloy metals are almost by definition inextricably involved in the fate of the steel industry although their role elsewhere is of considerable importance, and indeed in some instances of growing importance. Turning first however to the subject of production and specifically to the statistics of mine output it is clear that for the major ferro-alloy metals the last ten years have been a period of erratic output and such growth as has occurred has been at a substantially slower rate than in the previous decade. This is not in any way unusual and reflects the general slowing down in the world's economy over this period which is generally attributed to the first of the oil price increase in 1973.

I do not intend to make my talk a recital of statistics, some of which are in the appendix to the printed version of my speech, and many of which are in any case familiar to you as part of every day work. Instead I hope to highlight the more unusual features of the data and the outstanding changes that have taken place in the industry over the past decade or so which are evident from the numbers.

Before looking at the fate of the ferro-alloys themselves it might perhaps be helpful to establish some bench marks regarding the overall progress of the steel industry, for this is, or should be, the main impetus behind the demand for many of the ferro-alloy metals.

Steel together with all of the older non-ferrous metals, and indeed some of the newer ones also, is now very much a defender of markets against the incursions of newer materials, particularly plastics and latterly even ceramics. This is reflected in progress over the last decade where production of steel has grown hardly at all compared to some growth in the world industrial production. It is presently unlikely that any european statesman in the last quarter of this century would comment as Bismark did in the last quarter of the nineteenth century, that the issues of the future would be determined by "Blood and Iron". Indeed it seems that whereas even thirty years ago the United States would have viewed the loss of supremacy in steel production to both Japan and the Soviet Union as a matter of grave concern, today it views this with comparative indifference, and it is the Japanese challenge in fifth generation computers that the United States seems to fear most.

Turning again to the ferro-alloy metals themselves, the most dependant of these on the fortunes of the steel industry is of course manganese, and it is noticable although hardly surprising that total world mine output declined over the period 1975-1984.

Western world production fell by nearly a third between 1975 and 1983, although there was some increase in output in 1984 and again last year. Five countries Australia, Gabon, India, Brazil and South Africa account for over 90% of western world output, and since the production of the first four has been maintained at broadly the same level over the period since 1975, it is South African output which has declined the most markedly from nearly 6 million tons in 1975 to just over 3 million tons in 1984. Manganese ore is one of the few minerals for which some reliable production information is available for the Soviet Union, and it is interesting to note that production has increased fairly steadily over the decade to the point where the Soviet Union alone now accounts for over half the total world manganese ore output. There is probably no other metal where Russian dominance is quite so large, although manganese has much in common with quite a number of other metals, where Russian and South African production together account for a sizeable and indeed dominant part of total world output. This is the case for manganese, chromium and vanadium amongst the ferro-alloys and for most of the precious metals.

