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THE IRON AND STEEL INDUSTRY OF DULUTH: A STUDY IN LOCATIONAL MALADJUSTMENT

Langdon White and George Primmer

FOR many years the center of population in the United States has been moving westward. Coincident with this movement, consumption of iron and steel has also moved westward. One can understand, therefore, why many students of industry expected much of Duluth when in 1915 the United States Steel Corporation completed its great Minnesota Steel Company plant in that city. While construction was under way, some writers actually asserted: "Pittsburgh is moving west." Yet 21 years later (1936) Pittsburgh remains the undisputed capital of the world's iron and steel industry, whereas Duluth is a negligible producer and a keen disappointment.¹ Why should this be? Is Duluth a victim of circumstance, or is it suffering by reason of locational maladjustment?

THE BEGINNINGS

Duluth's first iron foundry was established in 1870 for the manufacture of railway cars. In 1872 it made 200 cars for the Northern Pacific Railway. It did not make its own pig iron. The city's first blast furnace started operations in 1873; but the enterprise was not profitable, and the plant soon shut down. Another blast furnace, constructed in 1880, also was unsuccessful. From time to time other experiments were made, but not one was profitable. In 1904 smelting for the first time began on a substantial basis. Capitalists interested in mining and shipping iron ore had taken over an old property, modernized it, and started the furnace. They built a coal dock and 50 coke ovens and arranged to supply Duluth and Superior with gas.

It was another decade, however, before there was any suggestion of an important metallurgical future for Duluth. Then, in 1915, the United States Steel Corporation constructed its \$20,000,000 plant. In analyzing the reasons for this location we find an excellent example of the dangers of overweighting the purely geographical argument. It appears that public sentiment in Minnesota, whence comes more than two-thirds of the ore mined in the Lake Superior region, has, since ore was discovered in the ranges, firmly believed that Duluth could be and should be one of the country's great centers of iron and steel manufacture. It was argued that it was bad economy for the mining industry to send millions of tons of ore down the lakes each year, leaving in the place of a rich heritage vast holes in the ground. Ore shipped down the lakes means only a dollar or so a ton to the

¹ Chicago gains steadily on Pittsburgh and ultimately will rank first; at the present time Pittsburgh has 23.3 per cent of the country's steel-ingot capacity, and Chicago follows closely with 22.6 per cent.

state; when converted into iron and steel, however, in Cleveland, Detroit, Gary, Pittsburgh, and other districts in the lower lakes region, it means from \$8.00 to \$200.00 and even more. To get an iron and steel plant, therefore, the state threatened to introduce new tax measures.² The local point of view was thus expressed:

The entire tonnage tax fight grew out of the feeling that it was not right that all of Minnesota's iron ore should be shipped out of the state without a proper portion of it being worked up within the commonwealth, to give employment to the workmen of this state, and to give the consumer of the Northwest the privilege of cheap and convenient access to a steel-producing point.³

Hence, as a means of preventing the threatened taxation, the so-called promise or gentleman's agreement was entered into—to trade a plant for the lack of unfavorable legislation.

In many respects the metallurgical industry, which Duluth citizens supposed would supply economically the extensive territory readily reached from that city, has proved disappointing. The prices at which the Steel Corporation offered locally manufactured products did not satisfy the people of Duluth. As early as 1917 they requested the corporation to make Duluth a basing point for steel billets and all primary mill products and to maintain the price the same as the Pittsburgh base. At that time the differential was about \$6.00 a ton; by 1921 it had more than doubled. With prices on a more equitable basis, Duluth argued, great expansion of manufacturing industries using steel as a raw material would result about the head of Lake Superior. That this optimism was unfounded seems proved now by the fact that the abolition of Pittsburgh plus⁴ did not result in any notable change in the relative positions of the producing districts. Duluth-district factories showed no appreciable increase in steel consumption, and the steel plant itself showed no marked activity. It has been stated that the total demands for steel of the territory tributary to the city would not keep the plant busy three months in the year.

SITUATION AND SITE

It is safe to say that, since American furnaces depend primarily on Lake Superior ore, the best general location for iron and steel

² Taxation continues as a vital issue between the state of Minnesota and the operators. Thus the tax for the two years 1931 and 1932 averaged \$1.86 for each ton shipped beyond the borders of the state. This actually exceeds the labor cost of production and amounts to one-quarter of the market value of the ore at the mines. The National Industrial Conference Board found that the tax on the Minnesota iron-mining industry is about ten times as great proportionately as the tax on the American mining industry as a whole.

