EMPLOYMENT AND PRODUCTIVITY IN A SHEET STEEL MILL

A Study of Labor Displacement
in Prosperity and Depression

BY

Jennette R. Gruener

A DISSERTATION

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Printed in United States of America
by
H. M. Downs Printing Co.
Fitchburg, Mass.

BRYN MAWR COLLEGE

SERIES IN SOCIAL ECONOMY

CAROLA WOERISHOFFER GRADUATE DEPARTMENT
OF SOCIAL ECONOMY AND SOCIAL RESEARCH

SUSAN M. KINGSBURY, HORNELL HART AND ASSOCIATES. *Newspapers and The News.* G. P. Putnam's Sons, New York, 1937. Bryn Mawr College, Series in Social Economy, No. 1. Sections appeared in *The New Republic*, October, 1930, Vol. LXIV, Nos. 827, 828, 829 and 830; *The Journalism Quarterly*, 1933-34; Vol. X, Nos. 2, 3 and 4, Vol. XI, Nos. 2 and 3.

STUDIES IN SOCIAL ECONOMY

JENNETTE ROWE GRUENER, PH.D. *Employment and Productivity in a Sheet Steel Mill: A Study of Labor Displacement in Prosperity and Depression.* H. M. Downs Printing Co., Fitchburg, Massachusetts, 1938.

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ACKNOWLEDGEMENTS

This study could not possibly have been made without the co-operation of the officials of the company who graciously made the data available for use. The writer feels she can express but inadequately her great appreciation not only for the material furnished but for the kindness and helpfulness of those members of the personnel with whom she came in contact during the study, particularly the vice-president in charge of operations and the superintendent of the mill studied intensively.

The writer is also indebted to Professor Mildred Fairchild and Professor Susan M. Kingsbury of Bryn Mawr College for their stimulating and continuous interest in the development of the problems presented here.

Nor can the writer fail to acknowledge gratefully a further debt to various students in the Carola Woerishoffer Graduate Department of Social Economy and Social Research, especially Miss Winona McGuire, for help in the more tedious processes of mathematical tabulation and calculation.

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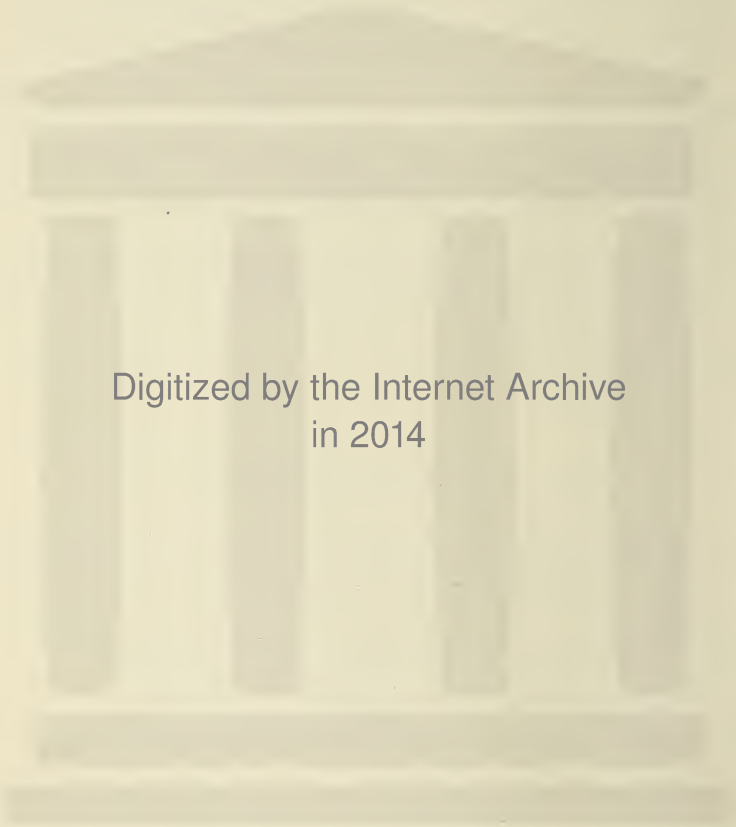

INTRODUCTION

The purpose of the study presented here is to analyze the problems and limitations confronting an individual industrial firm in its struggle for existence. Changes in production, employment, and productivity have been examined in as much detail as possible over a period of years, with a view to determining, first, the apparent chances for one company to achieve a certain stability in its production factors; and second, the extent of influence exerted by economic conditions on manufacturing policies. Obviously, the whole existence of an industrial plant depends on its ability to maintain through the years a volume of output which justifies its presence in a competitive field. If the struggle is keen, one may assume efficiency of the productive processes in the interests of profits. No small part of this efficiency lies in regulated production which involves stability in numbers of workers, amount produced per worker, and the demand for product.

