THE IRON AND STEEL INDUSTRY IN WARTIME JAPAN, 1931-1945

By

RICHARD LEE KRAUSE

Bachelor of Arts

East Central State College

Ada, Oklahoma

1968

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF ARTS
May, 1972

THE IRON AND STEEL INDUSTRY IN

WARTIME JAPAN, 1931-1945

Thesis Approved:

Sidney D. Brown
Thesis Adviser

Homer L. Knight

D D Durham
Dean of the Graduate College

ACKNOWLEDGMENTS

I would like to take this opportunity to express my appreciation for the assistance and guidance given me by Professor Sidney Brown, my thesis adviser. He was always available for counsel and encouragement. In addition, I would like to thank Dr. Douglas Hale for his careful reading of the text at all stages, which added greatly to its readability.

I would also like to thank the staff of the Oklahoma State University library for their help and time in researching this topic. In addition, I would like to thank Tulsa Junior College for their help and support in allowing me time to research and write this paper.

I would also like to thank Ann Smith for her typing excellence and advice.

Finally, I would like to express my sincere appreciation to my wife, Patsy, whose encouragement, understanding, and sacrifice made the preparation of this thesis possible and, indeed, worthwhile.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

Iron and steel have fundamental importance in industrial and military power. With steel production as a basic measure of industrial capacity to wage war, Japan's preparation for war manifested itself in the iron and steel industry in the early thirties when production increased each year and more than tripled in ten years, making Japan one of the ranking producers of the world.

How does one account for this tremendous growth rate in the Japanese iron and steel industry, when as a country, her basic supply of raw materials needed to produce iron and steel—iron ore, coke, and manganese—is very meager, if ranked on a world scale?

Ever since the Meiji Restoration, Japan had been conscious of her position as an industrial weakling and consequently had to look elsewhere for needed industrial materials. By the 1930's it was evident to the Japanese economists that Japan was going to have to expand her iron and steel industry in order to prepare for a war, probably with Russia.

In 1931 Japan invaded Manchuria. She did so for three reasons: first, the Army needed desperately to regain its position of superiority and prestige; secondly, Japan needed some place to relocate some of her extra population; and thirdly, there was a tremendous need for Manchuria's iron ore and coal. In 1937 the Kwantung Army invaded

North China. This time the major reason for invasion seemed economic: North China is one of the world's richest areas in high-grade iron ore and coking coal.

Beginning in 1937, Japan started to stockpile what she could of the seriously deficient metals, including steel (as ore and scrap), copper, lead, tin, zinc, and most of the ferro-alloys. By 1941 sizable amounts of iron ore and scrap iron had been acquired from abroad and shipped to Japan for storage. In 1937 ambitious programs were started on the continent to develop the iron and steel industries capacity to semi-process raw materials before shipping them to Japan. These programs fell far short of their goals, and because the finishing processes remained concentrated in Japan the usefulness of expanding mainland production was dependent upon its flow to the homeland.

Entering upon a war in December 1941, the leading Japanese strategists, misjuding both the character and the length of the fight ahead, felt that they could look upon Japan's industrial resources with some equanimity. Whereas in 1931, her production of steel had been 2,000,000 tons, Japan had a steel output in 1941 of more than 6,500,000 tons. The fact that by 1941 Japan would be able to produce at best no more than one-thirteenth of the quantities of steel which the United States was producing was considered, but apparently not very seriously.

The first successes seemed to have furnished the economic security and wealth which would place Japan out of the reach of her enemies. All Japan had to do was carry home the coal, iron and semi-processed material from Manchuria, the rich coking coal and iron ore from China, the equally good iron, manganese, chromite, and copper from the Philippines, and the other valuable metals and ferrous materials from Malaya,

the Celebes, the Netherland Indies, Burma, and Thailand. With the sea lanes being guarded by the Navy, and taking into account the distance from enemy bases, the transportation of these materials appeared an easy task.

But by 1942 the Allied blockade had gotten under way and soon began to take a heavy toll of Japanese merchant and transport vessels. In early 1943, realizing the necessity for concentrating her efforts, Japan decided to forego the raw materials of the southern areas and attempt instead full-scale mobilization of nearer minerals, notably coking coal from North China, and iron ore from the Yangtze Valley and Hainan Island.

As a result of U. S. submarine presence in the Yellow Sea and U. S. air forces operations up and down the Yangtze River and along the China coast, the Japanese heavy industries could not maintain their operations nor reach rated capacities. Some blast furnaces had to be shut down and stockpiles of scrap were used, because iron ore could not be parcelled out far enough. Resorting to drastic and difficult measures the steel industry utilized less desirable formulae in steel alloys, and the resultant steel product sometimes had to be re-smelted to reach specifications. Wooden ships were built to replace the steel ones because not enough steel was available.

The effects of these steel shortages soon ran through the whole economy, as each industry, for want of products from the steel industry, was able to produce less itself of what the others needed. Also, the use of poorer grade raw materials further compounded the difficulties and resulted in a qualitative decline in output. These factors further accented the effectiveness of the blockade.

By the end of the war the major heavy industries had been reduced to a state of near idleness. In mid-1945 the coal supply was only 56 percent of its wartime peak. Imports of coking coal from North China and Manchuria had been cut off. The supply of electrodes for the production of electric steel was almost gone because graphite from the mainland could no longer be brought in. Ingot steel production, which by mid-1945 had dropped to a rate of 2,900,000 tons per annum, compared to a 1943 peak of 7,800,000 tons, appeared certain to drop below 1,500,000 tons as the full effects of the shortages and damages to the industrial plants were felt in production.

The major cause of this appalling condition in the heavy industries was to the combined Allied attack on Japanese raw materials and their supply lines. As the Allied blockade had drawn tighter and tighter around Japan proper, access even to the nearby resources of Manchukuo, Korea and North China across the presumed inviolable Japan Sea had been attacked and all but stopped.

The cumulative effects of the Allied attack on shipping and the mining of ports were the predominant reasons for the poor condition of the Japanese heavy industries at the end of the war. One cannot improvise in these industries; bulk materials must move in unceasing volume, 24-hour-a-day operation is a necessity, and when the whole operation began to break down owing to a lack of raw materials, it is reflected in the war potential of Japan.

While the above factors are usually accepted to explain Japanese failure in the production of iron and steel during the war, I believe there are even more basic reasons for the industry's collapse.

Primarily these would be over-expansion in rated capacity without

commensurate expansion in actual production, and too much emphasis on homeland factories which produced only finished materials, while the raw materials were processed and sent over from the mainland. Japan proper had 59 percent of the pig iron capacity but 89 percent of the ingot capacity and 91 percent of the finished steel capacity, while the continent had 41 percent of the pig iron capacity but only 11 percent of the ingot and 9 percent of the finished steel capacity. From 1937 to 1941 the production of pig iron had expanded by more than 80 percent, but the output of ingot steel had expanded by only 17 percent and the production of finished steel was even less. Pig iron production in 1941 was 72 percent of capacity (about the same as 1937); meanwhile ingot steel production fell from 85 percent of capacity in 1937 to 64 percent in 1941. Consequently by the start of the Pacific War there was a rapidly growing excess capacity in the Japanese iron and steel industry. Even with this growing excess, capacity was further increased during the Pacific War. This was partially due to construction already underway and to Japanese optimism in the first year of the war. Coking capacity increased by 19 percent, pig iron capacity by 7 percent, ingot steel capacity by 27 percent, and rolling capacity by 7 percent.

The major thesis discussed in this paper is the failure of the Japanese iron and steel industry to supply adequately Japan's war machine from 1937 to 1945. Prior to the outbreak of the Pacific War in 1941 the iron and steel industry was in a relatively secure position, provided it could maintain its precarious raw material supply lines to the continent. The Japanese industry failed to maintain this supply, however, and by 1943 the iron and steel industry was in the position where it could not supply desperately needed steel for Japan's war-

making ability.

The multiple reasons for this failure will be discussed in the following chapter. The iron and steel industry in Japan from 1931 to 1945 is described and findings and conclusions will be presented. In Chapter II the physical expansion of the industry from 1931 through 1945 will be discussed, along with a description of the steel-making process used in Japanese steel mills. The ways and means that the Japanese steel industry used to supply raw materials needed for production, including imports from Manchuria, Korea, North China, and the United States, are presented in Chapter III. Also discussed in Chapter III is the significance of the role played by the Japanese government in the expansion of so vital an industry. Chapter IV concerns itself with causes and effects of the steel shortage in the iron and steel industry on the military machine and the civilian populace. Overall findings and conclusion drawn from them are presented in Chapter V.

CHAPTER II

THE DEVELOPMENT OF THE JAPANESE STEEL INDUSTRY, 1930-1945

Steel forms the skeletal framework of modern civilization. Without steel the whole range of power-generating and power-using industries would be virtually impossible. Modern buildings require great quantities of it, transportation is almost toally dependent on it, and communication also requires large amounts of steel and steel related products. No nation in the world can feel strong and safe in war or peace without an adequate supply of this material. Japan, therefore, could not hope to wage war successfully without an able iron and steel industry.

Iron, from whence comes steel, then, is clearly the one mineral that must be present in abundance within a country or within its economic control in order for that nation to be first in war or peace.

But what is iron, and how is it made into steel? Steel is an alloy of iron with carbon and various other elements present in small amounts. The percentage of iron (Fe) within the ore generally indicates which of the leading steel producers of the world have the richest iron ore deposits. Usually, ore has an iron content of anywhere from 25 percent

Fe to almost 75 percent.[1]

To make steel it is necessary to have three things---iron ore, coking coal, and limestone. These minerals should be located fairly close to each other and also near some means of transportation—railroads or shipping. Japan's steel industry has been dependent since its inception upon overseas supplies of raw ore and coking coal. Her domestic supply of iron ore accounted for only about 20-25 percent of steel produced during the 1931-1945 period. Japan has an abundant supply of coal, but it is not suitable for coking, and thus she must depend on imports. Domestic limestone, on the other hand, is in abundance. By contrast, the United States has an excellent domestic supply of rich iron ore and good coking coal as well as limestone.

Raw material came into Japan through port cities which were located close to the iron and steel industry. The major port cities were Kawasaki, Yokohama, Yokosuka, Kobe, Shimonoseki, Sasebo, Nagasaki, and Hakodate. From these ports of entry the raw ore was sent, via railroad, to the steel plants which had blast furnace[2] facilities.

---

[1]Japan's iron ore had an iron (Fe) content of 45 percent, which is very low if one compares it to an average Fe content of 65-70 percent in the United States.

[2]Blast furnace--a tall, cylindrical, refractory lined furnace for the production of pig iron, and consisting of five main parts: bottom, hearth, bosh, stack and top. A blast furnace may be as high as 90 feet and up to 20 feet in diameter (at the bosh). In operating the furnace, iron ore, coke and limestone are fed in at the top; as they descend through the furnace they are met by the ascending hot gases. This gas in contact with the coke forms carbon monoxide which in turn reduces the iron oxide of the ore to metallic iron, the limestone forming a slag with the earthy content of the ore. The molten iron and slag are collected at the bottom. A. K. Osborne, An Encyclopedia of the Iron and Steel Industry (London, Technical Press, Ltd, 1967), 39. Hereafter referred to as Encyclopedia of Iron and Steel.

The blast furnace is the major means for reducing the raw iron ore to molten iron or pig iron, which is then suitable for the steel furnace. The blast furnace is charged with specific amounts of iron ore, coking coal, limestone, and a stream of air under pressure to provide the oxygen necessary for combustion. The charge needed to make one ton[3] of pig iron is as follows: iron ore, 1.9 tons; coke, 0.9 tons, limestone, 0.4 tons; and air blast which amounts to 3.5 tons.

During th e period from 1931 to 1945, Japan's iron and steel industry expanded quite rapidly, both at home and abroad. In 1929 there were twenty-one blast furnaces in Japan, each with a daily capacity of 100 tons or more of pig iron; their total capacity amounted to 1,377,000 tons annually.[4] In the decade that followed, after the military takeover of Manchuria and the invasion of North China, the blast furnace capacity expanded rapidly. Between 1930 and 1936 there were fifteen stacks with a rated yearly capacity of 1,387,000 tons. By 1944 this rated yearly capacity was up to 6,515,250 tons. This tremendous growth was accomplished by erecting new furnaces or rebuilding the old ones.[5] Actual output during the period from 1931 to 1945 was not equal to rated capacity, however. Up until 1937 full capacity was realized, but afterwards blast furnace efficiency de-

---

[3]The metric ton of 2204 pounds is used throughout this paper.

[4]Elizabeth B. Schumpeter, et al, The Industrialization of Japan and Manchukuo, 1930-1940: Population, Raw Materials and Industry (New York, MacMillian Co., 1940), 666.

[5]United States National Military Establishment, Department of the Army, Iron and Steel Metallurgy of the Japanese Empire, prepared by Theodore L. Johnston. (Washington, Natural Resources Section, Supreme Command for the Allied Powers (SCAP), 1947), p. 15. To be found in microfilm section, Oklahoma State University. Hereafter referred to as SCAP Report, Japanese Iron and Steel.

creased as a result of over-expansion. This decrease in potential output related directly to the lack of raw materials, machinery and industrial technology.

By way of comparison, United States production of pig iron increased during this fifteen-year period to the extent that production exceeded rated capacity. During this period the United States produced 514 million tons of pig iron, compared to Japan's production of 37 million tons during the same time span.[6] At the end of World War II Japan proper had a total of thirty-six blast furnaces in operation. The United States, by 1946, had a total of eighty-six blast furnaces, one less than her total in 1937.[7]

Japan's blast furnace capacity expanded quite extensively, both at home and on the continent, during the early 1930's. In 1932 the Wanishi, Kamaishi, and Mitsubishi iron and steel plants reconstructed several of their blast furnaces and enlarged the output capacity of those three plants so as to produce an additional 77,000 tons of pig iron per annum. A year earlier, the Nippon Kokan (Japan Steel Tube Company) had installed a new 200-ton blast furnace. By September, 1933, the Yawata Works had installed a new 700-ton furnace in their plant located at the northeastern tip of the island of Kyushu. Also the Asano Shipyards had installed a new 200-ton blast furnace at their

---

[6]United Nations, Yearbook of Statistics 1948 (New York, Statistical Office of the United Nations, 1949), 236.

[7]United States Department of Commerce, Statistical Abstract of the United States 1944-1945, (Washington, D. C., 1945), No. 71, 809.

steel works located at Tsurumi.[8]

While most Japanese pig iron was produced in large blast furnaces, there were other means of making pig iron available to the Japanese. Among these other methods the most productive was the rotary kiln method. This technique utilized the Krupp-Renn[9] process which produced pellet-sized ores from soft limonite ores and iron beach sands.[10] As early as 1938 Japanese iron and steel producers were using the Krupp-Renn process, and by 1945 there were eight rotary kiln plants in Japan and one each in Korea and Manchuria. The basic operation of the rotary kiln consisted of charging it with a mixture of 100 parts iron ore, 55 parts anthracite coal,[11] and 10 parts limestone at the rate of three tons per hour. The charge passed through the kiln, and a reaction took place between the coal and iron ore which produced metallic iron and semi-fluid slag at a temperature of 1350° C. in the

---

[8] O. Tanin and E. Yohan, When Japan Goes to War, (New York, Vangard Press, 1936), 159-160.

[9] Krupp-Renn Process--a method of treating low grade ores in which finely divided iron ore is mixed with coke breeze and fed into the upper end of a slowly revolving kiln which is fitted with an annular barrier or stop-ring at the lower, or firing end, causing the depth of charge beneath the flame to be considerably increased. By this process the ore is reduced to pellets that grow in size as they pass down the kiln. The pellets are then suitable for re-melting in the open hearth, or they can be used to enrich the blast-furnace burden. Osborne, Encyclopedia of Iron and Steel, 238.

[10] Limonite--an iron ore consisting of hydrated ferric oxide. It is the main constituent of bog iron ore. (Ibid., 246). Iron beach sand--commonly called Iserine. A black sand which consists mainly of magnetic iron ore but also contains a considerable amount of titanium. (Ibid., 228.)

[11] Anthracite coal--hard coal which gives much heat and little smoke. Sometimes used in the place of coking coal which is made from bituminous coal.

discharge end of the kiln. This was then quenched with water, ground in a ball mill,[12] screened, and then magnetically treated to recover the iron pellets (Luppe) from the slag. The Luppe were melted with scrap iron and refined into steel in electric arc furnaces.[13] This method of iron production was expensive as to cost per metric ton, but the expense was somewhat mitigated by the recovery of valuable nickel and chromium found in this type of ore. In the period from 1939 to 1945 Japan produced 294,744 tons of Luppe by the Krupp-Renn rotary kiln method, with the most productive years being 1943 and 1944, during which output reached 80,634 tons and 97,712 tons, respectively.[14]

Another means of producing pig iron was the small blast furnace. These were of a 20-ton daily capacity and were built of simple materials. They were usually situated close to the iron mines and were erected in groups with hot stoves and beehive coke ovens in connection.[15] These minor plants were erected in Japan, Korea, Man-

---

[12]Ball mill—a mill in which material is finely ground by rotation in a steel drum with pebbles or steel balls. The grinding action is provided by the collision of the balls with one another and with the shell of the mill. Ibid., 27.

