IRON AND STEEL MATERIALS RESOURCES

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COLONEL FLYNN: General Mundy, General Houseman, Gentlemen: I feel a little bit out of character up here this morning. My usual routine in this auditorium is one of introducer, moderator, and listener. It reminds me of the afterdinner speaker who rose to the occasion with the well-known phrase, "Our speaker this evening needs no introduction. He didn't show up."

To turn to the serious side of this morning's business and my topic, materials resources for the production of iron and steel, I propose to cover the position of iron and steel in our economy, and, for that matter, in any modern industrial economy. I will cover capacity and production, and the iron and steelmaking processes, which consume, of course, iron ore, coking coal, limestone, and the additive metals, which will be handled in that order.

I can't stress too much the tremendous importance of iron and steel to our economy. We can make a real case out of using the steel yardstick as a measure of economic growth. Just think of it. Are there many measures available to us to better measure economic growth than steel production and capacity? You are well aware of the vast strides made by our steel industry since the horse-and-buggy days of the turn of the century, but, with your indulgence, and for the benefit of some, let's briefly review steel capacity and production of the United States and of the rest of the world.

CHART

This chart reflects the tremendous growth in steel capacity from the turn of the century, when capacity was just over 20 million tons, to the present time, as measured by the upper line. At the beginning of World War 1 capacity had doubled, and, by the end of World War I, it reached 58 million tons. Parenthetically, I might add that this is where the Soviet Union stands today--58 million tons, and this is where we were at the end of World War I.

It doubled again in World War II and then it went on up very speedily to where we are today, just under 150 million tons. While steel capacity increased very steadily, steel production, as measured by the lower line and the blue area, was much more erratic, with many peaks and valleys.

At the turn of the century steel production was just over 10 million tons. The World War I peak was 50 million tons. In the roaring twenties it hit 62, and then, at the depth of the great depression, it went down to 14 million tons, which was not even 20 percent of total capacity. It then made a good recovery and, with a few ups and downs, reached a record year of 117 million tons in 1955. Owing to the 1957-58 recession, it dropped down to a poor showing of 84 million tons last year. This year steel production was headed for another record. The first six month's production was just about 60 or somewhat more, but the recent steel strike of 116 days took care of any idea of a new record this year.

Before I leave this chart, it is significant to note that only once in our history did steel production and capacity come together--in 1951 during the Korean War. This is for an annual average. Of course steel production has been 100 percent of capacity on many occasions, but only for one month or quarter-year periods. But, for an annual average, this is the only time in our history that they have come together. We came close during each of the two World Wars.

In this regard we have a cushion which Russia, for the time being, at least, appears to lack. Their production and capacity over the years have been right together.

Let's now take a world view of productive capacity and output.

CHART

World steel capacity is now at 372 million tons. How do the nations of the world share in that capacity? The steelmaking capacity of the United States and the rest of the free world is 285 million tons--the lion's share--while that of the Soviet bloc is only 87 million tons.

CHART

As far as steel growth is concerned, the steelmaking capacity of the United States and the rest of the free world has increased 55 million tons since the year 1955. I have taken this year because we have had worldwide accurate data since 1955. The total Soviet bloc increase is but 19 million tons.

CHART

Capacity is one thing; production is another. The total world steel production has averaged over the past three years 310 million tons, which is about 85 percent capacity on a worldwide basis. Again, the United States and the rest of the free world enjoy the lion's share of this production--230 million tons--whereas the share of the Soviet bloc is only 80 million tons.

CHART

As far as production increase is concerned, that of the free world over the past decade--again using averages for 1947-49 and 1956-58--is 90 million tons. That of the Soviet bloc is 53 million tons. A significant figure here is the tremendous increase of the other free world nations, which is indeed a tribute to the success of the Iron and Steel Community.

It would be well to conclude this brief review of steel capacity and production with an even briefer resume of the production processes which consumethe bulk of the raw materials required to produce iron and steel. I don't propose to cover at length the manufacture of iron and steel, but I do feel that a few words are in order to set the stage for a full discussion of the raw materials involved.