MANGANESE
World Mine Production

THOUSAND METRIC TONS

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
EUROPE										
Austria	73.8	70.6	64.7	51.4	59.0	58.1	55.9	61.5	65.3	67.1
Greece	8.3	8.2	8.9	7.0	5.7	5.6	5.5	5.0[e]	5.0	5.0[e]
Italy	–	4.5	9.3	9.7	9.8	9.2	8.8	8.7	9.0	9.0[e]
Yugoslavia	13.3	19.0	24.8	27.4	30.2	30.0	31.0	27.4	25.0	25.0[e]
Total	95.4	102.3	107.7	95.5	104.7	102.9	101.2	102.6	104.3	106.1
AFRICA										
Egypt	3.6	4.1	3.6	0.2	–	–	–	–	–	–
Gabon	1 122.0	1 096.5	928.2	863.9	1 175.6	1 089.4	786.9	756.8	946.9	1 081.0
Ghana	415.3	316.9	292.4	316.7	253.8	249.9	223.1	159.9	197.3	248.0
Morocco	52.5	52.5	62.5	68.0	68.0	52.5	50.0	48.3	73.5	56.8
South Africa	5 881.0	5 503.0	5 290.0	4 425.0	5 209.0	5 700.0	5 032.0	5 216.5	2 886.0	3 049.4
Sudan	–	0.5	0.5	0.5	0.5	0.4	–	–	–	–
Zaire	308.5	182.2	150.0[e]	100.0[e]	..	..	30.8	4.0	–	–
Total	7 782.9	7 155.7	6 727.2	5 774.3	6 706.9	7 092.2	6 122.8	6 185.5	4 103.7	4 435.2
ASIA										
India	1 300.0	1 500.0	1 500.0	1 619.0	1 771.0	1 692.0	1 526.0	1 468.0	1 260.0	1 097.0[p]
Indonesia	13.9	9.8	6.0	5.9	5.9	4.3	2.6	17.9	8.3	8.0[e]
Iran	36.0	40.0	40.0	30.0	20.0	20.0	20.0	20.0	20.0	20.0
Japan	42.5	38.7	32.9	28.7	23.2	19.1	21.0	19.9	20.0	20.0[e]
Malaysia	133.3	94.1	54.7	42.7	31.6	4.0	–	–	–	–
Pakistan	0.1	0.1	0.4	0.1	0.1	0.2	0.1	0.1	–	–
Philippines	–	4.8	8.9	1.5	1.7	1.2	1.2	0.7	0.7	–
South Korea	1.3	0.6	0.3	0.3	–	–	–	–	–	–
Thailand	24.1	50.1	76.9	72.1	35.3	54.3	10.9	7.7	6.7	7.0[e]
Turkey	9.9	0.5	2.9	–	26.2	10.4	1.2	0.6	0.3	3.0[e]
Total	1 561.1	1 738.7	1 723.0	1 800.3	1 915.0	1 805.5	1 583.0	1 534.9	1 316.0	1 155.0
AMERICA										
U.S.A.	17.2	28.1	24.5	34.4	28.1	20.9	21.8	–	–	–
Argentina	51.2	53.1	52.4	18.5	10.2	6.1	3.1	1.3	1.3	1.3[e]
Bolivia	1.2	12.3	8.6	0.9	10.9	0.9	0.9	–	–	–
Brazil	2 828.0	2 881.0	2 732.0	2 744.4	2 729.0	3 044.3	3 165.7	2 883.2	2 594.0	2 600.0[p]
Chile	20.0	24.4	18.0	23.2	25.0	27.7	25.6	16.1	26.1	26.2[e]
Mexico	154.2	163.2	175.2	188.3	177.4	161.0	208.3	183.1	133.0	177.0
Peru	2.0	2.2	..	..	..	..	..	..	–	–
Total	3 073.8	3 164.3	3 010.7	3 009.7	2 980.6	3 260.9	3 425.4	3 083.7	2 754.4	2 804.5
OCEANIA										
Australia	1 554.9	2 154.2	1 389.0	1 248.9	1 724.1	2 019.5	1 449.0	1 127.0	1 370.0	1 717.0
Vanuatu	46.5	35.1	23.0	20.7	10.6	–	–	–	–	–
Total	1 601.4	2 189.3	1 412.0	1 269.6	1 734.7	2 019.5	1 449.0	1 127.0	1 370.0	1 717.0
TOTAL	**14 114.6**	**14 350.3**	**12 980.6**	**11 949.4**	**13 441.9**	**14 281.0**	**12 681.4**	**12 033.7**	**9 648.4**	**10 217.8**
OTHER COUNTRIES										
Bulgaria	35.0	40.0	40.0	40.0	42.0	49.0	45.0	50.0	50.0	
Hungary	182.4	165.1	160.6	156.2	130.9	134.5	122.0	150.0	160.0	
U.S.S.R.	8 459.0	8 636.0	8 595.0	9 057.0	10 244.0	9 750.0	9 150.0	9 200.0	10 400.0	
China	1 000.0	1 000.0	1 100.0	1 300.0	1 500.0	1 600.0	1 600.0	1 600.0	1 600.0	
Total	9 676.4	9 841.1	9 895.6	10 553.2	11 916.9	11 533.5	10 917.0	11 000.0	12 210.0	
WORLD TOTAL	**23 791.0**	**24 191.4**	**22 876.2**	**22 502.6**	**25 358.8**	**25 814.5**	**23 598.4**	**23 033.7**	**21 858.4**	

This table shows the gross weight ores and concentrates produced.

Notes 1. Estimated

In the United States, and probably elsewhere, around 95% of total manganese output is, and has been for many years, consumed one way or another in the steel industry, and within this total nearly 80% is used in the production of ordinary carbon steel. It would be difficult to envisage any significant shift in the demand pattern for manganese in the short term which would effect this overwhelming dependence upon the steel industry. A major trend which has occurred however over the past two decades is in the increasing tendancy of the manganese ore producers to upgrade more of their output to ferro-manganese or silicio-manganese locally than hitherto, reflecting the desire of major exporting countries to increase the value added content of their raw materials. An aspiration which is characteristic of all raw material producers. In the United States the production of manganese ferro-alloys had declined by 1978 to only 30% of the level in 1960, whereas by the same year South Africa had become the world's biggest producer of manganese ferro-alloys. A similar trend was evident also in Brazil, Mexico, Australia and India. Infact exports of manganese ore as a percent of total production peaked at just over 50% in 1974. East/West trade has also undergone some changes over the past decade.

Trade between EEC and the Soviet Union which in 1970 was significant had by 1976 almost ceased and the Eastern Bloc, despite the high level of Soviet output, has now become overall a net importer of manganese ores.