[13]Electric arc furnace--the furnace utilizes electrical heating in the form of an arc for providing and maintaining the required reaction temperature for the change--a function performed by coke in a normal blast furnace. This type of furnace is economical only where electricity is cheap and plentiful. Ibid., 134.

[14]SCAP Reports, Japanese Iron and Steel, 20, 50.

[15]Hot Blast Stoves—tall cylindrical refractory lined regenerative chambers filled with a checker work of refractory brick. They may be up to 125 feet in height, and are used for preheating the air for the blast furnace. Each blast furnace has at least two stoves, in one of which the refractory checker work is being heated by the burning gases coming from the top of the blast furnace, whilst the other is giving up the heat so derived to the incoming air blast. Osborne, Encyclopedia of Iron and Steel, 206.

churia, China, and Formosa. None of these compared with the output of the large blast furnaces, but their combined production of approximately 725,000 tons in five years (1940-1945) was significant. Plans were made to erect 197 small furnaces with a capacity of 1,000,000 tons pig iron per annum. 151 furnaces were constructed of which 113 operated and produced 110,000 tons of pig iron in 1943, 281,000 tons in 1944, and 12,000 tons in 1945. A breakdown of the number of small blast furnaces built by Japan is seen in the following table:

TABLE I

BREAKDOWN OF THE NUMBER OF SMALL BLAST FURNACES BUILT BY JAPAN

Location	Number of Furnaces			Production (tons)		
	Planned	Erected	Operating	1943	1944	1945
Japan	21	17	17	30,600	10,400	ND
Korea	80	59	39	31,471	95,133	12,562
Formosa	6	6	6	4,244	12,133	ND
Mongolia	17	14	8	7,407	16,687	ND
North China	53	43	35	33,268	138,272	ND
Central China	20	12	8	3,763	8,541	ND
Total	197	151	113	110,753	281,166	12,562

ND-No data available
Source-SCAP Report, Japanese Iron and Steel, 19.

Many difficulties were encountered in using these small furnaces. The major problems were shortage of raw materials, shortage of furnace technologists, too weak a blast, inadequate hot stoves, and the fact

that the anthracite coal from Korea failed as a substitute for coking coal.[16]

Two other methods were also used by the iron and steel industry to increase their supply of pig iron. These were brick kilns used to make sponge iron[17] and the high frequency electric method (Kikuchi). The Sagger method was employed in the operation of brick kilns. This is a process by which fine-sized ore is mixed with 6 percent lime, formed into cakes and placed in fire clay containers (Saggers) along with coal or coke. The containers were then placed in brick kilns and heated to 1250° C. for 24 to 30 hours. The metallic iron produced was used as melting stock for making steel or was combined with scrap iron to compensate for its low grade to make steel in electric furnaces. It has been estimated that only 10,000 tons of iron was made this way. By the high frequency electric method, a high frequency current is passed through a mixture of iron ore, coal, and limestone. This procedure produces pig iron in ten minutes. A low frequency method was also used, but production took thirty minutes. Though the yield of this method was small, it required but a limited investment. At the end of the war there were five plants in Japan using this method. Their output of pig iron was approximately 65,000 tons up to 1945.[18]

All in all these many and diverse methods of producing pig iron were not sufficient to keep up with Japan's growing capacity for making steel. As previously mentioned, output equaled capacity up until 1937,

---

[16] SCAP Reports, Japanese Iron and Steel, 18-19.

[17] Sponge iron--finely divided iron, obtained by the direct, low temperature reduction of iron ores. In this state, iron oxidizes readily. Osborne, Encyclopedia of Iron and Steel, 400.

[18] SCAP Reports, Japanese Iron and Steel, 20-21.

but afterwards output fell substantially behind. Even after 1937 and the apparent slowdown in output, Japan continued to increase her theoretical capacity rather than her actual production. Some stockpiling was ordered, but this resulted in the accumulation of steel rather than the materials used to make steel. Production of pig iron and coking coal in Manchuria, North China, and Korea was ordered, but it did little to alleviate Japan's desperate need for raw materials.

The Japanese iron and steel industry was more effective in its production of steel than it was in the production of pig iron. Steel production in Japan proper rose from 1.8 million tons in 1931 to 6.8 million tons in 1941 and by 1943 had reached 7.8 million tons.[19]

Steel is a malleable alloy of iron and carbon, the carbon content being generally less than 1.7 percent. It is produced in the fluid condition either by the crucible, Bessemer, open hearth, or electric furnace. Such steel is practically free from slag.[20] By far the greatest tonnage of steel is made in the basic open hearth. The Bessemer process had become almost obsolete so far as the United States and Japan were concerned, but the process was still used quite extensively on the Continent of Europe. The tonnages produced in electric arc and high frequency induction furnaces[21] were very small as compared with that of the open hearth, but since the highest quality high alloy steels were produced in these furnaces, their value was of far greater importance than the tonnage figures would suggest.

---

[19]Jerome B. Cohen, Japan's Economy in War and Reconstruction, (Minneapolis, University of Minnesota Press, 1949), 3.

[20]Osborne, Encyclopedia of Iron and Steel, 405.

[21]Electric furnace--a furnace whose heat is derived from electricity. The electric furnaces in most common use are the Heroult Electric Arc Furnace and the High Frequency Induction Furnace. Ibid., 133.

As mentioned previously, most of Japan's steel production, some 85 percent, was ordinary carbon steel, most of which was produced in basic open hearth furnaces. There was some minor production of carbon steel in the Bessemer converters. Japan had five of these, each with a 20-ton capacity, located at the Kawasaki plant of the Japan Steel Tube Company. The other 15 percent of steel produced was taken up by alloy steels, which is a type of steel to which some alloy--nickel or tungsten --has been deliberately added in order to give it special properties.[22]

Japan's steel industry prior to the 1930's was almost totally concentrated in the state-owned and operated Yawata Works[23] located on the northern tip of the island of Kyushu. Prior to the Manchurian Incident of 1931, this steel plant was responsible for the largest output of pig iron and ingot steel[24] and for a high proportion of the finished steel output.[25] The remainder of steel production was in the hands of a few great concerns associated with the zaibatsu.[26]

By comparison with world standards of steel production during the 1920's, Japan lagged far behind. Yawata, the largest plant in existence during the 1920's, had five blast furnaces with an aggregate

---

[22]SCAP Reports, Japanese Iron and Steel, 21, 23.

[23]Yawata Steel Works--the largest iron and steel plant in Japan. Founded in 1901, partially by the sale of government bonds. This plant recently (March, 1970) merged with the Fuji Iron and Steel Company to become the world's largest individual iron and steel company.

[24]Ingot steel--a mass of steel cast or poured into a bar or some other convenient shape. In Japan these ingots usually weighed 100 to 150 tons.

[25]G. C. Allen, A Short Economic History of Japan, 1867-1937, (London, George Allen and Unwin, Ltd., 1946), 122.

[26]The major zaibatsu (financial cliques) associated with the iron and steel industry during the 1920's and early 1930's were those of Sumitomo and Asano.

capacity of 400,000 tons and a steel plant with a 525,000 ton capacity. Other plants which contributed to steel output of Japan during the 1920's were the Kamaishi Iron and Steel Works, the Nippon, Sumitomo, Kokura, and the Mitsubishi works. The individual steel furnaces used in these plants were smaller than those used in the United States and were driven at a slower rate. Japan's 1926 steel production of 1,500,000 tons was smaller than even that of Luxemburg, which was credited with 2,192,700 tons.[27]

During the thirties there occurred a major expansion in the steel industry. In 1932, the Naval Arsenal at Kure installed a new 30-ton electric furnace. The following year, others joined the race for expansion; the Nippon Kokan (Japan Steel Tube Company) reconstructed their seven 25-ton open-hearth furnaces to raise output capacity to 30-tons each; the Sumitomo Seiko Company and the Nikkon Tokushu Company each installed a 15-ton electric furnace; the Asano Steel Works at Kokura installed a new 300-ton open-hearth furnace; and Yawata, the state-owned works, placed orders for new open hearth furnaces which would increase their output of steel by 900,000 tons per annum—an increase of 82 percent. The Yawata and Assano steel works placed orders for three large rolling mills[28] for the production of heavy

---

[27] H. Foster Bains, Ores and Industry in the Far East, (New York, Council on Foreign Relations, 1927), 101.

[28] Rolling Mills—consists essentially of two horizontal rolls, mounted one above the other, revolving at the same speed, but in opposite directions so that the metal is drawn between them, this operation not only working the material to the desired shape, but improving its mechanical properties. The action of rolling tends to separate the two rolls, but these are held in a fixed position by means of chocks, housings and housing adjusting screws, i.e. the screw down gear. The rolls may be made of steel or cast iron. Rolls vary in diameter from $\frac{1}{4}$ in. to over 4 ft. Osborne, Encyclopedia of Iron and Steel, 356-57.

rails from the Krupp industries of Germany.[29]

By the end of the war Japan proper had 193 open-hearth furnaces with a rated capacity of 7,426,000 tons. Her annual effective capacity was calculated at 680 heats[30] per annum. This represents quite a large expansion, since in 1931 and 1933, when Japan's capacity for steel output stood at 2.9 million tons and 2.1 million tons, respectively, actual output was 1.9 million tons and 2.7 million tons. During this period of the early thirties, the Japanese iron and steel industry operated 109 furnaces.[31]

The size of these early furnaces ranged from units with 10-ton capacity to tilting furnaces with a 200-ton per heat capacity. The Japan Iron Manufacturing Company, with its four large plants, was the largest steel producer in the Japanese Empire. It controlled 67 furnaces and accounted for over 50 percent of total Japanese capacity.

The open-hearth method remained by far the most efficient method for making steel. The process used was very similar to that used in the United States. Scrap is charged to the furnace, followed by an equal amount of hot pig iron from the nearby blast furnace. The refining takes about six hours, during which time ore and fluxes[32] are added until the desired specifications are reached. When this is

---

[29] O. Tanin, When Japan Goes to War, 159-60.

[30] Heat--(a) The steelmelting operation from the charging of raw materials, to the tapping of the molten metal. (b) The batch of steel produced by a single melting operation. Osborne, Encyclopedia of Iron and Steel, 197.

[31] O. Tanin, When Japan Goes to War, 166.

[32] Flux--lime, limestone or fluorspar (calcium fluoride ore) used in the manufacture of steel for the production of a fusible slag and to adjust its fluidity. Osborne, Encyclopedia of Iron and Steel, 166.

finished, the molten metal is tapped into ladles and then teemed[33] into ingot molds.[34] When molten pig iron is not available, cold pig is charged with the scrap, thus prolonging the time of refining. The large steel plants use coke oven gas for heating the hearth, while the smaller plants used producer gas.

While the open-hearth was responsible for the major portion of Japan's steel output during the 1931-45 period, some steel was produced by using Bessemer Converters (Thomas-Gilchrist Process). The Kawasaki plant of the Japan Steel Tube Company, with their five 20-ton basic Bessemer converters, was the only steel plant in Japan to utilize this method of production. There were three converters at Yawata belonging to the Japan Iron Manufacturing Company until they were dismantled in 1940.[35]

The Bessemer converter is a large pear-shaped vessel set on trunnions so that it can rotate through a half circle (180^{o}). The vessel is lined with a rammed mixture of dolomite and tar. Numerous small tuyeres, or nozzles, pass through the bottom or one side and provide means of blowing air into the converter. The operation of the converter consists of charging the converter with molten pig iron and then blowing air under pressure into it. The O_2 (oxygen) in the

---

[33]Teeming--discharging molten steel from the ladle into ingot molds. Ibid., 422.

[34]SCAP Reports, Japan's Iron and Steel, 22. A typical example of steel from open-hearths shows the following specifications; C (carbon), 0.11 percent; Mn (Manganese), 0.4 percent; S (sulphur), 0.034 percent; P (phosphorous), 0.024 percent; and Si (silicon), 0.21 percent. Slag from the same operation shows SiO_2 (silicone dioxide), 12.1 percent; P_2O_5 (phosphorus pentaoxide), 3.24 percent; Fe (iron), 16.4 percent; Fe_2O_3 (ferric oxide), 6.3 percent; Al_2O_3 (alluminum trioxide), 1.1 percent; MnO (manganese oxide), 4.4 percent; CaO (calcium oxide), 45.0 percent; and MgO (mangnesium oxide), 8.9 percent.

[35]Ibid., 23.

in-blown air oxidizes the carbon, manganese, phosphorous, and silicon in the pig iron and in doing so generates extreme heat. The basic lining of the converter as well as the added limestone serve to slag the oxidized elements. This blowing operation requires about 15 minutes time, and the burning condition of each element is detected by the color of the flame escaping through the pour-off spout. The molten steel and slag are then poured off. The steel from the process is soft and is used for wire, thin plates, and forgings. The slag is chilled, weathered, ground to fine powder, treated magnetically to remove iron, and then bagged and marketed as fertilizer.[36]

Electric furnaces were also utilized in the Japanese steel industry. They were used mainly to make high-grade alloy steel. These furnaces were installed in different small plants, resulting in 350 companies owning 91 plants which contained 441 electric furnaces. The Heroult Arc,[37] a tilting furnace, was the most common and was used in sizes ranging from 1 to 20-tons capacity. The use of this type furnace in the Japanese steel industry expanded quite rapidly in the decade prior to 1945. In 1935 less than four percent of the total steel production was credited to electric furnaces. By 1940, it had reached 12.4 percent and in 1945, 31.4 percent. The total capacity of all electric furnaces was estimated at 2,000,000 tons in 1945, but again,

---

[36] Ibid.

[37] Heroult Electric Arc Furnace—a direct arc furnace having three electrodes, one phase of a three-phase current being brought to each electrode. The current travels from electrode to electrode through the medium of arcs made with the bath. All electric steel melting furnaces are made to tilt. In a top-charged arc melting furnace, the whole charge can be placed at one time by means of a drop bottom basket. Osborne, Encyclopedia of Iron and Steel, 200-201.

due to lack of raw materials, actual output did not come up to capacity. Actual production in the period from 1926-1945 reached only 9,247,000 tons, or about 50 percent of capacity.[38]

The other type plant which is necessary to the steel industry is the rolling mill.[39] Japan had all types of rolling mills which enabled her to produce practically any size of products, from thin sheets to heavy armor plate for battleships, and from piano wire to heavy rails, structures, and tubes. Japan could build these different type rolling mills, but, prior to 1941 foreign equipment, chiefly from the United States and Germany, was imported in order to take advantage of cheaper costs and to promote more rapid expansion. Generally these rolling mills, of which there are many different types, were built in an assembly line fashion. The steel slab coming from the rolling mill was passed into a blooming mill, which was followed by a billet, rail, heavy structure, bar, rod, plate, and sheet mill.[40] All these mills were equipped with hot saws, shears, hot beds, reheating

---

[38] SCAP Reports, Japanese Iron and Steel, 24.

[39] See footnote number 28.

[40] Blooming mill—a rolling mill used in reducing steel ingots to blooms, which is a square slab more than 5 in. square. Billet mill—same as bloom except smaller sizes are called billets. Rail mill—makes tracts for flanged wheel rolling stock. Heavy structure mill—used to make I and H beams, T and Z bars, etc. Bar mill—produces round, square or other sections of bars. Rod mill—produces metal rods. Plate and sheet mills—produce flat pieces of steel usually starting at 1/4 in. and at 1/8 in., respectively. Osborne, Encyclopedia of Iron and Steel, 41, 339, 412, 28, 354, and 321.

furnaces, and inspection tables.[41] From this semifinished stage the steel products went to subsidiary companies, which were located close to the steel plants, and emerged from them as the finished product.[42]

Major Iron and Steel Plants in Japan

A survey of the individual iron and steel plants of Japan, their equipment, and rates of expansion during the period considered should aid in presenting a more detailed picture than the bare statistics cited above. The iron and steel industry's expansion on the continent will be taken up in the following chapter dealing specifically with Manchuria, North China, and Korea.

The backbone of the Japanese iron and steel industry was composed of two major companies, the Japan Iron and Steel Company, Ltd. and the Japan Steel Tube Company. The former, with its four main plants located at Yawata, Hirohata, Kamaishi, and Muroran, and the two plants of the Japan Steel Tube Company at Kawasaki and Tsurumi, produced the major portion of Japan's pig iron and steel, as is seen in the following table:

---

[41] Hot saws--circular saws used to cut steel to length immediately after hot rolling. Shears (Guillotine)--a machine consisting essentially of two blades arranged parallel to one another, with their faces in approximately the same vertical plane and normal to the horizontal axis of the piece to be cut. Hot beds--large enclosed area containing closely spaced rolls or rails for holding hot, partially rolled metal. Reheating Furnaces--a furnace for reheating ingots prior to hot working. Ibid., 207, 378, 206, and 345.