CHART

The basic conversion processes cover ironmaking and steel making. Over 2.5 tons of raw materials are used to produce 1 ingot ton of steel and, with an annual average production of steel of over 100 million tons, that means that we are consuming over a quater-billion tons of raw materials every year. These materials are consumed by what I like to call the ironmaking furnaces and the steelmaking furnaces. The ironmaking furnace is the ten-story blast furnace shown here. We charge or feed in carefully measured quantities of iron ore, limestone, and coke in the top of the blast furnace via the skip jack shown here at the left. Tremendous colums of air, heated to a temperature of 1200 $^{\circ}$F. are added. These cause the coke to ignite and burn. The iron ore melts and forms a molten pool at the base of the furnace. The limestone melts, too, and it merges with the impurities in the molten iron and forms a slag pool at the top of the iron, which is drawn off into this slag ladle.

The pig is drawn after each heat into a hot metal car, which is nothing more than a giant thermos jug lined with refractory brick. It can be cast right into pig iron for shipment to foundries or to steel plants which don't have a blast furnace operation. But the normal practice is to hold it or store it until it's time to pour it into the steelmaking furnaces.

CHART

These are the steelmaking furnaces, the open hearth, the Bessemer, and the electric. There is also a fourth furnace, a very efficient furnace, too, and brand new to the industry, called the oxygen furnace. Those of you who visit Pittsburgh will be privileged to see the two largest oxygen furnaces in use today at the Jones & Laughlin plant at Aliquippa.

The open hearth furnace is still the granddaddy of them all, producing 90 percent of all the steel made in this country today. It is theoretically possible to charge 100 percent scrap into the open hearth, 100 percent pig iron, or any variation of pig iron and scrap. The normal charge is 60 percent iron and 40 percent scrap, and this usually depends on the price of scrap, the objective always being to get the lowest price steel consistent with the quality desired.

Of the scrap used in the furnace, generally half of it is home scrap, scrap that is waste within the steel plant itself, and it is recycled through the steelmaking process. The other half is purchased scrap or dealer scrap.

In the open hearth, limestone is put in first; then the scrap is charged into the furnace. After the scrap melts the molten iron is poured in. We now come to an additive metal, manganese, which is now added to the mix. The function of manganese is twofold. First, it gives the steel and added strength, and therefore it is performing as an alloy. Second, it functions as a purging agent to remove certain impurities from the steel. There is no known substitute for manganese. Just as steel is fundamental to our economy, manganese is essential to steel.

The final product of the open hearth is a carbon or a low-alloy steel.

I'll skip the Bessemer converter. It is still in use and it has been of tremendous importance over the past years, but its usefulness is greatly diminishing, primarily because of its inflexibility. It just won't use a scrap. The total production of Bessemers in this country today is running only about 2 or 3 percent of the total production.

The electric furnace is the thoroughbred of the industry. Because of the ability of control the intense heat within the electric furnace, it is possible to make steels that just can't be made any other way. These are the high-temperature, heat-resistant steels which we use for tools, bearings, and jet engine parts. This production represents about 6 percent of total steel production in the country.

This morning, then, we have put the spotlight on steel as a yardstick of economic growth. We have taken a good, solid look at steel capacity and production in the United States and in the rest of the world. In our brief discussion of the processes involved in converting raw materials to iron and then to steel, we have hit on the major raw-material resources required--iron ore, coking coal, limestone, maganese, and, of course, there are the other additive metals.

Let's now examine the United States and the world resources outlook for these materials, and also discuss the extent of the United States' dependence on overseas sources.

The most important raw material is iron ore. Of the 2.5 tons of raw materials required to produce one ton of ingot steel, over one ton is iron ore. Only 10 years ago we produced over one-half of the world's output. In 1957 our production of iron ore didn't drop, but our production of 100 million tons represented only one-fourth of the world's output.

I thought I would be able to announce to you this morning that we are the world's largest producer of iron ore. We have been for years and years, but, unfortunately, I received a late report last week from the Bureau of Mines which pushed us into second place. The Soviet Union today is the world's largest producer of iron ore.

In 1958 we produced only 69 million tons in this country, which was but 17 percent of the total world production. The Soviet Union's production of over 80 million tons represented 22 percent.

We are, however, the world's largest consumer of iron ore. We consume one-third of the world's output, and today we are also the world's largest importer of iron ore.