As far as longer term consumption trends are concerned, it is generally felt that the continuing reduction in manganese use per unit of steel output is coming to an end. Even in the United States a relatively late convert to the wholesale continuous casting of steel, the US Bureau of Mines has estimated that from as early as 1987 there will be a constant intensity of manganese use. If this is so, then coupled to a rising demand for steel, manganese consumption should begin to move ahead at a comparable rate.

Although the production of chromium is not so heavily concentrated as that of mangenese, South Africa and the Soviet Union again account for the bulk of world output, and in the western world South Africa and Zimbabwe have born the brunt of the demand cycle. Elsewhere output in Brazil and Turkey has declined and only in New Caledonia, is output, although still small, growing at a reasonably rapid pace. In eastern europe, Albania has expanded production in recent years, and since this is one of their few commodities for which there is a market in the west, it is likely they will continue to do so if that is possible.

The fortunes of both chromium and nickel are linked very closely to that of the stainless steel industry and it might be helpful therefore at this point to look at the stainless steel industry over this period. For the ten years up to 1973 stainless steel production increased by an average of over 10% per annum, significantly in excess of the general growth in the world economy as a whole. Since then however there has

CHROMIUM
World Mine Production

THOUSAND METRIC TONS

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
EUROPE										
Finland	164.0	173.0	166.0	176.0	175.0	182.0	197.0	180.0	157.0	128.0
Greece	24.5	26.9	33.5	30.3	34.8	33.6	30.0	30.0[E]	30.0	30.0[E]
Yugoslavia	40.2	36.9	52.8	54.7	90.7	90.0	90.0	81.6	90.0	90.0[E]
Total..	228.7	236.8	252.3	261.0	300.5	305.6	317.0	291.6	277.0	248.0
AFRICA										
Egypt	0.1	0.1	0.1	0.1	–	–	–	–	–	–
Madagascar	194.0	211.0	165.0	119.0	128.0	146.5	99.7	100.0[E]	100.0	100.0[E]
South Africa	2 075.0	2 409.0	3 319.0	3 141.0	3 297.0	3 428.0	2 869.5	2 869.5	2 231.6	3 006.2
Sudan	7.8	10.9	17.3	20.6	19.1	23.0	25.5	25.0[E]	25.0	25.0[E]
Zimbabwe	875.7	863.9	677.3	477.8	541.8	553.5	536.1	431.6	431.4	465.0[P]
Total..	3 152.6	3 494.9	4 178.7	3 758.5	3 985.9	4 151.0	3 530.8	3 426.1	2 788.0	3 596.2
ASIA										
Cyprus	27.6	9.2	14.2	15.1	15.7	16.3	10.4	10.4	–	–
India	500.3	402.1	352.5	266.3	309.8	319.5	334.7	334.7	372.0	426.0[P]
Iran	172.4	159.7	233.1	197.8	136.1	81.6	29.9	30.0[E]	30.0	30.0[E]
Japan	7.6	7.3	5.9	2.9	3.9	4.4	3.5	3.5	3.5	3.5[E]
Pakistan	10.1	12.4	10.0	1.0	4.9	3.8	1.1	3.0	3.0	3.4[P]
Philippines	518.3	392.8	497.3	481.6	532.9	433.3	360.5	254.6	209.8	209.2
Thailand	0.2	–	0.5	0.1	–	–	–	–	–	–
Turkey	472.5	281.7	267.6	212.2	175.6	239.1	225.4	227.5	181.0	217.0
Total..	1 709.0	1 265.2	1 381.1	1 177.0	1 178.9	1 098.0	965.5	863.7	799.3	889.1
AMERICA										
Brazil	702.2	702.2	1 024.0	969.6	932.1	833.9	926.4	667.6	469.0	470.0[P]
Colombia	10.0	10.0	–	–	–	–	–	–	–	–
Total..	712.2	712.2	1 024.0	969.6	932.1	833.9	926.4	667.6	469.0	470.0
OCEANIA										
Australia	–	–	–	0.3	1.0	1.0	–	–	–	–
New Caledonia	1.1	1.1	8.3	8.2	12.4	2.2	2.7	133.5	209.4	224.2
Total..	1.1	1.1	8.3	8.5	13.4	3.2	2.7	133.5	209.4	224.2
TOTAL..	**5 803.6**	**5 710.2**	**6 844.4**	**6 174.6**	**6 410.8**	**6 391.7**	**5 742.4**	**5 382.5**	**4 542.7**	**5 427.5**
OTHER COUNTRIES										
Albania	780.0	795.0	880.0	990.0	1 016.0	1 080.0	1 140.0	1 200.0	1 230.0	
U.S.S.R.	1 950.0	2 120.0	2 200.0	3 300.0	3 200.0	3 400.0	3 300.0	3 400.0	3 400.0	
Viet Nam	..	9.0	13.0	13.0	14.0	15.0	15.0	15.0	15.0	
Cuba	32.0	32.0	20.0	30.0	30.0	30.0	30.0	30.0	30.0	
Total..	2 762.0	2 956.0	3 113.0	4 333.0	4 260.0	4 525.0	4 485.0	4 645.0	4 675.0	
WORLD TOTAL	**8 565.6**	**8 666.2**	**9 957.4**	**10 507.6**	**10 670.8**	**10 916.7**	**10 227.4**	**10 027.5**	**9 217.7**	