In this analysis, emphasis has been placed on changes in productivity of workers and the resulting effect on number of employees. At the same time, so interrelated are all the factors which enter into the quantity of output from any firm, that no one may be isolated from the others, Because the employment factor represents human beings, attention increasingly is directed toward its variation, particularly the displacement of labor due to mechanization.

In this connection, an impetus was received to the inquiry already undertaken from an address which Professor Harry Jerome gave before the American Economic Association in December, 1931. The idea underlying his speech is given in the following quotation:

> "My general thesis is that we shall be in a much better position to understand how technological developments take place, and hence to forecast future tendencies in labor displacement, when we have traced as best we can, industry by industry, or even process by process, those changes in productivity and displacement which have taken place in the past and the other concurrent changes in industry which accompanied, and in part, at least, account for, developments in productivity and displacement."[1]

In the exposition of his views, Professor Jerome gave some specific suggestions for conducting studies along the general line outlined above. He says:

> "The key to adequate statistics of labor productivity and labor displacement is the compilation of a large number of individual plant histories on a standardized basis."[2]

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1 Jerome, Harry, "Measurement of Productivity Changes," *Proceedings of the American Economic Association*, December, 1931, p. 35.

2 Ibid., p. 39. See also *Mechanization in Industry*, 1934, by the same author, in which he deals with increasing efficiency in a number of industries.

Necessarily not all of Jerome's ideas are followed here. He was concerned primarily with discovering the extent and rate of change in productivity, which is only one of several considerations in this paper. But he emphasized that individual studies are important in order to present a complete picture and bring to the fore significant developments vitally affecting one plant, one industry, or one community, which ordinarily are lost in collective presentation of data. Here, more attention than he suggests has beeen paid to the vagaries of the production trend, because output determines to some extent the numbers employed. Markets must be found which absorb the production of a plant, and change in market demand may exert great influence on amount and type of product; hence indirectly it affects those employed in producing the goods. The demand may be seasonal or again, it may be so important that competition to meet it attracts numerous concerns. What is the single firm to do in any situation confronting it, giving full consideration to its investors and its employees? The actual experience of a plant has been studied here in so far as data have been available. No effort has been made to forecast future tendencies, as this analysis is only a beginning of many which will be necessary before prognostications may carry any weight. Nevertheless, certain implications which seem to arise naturally from the intensive analysis presented in the following chapters have been pointed out in conclusion.

The problem then resolved itself into the selection of a suitable unit for study. Because of the dominant position which is attributed to the steel industry as an indicator of general business conditions, the unit selected was a small sheet steel mill. Although small from the point of view of tonnage produced,[3] the sample plant is part of a larger concern, other departments of which produce the billets and sheet bars rolled in the mill selected. The sheet department is isolated and self-sufficient, however, so that the various measurable factors of monthly production, employment, man-hours, etc., are available with respect to this section alone.

Actual figures were obtained from the plant as to amounts and kinds of products turned out, number of workers, hours of work, innovations in the mill, productivity rates, and costs per ton, and, in general, such type of data as would give a picture of the firm over a period of years. Where possible, comparable figures for the United States were examined to note any typical characteristics of the mill and the problems unique to the specific establishment. The time chosen for study was the post-war period from 1919 to 1933. Originally data were collected only through 1931 and market conditions were analyzed only for 1930 and 1931. In order to bring the material up to date, figures for 1932 and 1933 were included, where these years added significantly to the former picture. Fortunately productivity statistics in some detail had been gathered by the firm for a period from 1925 to 1930, and these have been used as a basis for the productivity discussion. All data were examined to note variations from year to year and within a year. Relationships between all factors and their differing rates of change were sought. Lack of sufficient figures on costs and prices has limited this phase of the problem to generalities, with the exception of data on labor costs. Influences of production costs and selling prices are pre-

3 The annual rated capacity of the mill is 100,000 tons as compared with 6,407,200 tons for the United States as a whole.

dominant as stimulants for improvements in machinery, processes of production, and efficiency of labor, especially in a field as highly competitive as sheet steel has been for the past decade, so the inadequate treatment represents a severe limitation. Attention has been centered on the changing number of employees resulting from the increase of productivity of the workers. This study is concerned merely with the statistical facts of the case and their interpretation.