[42] SCAP Reports, Japanese Iron and Steel, 24, 40.

TABLE II

MAJOR IRON AND STEEL PLANTS BY COMPANIES
(1000 metric tons)

Company	Pig iron		Steel	
	Capacity	% of total	Capacity	% of total
Japan Iron & Steel	4,644	72.2	3,900	52.7
Japan Steel Tube	1,098	17.1	984	13.0
Others	688	10.7	2,583	34.3
Total	6,430	100.0	7,557	100.0

Source: SCAP Reports, Japanese Iron and Steel, 48.

The Yawata plant, located on the northeastern tip of the island of Kyushu, is still the outstanding iron and steel producer in Japan. This plant started as a small iron foundry built under the auspices of the Japanese government in 1880.[43] The major plant was constructed in 1901.[44] By 1945 it had equipment which was capable of producing 1/3 of the total output of iron and steel in Japan. The works of Yawata consisted of three communities, Higashida, Fukuoka, and Tobata. These three contained 12 blast furnaces, 46 open-hearth furnaces, 13

[43]In March 1970 the Yawata Company merged with the Fuji Steel Company to form the Nippon Steel Corporation, the largest steel company in the world. In the last quarter of 1969, Nippon Steel Corporation placed first in world production of crude steel with 8,310,000 tons, leaving behind U.S. Steel Corporation at 7,870,000 tons. It now seems likely that Nippon Steel Corporation will place first in crude steel production in 1970. Oriental Economist, Vol. 38, No. 714 (April, 1970), 38.

[44]This is the same year the United States Steel Corporation (U.S.S.) was founded by J. P. Morgan, John D. Rockefeller and Andrew Carnegie with a capitalization of over $1,000,000,000.

electric furnaces, 7 blooming mills, and 21 miscellaneous rolling mills, including the only heavy rail mill in Japan. The Yawata works produced all types of steel, using the open-hearth furnace as the primary producer. The annual capacity for the works was rated at 2,485,000 tons of open-hearth production. Steel ingot production for 1931 amounted to 928,000 tons and reached a peak in 1939 with an output of 2,367,000 tons. During the war yearly output averaged 2,147,000 tons for the period 1941-1944.[45]

The Hirohata plant, located near Osaka and Kobe on the island of Honshu, constituted the newest and most modern of steel plants in Japan. Built during the years from 1937 through 1940, this plant was designed to produce large, heavy plate. Their equipment consisted of two 1000-ton blast furnaces, six 150-ton open-hearth tilting furnaces, and the largest continuous plate mill in Japan. The principal products were heavy armor and ship plate. They also supplied pig iron to the small steel plants in the Osaka-Kobe districts. Annual open-hearth capacity at the Hirohata works was 600,000 tons. Actual output during the period from 1941 through 1944 came to 1,145,000 tons of steel ingots. An annual peak of 427,000 tons was reached in 1943.[46]

The Kamaishi steel plant is located on the northeast coast of Honshu in close proximity to the Kamaishi iron ore mines. This is another of Japan's pioneer iron and steel plants, having started production in 1880 in the form of a small foundry and furnace. This

---

[45] SCAP Reports, Japanese Iron and Steel, 21, 51.

[46] Ibid.

plant received direct government help as did the Yawata plant. During the thirties and early forties, Kamaishi expanded into a large integrated steel plant consisting of three blast furnaces, ranging from 350-tons to 700-tons in size, ten open-hearth furnaces (four of which were tilting), three electric furnaces, one blooming mill, six rolling mills, and other miscellaneous equipment. Principal products were pig iron and semifinished steel. Total open-hearth capacity came to about 587,000 tons. Gross output for 1931-1945 amounted to 3,771,000 tons of steel ingots, with a peak yearly production of 416,000 tons in 1943.[47]

The Wanishi plant located at Muroran on the island of Hokkaido is the last of the major plants belonging to the Japan Iron and Steel Company. This plant receives most of its iron ore from the rich Kuchan mines 50 miles to the northwest. The Wanishi plant was started in 1909 and was partially capitalized with British capital. Equipment consists of seven blast furnaces, five open-hearth tilting type furnaces, one blooming mill, one continuous bar mill, and one wire rod mill. Due to Wanishi's proximity to the Kuchan mines, pig iron was produced in excess of steel needs. The surplus pig iron was sold to the Japan Steel Works which also had a plant in Muroran. Major production at Wanishi was taken up with pig iron, billets, wire rod, and wire. The plant, with its five open-hearth furnaces, had an aggregate yearly rated capacity of 500,000 tons. Production figures are available only for 1941-1944, and the total steel ingot production for these four years comes to but 539,000 tons, with the peak year

---

[47] Ibid.

being 1943, in which 260,000 tons were produced.[48]

The Japan Steel Tube Company had a large plant located at Kawasaki and a smaller unit at Tsurumi, both of which were conveniently situated near Yokohama. The original Kawasaki Iron and Steel Works was started in 1913 at Kawasaki. In 1934 it was one of the six companies that merged with the State's Yawata works to form the amalgamation known as the Nippon Seitetsu Kaisha (Japan Iron Manufacturing Company).[49] Principal equipment at Kawasaki consisted of five blast furnaces, thirteen open-hearth furnaces, five Bessemer converters, one blooming mill, three tube mills, one sheet bar mill, and three small rolling mills with a 400,000 ton capacity. Tsurumi has two blast furnaces, eight open-hearths, one slab and plate mill, and three plate and sheet mills. Principal products at Kawasaki were seamless tubes and pipes of all sizes, bars, rods, and fertilizers. Tsurumi produced plates and sheets of all sizes. Total rated capacity for these two plants was 708,000 tons per annum. Production for 1931-1945 was 8,838,000 tons of steel ingots. The high year for each plant was 1943 (Kawasaki-714,000 tons) and 1938 (Tsurumi-238,000 tons).[50]

Sumitomo Metal Company is the most important of the minor steel companies because of its amount and type of production. The company had two plants located in Osaka and Wakayama. They purchased pig iron and scrap and made all types of steel in open-hearth and electric

---

[48]Ibid.

[49]Cohen, Japan's Economy in War and Reconstruction, 26.

[50]SCAP Reports, Japanese Iron and Steel, 21, 50, 51.

furnaces. Principal products were forgings and castings of specialty steel products.[51]

Steel-making capacity in the Japanese Empire had expanded tremendously in the ten year period from 1931 to 1941. Pig iron capacity was 8.5 million tons per annum and ingot steel capacity was rated at 11.5 million tons.[52] By 1944 these figures had risen to 10.5 million tons capacity for pig iron and 15.2 million tons capacity for ingot steel. To attain this production Japan would have to be independently rich in coking coal and iron ore. She was not. In order to achieve production equal to her rated capacity Japan had to expand her economic empire. This she did, starting as far back as 1905, but the most rapid expansion took place following the 1931 invasion of Manchuria. This invasion had three major goals: (1) to allow the Japanese Army to regain its prestige and authority, (2) to expand and increase Japan's supply of raw materials, and, (3) to provide an area for colonization. To quote Hiroshi Saito, Ambassador to the United States in 1935, Manchuria was to be Japan's "life line".[53] This rapid expansion in raw materials took place primarily in three countries: Manchuria, North China, and Korea.

---

[51] Ibid.

[52] U. S. Strategic Bombing Survey No. 36, Coals and Metals in Japan's War Economy, (Washington, D.C., 1947), 65. Hereafter USSBS No. 36.

[53] Hiroshi Saito, Japan's Policies and Purposes, Selections from Recent Addresses and Writings, (Boston, Marshall Jones Company, 1935).

CHAPTER III

WHERE DID JAPAN EXPECT TO GET STEEL?

The Home Islands of Japan are not naturally endowed with abundant raw material resources necessary for the production of iron and steel. Despite a potential reserve of iron ore estimated at 55,000,000 tons, the actual production under normal conditions does not exceed 1,000,000 tons per annum, in part because of the dispersion of resources and partly to the poor quality of the ore.[1] Japan also had comparatively large deposits of coal, but its output contained very little of the high-grade coking coal required for the manufacture of iron and steel. Consequently it was necessary to produce the proper coking coal required for blast furnaces by blending imported coal with the Japanese coal. With the above shortcomings taken into account, Japan's iron and steel industry had developed since its very inception in full recognition of its dependence on the supply of raw materials from abroad. Because of this dependence, all the major iron and steel works were built close to the waterfront and equipped with large wharves and various other facilities for loading and unloading raw materials.

From 1931 to 1941 Japan's iron and steel industry imported most of its supplies of iron ore and coking coal from the Continent

---

[1]Oyoshi Ashizawa, "Iron and Steel Industry Reconstructed," Contemporary Japan, XXIV (December, 1956), 276-277.

(Manchuria, North and Central China), the Malay Peninsula, and areas of the Netherlands Indies, in addition to vitally needed scrap iron from the United States. The supplying countries which merit further discussion are Manchuria, North China, Korea, and the United States.

Imports: United States

The United States was important to Japan in the pre-war period primarily because she supplied most of Japan's scrap iron and oil. Scrap iron is a universal raw material for the entire iron and steel industry. To make open-hearth, carbon, or soft steel (as it is variously called) the charge of raw materials is usually about 50 percent scrap and 50 percent pig iron.[2] Prior to 1941, the Japanese used a ratio of 45 percent scrap to 55 percent pig. In 1937, of the scrap iron and steel consumed, 55 percent was imported, mostly from the United States.[3] In 1937, Japan imported 2,420,000 tons of scrap iron.[4] Prior to the war, in 1939, the United States figured as the largest supplier of the six most important war materials needed by Japan. (See Table III). As early as 1936 the Japanese government ordered the different steel plants to accumulate stockpiles in iron ore, scrap, and pig iron above what was needed for normal requirements. In 1939, scrap iron and steel stockpiles reached a peak of 5,791,000 tons, but because of the heavy demand by the Japanese iron and steel industries, the stockpiles of scrap materials fell to a four-months'

---

[2]Edwin C. Barringer, The Story of Scrap, (Washington, D.C., Institute of Scrap Iron and Steel, Inc., 1954), 4.

[3]USSBS #36, 62.

[4]Ibid., 93.

reserve by the end of 1941.[5] By the end of the war in 1945, the Japanese had a scrap reserve of only 308,000 tons.[6] Following the cutoff of scrap imports from the United States in 1940, Japan was forced to look elsewhere for scrap and other needed war supplies.

TABLE III

SHIPMENTS TO JAPAN, 1939: PERCENTAGES FROM THE UNITED STATES

Petroleum & products. . .	66.2	Ferro-alloyw.	98.5
Iron and Steel scrap . .	91.0	Metal-working machinery . .	70.2
Copper	92.1	Automobiles & parts	76.9

Source: Tsuru, Essays, 189.

Imports: Manchuria

Prior to and during the Pacific war Japan relied heavily upon imports from countries that had fallen to her during her drive for overseas expansion. According to Dempster, this expansionist policy was prompted largely by three objectives: (1) the need for food and food supplies, (2) the raw materials requirements of Japan's industrial development, and (3) the fulfillment of the Army's ambition for

---

[5] In 1938-1941, the industry used 1,623,000 tons of scrap.

[6] Cohen, Japan's Economy in War, 118. The United States mistakenly thought the Japanese reserve of scrap was 10,000,000 tons by 1942. Iron Age, 149, No. 4, (January 22, 1942), 73.

political power.[7] Most notable of the regions on which Japan depended for imports were Manchuria, North China, Korea, and Karafuto.[8]

Manchuria was to be developed into an economic lifeline. Its principal resources of iron ore, coking coal, and soy beans were essential to maintain the Japanese industry and economy. The Japanese had been in Manchuria since 1905 through their interests in the South Manchuria Railway (SMR).[9] In 1931, the Kwantung Army felt compelled to march into Manchuria and take over the country completely. They wanted this area in order to set up a continental base of military and industrial operations which would be free of the homeland industrial combines, the zaibatsu.

The principal source of iron ore in Manchuria was the province of Liaoning in southeastern Manchuria. The main processing plant for the ore was built at Anshan, about fifty miles south of Mukden. Thirty miles east of Anshan was another area of importance to the industry, that of Penhsihu.[10] Together these areas comprised the center of the iron and steel industry in Manchuria. There were extremely large reserves of low-grade ore and some fair reserves of high-grade ore, as revealed in the following table:

---

[7]Prue Dempster, Japan Advances, A Geographical Study, (London, Methuen & Co., Ltd., 1967), 179.

[8]The southern half of Sakhalin Island.

[9]Harold M. Vinacke, A History of the Far East in Modern Times, (New York, Appleton-Century-Crofts & Company, 1950), 531.

[10]Honkeiko is the Japanese name for Penhsihu.

TABLE IV

RESERVES OF LOW-GRADE ORE AND HIGH-GRADE ORE - MANCHURIA

Location	Lean ore (35% Fe) (metric tons)	Rich ore (50% Fe) (metric tons)
Anshan	4,000,000,000	49,000,000
Penhsihu	450,000,000	10,000,000
Total	4,450,000,000	59,000,000

Source: SCAP Reports, Japan's Iron and Steel, 34.

About half of the low-grade ore had to be beneficiated[11] before being used in the blast furnaces.[12]

The Kwantung Army had originally attempted to exploit these reserves on its own, but by 1933, beset by technical, administrative, and supply problems, it was ready to admit that it needed financial and industrial aid from the zaibatsu in order to make Manchuria pay off. Between 1932 and mid-1937 there was some increase in the chemical and mineral production, but not enough to entice the big zaibatsu--Mitsui, Mitsubishi, Sumitomo, and Yasuda—to invest their

[11]Beneficiation—any treatment by which the raw materials, iron oxides (ore), etc., coke and limestone are rendered more suitable for use in the blast furnaces. Beneficiating consists of drying, crushing, screening, and washing. Hard ores must be crushed, fine ores must be sintered, large lumps excluded, and lean ores concentrated to a standard iron content. Sintering is a method of converting fine ores into porous clinker or nodules, somewhat similar to the Krupp process. H. P. Tiemann, Iron and Steel (New York, 1933), 48-49.

[12]SCAP Reports, Japan's Iron and Steel, 34.

money. The main advances during this period were the laying down of foundations for future expansion.

Most notable of these were the building of new railways and highways, improvements made in harbors and navigable rivers, new exploration for mineral resources, and the founding of new companies to produce gold, coal, iron, aluminum and synthetic oil. This development was entrusted at first to the South Manchuria Railway Company and the Manchukuo government.[13] Half the money, some 400 million yen, was supplied by the Japanese government. The railway company, in conjunction with the Manchukuo government, established a number of companies designed for the express purpose of economic development. This operation took place in 1933.[14] By 1936, Japanese capital invested in Manchuria amounted to 1.2 billion yen,[15] but Japan had failed to recognize any material gain from their investment primarily because the rigid military control of the country did not allow the zaibatsu to expand within Manchuria.

Initially, the control of Manchukuo fell to the General Affairs Board, the policy determining agency within the Manchukuoan State Council, which was dominated by the Japanese military. The ten administrative posts of the Manchukuo government were held by Chinese. Under these puppet administrators lay the real power positions filled

---

[13]The title given to the puppet government in Manchuria.

[14]Schumpeter, Industrialization of Manchukuo, 376.

[15]After the U.S. dollar depreciated in 1933-34 the value of the yen was equal to about 30 cents as against its 1930 value of 50 cents in terms of U. S. gold dollars. (Cohen, Japan's Economy in War, 5.)

by the Japanese.[16] These men were supposed to be officers of the Manchukuoan government, but in fact took their orders from Japan. From 1932 on, all these various authorities were brought under one head, the Kwantung Army Commander-in-Chief. By this action the army gained the power in Manchuria that it lacked in Japan.[17]

By 1937 the homeland government was disappointed with the Manchurian results. Finance Minister Takahashi felt that "the nation should not continue large military expenditures and capital exports to Manchukuo."[18] Only after the outbreak of war with China in July, 1937, did the Kwantung Army and the Japanese home government begin to feel that Manchurian war materials should be available in large amounts to feed the then growing war industries. Schumpeter further states that the

> ...final phase of transition from a system of rigid state control anti-capitalist in its outlook, to one which welcomed private capital and gave it unusual opportunities for profit was the formation of the Manchuria Industrial Development Company in December of 1937.[19]

---

[16]Pu-Yi testified at the Tokyo war crimes trials that on paper, in order to fool the people of the world, Manchukuo was made to look like an independent state but in fact it was administered by the Kwantung Army. Nominally there were Ministers and Vice-Ministers in charge of the various departments of the government. Practically every one of the Vice-Ministers was a Japanese. Ministers were Chinese. On the surface the Chinese were put in charge, but underneath the Japanese ran the show. There was a Fourth Section in the Kwantung Army in control of Manchurian affairs. All ordinances and enactments would be proffered by the Vice-Ministers who were all Japanese, and then all had to be approved by the Kwantung Army. Cohen, Japan's Economy in War, 38.