This table shows the production of chromite(Cr_2O_3) ores and concentrates.

been some slowing down in the growth in production of stainless steel, although over the period 1975-84 it still grw by a very respectable 6.5% per annum again well ahead of the growth of comparable industrial output. Given the increasing role of scrap however, especially as the earlier output of stainless steel is recycled, it is hardly surprising that this continuing relatively high growth in stainless steel production has not been reflected in an equivalent growth in the demand for nickel or chromium. Scrap is for all metals an important consideration, but unfortunately the information available is substantially less accurate than that of primary production and therefore its impact is difficult to identify. Nevertheless the International Iron and Steel Institute in a review of chromium in 1981 estimated that as much as 55% of the chromium going into stainless steel is derived from scrap. This is a very high proportion of total output and points to an extremely efficient recycling industry in this sector. For copper for example the equivalent ratio is about one third. A comparison of production and consumption of stainless steel over the period indicates that consumption has grown at a slightly faster rate than production. This is due infact to the increasing use of continuous casting making it possible to recover a significantly higher percentage of the ingot

Western World

Production of Stainless Steel

THOUSAND METRIC TONS

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
WESTERN EUROPE										
Austria	56	59	76	74	77	79	71	74	68	78
Belgium	107	106	94	101	147	123	114	113	133	149
Finland	–	9	33	57	80	91	87	109	123	158
France	419	497	572	538	613	594	509	529	544	646
Germany, F.R.	437	673	636	761	821	816	753	680	747	878
Italy	267	366	418	440	502	493	393	438	438	520
Spain	77	110	142	156	156	161	160	192	197	292
Sweden	419	418	325	360	418	379	330	329	372	441
United Kingdom	148	222	194	238	266	144	243	219	229	256
Total	1,930	2,460	2,490	2,725	3,080	2,880	2,660	2,683	2,851	3,418
Japan[1]	1,571	2,097	2,062	1,978	2,190	2,217	1,862	2,121	2,230	2,595
U.S.A.	1,008	1,528	1,696	1,763	1,913	1,537	1,583	1,119	1,591	1,608
Other Countries[2]	149	196	212	247	237	252	269	245	300	400
TOTAL	**4,658**	**6,281**	**6,460**	**6,713**	**7,420**	**6,886**	**6,374**	**6,168**	**6,972**	**8,021**

Notes (1) HR production converted on an 80% basis 1975–78 and 85% basis 1979-84. Figures revised to include heat-resisting steels.
(2) The other countries (and estimate for 1984) are: Australia (20), Argentina (10), Brazil (100), Canada (30), India (125), Mexico (5), South Africa (70), South Korea (10), Taiwan (10) and Yugoslavia (20).

Consumption of Stainless Steel

THOUSAND METRIC TONS

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
WESTERN EUROPE										
Austria	18	22	22	23	29	33	23	28	42	42
Belgium	20	26	30	26	33	33	30	30	31	40
Finland	15	21	20	22	38	55	42	46	50	53
France	216	276	258	256	283	292	249	266	253	276
Germany, F.R.	328	419	412	579	498	548	493	474	516	671
Italy	185	250	298	269	353	398	306	330	288	386
Spain	67	90	103	81	106	100	103	117	107	107
Sweden	57	63	52	53	67	63	57	61	64	72
United Kingdom	99	154	144	146	168	115	138	130	170	195
Other Europe	242	269	259	218	280	233	205	223	239	296
Total	1,247	1,590	1,598	1,673	1,855	1,870	1,646	1,705	1,760	2,138
Japan	717	830	829	841	1,064	1,074	957	1,070	1,171	1,270
U.S.A.	769	1,053	1,138	1,232	1,347	1,124	1,196	972	1,181	1,355
Other Countries	542	672	730	614	744	682	696	628	908	967
TOTAL	**3,275**	**4,145**	**4,295**	**4,360**	**5,010**	**4,750**	**4,495**	**4,375**	**5,020**	**5,730**

Note The basis upon which this table has been calculated is explained in the introductory section.

as useable semis than was previously the case, and therefore the amount of new recycled scrap has paradoxically declined over the period, although and it must be assumed therefore that old scrap has grown in importance.