The investigation provokes many inquiries which cannot be answered here. No attempt has been made to follow up the employees displaced, either to note their reabsorption into industry or to trace the effect on the community of meeting the problem of those not reemployed. The latter problem is one of many ramifications, particularly if the town is small and opportunities for employment limited. Obviously in such a situation the consuming power of the inhabitants is affected by abrupt and irregular changes in the employment status of the wage earners. The tracing of these relationships would prove interesting if undertaken.[4]

The aim throughout the analysis presented here is to reveal the situation which envelops one mill over a period of years, in order to discover the changing relations which appear between the various factors of production and to observe the problems which one individual plant encounters in its effort to maintain itself in a crowded field. The writer is not concerned with the question of whether or not this particular plant should continue to function or should have been eliminated, as has been the fate of many small steel manufacturing units. It is assumed at the outset that this firm is in the sheet steel business to stay and that every effort of the management has been devoted to improving the competitive position of the plant, having regard for the nature of the markets and the general condition of the industry.

4 This study is part of a community survey of a small industrial town, another part of which deals with the changes in consuming power in the community.

CHAPTER I.

The Competitive Position of the Plant.

In the ultimate analysis it is the demand for goods which determines largely the number of workers employed in any industry. The loss of markets results in a decrease in employment, as abundant evidence in the recent depression indicates. Outlets for the products of an industrial plant, therefore, are necessary. To quote Jerome again:

> "The aids to the estimation of labor displacement which I have mentioned arise primarily in the production process. *Production, of course, is contingent on markets;* and additional aids to forecasting may be obtained from an analysis of the markets for commodities."[1]

Although sheet steel is designated as "finished steel," it is not sold directly to the public, but rather is distributed to certain industries where the sheet is fabricated or further processed to attain its ultimate form. But the manufacturers of goods which must undergo further treatment are as subject to the adversities of fickle demand from the ultimate consumer as are those in industries which serve the public with finished articles. Perhaps the former have a slight advantage over the latter, in that when orders from one consuming industry decrease, other markets may be discovered and stimulated without involving great changes in type of product or process of manufacture. But markets of some sort must be maintained if business is to survive.

General Market Conditions of Sheet Steel.

The selected industry has turned out to be an admirable one to examine since it has been expanding constantly for some years. During the World War, sheet steel was in great demand and since the war, the rapidly growing automobile industry has consumed quantities of it. With the exception of the year 1921, the production of sheet steel in the United States climbed upward until 1929. Not only was there great increase in yearly tonnage, but, also, sheets annually constituted a growing percentage of all finished steel. Chart 1, following, shows the course from 1914 to 1933.[2] The un-

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1 Jerome, Op. Cit., p. 37. Italics inserted.

2 It is very difficult to find figures for the United States as a whole which will be directly comparable to the production figures for the sheet mill studied, because of the nature of classification used by the various associations compiling statistics on the steel industry. One set of figures used in Chart 1, was taken from the series compiled by the American Iron and Steel Institute, designated "Black Sheets Rolled on Sheet or Jobbing Mills." Figures given by this same Institute under the simpler heading of "Steel Sheets" are available from 1925 on only. These latter figures average about 200,000 tons a year in excess of the figures used in the chart and for the years available follow very closely the trend as shown in the figures used, which are given in Appendix, Table 1.

The National Association of Sheet and Tin Plate Manufacturers also have available statistics of sheet steel production for the independent firms from 1919 to the present time. It may be said quite safely that the firms covered by the National Association of Sheet and Tin Plate Manufacturers cover over 80% of the sheet steel produced. The specific designation used by this Assoctation is "Steel Sheets, including Black, Blue Annealed, Galvanized and Tin Plate." The figures appear currently in *Iron Age*. The annual totals appear in Appendix, Table 1.

mistakable upward movement until 1929 is striking and it is accentuated further by the downward slope after that year. The logarithmic rulings, also, give an idea of the rate of change from year to year. In spite of the general decline in the recent depression, sheet steel has maintained its place as an important form of finished product. Indeed in 1932 more steel went into the making of sheets than into any other type of finished goods. For a decade or more merchant bars had been the form into which more steel was rolled than into any other one type, but in 1932 only 12.4 per cent of raw steel was so used, compared with 15.5 per cent which went into sheets. The latter held second place in total finished steel tonnage since 1924. At that time the amount of sheet tonnage, as compared with the total, surpassed that of steel plates, heretofore the second most important item.[3]