[17]Vinacke, History of the Far East, 522-23.

[18]Schumpeter, Industrialization of Manchukuo, 390.

[19]Ibid., 394.

Prior to the formation of this company in 1937, most Japanese industry was largely confined to Japan Proper. It was mostly composed of the "big four" zaibatsu families; Mitsui, Mitsubishi, Sumitomo, and Yasuda. These four families virtually controlled the industry, banking, and commerce of Japan Proper, and they were not interested in overseas expansion. The early overseas expansion was left to the younger financial groups such as Nissan, Noguchi, and Mori. The Nissan group under Aikawa Yoshisuke[20] was responsible for the early industrial development of Manchuria.[21]

In 1937 the Army worked out an agreement with Aikawa to develop the Manchuria Industrial Development Company ("Mangyo" for "Manshu Jukogyo Kaihatsu KK") into which his own Nissan Company was changed. Mangyo was established December 27, 1937, and was to begin operations on March 1, 1938. Aikawa became president and acted as such until December, 1942. This gigantic holding company was capitalized at 450 million yen (397 million paid-up) and was specifically designed to deal with development and management of the coal, iron and steel, light metal, automobile, and airplane industries. The capital was divided between the Manchukuo government backed by Japan and Nissan Industries. By the end of 1941 the Company had controlling interest in 32 companies. Some of these companies were already in existence, such as the Showa Steel Works, Penhsihu Colliery and Iron Works, Manchuria Light Metals,

---

[20]Aikawa Yoshisuke—a graduate of the Engineering College of the Tokyo Imperial University in 1903. Also studied in the United States. The president of Nippon Sangyo K.K., Nissan Motorcar Company, Hitachi Electric Power Company, and Chairman of the Nippon Mining Company, Hitachi Ltd., Osaka Iron Works, and the Nippon Colliery Company.

[21]Schumpeter, Industrialization of Manchukuo, 374.

and Dowa Automobile Company.[22]

The Manchukuo government, in an attempt to get more capital from the "big four" zaibatsu, guaranteed a return of 6 percent on capital invested. By 1940 the Company was earning 13.6 percent on capital and 10 percent dividends were being paid on non-government shares. Despite these lucrative inducements, the older financial and industrial combines held back, probably from their inherent fear of an Army-dominated economy.[23]

The five-year development plan was announced in 1937; it was to cover the years 1938 through 1942. Its scope is shown in Table V. Pig iron capacity was to be more than tripled, ingot-steel capacity increased by 125 percent and finished-steel by 85 percent.

TABLE V

FIVE-YEAR PLAN FOR THE EXPANSION OF CAPACITY OF THE JAPANESE IRON AND STEEL INDUSTRY, FISCAL YEARS 1938-1942
(IN MILLIONS OF METRIC TONS)

	1942 capacity goal				Planned Increase over 1937 capacity(in percent)			
	Japan Korea	Man-chukuo	China	Total	Japan Korea	Man-chukuo	China	Total
Pig iron	7.7	4.8	1.0	13.5	114	500	—	307
Ingot steel	12.7	3.6	.6	16.9	84	500	—	125
Finished steel	11.2	1.8	.5	13.5	62	350	—	85

Source: USSBS No. 36, 64.

[22]Cohen, Japan's Economy in War, 38-39.

[23]Ibid., 40.

The great increase in pig iron production as seen in the above table was due to the substitution of pig iron for scrap. The established prewar practice of using a high ratio of scrap to pig iron had made the Japanese steel industry quite dependent upon potential enemies such as the United States.

It was expected that the success of this Five-Year-Plan would provide Japan with a mainland industrial base from which the military could further expand. It has been suggested that the invasion of North China in July, 1937, was a part of the five-year program, since North China's iron, coal, and other resources would be needed to develop the program.[24] Some evidence to substantiate the validity of this theory exists in the form of a series of documents which indicate that as far back as 1934 the Japanese were taking detailed inventories of China's resources and determining the best method of exploitation.[25] The documents show that there was a close alliance between the Army and the South Manchurian Railway Company first in cataloguing and taking inventory of North China's resources and later in planning for their exploitation.[26]

While some gains were made from the first Five-Year Plan, it had to be revised in 1938 due to increased fighting in North China and to

---

[24]Kate L. Mitchell, Japan's Industrial Strength, (Institute of Pacific Relations, New York, 1942), 109.

[25]T. K. Hoo, "Some Economic Documents Relating to the Genesis of the Japanese-Sponsored Regime in North China", in the Far Eastern Quarterly, VI (November, 1946), 66.

[26]The earliest document was dated October 25, 1934, and was an outline of an economic investigation of North China prepared for the Army by the Committee on Economic Research of the South Manchuria Railway Company. It was entitled Hokushi Keizai Chosa Yoko Ansha, by Mantetsu Keizai Chosakai. Ibid., 67.

the fact that Japan could no longer afford to dump money into Manchukuo for purposes of self-sufficiency.[27] Accordingly the goals of the Five-Year Plan were revised upwards, and emphasis was shifted to the production of pig iron and steel, coal, and light metals and away from the goal of self-sufficiency. The original plan called for a production of 6,600,000 tons of iron ore, 2,400,000 tons of pig iron and 2,500,000 tons of steel ingots. The revised goals were 12,000,000 tons of iron ore, 4,860,000 tons of pig iron, 3,500,000 tons of steel ingots, and, a new entry, 2,000,000 tons of finished steel.[28]

What progress then did Japan make toward reaching these goals during the Five-Year Plan? An answer requires examination of the coal, iron, and steel sectors of the plan in turn. The original Five-Year Plan for Manchuria called for coal production and export, as follows:

Year	Production (1000 tons)	Exports (1000 tons)
1937	15,686	4,800
1938	18,046	5,440
1939	20,836	7,160
1940	23,373	6,250
1941	26,945	6,800

Source: Mitchell, Japan's Industrial Strength, 116.

As seen by the above figures, Japan had high expectations for coal production in Manchukuo. The actual production figures were considerably lower. In 1938 for example, production reached only 15 million tons. Exports for the same year were 2.9 million tons rather than the 5.4 million tons called for in the Five-Year Plan. The reasons for this drop in coal production and exports to Japan are two:

---

[27] In 1939 Manchukuo bonds and debentures floated in the Japanese capital market amounted to 59 percent of the Japanese bonds issued. Cohen, Japan's Economy in War, 41.

[28] Schumpeter, Industrialization of Manchukuo, 388.

the lack of labor, because of a cut in overhead and subsequently in hiring, and the fact that Manchukuo had a coal shortage.[29]

Concerning production of pig iron and steel in 1937, Manchukuo produced 762,000 tons of pig iron and 427,000 tons of steel ingots, from which 370,000 tons of steel products were manufactured. In 1939 the Showa Steel Works had brought their capacity up to 1.7 million tons of pig iron and 590,000 tons of steel. By 1942, they had planned the production of 3.6 million tons of pig iron. A pig iron capacity of 2 million tons was expected for 1941 by the Penhsihu Iron Works. The Tungpientao Development Company, whose reserves were estimated at 100 million tons of high-grade ore (60-65 percent Fe), planned to produce 1.5 million tons of iron ore and 1.3 million tons of coal by 1941.[30] None of these expectations were met, however, primarily owing to a lack of sufficient labor, shortages of material and equipment, and the failure of moneyed interests to put their capital into Manchukuo.[31]

The center of the iron and steel industry in Manchuria were the two plants located at Anshan and Penhsihu. The Anshan Iron and Steel Works was first established as a project of the Japanese South Manchurian Railway Company following the discovery of ore deposits by the geological staff of the railway in 1909. During World War I, a

---

[29]Cohen, Japan's Economy in War, 41.

[30]Mitchell, Japan's Industrial Strength, 117-118.

[31]Between 1937 and 1941, Japanese capital investment in Manchuria amounted to 3.4 billion yen. By the end of 1941 the Japanese had invested 7.2 billion yen in Manchuria in an attempt to transform an agricultural land into an industrial arsenal. Cohen, Japan's Economy in War, 41.

"partner-ship company" [sic] known as the Shinko Tekko Mugen Koshi was organized in 1916 on the basis of an annex to the 1915 Sino-Japanese agreement which granted Japan the right to mine iron ore in the Anshan area. In April 1919, the first blast furnace of the Anshan works was blown in, and until 1933 only pig iron was produced at Anshan.[32]

In 1933 this iron and steel works was detached from the South Manchurian Railway and became the Showa Steel and Iron Works, Ltd.[33] It was also in 1933 that production of pig iron approached Japanese planned capacity. This was partially attained through the use of American engineers and American equipment. From 1930 to 1937 the blast furnaces in Manchuria contributed 97 percent of the total pig iron produced in all of China. Peak production at Anshan came in 1943, and this was equal to 80 percent of the pig iron produced at Yawata in the same year. Thereafter, production decreased due to a combination of causes: excessive military demands, shortages of coking coal and manganese, lack of spare parts and repair materials, insufficient numbers of both skilled and unskilled workmen, the dispersal of industrial plants, air raids, and shortage and decrease in quality of iron ore.[34]

---

[32]Wu, Yuan-li, The Steel Industry in Communist China, (New York: F. A. Praeger, 1965), 19.

[33]In April, 1941, the Showa Steel and Iron Works, the Hon Keiko Iron Works, and the To Hon-do Development Company were consolidated under the name Manchukuo Iron Manufacturing Company. This amalgamation facilitated the concentration of work, a full supply of raw materials, and proper allotment of labor under the diligent superintendence of its technical experts. Nippon Times, July 12, 1945, p. 2.

[34]SCAP Reports, Japan's Iron and Steel, 35-56.

Iron ore for the Anshan blast furnaces came from mines 10 to 30 miles east and southeast of Anshan. The ore was mined by open cuts and the underground method, crushed to four inches, and screened at the mines. From the mines the ores went to the plant for one of the following treatments: (1) high-grade lump ore to the blast furnace storage bins; (2) high-grade fines to sintering and briquetting plants; (3) low-grade lump ore to beneficiating plants followed by sintering[35] and briquetting; and (4) low-grade fines to Luppe plants.[36]

The coal and coke for the Anshan plant came from the mines at Fushun, Penhsihu, and Pei Piao. After 1937 North China supplied large amounts of coking coal. At Anshan coke was made in four coke ovens of 17 batteries containing 216 Koppers cells and 216 Otto cells. By-products of the coke ovens were crude benzol, sulfuric acid, ammonium sulfate, and tar.[37] The coke oven gas was also used for heating.[38]

Pig iron was produced at Anshan through the use of nine blast furnaces or stacks having a rated yearly capacity of 1,989,250 tons output. The following shows the number, type, and output of the blast furnaces at Anshan.

---

[35]Sintering--is a method of converting fine ores into porous clinker or nodules, somewhat similar to the Krupp process. H. P. Tieman, Iron and Steel, (New York, 1933), 48-49.

[36]SCAP Reports, Japan's Iron and Steel, 36.

[37]Furthering of the benzol yields naphtha, motor benzol, xylol, pure toluol for TNT, and pure benzol for dye-stuffs and explosives. Distilled from coal tar were raw anthracene, raw naphthalene, pitch, and creosote.

[38]SCAP Reports, Japan's Iron and Steel, 38.

Blast Furnace	Year built	Daily capacity in tons
No. 1 and 2, German type	1919	2 @ 400 = 800
No. 3, American type	1930	1 @ 550 = 550
No. 4, German type	1937	1 @ 600 = 600
No. 5, 6, 7, 8, German type	1938	4 @ 700 = 2800
No. 9, German type	1943	1 @ 700 = 700

Source: SCAP Reports, Japan's Iron and Steel, 39.

Peak production year for pig iron was 1943, with 1,325,000 tons being produced. This represents 66.6 percent of rated capacity. Fifty-nine percent of the pig iron was sent directly to the open-hearths in a molten state, while 41 percent was cast and shipped to Japan. In the five year period from 1940 to 1944 Anshan produced a total of 5,561,000 tons of pig iron. Of this amount, 3,086,000 tons were used for steel while the rest, 2,475,000 tons, were exported to Japan. Most of the ore at Anshan had to be treated before going to the blast furnace. This treatment consisted of sintering, briquetting or lumping.[39]

The steel works of Anshan were two open-hearth plants located north and west of the blast furnaces. In the No. I steel plant, equipment consisted of one 600-ton mixer, three 300-ton tilting active mixers, four 100-ton and two 150-ton tilting basic open-hearth furnaces. In the No. 2 plant equipment consisted of two 600-ton mixers, four 300-ton tilting active mixers, and six 150-ton tilting basic open-hearth furnaces. Each steel plant was equipped with soaking pits, ingot strippers, charging machines, ladles, and overhead cranes.[40] Normal capacity for the open-hearth furnaces at

---

[39] Ibid., 38-39.

[40] Soaking Pits—pit-type furnace, fired by oil fuel or gas, and used for soaking metals. Usually such furnaces are employed for soaking newly-cast ingots before rolling or forging. Ingot Strippers—machine used to remove the ingot from its mold. A. D. Merriman, A Concise Encyclopedia of Metallurgy. (Great Britain, The Chaucer Press, 1965), 958, 1007.

Anshan was two heats per day. From 1940 through 1944 Anshan produced 3,106,000 tons of steel ingots, with 1943 being the peak year with 843,000 tons. Steel facilities at Anshan also included two rolling mills with a capacity of 500,000 tons per annum. Also located near the steel mills were subsidiary companies at Anshan and Mukden where finished steel was processed.[41]

The steel plants at Penhsihu[42] represent the other major endeavor of the Japanese in Manchuria. The principal iron mine is located at Miao ie Gou, 16 miles from Penhsihu. It consists of a mountain of low-grade (33.5 percent Fe) magnetite in which two enriched zones of high-grade (62 percent Fe) are found. By concentrating[43] the ore the low-grade could be increased to 63 percent Fe, and the high-grade to 69 percent Fe. Penhsihu had two 200-ton and two 500-ton blast furnaces with a yearly capacity of 511,000 tons. The two 500-ton furnaces were blown in in 1941 and 1942. Penhsihu pig-iron was especially important because of its low phosphorous properties. Consequently a large percentage of this low phosphorous pig iron was shipped to Japan to be made into naval armament.[44] During the war years, 1940 through 1945, Penhsihu produced 1,531,846 tons of pig

---

[41]SCAP Reports, Japan's Iron and Steel, 40.

[42]Consolidated and developed by the Okura Kumi Mining Company in 1911. The Manchoukuo Year Book, 1942 (Hsinking, Manchoukuo, The Manchoukuo Year Book Company, 1942), 497.

[43]Concentrating—a process of increasing the metal content of an ore by elimination of the gangue (the earthy part of the ore). This is done by breading the ore into small pieces and subjecting it to a separation process in which the difference between the specific gravity of the useful and unwanted material is utilized. Osborne, Encyclopedia of Iron and Steel, 85.

[44]Manchoukuo Year Book 1942, 498.

iron, with 1,017,814 tons of low-phosphorous pig going to Japan.[45]

Manchuria was also utilized as a production site for sponge iron. Tonnage was limited (93,517 tons), but it was significant in that it was used in the making of special steel for naval armament. The major sites for production were Anshan, Penhsihu, and Fushun.

Imports: Korea

From 1917 on, the iron and steel industry in Korea developed with the mineral resources available at home. The enormous demand the Japanese made in order to carry on the operation of their war machine was the primary factor leading to this expansion. About 1941, a total of 12 iron and steel plants of various sizes were built, and their pig iron output totaled 630,000 tons in 1944.[46] This industry was built and controlled by Japan to supplement Home Island production, and most of Korea's pig iron, iron ore, and steel was exported to Japan.

The largest portion of the industry was concentrated above the 38th parallel in northern Korea. The expansion of the industry was very rapid after 1930, reaching peak production in 1944 when 3,387,000 tons of iron ore were consumed and 630,000 tons of pig iron and approximately 100,000 tons of steel ingots were produced and sent to Japan.[47] Korea had ample supplies of iron ore, anthracite and lignite

---

[45] SCAP Reports, Japan's Iron and Steel, 41-45.

[46] The Korean Reconstruction Bank, Industry in Korea 1967 (Seoul, Korea, Samhwa Printing Company, Ltd., 1967), 215.