Elsewhere consumption of chromium is concentrated into chemicals, plating and refractory uses all of which have enjoyed either slow or no growth over the period under review and are likely to continue to do so. The prospect of tin-free steel using chromium as an alternative to tin plating has made comparativerly little impact so far, and with the likelihood now of a much lower tin price for the foreseeable future and relatively unlimited supply, there seems no reason why there should be any substantial switch to tin-free steel, particularly as the production of chromium is highly dependant on countries whose political systems are somewhat unfashionable.

As has been noted, nickel is another metal whose fortunes are also closely linked to the stainless steel industry. The period since the high nickel prices of the early 1970's has been one of almost unrelieved gloom for the nickel industry. The fast growth in consumption, particularly in the stainless steel industry, during the early post war era, coupled to the low energy prices available encouraged the development of the lateritic ore bodies to produce ferro-nickel or nickel oxide sinter, class 2 material, rather than the more intensive development of the tradicional sulphide ore bodies, which had hitherto been used to produce mainly nickel metal. The result of this policy, in which most of the

NICKEL

THOUSAND METRIC TONS World Smelter—Refinery Production

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
EUROPE										
Austria	–	–	–	–	–	0.5	1.0	2.0	2.0	2.0
Finland	6.5	7.6	9.4	7.5	11.5	12.8	13.3	12.6	14.8	15.3
France	10.9	11.8	10.5	8.1	2.6	9.8	10.1	7.4	4.9	4.9
Greece	14.8	16.5	9.6	14.9	14.6	13.9	10.9	5.0	12.9	18.8
Norway	37.1	32.7	38.2	23.7	30.7	36.9	37.1	25.8	28.6	35.5
United Kingdom	37.3	33.1	23.2	21.4	18.9	19.3	25.4	6.9	23.2	22.3
Yugoslavia	–	–	–	–	–	–	–	1.5	1.0	1.0
Total..	106.6	101.7	90.9	75.6	78.3	93.2	97.8	61.2	87.4	99.8
AFRICA										
South Africa	14.0	17.0	17.2	15.0	20.4	18.1	17.2	17.3	18.4	18.4
Zimbabwe	9.0	14.6	16.7	15.7	14.6	15.1	12.4	14.6	13.0	10.0
Total..	23.0	31.6	33.9	30.7	35.0	33.2	29.6	31.9	31.4	28.4
ASIA										
Indonesia	–	3.6	4.9	4.4	4.0	4.4	4.7	5.0	4.3	4.3
Japan	78.0	94.8	93.9	79.2	105.9	109.3	93.6	87.3	82.3	86.3
Philippines	9.4	14.3	19.3	18.7	17.9	22.7	19.4	10.2	8.5	1.9
Total..	87.4	112.7	118.1	102.3	127.8	136.4	117.7	102.5	95.1	92.5
AMERICA										
Canada	157.8	168.2	152.0	104.1	91.6	145.3	110.5	65.3	96.3	99.6
U.S.A.	19.9	30.8	34.4	33.8	40.1	40.1	44.3	40.8	30.7	30.7
Brazil	2.3	2.1	2.5	2.2	2.5	2.5	2.3	4.8	10.7	12.7
Colombia	–	–	–	–	–	–	–	1.5	13.1	16.6
Dominican Republic	26.9	24.4	24.9	14.3	25.1	16.4	19.0	5.6	20.2	22.4
Total..	206.9	225.5	213.8	154.4	159.3	204.3	176.1	118.0	171.0	182.0
AUSTRALASIA										
Australia	32.9	39.9	34.1	37.3	39.3	35.3	42.5	45.9	41.8	38.7
New Caledonia	52.8	38.2	28.3	19.9	30.4	32.6	28.0	28.0	21.7	29.2
Total..	85.7	78.1	62.4	57.2	69.7	67.9	70.5	73.9	63.5	67.9
TOTAL..	**509.6**	**549.6**	**519.1**	**420.2**	**470.1**	**535.0**	**491.7**	**387.5**	**448.4**	**470.6**
OTHER COUNTRIES										
Albania	–	–	3.7	4.0	4.5	4.5	4.5	4.5	4.5	
Czechoslovakia	–	3.5	4.0	4.0	3.0	1.8	1.6	1.5	3.0	
German D.R.	2.6	2.8	2.8	3.0	3.0	3.0	2.8	3.0	3.0	
Poland	2.5	2.2	2.2	2.1	2.0	1.8	1.5	0.7	0.3	
U.S.S.R.	143.0	151.0	155.0	160.0	160.0	165.0	170.0	190.0	192.0	
Cuba	18.5	18.4	18.6	18.3	19.1	20.0	20.9	21.0	21.0	
China	–	9.0	10.0	10.0	11.0	11.0	12.0	12.5	13.5	
Other	7.5	–	–	–	–	0.6	–	–	–	
Total..	174.1	186.9	196.3	201.4	202.6	207.7	213.3	233.2	237.3	
WORLD TOTAL	**683.7**	**736.5**	**715.4**	**621.6**	**672.7**	**742.7**	**705.0**	**620.7**	**685.7**	

This table includes production of smelter products such as ferro nickel and nickel oxides as well as fully refined nickel.