As might have been expected in a rapidly expanding industry, capital was attracted to this particular branch of manufacture, so that it became highly competitive. Many small independent firms sprang up, which were not integrated with the earlier process of making pig iron and steel ingots, but were equipped only to roll the bars or billets into sheets of the desired specifications. These firms required substantially less capital than did the great plants and, thus, were within the reach of small investors. Because of the rapid growth of these mills and the consequent overdeveloped productive capacity, prices for sheets became unstable, provoking continual discussion among manufacturers. The growing demand for the product and the chaotic price condition naturally caused manufacturers to turn their attention to improving processes in order to realize more profits from the industry. These changes, utilized in part by the plant studied[4] have been, in general, the electrification and motorization of rolling mills, installation of automatic controls, and the introduction of continuous sheet rolling by methods perfected in 1927. Although the latter process has not been brought into all, or even the majority, of sheet mills because of the expensive machinery required, its appearance has increased tremendously the tonnage capacity available for rolling sheets. All the innovations have served to displace the number of employees required in individual establishments, even though the total number of workers in the entire steel industry had not decreased prior to the depression.[5] Improvements in equipment and methods have been accompanied by a reduction in costs, particularly in those of labor.

In the midst of all the changes in manufacture, the expansion of the sheet steel industry and the clamor to participate in the new development, each mill has been engaged in a struggle to gain purchasers and to increase the consumption of its output. David Gould in an article written in 1931, although referring to the steel industry in general, brings out some ideas which seem in point here.[6] So intensely competitive had the industry become, he states, that individual firms were concerned more with self-preservation than with increasing profits, and that, faced with an excess capacity,

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3 The percentages of all types of finished steel produced from 1922 to 1933 may be found in Appendix, Table 2. Data are from *Iron Age*, volume 135, January 3, 1935, p. 202, and volume 131, January 5, 1933, pp.9-10.

4 See pp. 55-56 of this study, Chapter IV.

5 See Jerome, Harry, *Mechanization of Industry*, 1934, pp. 58-66, for a brief summary of changes mentioned here. The section entitled "Iron and Steel," was written by Meredith Givens.

6 Gould, David, "Where Mass Production Has Led the Steel Industry," *Annalist*, volume 38, September 11, 1931, pp. 419-420.