[47] From 1925 to 1945 Korea produced about 2,000,000 tons of iron ore, an amount approximately equal to the Japanese Home Island production during the same period. SCAP Reports, Japan's Iron and Steel, 28.

coal, but no coking coal; this came from Manchuria and North China.[49]

In 1942 and 1943 there was a concentrated effort to increase pig iron production in Korea, because the Japanese finally realized that they had over-expanded their capacity in the homeland. Many small blast furnaces were built in 1943.[50] Plans called for seventy-five 20-ton and five 50-ton furnaces; fifty-nine were erected and thirty-nine were operated. The furnaces were the German band-type, of simple design, and were provided with hot stoves capable of heating to 600° F. Beehive coke ovens were also erected.[51]

The Mitsubishi plant at Seishin, in northeast Korea, had six large rotary kilns used to make Luppe. They annually produced 50,000 tons during the period from 1941 to 1944. The Joshin plant of the Japan High-Frequency Current Heavy Industry Company, located in northeast Korea just south of Seishin, was an important producer of raw iron, ferro-alloys, and special steel. Their supplemental iron production, while not the high-grade iron of the blast furnace, amounted to 170,000 tons in 1944. This would appear to justify the effort by the Japanese to install kilns of this type.[52]

The principal steel plant and the only integrated plant in Korea was the Japan Iron and Steel Company works at Kenjiho (Kyomipo). This plant was located on the northwest side of North Korea, and had been owned and operated by the Japan Iron Manufacturing Company, Ltd. since

---

[48] Ibid.

[49] Ibid.

[50] See Chart, Page 13, Chapter II.

[51] SCAP Reports, Japan's Iron and Steel, 29.

[52] Ibid., 29-30.

1934. This plant had three Greenawalt sintering pans with a daily capacity of 240 tons and three American type blast furnaces with a combined daily capacity of 1000 tons. Four batteries of 35 coke ovens, each containing 35 cells, had a daily capacity of 1000 tons of coke. Three 50-ton basic open-hearth furnaces and a 200-ton mixer had a daily capacity of 400 tons of ingot steel. Also at Kenjiho was a blooming mill, slab mill, and secondary mills, having a daily capacity of 235 tons of heavy sections and 335 tons of plates, respectively. Iron ore for this plant came from mines located 43 to 147 miles away, while coking coal came from Manchuria and North China, a distance of 620 miles.[53]

In their drive to further increase production, the Japan Iron Manufacturing Company started another iron and steel plant located at Seishin (Chongjin) in the extreme northeastern part of Korea. The plant was begun in 1942 with two 500-ton German type blast furnaces and two batteries of 57 coke ovens with a daily capacity of 1,000 tons of pig iron and 1,240 tons of coke, respectively. Coking coal for the Seishin plant came from Manchuria, while iron ore came from the Mosan mine some 58 miles to the north. Also in Seishin was a sponge iron plant owned by the Mitsubishi Mining Company, which had begun operations in 1939. In addition to six large rotary kilns for making Luppe, there were also two 7-ton electric furnaces for converting the Luppe into steel. Principal products were cast and alloy steels; some 80 percent of the output was shipped to Japan. No coking coal was necessary for operation of these rotary kilns, but anthracite

---

[53]Ibid., 30-31.

and bituminous fuels which came from Heijo and south Sakalin, respectively, were used extensively.[54]

Korea, while not the leading exporter to Japan, played a significant role in fueling Japan's war machine because of her proximity to the Home Islands[55] and the fact that the private investors and combines could make immense profits. According to Grajdanzev, profits in Korea regularly ran from 11 to 33 percent per annum.[56]

Imports: North China

North China was also of vital importance to Japan's war machine since it supplied high-grade coking coal and iron ore. Estimates of Chinese coking coal reserves ran as high as 200 billion tons.[57] Most Japanese iron and steel plants used blast furnaces and open-hearth furnaces and consequently required large amounts of coking coal. Steel can be made with electric furnaces, but Japan did not have an adequate and cheap supply of electricity.

Total production of coal in North China rose from 10 million tons in 1938 to 24 million tons in 1941, and from 16 to 24 million tons in Manchuria during the same time span.[58] In 1941 China was responsible

---

[54]Ibid., 31-32.

[55]The port of Pusan is only 120 miles from Shimonoseki.

[56]Andrew J. Grajdanzev, Modern Korea (New York, Institute of Pacific Relations, 1944), 161.

[57]Mitchell, Japan's Industrial Strength, 133.

[58]United States Strategic Bombing Survey, No. 53. The Effect of Strategic Bombing on Japan's War Economy (Washington, 1946), 13.

for 96 percent of Japan's imports of coking coal.[59] So essential was North China's coking coal to Japan that throughout the Pacific War it accounted for 50 percent of Japan's total coal imports, reaching a peak of 4 million tons in 1942.[60] Coal consumption in Japan Proper went from 51 million tons in 1937 to a high of 66.5 million tons in 1940. The steel industry in 1937 ranked second behind textiles as a consumer of coal; by 1940 steel ranked first and accounted for one-sixth of the total coal consumed.[61]

North China also accounted for a substantial part of Japan's iron ore. In 1937 China supplied 14 percent; by 1941 she was supplying 50 percent of Japan's needs.[62] Most of this iron ore came from mines already in existence in the Yangtze Valley and from the somewhat underdeveloped Lungyen mines at Chahar. These Yangtze Valley mines were important because of their position on the river, which the Japanese used as a major artery of transportation. There was some attempt to develop the mines at Lungyen, whose reserves were estimated at 100 million tons of 60 percent Fe content, but Japan did not fare too well because of the inland location of the mines, transportation problems, and the activities of the Chinese guerrillas.[63]

In North China, from 1937 on, the Japanese strategy was sokusen sokketsu—blitzkrieg or lightning warfare; for China it was the period

---

[59]Cohen, Japan's Economy in War, 119.

[60]1940 was the peak year (10 million tons) for coal imports to Japan. Ibid., 164.

[61]Ibid., 170.

[62]USSBS No. 36, 63.

[63]Mitchell, Japan's Industrial Strength, 135-36.

of "prolonged resistance" in Chiang Kai-shek's phraseology, or the 'protracted war' in Mao Tse-tung's terms.[64] Mao felt the war would go through three stages—"the enemy's strategic offensive and our strategic defensive, the enemy's strategic defensive and our preparation for the counter-offensive, and our strategic counter-offensive and the enemy's strategic retreat".[65] Chiang's policy, like Mao's, was to "trade space for time, prepare for a counter-attack, and . . . to launch the counter-attack".[66] Instead of these three phases predicted by Chiang and Mao, the war fell into two stages—from 1937 to the end of 1938 and from 1939 to August, 1945. In the first period Japan's swift advance netted her the major cities along the coast,[67] while the second period was one of military stalemate characterized by guerrilla activities. It was in this second period that the iron and steel centers set up by the Japanese suffered as a consequence of guerrilla attacks against Japanese communication systems, blockhouses, and railroads. These operations succeeded in destroying nearly 3000 strong-points, 588 miles of railway, and almost 2000 miles of roads.[68]

---

[64]F. F. Liu, A Military History of Modern China, 1924-1949 (Princeton, Princeton University Press, 1956), 104.

[65]Jerome Ch'en, Mao and the Chinese Revolution (London, Oxford Press, 1965), 217.

[66]Ibid., 237-238.

[67]This advance was accompanied by the formation of several new or reorganized plants at Shanghai, Tientsin, T'angshan, Ma'anshan, T'ai-yuan, Tsingtao, Shih-ching-shan, and Hainan Island. Here too the new mills were not simple smelters, but relatively integrated mills planned to produce finished products. Wu, Steel Industry in Communist China, 205-207.

[68]Ch'en, Mao, 246.

Imports: Karafuto

Prior to the Manchuria takeover and the "China" war, Karafuto[69] did not figure as a large supplier of war materials to Japan. As was the case with Korea, Karafuto exported mainly non-industrial products: wood pulp, timber, and fish guano.[70] With the launching of the attack on China in 1937, Karafuto became quite important to the Japanese as a source of coking coal. The production in 1936 came to 2,000,000 tons; by 1940 it was up to 5,000,000 tons.[71] During the war Karafuto supplied quite a bit of Japan's coking coal. In 1940 Japan received 18 percent of her coking coal from the island, but by 1944, imports had dropped to 10 percent.[72] This was because Japan did not have the available shipping to transport the coal, a direct result of the steel shortage.

Existing Resources in Japan Proper

At the outbreak of the Pacific War, Japan was critically dependent upon imports of oil, coking coal, iron ore, and pig iron. Seizure of the southern areas appeared to solve some of these requirements, but by early 1942 these areas were cut off by the Allied blockade.[73] Follow-

---

[69] The southern half of Sakhalin Island.

[70] Harold G. Moulton and Louis Marlio, The Control of Germany and Japan (Washington, Brookings Institution, 1944.), 63.

[71] Ibid., 69.

[72] USSBS No. 36, 86.

[73] The Philippines yearly supplied 500,000 tons of iron ore from 1934 to 1941. British Malaya was the biggest supplier of iron ore up until 1941. Following 1941 Japan had to rely on the imports from the continent. SCAP Reports, Japan's Iron and Steel, 10.

ing this the Japanese iron and steel industry became dependent on the continent and upon Japan proper. The contributions of the continent never came up to expectations. To counter this, the Japanese took a variety of precautionary measures, such as the building up of stockpiles of iron and steel scrap, and the building of a tunnel between Kyushu and Honshu. Heavy government subsidies were paid to stimulate production of low grade ores such as iron, copper, and manganese.

As early as 1936 the Japanese government had ordered the steel plants to increase their stockpiles of pig iron, scrap, and iron ore beyond their normal requirements. Yawata, the largest steel plant in Japan proper, was told to increase their stockpile to 3 million tons of iron ore and 115,000 tons of manganese ore.[74] The total iron ore stockpile reached its peak in 1938 with a total of 4.2 million tons, but by 1941 this was down to 2.6 million tons, and in 1942 and 1943 this stockpile dropped to 1.3 million tons and 792,000 tons, respectively. By 1944 the Japanese war planners had "seen the light", so to speak, and they started to curb excess use of the stockpiled iron ore. In 1944 they used 120,000 tons and by 1945, still had 672,000 tons on hand. As a consequence of Japan's free hand with her iron ore reserves in the early years when there was an ample supply, she suffered and paid for the shortages which occurred later.[75]

The exhaustion of stockpiles and the stoppage of imports occurred in Japan at the same time. A wartime report stated:

---

[74]Manganese ore—principally used as a deoxidizer in the removal of impurities and gases in the manufacture of ordinary steel and as an alloy in the making of special steels.

[75]Cohen, Japan's Economy in War, 118.

> Iron ore, which is the chief raw material of iron production in Japan, has hitherto been dependent upon overseas materials. In the fiscal years of 1940-41, the main stress was transferred to Chinese ore, and in 1944 Japanese ore became comparatively important. Year by year the source of ore supply has consistently diminished and stockpiles have evaporated. The ore of Japan is not of suitable quality. We must consider the storage of ore within the homeland by increased advanced imports of high grade ore.[76]

The basic weakness of the iron and steel industry was their great dependence upon imports. Japan's domestic production of iron ore was small and poor in quality.[77] She hoped to decrease her reliance upon imports by increased production at home, by the substitution of pig iron for scrap, and the building of stockpiles. Production of domestic ores started to increase about 1939 and reached a point in 1944 where home production exceeded imports. This peak in home production was made necessary because of the Allied interdiction of continental supply lines. Domestically produced ores amounted to 37 percent of the total ores available to Japan from 1939 to the end of the Pacific War.[78]

The contrast between the iron content of imported ores and that of domestically-mined ores in Japan over the period 1940-45 may be seen in the following chart, which shows both total ore produced or imported and the iron content in thousand metric tons.

---

[76]February, 1945. Ibid., 119.

[77]Most of the Japanese iron ore had to be beneficated prior to going to the blast furnace.

[78]Cohen, Japan's Economy in War, 117.

Fiscal year	Domestic ore production	Iron content	Ore imports	Iron content of imports	Total iron content
1940	1229	564	5129	3095	3659
1941	1614	745	5058	3021	3766
1942	2532	1179	4880	2911	4090
1943	3057	1459	3660	2147	3606
1944	4367	1911	1668	925	2836
1945*	837	394	144	67	461

*First quarter only
Source: Cohen, Japan's Economy in War, 116.

As seen in the above chart, the total iron content available to the Japanese from domestic production and imports reached its peak in 1942 and dropped afterwards in spite of the increased domestic production.

In 1937, Malaya and the Philippines supplied 51 percent of total iron ore imports, while Korea, Manchuria, and China together supplied 21 percent. By 1940 Malaya and the Philippines were supplying 57 percent, but the share provided by Korea, Manchuria, and China had risen to 29 percent. In 1941, following the embargo, China became the largest supplier, providing for 50 percent in 1940 and 88 percent of total imports in 1943. In late 1942 and early 1943 the Japanese took stock of their position, and they decided to exploit the low-grade mines in northeastern Korea, since this would require a minimum of transportation and could move across the comparatively safe Japan Sea. They were partially successful in this endeavor, and iron ore imports from Korea rose from 235,000 tons in 1943 to 600,000 tons in 1944. In 1943, Korea supplied 7 percent and China 88 percent of Japan's iron ore imports; by 1944 the Korean share climbed to 37 percent, and the Chinese fell to 61 percent. However, the 400,000-ton Korean increase did not offset the 2,230,000-ton drop in iron ore imports from China between 1943 and 1944. Also Chinese ore had a Fe content of 60 percent, whereas Korean ore reached only 54 percent. Throughout the war

years, Manchuria never provided more than 4 percent of Japan's iron ore needs, though she met her own demands through the production of the Anshan district.[79]

In studying the iron and steel industry during wartime the observer becomes aware of its many shortcomings. Stockpiles were not utilized correctly, pig iron and steel capacities were set far too high, and there was constant bickering between the armed forces and the civilian concerns as to who received what in the way of steel allotments. These factors and many more directly affected the iron and steel industry in its attempt to keep the Japanese war machine in peak operating condition. The effects of the iron and steel shortage on the Japanese war machine and on the people behind the war effort, the civilian populace, were far-reaching and severe, as will be seen in the following chapter.

---

[79]Ibid., 116-117.

CHAPTER IV

"TOO LITTLE, TOO LATE"

The emergence of Japan as one of the world's industrial leaders should not have come as too much of a surprise to the West. The nation's abilities and skills in technology and industry had been clearly demonstrated to the world during the 1930's and early 1940's. It had built one of the world's largest navies and merchant marines and had developed sufficient military power to challenge the United States for supremacy in the Pacific.

The iron and steel industry was the leading force in the development of Japan's industrial power; without it Japan could not wage war. The steel industry depended heavily on imported raw materials from Manchuria, China, Korea, and other Asian sources. Iron ore, coking coal, and pig iron flowed from the Asian Mainland to Japanese mills which produced the steel needed for the rapid buildup of Japanese industrial and military strength. Iron and steel plants were built in Korea and Manchuria to make better use of local resources, and to expand production. The Anshan-Fushan (Manchuria) industrial complex became one of the largest in Asia, with its iron and coal mines, blast furnaces, rolling mills, and finishing and fabricating plants being used for a wide range of metal products and machinery. By the start of the Pacific War Japan's steel industry was producing almost

seven million tons of steel each year.[1] At the end of World War II, Japan's steel industry had come to a virtual standstill because of a great many factors, most notable of which was the Allied interdiction of supply lines from the continent, direct air attacks on the steel plants and their spillover results, lack of coordination between the military and civilian concerns, interservice rivalries, and problems with labor for the plants and mills.

A lack of coordination existed between the military and administration throughout the period from 1931 to 1945. This lack of planning, poor administration, and internal conflict of interests, as noted for example in the allocating of iron and steel products, was one of the major reasons for Japan's defeat. As early as 1931, with the invasion of Manchuria by the Army for purposes of colonization, self-aggrandizement, and self-sufficiency, Japan had been plagued by a willful and headstrong military. The Army was so frustrated with the zaibatsu control of government during the 1930's, that they took it upon themselves to invade Manchuria and North China in order to regain their fading power and prestige. The Army's opinion on economic control in wartime was stated thus:

> In order to meet the needs of the defense service in wartime and to enable them to devote the whole national strength to war operations,...it is of paramount importance to adapt all national activities to war conditions, to place manpower, material, and all other

---

[1] By way of comparison the United States, in November 1941, had an 85 million ton capacity in steel, and during the eighteen months prior to this date had produced 120 million tons of steel. Office for Emergency Management, Division of Information, The Situation in Steel: Transcript of the Meeting of Iron and Steel Industry with the Iron and Steel Branch Office of Production Management. (Washington, 1941), 4.

> resources at the disposal of the government [military], and to utilize them for war purposes....
>
> In time of war, industries should be brought under national control with a view, first to supplying war material, and then, to meeting the needs of the people at large. Unless industries are readily integrated into the wartime structure, it is inevitable that the nation's economy will be overwhelmed, the supply of materials will become uneven and scarce, and, as a result, the determination to fight out the war will be seriously impaired.[2]

It was not until after the start of the "China War" that the Army was strong enough to bring pressure to bear upon the Konoye government to have it pass the National General Mobilization Law. This law, which became effective April 1, 1938, and which was to provide the basis for unlimited government control of industry, was passed over extreme business opposition. Revised in 1939 and 1941, the law consisted of fifty articles, and gave the government the power to "regulate production, distribution, prices, wages, exports and imports, pay subsidies, build stockpiles, control capital issues, etc."[3]

The most important and powerful ordinance passed under this law which concerned war controls prior to 1942 was the Major Industries Association Ordinance of September, 1941. This long planned and disputed control measure came into being with the appointment of Lt. Gen. Suzuki to the post of Chairman of the Planning Board, and the

---

[2]From August, 1937 Army publication, quoted in Cohen, Japan's Economy in War, 10.