CHART

This chart provides 1957 estimates of iron ore reserves in the United States. I have divided my data regionally. We have five ore-producing regions in the country. First and foremost, of course, is our Lake Superior region, the States of Minnesota, Michigan, and Wisconsin, which produce and which have reserves which are four times those of the other regions combined.

The Southeast Region ranks second, and this, for the most part, comprises just the State of Alabama. There are some iron-ore deposits in the fringe States, but most of the iron ore is in Alabama. I might add that this is the one spot in the country where iron ore, limestone, and coal coincide geographically.

The Northeast Region consists of the States of New York, Pennsylvania, New Jersey, and a few others. We have the Benson Mines in New York, the Cornwall district in Pennsylvania, and the Oxford district in New Jersey.

You note that we then drop off to relatively insignificant reserves, which are for the most part in Utah and California, in the Western Region, which are important to local steel-producing complexes on the west coast.

You will note the Fe divisions. Fe of course means iron. I have shown in red the reserves of high-grade ores, those containing more than 50 percent iron. For blast furnace use, the ore must be greater than 50 percent metallic iron. The best of the ores range from 22 to 45 percent. These are the lean or the low-grade ores which must be treated or upgraded by one or more processes which are known within the trade as beneficiation. In the old days beneficiation amounted to no more than hand-sorting or washing. Today it involves complicated treatment processes which are designed to remove the worthless matter from the ore and to increase the iron content of the final product.

The taconite development on the Mesabi and the jasper development in Michigan are dramatic examples of taking a heretofore noncommercial, worthless rock, containing but 22 to 35 percent iron ore, and converting it to extremely high-grade iron ore pellets which contain plus or minus 65 percent iron ore. This will be discussed later, and you'll see a very excellent film at 10:30 on taconite development.

Reserves are those which have been proved by drilling or geologic exploration. These, listed as a potential, are estimates made by expert geologists. The figures on this chart which are of primary interest to us are these grand totals. We have close to 3 billion tons of high-grade reserves left in the United States, and in our history we have consumed close to 4 billion tons of ore. Just a little easy arithmetic on your part will indicate to you the life of these reserves.

The low-grade ores, which range from 22 to 45 percent iron, are represented by a very considerable 70 billion tons. These are the ores which will keep our blast furnaces operating into the remote future, particularly from the concentration of low-grade taconites and jaspers in Minnesota and Michigan.

For years the Lake Superior region contributed, roughly, 80 percent of all the iron ore requirements of the United States steel industry. Recently, Lake Superior production has dropped to approximately 60 percent of total U.S. requirements, and the difference has been made up by imports. This 60 percent, however, still represents 80 percent of all of the iron ore produced in the United States.

CHART

The tremendous importance of the Lake Superior iron ranges, such as the Mesabi, the Vermilion, and the Cuyuna, and the upper Michigan ranges of Marquette and Menominee, are vividly portrayed on this map. It shows the flow of Lake Superior ores through the Lake to the steel complexes at Gary, Cleveland, Pittsburgh, Buffalo, and so forth.

Over 80 million tons of ore fill this wide red line in a normal year. If you were to load that iron ore into a single train of standard ore cars, it would reach a length of 6,600 miles. Started in Duluth, it would terminate in Peiping, China. Brother, that's a lot of ore!

Because of our very considerable dependence on Lake Superior ores and the dwindling resources of high-grade, readily accessible ores in this district, we must look now to other sources of iron ore to sustain our industry in the future. Many studies have been made of future iron ore requirements and sources of supply. I like this one.

CHART

It has appeared in many recent iron and steel publications and it is an estimate made by experts--mining engineers, steel plant executives, and geologist. This upper black line is a projection of our composite requirements to meet the needs of industry through 1988, and it is an estimate made by steel plant executives.

The seven irregular blocks indicate the sources of our iron ore over the next 25 or 30 years. Blocks 1 to 5 are our domestic sources, and 6 and 7 are necessary import ores. Blocks 1 to 3 show the dwindling resources of our high-grade ores from the Lake Superior region, which I have already referred to. Block 4 shows a really good expansion of taconite concentrates from low-grade ores. Block 5 shows a slight increase and then relative stability for the other four regions.

Domestically, then, the answer to our problem lies in Block 4, the production of high-grade concentrates from low-grade ores, and that is nothing but this process here on a tremendous, multimillion-dollar scale. In that regard we can be mighty thankful for the farsighted men like Professor E. W. Davis of the Mines Experiment Station of the University of Minnesota, who made this process not just a potential but a reality.