³ *Duluth Evening Herald*, April 2, 1907, p. 8.

⁴ By "Pittsburgh plus" is meant the practice of quoting steel prices on a Pittsburgh base plus the freight. It came about as a natural economic outgrowth of Pittsburgh's dominance in the steel industry. Pittsburgh tonnage offered to all parts of the country made the market, and the entire industry fell into line. In 1924 the Federal Trade Commission issued its famous edict to the United States Steel Corporation to "cease selling in the course of interstate commerce rolled steel products upon any other basing point than that where the products are manufactured or from which they are shipped."

manufacture is somewhere on the Great Lakes. This does not mean, however, that all places on the lakes are equally well situated; it is obvious that location on Lake Superior is far less strategic than location on Lake Erie or Lake Michigan. There are few ideal industrial locations anywhere; usually there are counterbalancing advantages and disadvantages.

Duluth lies strategically at the west end of Lake Superior. Among its outstanding attributes for industry are: (1) It lies at the head of navigation on the Great Lakes. (2) It is one of two lake cities having an excellent natural harbor. (3) It is less than 100 miles from the world's most productive iron mines. (4) It can procure coal and limestone cheaply as return cargo. (5) It has the deepest Great Lakes harbor (30 feet in the entrance channel, 22 feet in the anchorage area, and 20 feet in the inner channels). (6) In commerce (receipts and shipments) it stands first among Great Lakes ports. (7) It is a very important railway center. (8) It possesses an adequate supply of good industrial water. (9) It has an abundance of room (hundreds of acres for expansion and future growth).

Only two companies, engaged in the primary industry, are located in Duluth—the Minnesota Steel Company, a subsidiary of the United States Steel Corporation, and the Zenith Furnace Company (Interlake Iron Corporation), a local manufacturer of pig iron.

The plant of the Minnesota Steel Company is at Morgan Park on a 1500-acre tract 9 miles southwest of Duluth, where the mouth of the St. Louis River becomes the head of navigation on the

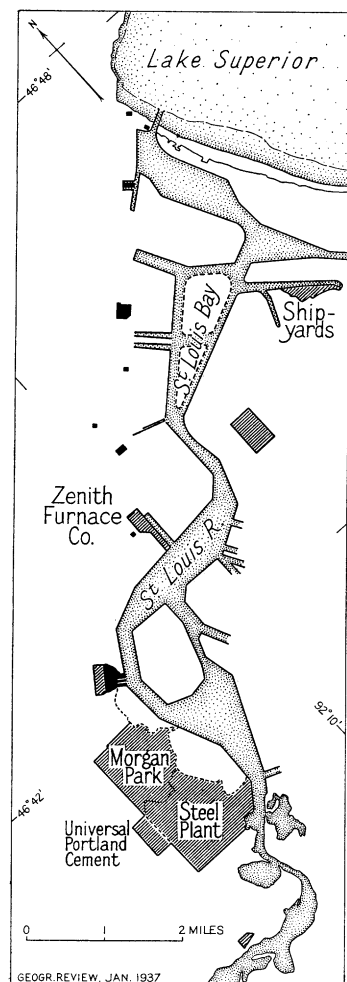


FIG. 1.—The lower St. Louis River, Duluth, showing iron and steel producing (Steel Plant and Zenith Furnace Co.) and consuming plants. Diagonal ruling distinguishes those plants whose areas are not entirely occupied by buildings.

Great Lakes (Fig. 1). Unfortunately for Duluth, lake carriers do not deliver coal and flux direct to the blast furnaces, because the river has not been dredged enough to accommodate them. They use an unloading dock a few miles down the river, from which coal is sent to the plant in hopper-bottom cars. The federal government would

undoubtedly deepen the river to the steel plant if the company were actively engaged in manufacturing; several years ago dredging of the channel was planned and actually started, but it was stopped when it became evident that the Steel Corporation did not plan to use the river above the coal docks.