Notes 1. Excludes nickel oxide from April 1983

major nickel companies participated, led to a substancial increase in capacity in the early seventies, a great deal of which became uneconomic after the oil price increase in 1973, and some of which has subsequently been closed in meantime. Output of nickel in the form of refined nickel, ferro-nickel and nickel oxide sinter has grown only very slowly over the period and, apart from the new capacity coming on stream in Brazil, output is now generally concentrated in the traditional producing areas. As far as the steel industry is concerned the bulk of nickel produced is consumed in stainless steel and special steels both of which have enjoyed reasonably fast growth rates throughout the period, but although it is difficult to pin numbers on the effect of secondary recovery, as has already been noted that there has been a growing use of scrap by the stainless steel industry, which in turn has depressed the demand for new metal.

The emergence of new nickel producers has of course meant that the once dominant position of Inco has been further eroded so that by their own estimate they controlled less than 30% of the market in 1982, compared with over 40% a decade earlier. Again this increasing diversity of supply has added to the difficulty of maintaining a producer price at a time of falling demand, and the nickel prices quoted by Inco throughout much of the period were significantly discounted by other producers, leading in fact to the unprecedented move by this company of dropping their producer price quotation altogether for a short period beginning in July 1977. This in turn created the climate for a terminal market for nickel, which the London Metal Exchange contract for nickel metal has filled successfully. Trading began in 1980 and seems now to be an established feature of the non-ferrous metal markets.

Molybdenum is also a metal for which the steel industry is the major market. Here however the last ten years have seen quite a dramatic change in the fortunes of the metal itself and in particular of the principle producers. It is possible that had the price of copper been more attractive over this period the copper producers would have paid less attention to molybdenum than

MOLYBDENUM
World Mine Production

THOUSAND METRIC TONS

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
ASIA										
Japan	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1
Philippines	–	–	–	0.1	0.1	0.1	0.1	0.1	–	–
South Korea	0.1	0.1	0.1	0.2	0.2	0.3	0.5	0.4	0.1	–
Turkey	–	–	–	–	–	0.1	0.1	0.1	0.1	–
Total..	0.2	0.2	0.2	0.4	0.5	0.7	0.9	0.7	0.3	0.1
AMERICA										
Canada	13.0	14.5	15.6	14.3	10.2	15.2	16.8	14.3	9.7	10.8
U.S.A.	48.1	51.4	55.5	59.8	65.3	68.4	63.5	38.3	12.6	46.9
Chile	9.1	10.9	10.9	13.2	13.6	13.7	15.4	20.0	15.3	16.9
Mexico	–	–	–	–	0.1	0.5	0.5	5.2	5.9	4.1
Peru	0.7	0.5	0.6	0.7	1.2	2.7	2.6	2.9	2.6	3.1
Total..	70.9	77.3	82.6	88.0	90.4	100.5	98.8	80.7	46.1	81.8
OCEANIA										
Australia	–	–	–	–	–	0.1	0.1	0.1	0.1	–
TOTAL..	**71.1**	**77.5**	**82.8**	**88.4**	**90.9**	**101.3**	**99.8**	**81.5**	**46.5**	**81.9**
OTHER COUNTRIES										
Bulgaria	..	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	
Mongolia	..	..	..	0.2	0.2	0.5	0.7	0.7	0.7	
U.S.S.R.	9.1	9.3	9.7	9.9	10.2	10.4	10.7	11.0	11.0	
China	..	1.5	1.5	2.0	2.0	2.0	2.0	2.0	2.0	
Other	..	..	..	..	..	..	..	..	..	
Total..	9.1	11.0	11.4	12.3	12.6	13.1	13.6	13.9	13.9	
WORLD TOTAL	**80.2**	**88.5**	**94.2**	**100.7**	**103.5**	**114.4**	**113.4**	**95.4**	**60.4**	

This table shows the recoverable molybdenum content of ores and concentrates produced.