The second answer to the problem of tomorrow's ore lies in the import of ores from foreign sources. Note the tremendous expansion of expected imports from Canada and a relatively modest expansion of ores from countries other than Canada. Obviously, as new deposits of iron ore are discovered in the world, the lines between blocks 6 and 7 could shift, meaning more ores from Canada and less from the rest of the world, or vice versa.

CHART

Other than Canada there are three main sources of ore. They are Northern Sweden, West Africa, and South America. Swedish ore is relatively insignificant from a tonnage point of view. In Africa iron ore activity is currently centered in Liberia, from whom we import in excess of a million tons on an annual basis. Liberian capacity is expected to increase to 10 million tons by 1962, and we can count on a large share of this expansion.

Iron ore is also being developed in French Northwest Africa, in Mauritania, and it is being mined in Algeria. This ore, however, I believe, will find its way into the European steel complex.

In South America all the known deposits of iron ore on both the east and the west coasts are under very active study. Venezuela is our most important foreign source of iron ore, and we are currently importing about 15 million tons a year of really high-grade ore from Venezuela. The potential is double and even triple that figure. On the west coast we are now importing over 3 million tons a year from Peru. Its output is expected to double. The same is true of Chile, but a portion of its expansion is expected to go to Japan.

We are importing lesser tonnages from Brazil at present, but its deposits are being very actively explored.

By merely viewing the map, I think that you will agree with me that I need say little concerning the vulnerability of sea lanes in the event of a national emergency which would pertain to all these countries that I have mentioned, with the exception of Canada. In researching Canadian iron deposits, I was just a little more than amazed to learn that just 20 years ago Canada was conspicuously absent from the ranks of iron-ore producing nations. In fact, it was in 1939 in Ontario that iron-ore production was resumed after a period of 15 years of total inactivity. Higher ore prices and World War II were the initial stimuli. The discovery and development of iron ore in the Labrador-Quebec area, an area which hadn't produced one pound of ore prior to 1954, and the opening of the St. Lawrence Seaway combined to make Canada the key factor in the answer to the problem of tomorrow's ore.

Canada is currently exporting close to 20 million tons on an annual basis to the United States and Europe, and its exports are expected to increase to 35 million tons by 1965 from expansion programs currently under way. Canada has the reserves to double and even triple this production in the next 25 years.

So, from a continental point of view--and I think that for many of these items a continental point of view is of real importance to us--vulnerable sea lanes from South America and from Africa should be of much less concern to us.

In sum, iron ore supplies are more than ample for the immediate future. For future generations, I feel we will have to call more and more on the production of high-grade concentrates from low-grade ores.

Also, over the long run, our dependence on foreign ore from Canada, Africa, and South America will certainly increase.

Now for a look at Russian iron ore recources. Russia, as I mentioned before, took over first place in the ranks of iron-ore producing countries in 1958. In addition to being self-sufficient, she exports iron ore to the satellites, notably to Poland and to Czechoslovakia. Russia has abundant iron ore reserves. Her potential reserves are estimated to be greater than those of any other nation. Much are of a lower grade, but, with improved beneficiation processes, Russia, like the United States, will never suffer from the lack of blast furnace iron.

Let's now turn to coal. The main use of coal is to produce a high-strength coke for blast furnaces. It is also important as a producer of energy for the electric furnaces. Coking coal should have these characteristics: First, it should have a low volatile content so that it burns slowly. Second, it should have a low ash content. Third, it should have technical characteristics which will produce a high-strength coke.

Both the United States and Russia have abundant coal reserves. We are said to have reserves of over 1 trillion tons of bituminous coal alone in this country, and over half of these are recoverable from present-day mining techniques. Russia's reserves are second only to ours and she controls over three-fourths of the coal deposits of Europe. Neither the United States nor Russia has a coal problem. Both are self-sufficient and both are net exporters of coal.

Coal with the necessary characteristics that I have mentioned, however, might some day present a problem, but I am sure that with research processes will be developed to allow a greater use of high-volatile coal as a blend with, or, perhaps, even as a substitute for, low-volatile coal.