TABLE I—FREIGHT COST OF ASSEMBLING IRON ORE, COAL, AND LIMESTONE AT SEVERAL DISTRICTS USING LAKE SUPERIOR ORE

DISTRICT	IRON ORE (\$ a gross ton)	COAL (\$ a net ton)	LIMESTONE (\$ a gross ton)
Duluth	.90 by rail	1.69 rail rate to lower lake port Connellsville (2.11, Pocahontas) .08 dumping charge .40 lake rate to Duluth .35 rail rate from coal docks to furnaces — 2.52 Connellsville (2.84 Pocahontas)	.40
Cleveland	1.94	1.90 Connellsville 2.39 Kanawha 2.64 Pocahontas	.90 Marblehead .45 Calcite .40 Kelleys Island
Pittsburgh	2.97*	1.26 rail (Connellsville) .25 barge (includes .10 barge unloading charge)	1.13 Kaylor, Pa.
Youngstown	2.64*	1.42 Connellsville 2.39 Kanawha 2.64 Pocahontas	.55 Hillsville and Walford, Pa.

*"Direct" ore is placed in waiting railway cars under the unloaders and transported to inland districts, where it is placed in huge stock piles. "Dock" ore is retained at the rear of the unloaders in large storage piles and is transported to inland points during the winter. Furnaces so arrange their schedules as to absorb a steady stream of "direct" ore, since by so doing they save about 25 cents a ton over the equivalent "dock"-ore rate.

ASSEMBLY OF RAW MATERIALS

The cost of assembling the three raw materials for making pig iron—ore, coke, and flux—is a vital factor in the location and success of any company or district, for it constitutes 73 to 85 per cent of the total furnace cost.⁵ It is manifest that because of Duluth's location near the iron mines and at the head of Lake Superior, to which ore boats returning from the lower lakes bring coal and limestone as return cargo, the city must have low assembly costs (Table I). Most iron districts in the United States are far from ore and close to coal

⁵ Tariff Information Surveys, revised edit., FL-21, On Articles in Paragraphs 518-537 of Tariff Act of 1913 and Related Articles in Other Paragraphs: Iron Ore, Pig Iron, and Scrap, U. S. Tariff Commission, Washington, 1921, p. 64.

This movement of the ore to the coal has been attributed to the fact that twice as much coal as ore is required to make a ton of pig iron. This is not so! To make a ton of pig iron in any area using Lake Superior ore requires about 2050 pounds of coke, 4000 pounds of ore, and 900 pounds of limestone.⁶ Ore goes to coal because of the greater

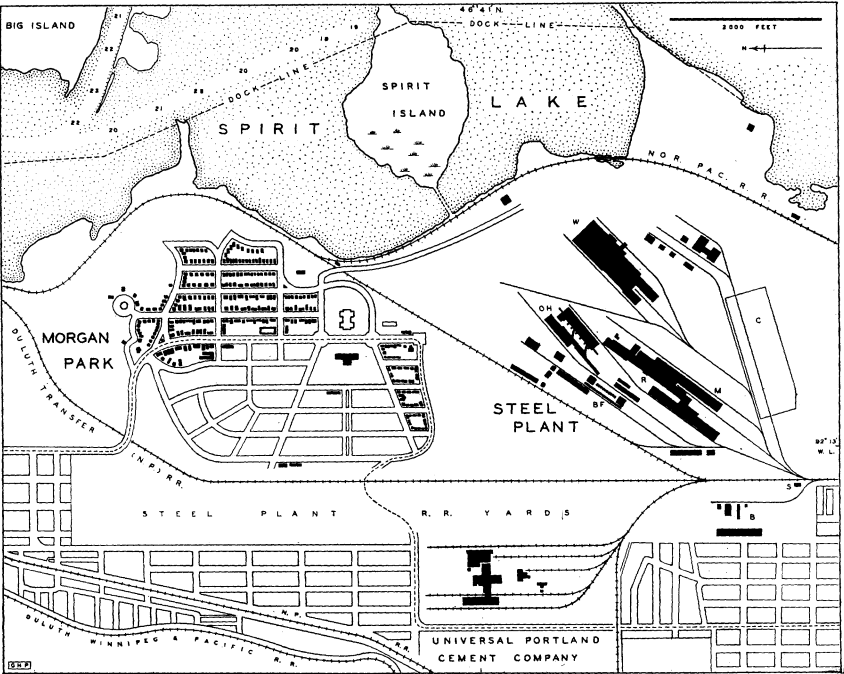


FIG. 2—Morgan Park and its balanced iron and steel layout. Reference: BF, blast furnaces; OH, open-hearth furnaces; R, rail mill; M, merchant mill; W, wire, nail, and fencing mill; C, coal storage; B, benzol plant; S, Steelton Station. Compare Figure 1.

economy in handling and because the ore is going also toward the ultimate market for the products into which it will be converted.