[3]Cohen, Japan's Economy in War, 11.

succession of Adm. Toyoda[4] to the position of Minister of Commerce and Industry. Its major purpose was to unify and coordinate the control patterns through the use of two organizations, the Tosei Kai and Tosei Kumiai. The Tosei Kai represented the national industry-wide control associations and the Kumiai stood for the smaller local or regional business.[5] The Iron and Steel Control Association (Tekko Tosei Kai) was empowered to allocate raw materials equipment, production quotas, and dictate production details, control management and finances of industry, including the power to take over any concern, and to administer allocation of pig iron and steel products according to the plans of the Cabinet Planning Board.[6]

As a result of the power given to these associations, they virtually controlled and planned the economic life of the industry. Normally they were responsible to and under the jurisdiction of the various Ministries. In practice, however, they enjoyed great autonomy and received wide government power to allocate raw materials and regulate output. The associations were usually headed by the former

---

[4]Admiral Teijiro Toyoda, not to be confused with Admiral Soemu Toyoda, who was successively C. in C. Combined Fleet, C. in C. Overall Naval Command, and Chief of Naval General Staff. Teijiro Toyoda was later made president of the Iron and Steel Control Association (Nippon Seitetsu) and Head of the Munitions Industry. Teijiro was also married to the daughter of Hideo Takeda, a prominent Mitsubishi director. T. A. Bisson, Japan's War Economy (New York, Institute of Pacific Relations, 1945), 27.

[5]Cohen, Japan's Economy in War, 31.

[6]USSBS No. 36, 66. The Planning Board was dominated by the Army but it had to defer to the Cabinet as a whole or to the individual Ministeries. Also the Minister of Commerce and Industry appointed the president of Tekko Tosei Kai who held absolute power, subject to the Ministers approval or disapproval. Ibid.

president of the largest concern in the industry, who had resigned explicitly for that purpose. Thus the zaibatsu, although they had yielded nominally to government control, were in fact able to obtain almost complete domination of all industry.[7] Consequently by 1941 the system of controls over the distribution of steel had been fixed and had become the pattern for the other numerous materials allocation systems.

An administrative reorganization, resulting eventually in the formation of a new Munitions Ministry, was undertaken early in 1943 in order to clear the way for greater production.[8] Five industries were selected for special controls—iron and steel, coal, shipping, aircraft, and light metals. This Wartime Special Administrative Powers Act was designed to invest dictatorial powers in the Prime Minister. Tojo Hideki's further dissatisfaction with the administrative controls over industry, and especially the rivalry of the Army and Navy, led to the establishment of the Munitions Ministry in November 1943.[9] The Ministry of Commerce and Industry and the Cabinet Planning Board was abolished, and control over industry as a whole was vested in the new

---

[7] Jerome B. Cohen, "The Japanese War Economy: 1940-1945", Far Eastern Survey, XV (December 4, 1946), 364.

[8] This went into effect March 17, 1943. An advisory Council, of seven leading zaibatsu representatives, was established to act as a guide for the Prime Minister. Production was to be increased 170 percent over the 1942 production goals. Ibid.

[9] This act was pushed through by Tojo Hideki.

Ministry under the leadership of Vice-Minister Kishi.[10] The five vital war industries mentioned above were designated as "munitions companies" and placed under the control of the new Ministry.[11] However, even with these new controls, the desired centralization of administration and planning was impossible because of the constant Army and Navy mistrust and lack of coordination between them.

These two groups had been at each others' throats especially since the start of the Pacific War, and as the war progressed further downhill, animosities between these two reached the breaking point and the fierce competition between them was carried to ridiculous extremes. An example of this is given in the testimony of Vice-Admiral Miwa before the interrogation board on October 10, 1945:

> Q. We understood that towards the end of the war, the Army was building submarines to operate itself. That seems somewhat peculiar. Do you know what the reasons were?
> A. When the Army planned on building up his own submarines, the Navy side opposed that plan; but the Army answered they were planning on building up special submarines for supplying these islands and the Army didn't want to use Navy submarines for such supplying because Navy submarines had more important missions to fight with the fleet, and the Navy agreed with that plan. The Navy

---

[10] Kishi Nobusuke in his position as vice-chief of the economic section of the Manchukuo government, had worked closely with Tojo during his 14 month stay in Manchuria. Kishi had also been the last Commerce and Industry Minister. Also included in Tojo's circle of friends was Hoshino Naoki, who was in charge of economic affairs in Manchuria under the authority of the Kwantung army, Matsuoka Yosuke, who had served as president of the South Manchurian Railway, and Aikawa Yoshisuke, president of the Manchurian Heavy Industries Development Corporation, which had acted as the advance guard for Japan's industrialization of Manchuria. Together, these five men—Tojo, Hoshino, Matsuoka, Kishi, and Aikawa, became known as the ni-hi san-suke (the two hi and the three suke)--a reference to the fact that Tojo and Hoshino's first name ended in hi, while those of the other three ended with suke. Robert J. C. Butow, Tojo and the Coming of the War (Princeton, Princeton University Press, 1961), 74-75.

[11] Cohen, Japan's Economy in War, 74.

> explained to the Army that building of submarines was very difficult, and they wanted to show them how to build them; but the Army did not want to be assisted by Navy, so the Army themselves built the submarines.[12]

Another example of the Army-Navy feuding is seen in a statement of Fujihara's, who was Munitions Minister in the Koiso Cabinet:

> The results of my efforts to expand production were just the reverse of successful.... There were three main reasons why I was not successful; first, the decrease in shipping tonnage so drastically affected the bauxite supply; second because of shipping shortage the imports of coal from China, Hokkaido, Karafuto and other places to Japan were drastically cut. Therefore steel production went down. Thirdly it was agreed among the Ministers and particularly the Navy, Army and myself that unification was necessary--very, very urgent, but there had been this old competition between the Army and Navy and the lower ranks simply did not like the idea, so even though I urged unification, I could not get the people to do it to any appreciable extent....what I am saying in effect is this—I was Munitions Minister, but my function actually was that of conciliator between Army, Navy, and Air people.[13]

The Army and Navy had their own plants, stocks of raw materials and procurement agencies, but were unwilling to join forces in order to alleviate some of their mutual problems. As for the strong zaibatsu business groups, they were unwilling to relinquish control of their enterprises or to submit to total military control.[14]

Another problem which faced the Japanese iron and steel industry during the war was that of labor. In 1930 John Orchard noted: "Labor is the chief industrial asset of Japan. With few resources in power or raw materials, a limited supply of capital, and no special

---

[12] Ibid., 73.

[13] Ibid., 78-79.

[14] Competition between the Army and Navy procurement agencies was matched by that of the extra-legal activities of the large private war contractors and their brokers. U.S. Strategic Bombing Survey No. 58, Effects of the Air Attack on Osaka-Kobe-Kyoto (Washington, 1947), 73.

distinction in mechanical skill, Japan has built an industrial system upon cheap labor..."[15] The Japanese labor force was marked by deficiencies: it had a very small reserve of skilled workers and almost no adequate training programs. The primary labor problem facing the iron and steel industry was the necessity of relying upon unskilled workers, because the military had indiscriminately drafted skilled workers. Admiral Toyoda, head of the Iron and Steel Control Association stated that "a number of key engineers were shipped to the continent and were lost to the industry at home".[16] This uncontrolled military conscription of workers had a drastic effect on the civilian economy. As early as 1938 turnover rates ran as high as 35 to 38 percent. Both large and small industrial firms were equally guilty as the military in their labor practices. The smaller firms were guilty of "pirating" skilled workers from other plants by the practice of paying "black market" wages; while the larger industrial concerns were guilty of "padding" their requirements when asking for labor allocations.[17]

The Japanese government attempted to stop these practices by allowing the industries to conscript or freeze their labor force. This industrial conscription occurred as early as July, 1939, in order to recruit skilled technicians and fill the vacancies in the government-operated plants, such as Yawata. By December, 1941 this

---

[15]John E. Orchard, Japan's Economic Position, (New York, McGraw-Hill, Inc., 1930), 339.

[16]Cohen, Japan's Economy in War, 122.

[17]U. S. Strategic Bombing Survey No. 42, The Japanese Wartime Standard of Living and Utilization of Manpower (Washington, 1947), 73.

law was changed and enlarged to include males, age 17 to 40, and unmarried women, age 16 to 25. They could be conscripted to any factory that was designated by the Welfare Ministry.[18] Some 33 percent of the young men who did heavy labor and the older men who were skilled operatives or foreman were called up for military service. This callup represented a 50 percent cut in the capabilities of the working force. In 1941 the output per worker in the Japanese steel industry was 54 tons while the per annum comparable German figure was 81 tons. By 1944 the output per Japanese steel worker had fallen to 21 tons as compared to 56 tons for the Germans.[19] The Iron and Steel Control Association, in commenting on this decline in worker efficiency, gave as the major reasons: "conscription of skilled workers into the service, the resultant increase in inexperienced workers, and the shortages of food, transportation, and homes".[20] In 1941 practically all the workers in the strategic or war industries were Japanese men; by 1944, about half the workers in these strategic industries were composed of women, students, and Koreans.[21]

Conscription of skilled labor by the military and its consequences

---

[18]Ibid., 51. The Japanese divided their human resources into six classifications: first, general laborers or "indoor" workers which included virtually all factory workers, skilled, semiskilled, unskilled, and office workers; secondly all day laborers—construction, transportation, dock workers, and some type of factory workers. Third, fourth, fifth, and sixth were technical school graduates, primary school graduates, students, and aliens, respectively. Ibid., 50.

[19]Cohen, Japan's Economy in War, 348.

[20]Ibid., 349.

[21]United States Strategic Bombing Survey No. 43, Japanese War Production Industries (Washington, 1946), 7.

were not the only problems which confronted the industries. Absenteeism played a major role in the industrial output drop. Following the start of concentrated Allied air raids upon the homeland, it became the major problem of industry. Premier Suzuki stated, "it is most regrettable to observe frequently, since the enemy began huge air raids not so long ago, there have been factories whose attendance rate had dropped."[22] The Japanese workers were absent because of the effect the air raids had on their homes, anxiety about further raids, the transportation difficulties encountered because of the air raids, and the fact that the industrial site was quite frequently hit by air attacks. Other reasons given by the Japanese workers were the fact that they took to the country to avoid the strikes or that they were injured in the air raids.[23]

While the above reasons are quite important, I feel that there were three major reasons for the failure of the Japanese steel industry to provide adequately during the war. These were air strikes, both continental and homeland; the extreme shortages of pig iron and steel; and the loss to Japan of her major coking coal suppliers.

Japan was almost entirely dependent on coal and waterpower for industrial energy. Coal was indispensable in the operation of Japan's blast furnaces and irreplaceable as a raw material for much of the chemical industry. Coal was also the primary fuel for the railway network. Coal reserves in Japan Proper were small if compared with

---

[22]United States Strategic Bombing Survey No. 14, The Effects of Strategic Bombing on Japanese Morale, (Washington, 1946), 56.

[23]Ibid., 66.

those of the world's great producers of coal. Almost all the coal produced in Japan is medium to low-grade bituminous; almost none is usable for making good metallurgical coke unless blended with imported coals which have high coking properties. Of special importance was the coking coal from North China-Inner Mongolia and Karafuto, without which the iron and steel industry could not function properly or efficiently.

Shipments from all overseas areas to the home islands, which reached an all-time peak of 10,123,000 tons in 1940, dropped to 9,585,000 tons in 1941, and to 8,748,000 tons in the following year. By 1943, total imports had fallen to 6,029,000 tons, and in 1944 fell to 3,135,000 tons, a drop of 67 percent from 1941.[24]

During the war, shipments of coal from North China-Inner Mongolia made up almost 50 percent of the total imports. The iron and steel industry depended on the coking coal for its very existence, and the Japanese war planners endeavored mightily to keep up this vital supply line but failed to do so. By 1944 coal supplies from North China had fallen to 1,515,000 tons, as compared with 4,539,000 tons in 1942.[25]

To counter this downward trend in 1944, the Army took over the rail traffic of coal. They attempted to use coal from the Mishan fields in northeast Manchuria. To replace the water-borne shipments from North China to both the Anshan steel mills and to those in Japan Proper, which had been interdicted and virtually cut off entirely by

---

[24]USSBS No. 36, 19.

[25]Ibid.

Allied air and submarine attack, the Mishan coal would move by rail to Anshan and the shipments to Japan would move from Rashin and Seishin, in Korea, across the Japan Sea to Hokkaido and Honshu. From here the coal was transported, mainly by rail, to the vast industrial centers located in southern Honshu and northern Kyushu.[26] The railroads proved to be the limiting factor because of the Allied airstrikes against the transportation lines. By 1944-45 the Japanese iron and steel industry was having to rely on coking coal from Hokkaido, which was of a lower grade and contained more ash. Consequently, at the steel plant there was more slag and impurities in the finished steel. Two plants in Japan Proper succeeded in becoming self-sufficient by using the Hokkaido coal. These were the Wanishi plant, of the Japan Iron Manufacturing Company, in Hokkaido, and the Kamaishi plant, belonging to the same company, which was located on the northeastern coast of Honshu. Together these two plants accounted for 40 percent of the total pig iron production in 1945. Their 1945 output expressed in percentage of production to capacity as compared to the national average is as follows:

	Coke	Pig Iron	Ingot Steel	Rolled Steel
National Average	27	32	17	19
Kamaishi plant	56	38	42	53
Wanishi plant	33	31	10	20

Source: Cohen, Japan's Economy in War, 120.

The result of the decline in the importation of coking coal was seen in the quality of steel produced and the increased fabricating difficulties and rejections. Efforts were made to utilize domestic coal for coking purposes, and by the latter half of 1944 the Yawata

---

[26] Cohen, Japan's Economy in War, 119-120.

plant was using sixty-eight percent low-grade domestic coking coal. Consequently competing demands for a share of the dwindling supply of steel meant that the coal industry received smaller and smaller allocations of steel for maintenance, and coal output declined more sharply in turn. Thus the coal-steel relationship developed into a vicious circle.[27]

The shortage of steel affected Navy and merchant shipbuilding more so than the ground forces, but the Army did suffer real losses because of a lack of steel and steel-related products. The largest loss suffered by the Army was in the area of munitions and in the supplying of overseas forces. In 1941 the munition industry was receiving 56 percent of the overall allotment of steel; by 1945 this allotment was up to a staggering 85 percent. Even with this, the munitions industry could not supply the Japanese war machine with needed materials. By 1944 heavy artillery manufacture was stopped outside of the home islands, and small arms amunition for training purposes was no longer available. Production of light tanks was halted, and medium tank and armored car production was severely curtailed.[28] A modern army moved on trucks and other wheeled transportation, but Japan did not have the steel for truck production. At the end of 1944, the Japanese Army had one truck for every 49 men in the overseas areas. The United States, at this time, had one truck for every 13 men in the Pacific area.[29] As for supplying their overseas

---

[27]Cohen, Far Eastern Survey, 367.

[28]Cohen, Japan's Economy in War, 119-120.

[29]Ibid., 197.

forces, the Japanese Army had to depend on merchant shipping. In 1943, they lost 17 percent of their supplies to sinkings; by 1944, sinkings accounted for 33 percent of their losses, and during the first half of 1945 losses were up to 50 percent.[30]

In the naval shipyards the emphasis on construction had been shifted away from large ship production, to that of small ships built on a large scale. Naval shipbuilding was faced with three major bottleneck periods:

1) August 1942 to November 1943
   The shortage of steel delivered for naval shipbuilding in 1942 and 1943 was lower than 1941, but, ship construction was higher by 1943 than in 1941.

2) November 1943 to November 1944
   The stocks of steel available for shipbuilding decreased quite drastically. Construction of large capital ships was stopped.

3) November 1944 to the end of the war
   Steel deliveries declined even more. Deliveries in the April-June quarter of 1945 were less than 30 percent of the delivery rate in 1944. Steel was no longer available for any naval shipbuilding other than special attack vessels.[31]

In 1942 carrier construction was slowed, and by the end of 1944 construction was stopped entirely. The production of destroyers was stopped by mid-1945.[32] This failure to produce naval ships was not entirely due to a lack of raw materials, as is seen by the following table.

---

[30] Ibid., 196.

[31] United States Strategic Bombing Survey No. 46, Japanese Naval Shipbuilding (Washington, D.C., November, 1946), 10-11. Hereafter referred to as USSBS No. 46.

[32] Cohen, Japan's Economy in War, 199.