I have covered the function of limestone in the manufacture of iron and steel. As you recall, its primary function is to remove silica from the iron in the blast furnace. In the steelmaking furnace it removes the small remaining quantity of silica from the steel. It also removes phosphorus. Limestone is of very common occurrence throughout the world. Adequate resources are no problem and most steel companies have captive sources in close proximity to the producing areas.

Let's now proceed to the additive metals.

CHART

These alloying metals were used in the quantities shown in the manufacture of steel in 1958. Those shown in blue are the metals which we brought in from foreign sources, and those shown in yellow are those which we produced domestically.

I covered the functions of manganese earlier. You recall my mentioning that there is no substitute for manganese in steelmaking. For every ton of steel produced, an average of 13 pounds of manganese is required. As far as the United States is concerned, we are definitely a have-not Nation. The same can be said of Canada. We don't know of a single commercial deposit there. We are heavily dependent on India, Africa, and Latin America. It is a critical item on the stockpile list, and, in the event of an emergency, the stockpile would come into play.

Russia, on the other hand, has vast sources of manganese. She is the world's largest producer. She produces some 40 or 45 percent of the total world's production.

Because it is critical, Colonel Leidy has chosen it as an OP topic, and I am counting on him to give you the complete run-down on manganese from this platform in the next few weeks.

Chrome ore is an important alloying element used in the hardening of steels. Again, here, we have a very pathetic picture. All of the chrome produced in all of the Western Hemisphere would scarcely make one small dent in the total consumption of the United States on a one-year basis. Our principal sources of chrome ore are Turkey, the Philippines and South Africa.

In the event of an emergency, again the stockpile must meet our requirements.

Russia ranks fifth among the chromite-producing countries of the world. She appears to be in a good position for the future.

Nickel is another important alloying element and it is used particularly in our stainless steels and for heavy armor plate. Canada produces close to two-thirds of the world's output of nickel, just north of us, in the Sudbury District. Russia, New Caledonia, and Cuba account for most of the remaining one-third. From a continental point of view, we we are not a have-not Nation. Our good neighbor to the north will see to that.

In sum, we are in an excellent position with respect to the natural resources upon which our iron and steel industry depends, with only, a relatively few minor problems which research, the stockpile, and the continental point of view readily resolve. We are far out front, although the gap is narrowing, and in spite of talk of Russia's catching up and eventually outdistancing us, I am convinced that with the proper policies, inborn ingenuity, and technological improvements that are bound to come we will maintain our advantage, not just for a decade or a generation but for all time and forever.

Thank you.

CAPTAIN HUMES: Colonel Flynn is ready for your questions.

QUESTION: Paul, I noticed that you didn't mention the water problem in your steelmaking processes. We have been led to believe that this is becoming a critical problem. I wonder if you could touch on that in some of your steel-producing areas.

COLONEL FLYNN: Yes. Two items which I didn't mention and which are both natural resources and are heavily involved in steelmaking are air and water, two items which take pretty much for granted.

Perhaps I can best describe the water problem by citing two examples, one a steel-production example and one a mining example, where water in tremendous quantities come into play. Just north of here, at Sparrows Point, we have the largest steel company in the world, the Bethelehem Steel Corporation plant, 12 miles from Baltimore. They produce over 8 million tons of steel a year, which is over 12 tons of steel a minute. Now, to produce this steel they use 800 millions gallons of water every day, and that's a lot of water. That is four times the daily consumption of water by the City of Baltimore.

An interesting example of industrial and civic cooperation occurred up there. Back in 1940 the city discharged its effluent in one of the nearby rivers, and, obviously, the people living along this river complained vigorously. A farsighted Bethlehem Steel engineer developed a very simple chemical clarification process and today they take 50 million tons a day of this effluent and use it in the steelmaking process at Sparrows Point.

I recently had lunch with Mr. Armstrong from the World Bank, who went to Africa and surveyed, in company with Dr. Grover J. Holt of Cleveland Cliffs, an iron deposit in French Mauritania which I referred to during my talk. There the French, Italians, Germans, and British are developing a range of very high-grade ore which amounts to over 100 million tons. They plan to develop this over a period of the next 20 years. Then the whole thing will peter out. There are billions of tons of low-grade ore in this deposit, but, with no water and no known dry process of beneficiation, it is doubtful that they'll ever do anything with it.