Duluth has considerable net advantage over all other districts using Lake Superior ore because it lies within a day's journey of the iron ranges. Ore can be brought to the furnaces the year round: open-pit mining ceases in winter, but underground mining goes on continuously; hence there is no need for the huge stock piles that characterize districts at lower lake and inland points. In summer ore is hauled directly from cars to the charging bins, but in winter it must be thawed in a sweat house.

Although far from the areas that supply coking coal (Fig. 3), Duluth benefits from low water rates. The many vessels transporting ore to lower lake ports can return to Duluth with either coal or water

⁶About 3100 pounds of coal is required to make 1 net ton of coke when 85 per cent is Connellsville and 15 per cent is Pocahontas, the proper proportion to give the desired coke structure.

ballast. In order to get cargoes of coal, a rate of \$0.40 a ton is offered, as against \$0.70 a ton for ore on the down trip. However, to benefit by this low rate, Duluth must procure its entire annual supply during the season of navigation, and this means that a part of what is gained in low cost of transportation is lost in interest charges on the coal.

The coal is unloaded at the dock a few miles downstream from the plant. This adds an extra charge of \$0.35 a ton to Duluth's assembly cost and is inexcusable, since the river could have been dredged at government expense directly to the coke ovens. Had the channel been dredged, there would be no re-handling to cars, as is now the case.

The coal is delivered in hopper-bottom cars, from which it is dumped directly into track hoppers. These in turn feed automatically into an underground belt conveyer, which transfers the coal to a breaker. In the breaker it is cut to the predetermined size and elevated to the storage bins over the hammer mills. The coke ovens are not directly on the water front.

Duluth is far from limestone deposits of desired chemical and physical properties for smelting. The largest and most modern quarries in the world and the ones on which Duluth depends are at Alpena, Calcite, and Rockport, on the Lake Huron shore of the southern peninsula of Michigan (Fig. 3). Distance is not a handicap in this case, however, because the quarries lie almost at the water's edge and on the direct route used by the lake carriers on their way back to Duluth for more iron ore. Hence low transport costs are available. To transport stone so far by rail would, of course, be economically impossible. As with coal, the entire year's supply must be delivered during the season of navigation.

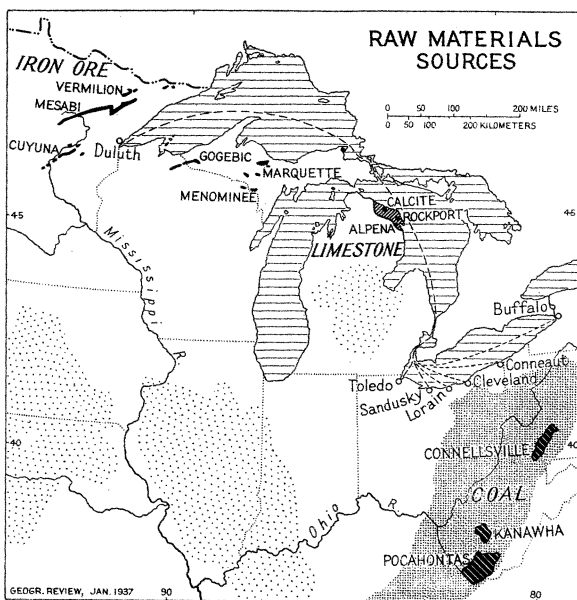


FIG. 3.—Map showing the location of Duluth with respect to the sources of raw materials—iron ore, coal (close stipple shows the Appalachian field; open stipple non-available coal), and limestone. At no other place in the northern United States are assembly costs lower. Scale of map approximately 1 : 18,500,000.

Scrap is an important raw material for making steel. About a half of the mixture in the basic open-hearth furnaces consists of scrap, the other half of pig iron. Scrap is used because it is economical, saves time, and produces good steel. That used in Duluth is procured from local sources and from the district's natural trade territory. It comes by rail and not by lake carrier from the lower lakes region, as is commonly believed. That Duluth is not an important steel producer is indicated by the fact that it ships scrap. At present the blast furnaces lie idle, and the steelworks are using scrap altogether.