TABLE VI

PLANNED AND ACTUAL DELIVERIES OF ROLLED STEEL FOR NAVAL SHIPBUILDING, 1941-1945, BY FISCAL YEAR (per 1000 TONS)

Year	Planned	Delivered
1941	374	382.5
1942	326.4	345.7
1943	271.1	352.6
1944	147.3	222.2
1945	10.4	16.2

Source: USSBS No. 46, 12.

Most of these materials had come out of stockpiles, and most of them went into the construction of small special attack ships.[33]

Merchant shipbuilding was the hardest hit by the wartime shortage of steel. Prior to the start of the Pacific War, in 1940, Japan had a fleet of 700 ocean-going freighters, 132 cargo-passenger vessels and 49 huge ocean-going tankers.[34] Up until 1941, the Japanese had planned to decrease her merchant tonnage and increase her naval tonnage. This reflected the lack of realization on the part of the Japanese of the precariousness of their shipping position and their failure to realize the American's effective use of submarine

[33]These consisted of suicide boats (Shinyo), midget subs (Kairyu and Koryu), and "human" torpedoes (Kaiten), all of which the Japanese Navy regarded as so expendable that they classed them as "naval ammunition" and not as ships. The Shinyo were made of wood with an explosive charge in the bow. The Kairyu were 2-man, 18-20 ton submarines and the Koryu were 5-man, 40-50 ton subs completed in 30 and 60 days, respectively. The Kaiten or human torpedo was a one-man affair of about 4-8 tons. Ibid., 262.

[34]Ibid., 251.

warfare. By November, 1942, the Japanese had seen too late the error of their ways, and by 1944 merchant shipbuilding was up to six times that of the 1942 plans. During the Pacific War the Japanese lost 8.6 million tons of shipping. Another way of putting this is that for every ton the Japanese built, three tons were sunk. By the end of the war Japan had only 557,000 tons of operable merchant shipping.[35] In 1941 the Japanese merchant shipyards received 7 percent of the total steel production. By 1945 they were getting 46 percent of the total produced.[36] Even with these stepped-up efforts in 1944-45, the increased steel allocations for merchant shipping was at the expense of the other industries, most notably naval shipbuilding. The merchant shipbuilding industry had no steel stocks to speak of; they fell from a 7.6 months' supply in 1942 to a 3.6 months' supply in 1944. Specifications for steel were lowered, and consequently both merchant and naval shipbuilding suffered. For merchant ship construction the bubble finally burst in October, 1944, and by November, 1944, production took a definite downward trend. By the end of February, 1945, before the air attacks affected the industry, production had fallen far below the average for 1943.[37] This decline was the direct result of the exhaustion of the steel supply.

The decline in Japan's steel making capabilities and consequently in her abilities to wage war were not caused by direct air attacks,

---

[35]Ibid., 266-268.

[36]United States Strategic Bombing Survey, No. 48, Japanese Merchant Shipbuilding (Washington, D.C., 1947), 32. Hereafter USSBS No. 48.

[37]Ibid.

but rather by the losses she suffered in the shipping of raw materials to the steel mills. The steel industry had initially been selected as the target of priority when the first air attacks were delivered against Japan. China-based B-29's delivered two attacks in June and August, 1944, against the huge Yawata Works located on the northwestern edge of Kyushu island. Damages were slight, with most repairs being made within two weeks and the rest within the month.[38] Production at Yawata had been on the decline prior to the air raids—a result of the shortage of imported coal and ore, pig iron and ingot steel, and electric power.

Steel plants on the mainland, notably those located at Showa Steel Works in Manchuria, were more directly affected by the air raids. The three raids directed against this plant in July and September of 1944 achieved the best results of all the air attacks on any steel target. The factor of difference between the plants at Anshan, and those in Japan Proper was the availability of raw materials. The raw materials required to operate the Anshan Works at capacity or near capacity were locally available or accessible by rail, a condition not seen by Yawata.[39]

Naval bombardment directed at the three steel mills located at Kamaishi, on the island of Honshu, and Wanishi and Muroran on Hokkaido island accounted for considerable damage.[40] These bombardments were carried out during mid-1945 and accounted for significant damage to the

---

[38]USSBS No. 36, 78-80.

[39]Ibid., 83.

[40]These plants accounted for 40 percent of the pig-iron production during the first quarter of 1945. Ibid.

plant's blast furnaces and coke ovens. Repairs for these facilities were considered impossible, and replacement would have taken some 18 months at the minimum.[41]

An overall view of the damages to the Japanese steel industry may be seen in the following statistics taken from the United States Bombing Survey on Coals and Metals in Japan's War Economy.[42]

Annual Rated Capacity in 1000 Tons
Before and After Attack

	April 1944	September 1945
ingot steel	13,644	11,696
finished steel	10,388	9,799

Index of Ingot Steel Production In All Plants And In All Attacked, (Index: October-December 1944=100)

	attacked plants	all plants
Oct-Dec 1944	100	100
Jan-Mar 1945	75	71
Apr-June 1945	55	54

Thus the effects of Allied air attacks on production were not substantial and were limited to those few plants which were operating at a fairly high level when hit. This strategic bombing of the steel industry in Japan Proper was insignificant in its effects on the industry as compared to the effects gained by the Allied attacks against shipping. By December, 1944, lack of good quality and sufficient quantity of raw materials had reduced steel production to 43 percent of rated capacity.

The allied air and naval attacks also played an important role with their offensive against the urban areas of Japan Proper.

---

[41] Ibid., 84.

[42] USSBS No. 36, 84.

According to the Strategic Bombing Survey report The Effects of Air Attacks on Japanese Urban Economy these offensive raids expected to achieve their results through:

> (1) Direct physical damage to major production facilities and to the numerous small feeder plants concentrated in such areas.
> (2) Destruction of finished items, raw materials, components, and goods in process at plant sites and in warehouses.
> (3) Disruption of internal transportation and public services, thus creating obstacles to the normal movement of labor and goods.
> (4) Reduction of labor efficiency through increased absenteeism caused by the disruption of living conditions.[43]

Railroads were hit severely and although no major lines were out of operation for lengthy periods of time,[44] the local transportation facilities bore the brunt of disruption and delays. This was in the form of delays in moving freight from the railhead to receivers. Most of this was caused by worker absenteeism and consequently became the chief limiting factor to efficient rail service. Railway absenteeism went from 20 percent in 1944 to a staggering 49 percent by July, 1945.[45] Trouble with the domestic railroads can be seen by the following attempt to move coking coal and low-grade iron ore from Hokkaido to the southern islands of Honshu and Kyushu. The backbone of the rail system on Honshu and the main railroad was the Aomori-Sendai-Tokyo-Nagoya-Osaka-Shimonoseki which connects to the island of Kyushu by an underwater tunnel.[46] In this vicinity were the large

---

[43] USSBS No. 55, 11.

[44] The main railroads in Hiroshima were back in operation some 48 hours after the dropping of the atomic bomb. USSBS No. 55, 20.

[45] Ibid., 20-25.

[46] Shimonoseki-Moji tunnel. Reports of General MacArthur, Japanese Operations in the Southwest Pacific Area, Vol. II, part II, (U.S. Government Printing Office, Washington, D.C., 1966), 604-614.

steel plants of Yawata and Fukuoka. Because of interruption by carrier strikes against this major line and its trunk lines, the overcrowded Honshu railroads could not move 700,000 additional tons of iron ore and 1.2 million tons to the idle blast furnaces in central Honshu and northern Kyushu.[47]

Living conditions for the Japanese worker in the steel industry and other related industries were inadequate from the standpoint of wages, hours, or material goods, and they continued to worsen as the war was brought directly to the Homeland. The effect of the steel shortage hit the Japanese civilians with a harder impact than did anything else in the economy. The impact of shortage was seen most in the housing and shelter areas. The war industries were concentrated in Tokyo, Yokohama, Nagoya, Kobe, Kyoto and Northern Kyushu. In these areas residential buildings utilizing steel could not be built without governmental permission. Even with permission there was an acute shortage of construction materials. Of the 37,000 houses and dormitories planned for 1942-42, only 4000 were completed with 27,000 still under construction. Finally in 1942 the government decided to restrict further industrial development in the above mentioned areas. Reasons given for this decision were fear of air raids, reduction in efficiency in industrial production, and shortages of materials. The only exceptions to this restriction were in the metal, machine tool, and chemical industries.[48]

Besides the non-availability of steel for housing, the civilian

---

[47]Cohen, Japan's Economy in War, 117.

[48]Andrew J. Grajdanzev, "Japan's Economy Since Pearl Harbor, Part II," Far Eastern Survey, XII (June 30, 1943), 130.

was affected by steel shortages in other ways. Black market prices of household goods containing metal soared. Note the following comparison:

	Official price (Yen)	Black Market Price (Yen)			
Commodity	Dec'43-Jul '45	Dec'43	Mar'44	Nov'44	Mar'45	Jul'45
Iron Kettles	7.6	25.0	45.0	60.0	120.0	230.0
Saucepans	3.1	15.0	30.0	60.0	90.0	120.0
Bicycles	76.8	225.0	400.0	1000.0	1300.0	2000.0

Source: Cohen, Japan's Economy in War, 363.

Steel is, more than anything else, the foundation material in war production. It is the prime ingredient in ships, both naval and merchant, guns, ammunition, trucks, and tanks, and it is very important in aircraft, radio, and optical equipment.

While lack of steel in Japan did not effect war production as a whole until late 1943-1944, steel was never abundant, and its deficiency kept down production of many low-priority items, such as tanks, motor vehicles and heavy artillery. A shortage of steel was the main cause of the decline in output of motor vehicles after 1941. As early as 1943, lack of steel was one important factor in the shift in emphasis in naval shipbuilding away from large ships to destroyers, submarines, and small escort craft. This same lack of steel was also responsible for the Japanese attempting to substitute wood for steel in their merchant fleet. The program was instituted in 1943 and by the second half of 1944 wooden ships accounted for 20 percent of the total value of merchant ship production.[49] This shift by the Navy was dictated both by military demands and the steadily growing shortage of steel.

---

[49]USSBS No. 43, 8.

Over-all steel deliveries in Japan fell by 39 percent in the April-June quarter of 1945 from that of the same time in the previous fiscal year. This percentage in April-June 1945 was 47 percent below that of the equivalent time in 1941. With the decrease in Japanese steel deliveries during the war there was an increase in the amount of steel going towards war production. In 1941 war production was receiving 56 percent of the delivered steel, by 1943 this figure had climbed to 70 percent, and in the April-June quarter of 1945 had reached the staggering amount of 85 percent. The increasing overall steel shortage, plus the fact that aircraft[50] took an increasing share of deliveries, placed a limiting burden on other war production—the primary cause for the decline in output from the peak production levels in the fall of 1944.[51]

Merchant ship construction plans for early 1945 called for a planned tonnage of steel ships which was 35 percent lower than that of the November, 1944, tonnage. The main reason for the reduction was the fact that the necessary steel had not been available for the earlier program. This non-availability was the result of the interdiction of the Southern Pacific sea lanes by Allied forces. Steel deliveries for merchant in 1944, the highest year, were only 256 percent above 1941, even though construction of steel ships for 1944 was 314 percent higher than 1941. In the April-June quarter of 1945 deliveries were 33 percent below that of the previous year while

---

[50]The growing shortage of aluminum had prompted the Japanese to begin experiments with airframes using light steel as a substitute.

[51]USSBS No. 43, 8-9.

construction in this period was 70 percent below the 1944 figures.[52]

While the requirements of the strategy of defense for the Home Islands did not require an outlay of steel as great as the early period of the war when Japan had most of her overseas empire, she did not save much because of the increasing deficiency of the steel supply. Because of this the lack of steel was the most important reason in the drastic drop in output of most articles of war production in 1945, with the exception of aircraft.

---

[52] Ibid., 9.

CHAPTER V

SUMMARY AND CONCLUSIONS

The basic cause of Japan's defeat was the failure of her war plan—the failure of her gamble on a short war—and the final necessity of having to pit her economy in a lengthy contest against a vastly superior economic and military power.

The most fundamental limiting factor of the Japanese war economy was its extremely low iron and steel output. This limitation in Japan's ability to wage war had been recognized as early as the 1930's and although there were political and military motives in the invasions of Manchuria and China, there can be little doubt that the important iron and coal resources of those areas were also major objectives.

Japan felt that if she was to wage war against the west she must develop her home industries utilizing these overseas raw materials. Starting in 1937, Japan attempted to stockpile what she could of the alarmingly deficient metals, including steel (as scrap and iron ore). By the start of the Pacific War, sizable amounts of metals had been acquired abroad and shipped home, but coal and coke could not be stockpiled, and these two materials are basic to the steel industry. An ambitious program started on the continent in 1937 to develop capacity to semi-process steel materials there before shipment to Japan fell far short of its goals. In Manchukuo, pig iron capacity

reached less than one-half and steel-making capacity less than one-third the planned levels. Steel finishing processes remained concentrated in Japan, consequently, the usefulness of expanding mainland production was dependent upon its flow to Japan Proper. Along with this problem of overemphasis upon production of finished materials in Japan and raw materials on the continent, the Japanese placed too much emphasis upon rated capacity of their iron and steel plants rather than actual production output of these plants. Japan proper had 59 percent of the pig iron capacity but 89 percent of the ingot capacity and 91 percent of the finished steel capacity, while the continent had 41 percent of pig iron capacity but only 11 percent of the ingot and 9 percent of the finished steel capacity. If one looks at actual production output it shows the same disparity as the above figures. From 1937 to 1941 the production of pig iron had expanded by more than 80 percent, but the output of ingot steel had expanded by only 17 percent and the production of finished steel was even less. Pig iron production in 1941 was 72 percent of capacity, which was not much advancement over 1937; at the same time ingot production had fallen from 85 percent of capacity in 1937 to only 64 percent in 1941. Surprisingly enough, even with the already existent excess capacity in the Japanese iron and steel industry, it was increased even more during the Pacific War. Coking capacity increased by 19 percent, pig iron capacity by 7 percent, ingot capacity by 27 percent, and rolled steel capacity by 7 percent. This was partially because of plant construction already underway and to the Japanese optimism during the first year of the war.

Prior to the start of the Pacific War the Japanese iron and steel

industry attempted to alleviate their steel shortage by a greatly accelerated expansion of all heavy industry. Utilizing government help in the form of tax concessions, subsidies, tariff protection, and government sponsored cartels and transportation, the plans for expansion emphasized two goals: (1) over-all expansion of capacity and production and (2) self-sufficiency within the Japanese sphere of influence. The expansion plan covered a period of five years, from 1938 through 1942. Although the war started a year before the end of the five-year expansion period, a remarkable degree of sucess had been achieved by 1941. Increases in capacity on an overall basis more than doubled during the period 1937 to 1941, while production increases, though not as spectacular as capacity figures, were also quite substantial. The Japanese had made tremendous progress but they still remained a minor industrial power in 1941, with an ingot-steel production of 7,600,000 tons, while the United States had an output of 74,000,000 tons in the same year.

The stockpiling attempts were not very successful. The government had ordered the major iron and steel plant, the Yawata plant, to stockpile 3,500,000 tons of iron ore and other materials needed to produce steel. This figure was not reached, and some of the stockpiled iron ore had to be used before the beginning of the war to make up shortages in the supply from overseas. The consumption of steel never followed a workable or informed system even though there had been a fixed price and allotment system set up by the government and industry associations. The leaks in the steel consumption during the years 1938-1941 were caused by the military forces (who needed) no allotment system. Even within the military there were interservice

arguments and bickerings concerning who got the most steel. This interservice rivalry throughout the war played a role in the failure of the steel industry to adequately provide Japan's war machine with materials.

When the war started in December, 1941, the lack of balance between Japan and the mainland was further accentuated. The Japanese steel industry became totally and utterly dependent upon water-borne transportation itself and upon the availability of much greater amounts of iron ore and coal within her sphere of influence. Part of these increased quantities of iron ore and pig iron were needed to replace the scrap iron which had been imported from the United States prior to 1940.

Once the war had started the Allied forces immediately recognized the dilemma that the Japanese war planners had placed themselves in. As Japan's drive for a Co-Prosperity Sphere gained momentum during the first year of the war, it was against her vulnerable raw materials position that allied sanctions were applied. The first serious blow was the scrap embargo by the United States in October, 1940, and in June, 1941, after Japanese forces marched into French Indo-China, the United States and the Allies imposed a complete embargo which deprived Japanese blast furnaces of the high quality iron ores from the Philippines and Malaya.

As a result, the Japanese turned to developing China, especially the Yangtze Valley, as a substitute source for iron ore. At first these endeavors were successful, with iron ore imports from China increasing to 4,000,000 tons by 1942, compared to 1,750,000 tons in 1940. Despite these increases, however, over-all iron ore imports

to Japan in 1941 fell short of the 1940 peak by 600,000 tons and by about 850,000 tons in 1942.