was the case. Nevertheless it is clear that even in this situation the production of molybdenum as a by-product of copper mining would have grown substantially over this period, to the point where it posed a significant threat to the primary molybdenum mining industry in the United States. As a by-product of course the costs of producing molybdenum from the major porphry copper deposits in the Andies and in Mexico are substantially lower than the Climax operations in Colorado, although it is generally assumed that output from the latter command a premium price in the marketplace due to low level of impurities. In the period upto 1975 the United States and in particular the Climax operations of Amax were the biggest producers of molybdenum and indeed accounted for well in excess of 60% of global production. From then onwards however US production although peaking at a level of 68,000 tons in 1980 has accounted for significantly smaller share of total output and we reached the almost unprecedented situation in 1983 when Chilean output was for the first time ahead of that of the United States. In 1984 this situation was reversed, but Chilean production remains substantial, and if their copper output grows according to plan, and experience suggests that it will, and molybdenum continues to be available in the ore as a useful by-product, then Chilean molybdenum production will almost certainly exceed 25,000 tons per annum in the fairly near future. Although there has been a dramatic shift in production within the American continent, so far, very little molybdenum has been produced elsewhere in the western world, although recently the new Sar Chesmeh mine in Iran has also featured molybdenum as a by-product. The collapse of the dominant Climax position in molybdenum took place very much more rapidly than the comparable although earlier, demise of Inco as the overwhelming nickel producers, and in both cases the industry has now been left without a firm price maker and indeed without the marketing leadership that both companies provided for so many years. This leadership meant that substantial sums were spent on developing new markets and new uses for both nickel and molybdenum, in contrast to some of the other non-ferrous metals, where the ownership of both producing and consuming companies was sufficiently diverse to make it impossible for one company alone to justify any substantial expenditure in this area, much of which would inevitably benefit rival producers. Without this leadership it seems reasonable to suppose that the growth in consumption of both metals may be slower in the future than would otherwise have been the case.

At first sight this does not seem to be the case for tungsten where production is wide spread. Nevertheless if we were to characterise China as a single producer, and given the central control of production within the Chinese economy, this is a reasonable inference, then the Chinese have certainly been the dominant influence in the tungsten market in the past two decades. Although accurate figures are not available, using chinese exports as a guide, it seems very likely that they account for at least a third of world output. Soviet production is also significant but estimates indicate that it has remained at about 10,000 tons per annum for quite sometime. Elsewhere production is widely spread and no country accounts for more than 15% of total western world output. Small quantities of tungsten ore produced as a by-product and about 10% as a co-product, usually of tin mining, which until the collapse of the International Tin Council Buffer Stock last year had been a bouyant industry. If as is expected tin output is cut back sharply there will presumably be a further decline in tungsten output in addition to that created by the closure latterly of a number of small operations particularly in Canada and the United States. Since there appear to be no obvious new end-use which will stimulate growth and lead to an expansion in output for this metal, western world production at least is likely to continue to decline.

The demand for the tungsten is influenced increasingly by factors outside of the steel industry and consumption as an alloy metal,

TUNGSTEN
World Mine Production

METRIC TONS

	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
EUROPE										
Austria	–	541	1 116	1 179	1 496	1 495	1 162	1 335	1 408	1 400
France	619	904	933	868	500	577	591	727	832	625
Portugal	1 424	1 268	1 006	1 106	1 387	1 578	1 397	1 468	1 188	1 400
Spain	351	329	308	358	394	446	437	556	521	600
Sweden	143	194	199	381	319	327	365	349	365	388
United Kingdom	11	11	86	74	75	40	40	40	40	40
Total	2 548	3 247	3 648	3 966	4 171	4 463	3 992	4 475	4 354	4 453
AFRICA										
Namibia	8	10	169	169	185	169	169	–	–	–
Rwanda	391	654	663	566	580	538	281	324	231	300
Uganda	124	124	124	124	62	56	56	–	–	–
Zaire	271	272	193	167	127	72	136	136	120	120
Zimbabwe	43	29	136	147	125	102	103	41	38	40
Total	837	1 089	1 285	1 173	1 079	937	745	501	389	460
ASIA										
Burma	227	136	214	354	472	494	494	416	397	400
India	21	25	24	23	21	52	31	30	18	20
Japan	870	922	874	878	845	757	756	635	486	475
Malaysia	154	86	143	109	79	54	54	56	56	4
South Korea	2 441	2 628	2 786	2 601	2 569	2 571	2 643	2 234	2 294	3 193
Thailand	1 774	2 055	2 204	3 186	1 827	1 654	1 654	861	660	892
Turkey	–	10	11	8	147	111	105	83	62	104
Total	5 487	5 862	6 256	7 159	5 960	5 693	5 737	4 315	3 973	5 088
AMERICA										
Canada	1 172	1 719	1 614	2 289	1 627	3 178	1 994	2 403	893	3 432
U.S.A.	2 927	3 017	3 087	3 539	3 414	2 738	3 545	1 575	1 016	1 300
Argentina	98	106	79	110	67	40	57	21	41	80
Bolivia	2 126	2 509	2 435	2 463	2 464	2 662	2 735	2 534	2 046	2 590
Brazil	1 304	1 336	1 607	1 536	1 534	1 504	2 022	2 063	1 057	1 100
Mexico	314	266	216	265	285	211	69	99	90	90
Peru	659	669	596	659	638	583	521	654	730	747
Total	8 600	9 622	9 634	10 861	10 029	10 916	10 943	9 349	5 873	9 339
OCEANIA										
Australia	1 497	1 989	2 358	2 707	3 193	3 575	3 517	2 618	2 015	1 843
New Zealand	–	–	6	10	17	21	17	16	10	10
Total	1 497	1 989	2 364	2 717	3 210	3 596	3 534	2 634	2 025	1 853
TOTAL	**18 969**	**21 809**	**23 187**	**25 876**	**24 449**	**25 605**	**24 951**	**21 274**	**16 614**	**21 193**
OTHER COUNTRIES										
Czechoslovakia	80	80	80	80	80	80	80	80	80	
U.S.S.R.	9 040	9 040	9 280	9 600	9 800	9 800	10 000	10 150	10 150	
China [2]	11 340	16 257	10 785	14 433	16 891	16 177	21 283	8 872	8 872	
North Korea	2 460	2 460	2 460	2 460	2 460	2 460	2 460	2 460	2 460	
Total	22 920	27 837	22 605	26 573	29 231	28 517	33 823	21 562	21 562	
WORLD TOTAL	**41 889**	**49 646**	**45 792**	**52 449**	**53 680**	**54 122**	**58 774**	**42 836**	**38 176**	