QUESTION: You referred to the brand new figure from the Bureau of Mines on the comparison of U.S. and U.S.S.R. iron ore production. How do we compare as to the yield from the type of ore? Is there any show on that?

COLONEL FLYNN: That figure wasn't given. This release from the Bureau of Mines was in Saturday's paper. Many of you perhaps read it, on 10 November in The Washington Post and Times Hearld. It listed some 63 or 69 minerals. Of those the United States is still in first place for 29, Russia is in first place for, I think, 8, Canada for 3, and the other first places are scattered.

The item of interest was the iron ore. But that doesn't alarm me too much, because we produced only 84 million tons of steel last year because of the recession, and we didn't have the iron ore requirement. If it hadn't been for the recession, we'd have required more steel and more iron ore. This year we've had the strike. Next year, in 1960, I think you'll see the United States back in first place on the production of iron ore.

On yield I don't have any data.

QUESTION: On that matter of water, we run into these staggering figures on the use of water, and immediately wonder where all this water is going to come from. Are these consumption figures or are they use figures? In other words, there is such a thing as using water but having it left over for other use. Then there's the other side. Consumption means the water is gone forever. I think your figures are use figures and not consumption figures.

COLONEL FLYNN: That's right. These are use figures. A large percentage of the water used is treated and recycled through the steel plant. You are right. I'm glad you brought that up.

QUESTION: In your manganese supplies that are needed, in the event of overseas supplies being cut off, we go to the stockpile. Do you have any idea of the amount the companies stockpile on their own? They must keep quite a reserve. Do you have anything on that?

COLONEL FLYNN: I don't believe that the steel companies are stockpiling for reasons of national security. I believe that they are maintaining a current stockpile of all these materials that they require to meet the needs of their annual production. I have no knowledge of their stockpiling for reasons of national security, but Dr. Morgan, I believe, will point out to you on Thursday that the stockpile for manganese, at any rate, is right up where it should be, and there is sufficient manganese to carry us through any reasonably long national emergency.

QUESTION: I am interested in how they calculate the capacity figures. It is my understanding that the furnaces have to be down a certain percentage of the time. Are those figures based on what you could do if you didn't put them down, or would this percentage be taken out? That's the question. How do they calculate this capacity? Not once did you mention that they reached full capacity, indicating that they were overusing these furnaces. I am not so sure that this capacity versus production is too significant until you add in this factor.

COLONEL FLYNN: Figures for steelmaking capacity represent net steelmaking capacity after deduction of from 8 to 9 percent for operating time lost for rebuilding, relining, reparing, and holiday shutdowns. This percentage is an average recommended for use by the American Iron and Steel Institute. Now, I didn't want to give you the impression that we never produced at 100 percent of capacity in this country. We produced at 100 percent capacity during the first six months of this year. The point I was trying to make was, on an annual average we have produced at 100 percent capacity for a full year just in 1951, during the Korean War.

QUESTION: How extensive has the search been for new sources of iron ore deposits in this country, as compared, for instance, with the oil search? It seems to me that iron ore ought to be pretty plentiful around the world, since the core of the earth is supposed to be composed of it.

COLONEL FLYNN: Well, iron ore is one of the most abundant minerals in the United States, I believe it is accurate to state that no other region in the world has been more actively geologically explored than the iron ranges and the iron-range regions of Michigan and Minnesota, the Lake Superior district. I believe that the data that we have on known reserves in that area are pretty accurate.

As for the rest of the country, the iron-ore ranges where iron ore occurs naturally have been actively explored, too. I believe they have done a good job on iron-ore exploration in this country.

Now, in the out-of-the-way places in Canada and South America and in other parts of the world, they are coming up with some tremendous deposits of iron ore. Is that about right, Mr. Mote?

MR. MOTE: That is correct.

COLONEL FLYNN: Mr. Mote is our expert in this area.

QUESTION: Could you tell me whether or not the capacity to which you referred a moment ago would involve three-shift operations? If it does involve or doesn't involve three-shift operations, do we have any limiting criteria on our transportation, like barges in the Great Lakes, freight cars, and so forth?

COLONEL FLYNN: This capacity involves three shifts, around-the-clock operations. Our transportation is geared to that type of operation.