Few other industries use such quantities of water as the iron and steel industry. Not only must the supply be plentiful, but the cost must be low and the quality satisfactory. Water is used for cooling, gas washing, and steam. Although water plays only a minor role in determining the general location of the industry, it is usually the deciding factor in determining the specific site. It is in order to obtain cheap surface water that most iron and steel plants are on rivers and lakes. Duluth is fortunate in this respect, for it has access to a huge supply of cold, soft water in the St. Louis River. The Minnesota Steel Company does its own pumping and uses each 24 hours of full operation 5 times as much water as the city of Duluth.

CLIMATIC AND SITE FACTORS

One environmental factor that few industrial districts anywhere have to contend with is a long and extremely cold winter. Duluth is the exception in the western hemisphere. Provision had to be made to withstand the low winter temperatures at all exposed points. The two blast furnaces, for example, were originally cased to the top with a well fitted cover of corrugated-iron sheathing (later discarded), and five stoves were built for each stack instead of the usual four.⁷ Provisions had to be made throughout the coking plant to prevent water from freezing in the supply lines. The quencher is self-draining; that is, there is no water in the exposed part except when coke is being quenched. All of the pipes through which slow-running water is sent were laid 7 feet below the surface of the ground. A steam-heated sweat house, built for thawing frozen ore in winter, is capable of providing ore for 36 hours' operation of both furnaces.

The iron and steel industry, in order to expand and grow, must have access to large tracts of cheap land. No other industry requires so much land and such cheap land; the various plants are one-story buildings, and, in a scientific layout, they are relatively close together.⁸

⁷ "The probable expectancy of high hot-blast stove efficiency appears to have been offset by the extra provisions for extreme winter temperatures in the building of five stoves for each stack." From "Minnesota Steel Company Completes Plant," *Iron Age*, Vol. 96, 1915, pp. 1507-1519; reference on p. 1510.

⁸ In the valley district (Youngstown) plants of the Republic Steel Corporation are scattered through four towns; obviously this forbids the operating economies possible in concentrated production.

In many of the older districts—Pittsburgh, Wheeling, Youngstown, and Cleveland—the only available flat land consists of narrow ribbons of flood plain; hence industrial sites are neither numerous nor cheap.⁹ In the younger, more scientifically located districts—Gary, Buffalo (Lackawanna), and Sparrows Point—the companies have assured themselves of ample room.¹⁰ Duluth, too, is fortunate in this respect, the Steel Corporation having purchased a tract of 1500 acres.

THE LABOR SITUATION

Labor is obviously indispensable in the fabrication of iron and steel, but it is usually not significant in the localization of the industry. Although the cost of labor is appreciably less than in many other industries, it represents about one-third (36.4 per cent in 1932) of the total cost of manufacture. Steel is the product of a few men and much machinery rather than the product of many men and little machinery. As one writer puts it:

Three things impress you when you go into the mills: the size, the absence of men, the absence of haste. Here a tremendous work is in progress. Here is being manufactured the steel skeleton of our monstrous civilization. Here before your eyes you may see it being made from fire and iron with the help of great machines. That is what you think first. Later you say "Oh, men are helping, too!" This is an after-thought.¹¹

The development and adoption of the all-but-human labor-saving devices were inevitable in the United States, where labor costs are about four times those in Europe. Moreover, the gap between labor needed and volume of production constantly widens.

Labor costs in Duluth are higher than in other American steel centers because the climate is more rigorous and the cost of living therefore greater and because of the heavy demand for labor in spring and summer in open-pit mining, railway operation, lake shipping, and the like. In fact, the securing and retaining of workers at first caused considerable anxiety because "Duluth is distant from other steel mill communities and is located where the accustomed lack of sustained employment in one occupation had made for a migratory common labor."¹²

⁹ Langdon White: The Iron and Steel Industry of the Pittsburgh District, *Econ. Geogr.*, Vol. 4, 1928, pp. 115-139, reference on p. 135; *idem*: The Iron and Steel Industry of Youngstown, Ohio, *Denison Univ. Bull., Journ. of the Sci. Laboratories*, Vol. 25, 1930, pp. 125-146, reference on pp. 144-145.