This table shows the tungsten content of ores and concentrates produced.

Notes 1. Estimated 2. Exports only

although still important, accounts for only about one fifth of the total demand. More than half of all the consumption of tungsten is used as an hardening agent in the tungsten carbides. Given the relatively slow growth in the demand for metal in general the improved technology leading to less machining of parts it is not surprising that demand has been at best static, and is likely to remain so. A renewed growth in the use of tungsten carbides for either mining of drilling, or both, would stimulate demand, but this does not appear likely in the short term. Demand for tungsten in special steels and in superalloys is small and again unexciting as a prospect for growth.

Tungsten is the only one of the ferro-alloys which is presently the subject of an international study group, in this case under the auspices of the United Nations Commission for Trade and Development, UNCTAD. This body has not attempted to promote consumption of this metal nor to iron out price movements, although it has established a price indicator to which reference can be made in contracts and other commercial dealings. Tungsten prices are however some of the most volatile of all metal prices due in part to the unpredictability of the Chinese, but also to the absence of a terminal market creating a universally acknowledged pricing basis. With the demise of the International Tin Council Buffer Stock it seems

unlikely that there will be any further attempts to stablize commodity prices, at least for the moment. Manganese was also in the list of commodities in the original UNCTAD proposal for an integrated scheme of commodity price stabilisation, but this whole idea is now defunct. Plans are in hand however to establish a nickel study group, probably late in 1986, possibly in London, either with its own secretariat or possibly with a joint secretariat with the International Lead and Zinc Study Group. Such an organisation may have a very useful, albeit modest, role to play in improving the general understanding of the industry which in turn might make it less prone to repeating its past mistakes.

As has already been noted vanadium is another metal for which South Africa is the dominant producer, although the volumes involved are of course small. Production elsewhere is however significant and could perhaps be expanded if needs be, albeit at a cost. In the United States where output reached a peak in 1977, the steep decline in the demand for uranium has affected the output of by-product vanadium. Additional supplies could probably be recovered from petroleum residues and ashes however if required.

Apart from its use as a catalyst in the production of sulphuric acid , a most important process, but needing very little vanadium, the consumption of vanadium is almost wholly within the steel industry.

It does play an important role in a range of titanium alloys for aerospace uses, although the volume of vanadium involved is small.

Vanadium is not alone in looking to aerospace as a possible major consumption area. Many of the ferro-alloys are used, albeit in small quantities in special steels which are used in aerospace and also in various superalloy mixtures which are required particularly in aero-engines. This is an area where the ferro-alloy metals become infact strategic metals each with a role which makes substitution difficult if not impossible. The volumes however are small and competition from even more exotic alternatives including ceramics is fierce. There has however been considerable concern that, despite the low volumes involved, the concentration of production of these metals in the hands of relatively few producing countries may lead to periods of artificial shortages. It remains a possibility therefore that some further stockpiling of ferro-alloys may occur, but without this their economic future as far as some of the raw material producers are concerned, looks at best uncertain.

I am sorry to end with a rather subdued endorsement of the ferro-alloy metals but like the major non-ferrous metals, copper, lead, zind, etc. they need to develop substantial new volume uses if they are to be the centre of a profitable mining industry in the years to come.

May I conclude by noting that our host country Brazil is now one of the world's largest producers of most of these metals and as a generally low cost producer will I hope avoid some of the problems which have beset much of the industry. For much of the mining industry however this may not always be the case, and it is difficult to see prospects for genuinely profitable growth. Perhaps during the course of this congress we may hear of new developments which will vitiate this conclusion. I certainly hope so! Ladies and gentleman thank you again for your interest in my presentation this morning.