The same is true at the iron mines. I was at the Mesabi in June, and one of the most interesting visits I made to the pits was the nighttime operation. The pits looked like one big amusement park, all lit up. They worked around the clock. The only things that shut down during the two night shifts are vehicle maintenance and administration. But the operation is a continuous operation.

The same is true in the steel mills. Administration and maintenance close down for the two nighttime shifts, but the furnaces keep producing around the clock.

QUESTION: I know you have mentioned it sort of indirectly, but isn't steel scrap one of the principal major resources for making steel? Approximately 50 percent of the melt that goes into making steel has to be scrap, as I understand it, or they have to burn it twice. The electric furnace is 100 percent scrap, for example. How do the resources of the United States on scrap compare with the resources of Russia and the Soviet in scrap? We have, as I understand, something over a billion tons of scrap resources in this country, whereas the other countries that haven't used it have very little.

COLONEL FLYNN: You'll get an argument on this from mining engineers and others. It's all semantics. I look upon scrap as a raw material. It's not a natural resource but it is a raw material, I think, in steelmaking. This is semantics.

STUDENT: You add it to our basic resources.

COLONEL FLYNN: Yes. Back in the old days they had the junkies and the horse and team. A lot of these junkies today are really important people in this country. In fact I know one. He calls himself a conservation engineer. He has a daughter and in her circle she refers to her dad as an antique dealer.

But you are right. In the open hearth the ratio is more like 40 percent scrap to the 60 percent iron, rather than 50-50, but, again, this can vary. It is 100 percent in the electric furnace.

We, though, have more reserves and resources of scrap than any nation in the world. The bulk of the scrap is generated from sheet metal works and from automobiles that are junk. We have always been a net export nation as far as scrap is concerned. We have for years exported scrap to Japan.

Scrap is important, when you stop to think that a blast furnace which cost $7.5 million 20 years ago today costs $25 million, and labor--20 years ago blast furnace operators received about 65 cents an hour, and now they get $2.95. If we can use more scrap and produce with five blast furnaces what we produced with six before, think of the savings. Scrap doesn't have to go through a blast furnace.

QUESTION: Paul, you pointed out the vulnerability of our sea lanes for the importation of ore. What about the vulnerability of the production plants themselves? It is a pretty concentrated industry, isn't it?

COLONEL FLYNN: May we reserve that question for the production phase? That is on the agenda of the production phase of the Material Management Unit of study.

QUESTION: With the dependence of the U.S. domestic steel industry on iron from the Mesabi Range, and with the strike having shut down the shipments during the major part of the limited shipping season, due to the weather, how is it proposed that our steel industry plans to operate at 100 percent capacity in the early part of 1960?

COLONEL FLYNN: That's a good question. There has been an awful lot in the papers these last several weeks about the shortages of ore that will develop as the result of the strike, but I think too much attention has been given to the ore that hasn't been shipped since the 15th of July, when the strike started, and not enough attention has been given to some of these other things that I think will see the industry through.

Number one: The strike was anticipated, and, therefore, when the strike started, we had unusually large stockpiles of iron ore, due to the extraordinary buildup in anticipation of the strike. Usually your steel industry goes into the winter months with from 40 to 50 million tons of iron ore, stockpiled at the lower lakes and at the plants. When the strike started we had about 35 million tons, because of this extraordinary buildup. In addition, throughout the strike period, we have been bringing foreign ore into the lower lake ports and into the steel plants from Canada. We've moved ore in from South America. We've even moved ore up the Mississippi River to the Granite City plant at St. Louis, and up to Chicago.

This shipping season will end about the first week of December, and, from the time the strike ended until that period, we'll get a little bit of ore into the lower lake ports and into the steel mills. But I don't think we can count on any substantial amount, because time is running out, the crews are scattered, the lakes are rougher, and the channels and the waterways connecting the lakes are bound to freeze up within the next few weeks.

So I would say that, with the unusual buildup that we had, with the foreign ores that were brought in during the strike, and with the few million tons that we'll manage to get in before the freeze-up, it will be a tight squeeze at best, and an expensive one, and the real problem will come next spring in grades of ore on hand at the plants. I think there will be a sufficiency of ore, but the problem will be the right grade of ore at the right place at the right time. I think your problem is going to be on grade of ore and not on a real quantity shortage of ore.

CAPTAIN HUMES: Thank you, Paul, for an excellent lecture.