¹⁰ J. B. Appleton: The Iron and Steel Industry of the Calumet District: A Study in Economic Geography, *Univ. of Illinois Studies in the Social Sciences*, Vol. 13, No. 2, 1925, pp. 81-89; Langdon White: Location Factors in the Iron and Steel Industry of the Buffalo District, New York, *Denison Univ. Bull., Journ. of the Sci. Laboratories*, Vol. 24, 1929, pp. 245-264, reference on p. 262; Langdon White and E. J. Foscue: The Iron and Steel Industry of Sparrows Point, Maryland, *Geogr. Rev.*, Vol. 21, 1931, pp. 244-258, reference on pp. 255-256.

¹¹ Mary Heaton Vorse: *Men and Steel*, New York, 1921, p. 19.

¹² Morgan Park—A Beautiful Steel-Mill Town, *Iron Age*, Vol. 97, 1916, pp. 48-52; reference on p. 48.

On the other hand, Duluth workmen are said to be more efficient, and the output per capita is said to be larger, as a result of the more stimulating weather. During summer there is never a day when labor cannot reach maximum efficiency; whereas in Ohio, Pennsylvania, and elsewhere during some three weeks in July and August there is a period when the weather is close, temperature and humidity are high, factory discipline becomes demoralized, and production suffers. The writers believe that too much emphasis should not be placed on this point, however, because of increasing mechanization: work in steel plants is now primarily a matter of controlling machines. In all modern plants there are numerous appliances contributing to greater human comfort; hence the men can and do work more efficiently during summer than in the past.

Living conditions for workers in Duluth are among the best in the country, far superior to those in the older districts. The Steel Corporation built a model town at Morgan Park, a suburb of Duluth. It was laid out on high ground overlooking Spirit Lake and the St. Louis River and is sheltered by picturesque bluffs on the west. Houses and apartments were erected for the employees. Millworkers may rent a modern apartment with all conveniences including electricity for \$3.75 a room a month. The district has an exceptionally attractive natural setting.

THE MARKET PROBLEM

It was pointed out above that Duluth has the lowest assembly cost on raw materials of all the districts using Lake Superior ore. It was pointed out also how very important low assembly cost is to any district. One may wonder then why Duluth's iron and steel industry has not grown and prospered. The answer lies in the district's remoteness from great markets. The nation's principal steel markets are in its most densely populated area. With the exception of Michigan, the first five states in consumption of rolled steel—Pennsylvania, Illinois, Ohio, Michigan, and Indiana—are themselves the heaviest producers. Although to date Michigan has not been a large manufacturer of primary steel, the Detroit area is growing metallurgically, and its future is bright; only the Chicago-Gary district has a better location.

The successful location of iron and steel plants is largely a matter of transportation costs, but not, as is so commonly assumed, of freight charges on raw materials only. Transportation charges on finished steel to the point of consumption are equally, if not even more, significant. It is here that Duluth's weakness and Detroit's strength become apparent: Duluth, situated in a region where farming is the chief occupation, obviously requires little steel; Detroit, capital of the automotive industry,¹³ is the largest consumer of high-finished

steel in the world.¹⁴ In addition, Detroit's location on navigable water midway between the iron-ore region and the coalfields and close to limestone quarries gives it the advantage of low assembly cost. Furthermore, it benefits from low scrap prices.

Another discouraging factor for Duluth is that the larger districts to the east and south produce far more steel than their near-by territories require; hence they ship into competitive markets, one of which is Duluth. Moreover, regional rivalry has practically disappeared because most of the large corporations have plants in several districts.

As local industries develop where an adequate market exists, as the territory tributary to Duluth seems destined to remain agricultural and pastoral, and as nearness to market is probably the most important location factor, it would seem that Duluth's metallurgical future is not promising. Duluth will not be abandoned as a metallurgical center, however; some steel will continue to be made, though under ordinary conditions smelting will not be resumed. The selection of the head of Lake Superior as a site for iron and steel manufacture thus appears to be a striking example of locational maladjustment.

¹³ The automotive industry is now the nation's largest consumer of steel: in 1935 it used 24 per cent.

¹⁴ R. E. Baker and H. R. Moorhouse: *The Probable Five-Year Future of Steel*, *Harvard Business Rev.*, Vol. 11, 1932-1933, pp. 133-145; reference on p. 137.