After 1942, Japanese steel production started its downward trend and by 1945 was almost at a complete standstill. The major reason for this was the attack on the flow of raw materials via shipping. The steel industry was totally dependent upon shipping in order to keep its blast furnaces stoked and producing steel. Consequently any problem in shipping was reflected in the steel industry. The Japanese recognized this dependency and attempted countermeasures to alleviate their problems. The following measures were put into effect with varying success:

a. Iron ore production in Japan proper was expanded. This measure was effective if one considers that Japan's domestic iron ore is of very low ferrous content and very difficult to mine. Production rose from 2,800,000 tons in 1942 to better than 4,400,000 tons in 1944.

b. Iron ore production at the Mozan mines in northeastern Korea was to be expanded as rapidly as possible. The ore produced here would require a minimum of transportation and it could move across the comparatively safe Japan Sea. Production increased, with 610,000 tons of 54 percent concentrates going to Japan in 1944 compared to 255,000 tons of 51 percent concentrates in the previous year.

c. Iron sand production and the use of it in sponge iron was to be increased. Iron sand is very plentiful in Japan but is of little use because of the large amounts of impurities it contains. There were 480,000 tons produced in 1944 which represents an increase of only 112,000 tons over that of 1942.

d. The most prominent failure among all the counter-measures tried by the Japanese was the much acclaimed small blast furnace effort. These were to be utilized in China, Inner Mongolia, Korea, and Formosa, near the sources of raw materials. The Japanese felt that in this way transportation could be conserved by shipping pig iron instead of the raw materials which weighed from two to three times as much. From the very first everything went wrong; in relation to rated output and materials consumed, the small blast furnaces were far less economical than large furnaces. There were 117 furnaces built with about 730,000 tons of annual capacity. These furnaces in their peak quarter of production in 1944 reached 86,000 tons of pig iron output.

e. The coking coal and iron-ore production in Hokkaido were to be increased in order to make the steel industry on the island self-sufficient. The Wanishi plant of the Japan Iron Manufacturing Company did, in fact, become almost self-sufficient; but the quality of coke produced with local coal was so poor that the iron output decreased drastically and the resultant pig iron was almost unusable at a nearby armament plant.

The poor results from the foregoing measures were further outlined by the extension of the Allied submarine campaign into the Yellow Sea. Prior to this the movements of raw materials had come directly from China. This direct route was replaced by the movement via rail through Manchukuo, Korea, and across the Shimonoseki Straits. Imports still declined because the rail lines could not handle the increased traffic.

The Japanese steel industry still was not ready to throw in the towel; early in 1945 they decided (finally) to move a large amount of

iron and steel-making equipment to the sources of raw material in Manchukuo, Korea and North China. Some of this equipment reached its destination; some of it was sunk on the way, and at the end of the war part of it was still sitting in crates on the old site. Had it been carried out early in the war, this transfer movement more than likely would have had better results.

With all these countermeasures and their poor results the Japanese steel industry became involved in a vicious circle from which there was no escape. Raw materials shortages caused lower ratios of production to capacity for blast furnaces which, in turn, demanded longer finishing periods in the steel furnaces. The resultant lower-grade and less uniform steel then caused a heavier strain on rolling mill equipment which was already in poor shape.

As the supplies of steel fell below the needs of the nation, administrative controls soon became an object of very bitter dispute. The Cabinet Planning Board in charge of overall planning was dominated by the Army and Navy. But actual administration had been left to the industrialists or Zaibatsu. For obvious reasons their planning was overly optimistic, and when production fell behind it was impossible to satisfy their major customers. As a consequence the Army and Navy operated outside the normal distribution procedures and built their own private stocks of raw materials. In the fall of 1943 the argument was settled in favor of the military with the formation of a Munitions Ministry. Thus a short-term gain in the war-making strength of Japan was offset in the long run by the fact that there still was not enough steel to go around. In 1943 the Army received their peak distribution of steel; afterwards this supply was reduced. The Navy received about

one-fifth of the national total of steel throughout the war.

The Allied forces chose the steel industry as their first target when the air war was brought to the Japanese homeland. Their specific target was the highly critical coking industry. This later was changed when Allied intelligence came to the conclusion that there was too much excess capacity in the steel industry for air raids to have a pronounced short-range gain. As pointed out in the previous chapter, the Allied air strikes had no major direct damage upon the steel plants but did cause damage from spillage on targets near the steel plants. If the war had continued past August, 1945, the damage factor from air and naval bombardment would have been much higher. The Japanese for their part attempted no major relocation process as had the Germans and the Allies had by this time started bombing from a much lower altitude, which would have had more concrete results.

It is a rule that a nation without an assured and plentiful source of iron and steel cannot hope to wage war against a strong opponent for any extended length of time. Despite the fact that she had somewhat successfully expanded her steel-making and production efforts in 1937-1941, Japan approached December 7, 1941, with a capacity to produce crude steel of less than one-eighth the capacity of her adversaries. Her steel industry also was dependent upon water-borne transportation for the quantities of coking coal, iron ore, pig iron and other alloy metals needed for the production of steel. This necessary dependence upon imports cancelled the increase in capacity. The Japanese had hoped and attempted to exploit and utilize the resources of Manchukuo, China and Korea in order to overcome their own serious raw material shortage. In order to do so

it was mandatory that she keep the sea lanes to the continent open. Japan failed to achieve this, and the differences between capacity and production continued to grow worse and worse. This failure to maintain the flow of desperately needed raw materials was the primary cause of the strangling of Japan's iron and steel industry during World War II.

A SELECTED BIBLIOGRAPHY

Books

Allen, G. C. A Short Economic History of Modern Japan, 1867-1937. London: George Allen and Unwin, Ltd., 1946.

_____. Japan: The Hungry Guest. New York: E. P. Dutton and Company, Inc., 1938.

_____. Japanese Industry, Its Recent Development and Present Conditions. New York: Institute of Pacific Relations, 1940.

Barringer, Edwin C. The Story of Scrap. Washington: Institute of Scrap Iron and Steel, Inc., 1954.

Bisson, T. A. Japan's War Economy. New York: Institute of Pacific Relations, 1945.

Borton, Hugh. Japan's Modern Century. New York: Ronald Press Company, 1955.

Broadridge, Seymour. Industrial Dualism in Japan, A Problem of Economic Growth and Structural Change. Chicago: Aldine Publishing Company, 1966.

Butow, Robert J. C. Japan's Decision to Surrender. Stanford: Stanford University Press, 1954.

Carus, Clayton D. and Charles L. McNicholas. Japan, Its Resources and Industries. New York: Harper and Brothers, 1944.

Chamberlin, William Henry. Japan Over Asia. Boston: Little, Brown and Company, 1937.

Cohen, Jerome B. Japan's Economy in War and Reconstruction. Minneapolis: University of Minnesota Press, 1949.

_____. Japan's Postwar Economy. Bloomington: Indiana University Press, 1958.

Dempster, Prue. Japan Advances, A Geographical Study. London: Methuen and Company, Ltd., 1967.

Fairbank, John K. and Edwin O. Reischauer. East Asia The Modern Transformation. Boston: Houghton Mifflin Company, 1965.

Feis, Herbert. Japan Subdued. Princeton: Princeton University Press, 1961.

Fisher, Douglas A. The Epic of Steel. New York: Harper and Row, 1963.

Gleason, Alan H. The State and Economic Enterprise in Japan. Ed. William W. Lockwood. Princeton: Princeton University Press, 1965.

Grajdanzev, Andrew J. Modern Korea. New York: Institute of Pacific Relations, 1944.

Huh, Kyung-Mo. Japan's Trade with Asia: Development Since 1926-Prospects for 1970. New York: Praeger, 1966.

Hunsberger, Warren S. Japan: Lesson in Enterprise. Chicago: Scott, Foresman and Company, 1963.

Ichiro, Nakayama. Industrialization of Japan. Tokyo: Centre for East Asia Cultural Studies, 1963.

Jansen, Marius. Changing Japanese Attitude Towards Modernization. Princeton: Princeton University Press, 1965.

Jones, F. C. Manchuria Since 1931. New York: Oxford University Press, 1949.

_____. Hokkaido, Its Present State of Development and Future Prospects. London: Oxford University Press, 1958.

Liu, Ta-Chung and Kung-Chia Yeh. The Economy of the Chinese Mainland: National Income and Economic Development, 1933-1959. New Jersey: Princeton University Press, 1965.

Lockwood, William W. The Economic Development of Japan, Growth and Structural Change, 1868-1938. Princeton: Princeton University Press, 1954.

Mitchell, Kate L. Japan's Industrial Strength. New York: Alfred A. Knopf, 1942.

Miyohei, Shinohara. Growth and Cycles in the Japanese Economy. Tokyo: Kinokuniya Bookstore Company, Ltd., 1962.

Moulton, Harold G. Japan: An Economic and Financial Appraisal. Washington: The Brookings Institution, 1931.

Moulton, Harold G, and Louis Marlio. The Control of Germany and Japan. Washington: The Brookings Institution, 1944.

Norman, E. Herbert. Japan's Emergence as a Modern State, Political and Economic Problems of the Meiji Period. New York: Institute of Pacific Relations, 1940.

O'Connor, Harvey. Steel-Dictator. New York: The John Day Company, 1935.

Orchard, John E. Japan's Economic Position, The Progress of Industrialization. New York: McGraw-Hill Book Company, 1930.

Rosousky, Henry. Capital Formation in Japan, 1868-1940. New York: Free Press of Glencoe, 1961.

Saito, Hirosi. Japan's Policies and Purposes, Selections from Recent Addresses and Writings. Boston: Marshall Jones Company, 1935.

Schumpeter, Elizabeth B. et al. The Industrialization of Japan and Manchukuo, 1930-1940: Population, Raw Materials and Industry. New York: Macmillian Company, 1940.

Tanin, O. and E. Yohan. When Japan Goes to War. New York: Vanguard Press, 1936.

Tsuru, Shigeto. Essays on Japanese Economy. Tokyo: Kinokuniya Bookstore Company, Ltd., 1958.

Utley, Freda. Japan's Feet of Clay. New York: W. W. Norton and Company, 1937.

Wertime, Theodore A. The Coming of the Age of Steel. Chicago: University of Chicago Press, 1962.

Wu, Yuan-Li. Economic Development and the Use of Energy Resources in Communist China. New York: Frederick A. Praeger, 1963.

_____. The Steel Industry in Communist China. New York: Frederick A. Praeger, 1965.

Japan's Decision for War, Records of the 1941 Policy Conferences. Ed. Nobutaka Ike. Stanford: Stanford University Press, 1967.

Articles

Ashizawa, Oyoshi. "Iron and Steel Industry Reconstructed." Contemporary Japan, XXIV (December, 1956), 276-277.

Bains, H. F. "Manchuria, A Key Area." Foreign Affairs, XXIV (October, 1946), 113-117.

Coox, Alvin D. "Showa 13: Year of the Tiger." The Japanese Image, IX (September, 1965), 61-69.

Edwards, Corwin D. "Dissolution of Japanese Combines." Pacific Affairs, XIX (September, 1946), 227-240.

Hoo, T. K. "Some Economic Documents Relating to the Genesis of the Japanese-Sponsored Regime in North China." Far Eastern Quarterly, VI (November, 1946), 65-68.

Kramer, Irving I. "Japan in Manchuria." Contemporary Japan, XXIII (January, 1954), 71-76.

Government Publications

Edwards, Corwin D. Report of the Mission on Japanese Combines. Washington: United States Department of State, Far Eastern Series, 1946.

General Headquarters, Supreme Commander for the Allied Powers. Natural Resources of Japan. Tokyo: Natural Resources Section, 1947.

_____. Japanese Trade Patterns, 1930-1934. Tokyo: Economic and Scientific Section, Programs and Statistics Division, 1952.

_____. Selected Data on the Occupation of Japan. Tokyo: Far East Command, 1950.

Judgment International Military Tribunal for the Far East. The Military Domination of Japan and Preparation for War. 1948.

Pauley, Edwin W. Reports on Japanese Assets in Manchuria to the President of the United States, July, 1946. Washington: United States Department of State, 1946.

Reports of General MacArthur. Japanese Operations in the Southwest Pacific Area. Washington: United States Government Printing Office, 1966.

Roscoe, Theodore. United States Submarine Operations in World War II. Annapolis: United States Naval Institute, 1949.

Supreme Commander for the Allied Powers. The Coal Industry of Japan in Recent Years. Tokyo: Natural Resources Section, 1946.

Suagee, J. T. and Major Nels W. Stalheim. The Impact of the War and Japanese Imperialism Upon the Economic and Political Rehabilitation of Korea. Washington: Civil Affairs Division, War Department, 1947.

Technical Industrial Disarmament Committee. Study by Interagency Subcommittee on the Treatment of German Iron and Steel Industry from the Standpoint of International Security. Washington: Enemy Branch, Foreign Economic Administration, 1945.

United Nations. Coal and Iron Ore Resources of Asia and the Far East. Bangkok: Mineral Resources Development Series, 1952.

_____. Statistical Yearbook, 1948. New York: Statistical Office of the United Nations, 1949.

United States Department of Interior, Bureau of Mines. Minerals Yearbook, 1937. Ed. H. H. Hughes. Washington: United States Printing Office, 1938.

_____. Minerals Yearbook, 1941. Ed. F. M. Shore. Washington: United States Printing Office, 1942.

United States National Military Establishment, Department of the Army. Iron & Steel Metallurgy of the Japanese Empire. Washington: Natural Resources Section, 1947.

United States Strategic Bombing Survey No. 1. Summary Report (Pacific War). Washington: United States Government Printing Office, 1946.

_____. No. 14. The Effects of Strategic Bombing on Japanese Morale. Washington: U. S. Government Printing Office, 1947.

_____. No. 36. Coal and Metals in Japan's War Economy. Washington: U. S. Government Printing Office, 1947.

_____. No. 39. The Japanese Machine Building Industry. Washington: U. S. Government Printing Office, 1946.

_____. No. 42. The Japanese Wartime Standard of Living and Utilization of Manpower. Washington: U. S. Government Printing Office, 1946.

_____. No. 43. Japanese War Production Industries. Washington: U. S. Government Printing Office, 1946.

_____. No. 46. Japanese Naval Shipbuilding. Washington: U. S. Government Printing Office, 1946.

_____. No. 47. Japanese Motor Vehicle Industry. Washington: U. S. Government Printing Office, 1946.

_____. No. 48. Japanese Merchant Shipbuilding. Washington: U. S. Government Printing Office, 1947.

_____. No. 53. The Effects of Strategic Bombing on Japan's War Economy. Washington: U. S. Government Printing Office, 1946.

_____. No. 54. The War Against Japanese Transportation, 1941-1945. Washington: U. S. Government Printing Office, 1947.

_____. No. 55. Effects of Air Attack On Japanese Urban Economy (Summary Report). Washington: U.S. Government Printing Office, 1946.

_____. No. 58. Effects of Air Attack on Osaka-Kobe-Kyoto. Washington: U. S. Government Printing Office, 1946.

_____. No. 72. The Interrogation of Japanese Officials (Vols. I and II). Washington: U. S. Government Printing Office, 1946.

_____. No. 107. Evaluation of Photographic Intelligence in the Japanese Homeland, Part X, Roads and Railroads. Washington: U. S. Government Printing Office, 1947.

Economic Planning Board. National Income and National Economic Accounts of Japan, 1930-1955. Tokyo: 1956.

Mitsubishi. The Economic Situation in Japan During 1938. Tokyo: Economic Research Bureau, 1939.

Geological Survey of Japan. Geology and Mineral Resources of Japan. Tokyo: Dai-Nippon Printing Company, Ltd., 1956.

South Korea Interim Government. Industrial Labor Force and Wage Survey of South Korea, November, 1946. Seoul: National Economic Board, 1948.

Industrial Sources

Iron and Steel Works of the World. Ed. H. G. Cordero. London: Quin Pres, Ltd., 1962.

Osborne, A. K. An Encyclopedia of the Iron and Steel Industry. London: Technical Press, Ltd., 1967.

Tiemann, H. P. Iron and Steel. New York: 1933.

Newspapers and Yearbooks

Japan Times and Advertiser

North China Herald

China Yearbook, 1932. Liechtenstein: Kraus Reprint, 1969.

China Yearbook, 1938. Liechtenstein: Kraus Reprint, 1969.

Manchoukuo Year Book, 1942. Hsinking: Manchoukuo Year Book Company, 1942.

VITA

Richard Lee Krause

Candidate for the Degree of

Master of Arts

Thesis: THE IRON AND STEEL INDUSTRY IN WARTIME JAPAN, 1931-1945

Major Field: History

Biographical:

Personal Data: Born in Oklahoma City, Oklahoma, February 26, 1940, the son of Mr. and Mrs. R. R. Krause.

Education: Graduated from Ada High School, Ada, Oklahoma, in May, 1957; attended St. Gregory's College, Shawnee, Oklahoma in 1957 and 1958; received Bachelor of Arts degree from East Central State College, Ada, Oklahoma, in 1968, with a major in History.

Professional Experience: History instructor, Tulsa Junior College, Tulsa, Oklahoma, 1970-present.