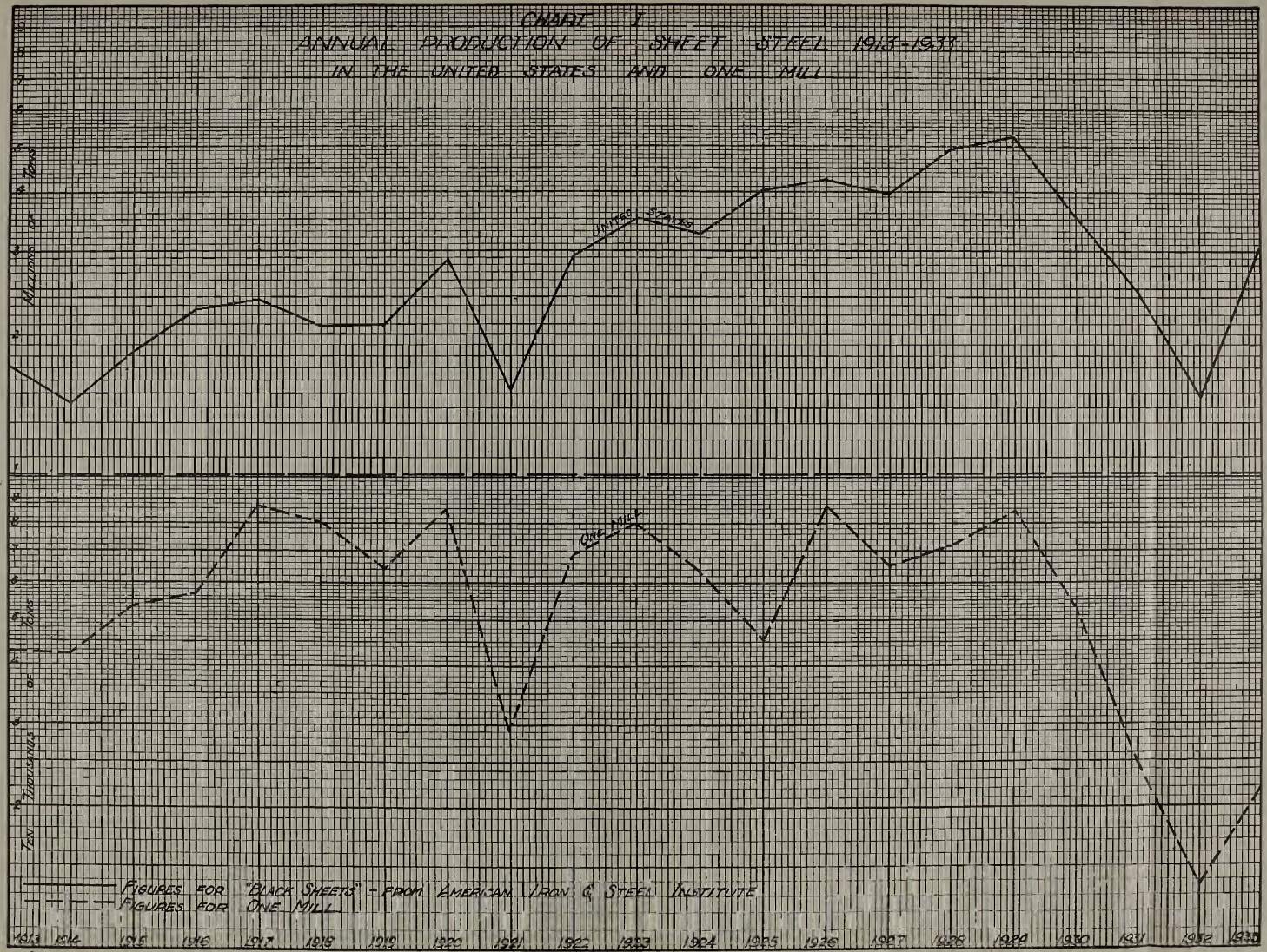
CHART 1
ANNUAL PRODUCTION OF SHEET STEEL 1913-1933
IN THE UNITED STATES AND ONE MILL
MILLIONS OF TONS
UNITED STATES
THOUSANDS OF TONS
ONE MILL
FIGURES FOR "BLACK SHEETS" - FROM AMERICAN IRON & STEEL INSTITUTE
FIGURES FOR ONE MILL
1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933

they were exerting every effort to stimulate new demands for finished steel, hoping to reduce unit costs by quantity production. Certainly sheet steel manufacturers were far from oblivious of the possible outlets for their goods and, as the years after 1923 show, devoted concentrated energy and research toward enlarging markets.[7] They not only induced established purchasers to consume greater quantities but they also evolved a variety of new uses to which steel could be put.

With all the energy expended by producers in lowering production costs and expanding markets, one would expect an accompanying advance in consuming industries. Table 1, following, shows the distribution to certain consuming groups of various types of steel sheets from 1922 to 1933. Analysis of them is not available prior to 1922. Although one notices some changes in the classification such as the elimination of "Street Railways," and the introduction of "Highways and Highway Bridges," and "Jobbers" in 1927 and 1926 respectively, the chief changes apparent in Table 1 are found in the quantities going to the different purchasing groups. Thus, the automotive industry has been an increasingly large purchaser of sheet steel, and, exclusive of a miscellaneous group, the building industry has been next in size. The food and packing industry and the machinery and tool makers also have been using more sheet steel in the past few years than in former years. The greatest recent decreases have occurred in the amount taken by the railroads and the oil, gas and water companies. The predominance of the automotive and building industries as consumers of sheet steel reflects the advance in the types rolled and the discovery of better quality.

As a part of their program to extend markets, sheet steel manufacturers have been improving their product to meet the ever more exacting requirements of buyers. In addition they have devised new analyses of sheets with emphasis upon alloy steels whose peculiar properties have multiplied the adaptability of sheet many times. Important developments in patents and processes have made great headway in the past few years and have served to place on the market numerous special products, mostly made under trade names and designed for the specific requirements of high strength, stainless quality, heat resistance, pliability, resistance to corrosion, ease of polishing and the like. These alloy steels are now very costly to produce and hence are expensive, but the demand for them is growing in other fields beside that of sheet. The uses are so varied that the tonnage buyers of alloy sheets represent quite diversified interests.

7 In 1923 the National Association of Sheet and Tin Plate Manufacturers appointed the Sheet Steel Trade Extension Committee to promote joint advertising and engage in research activities with a view to promoting uses and demand for steel sheets. The trade journals have also been very active in giving space to articles dealing with new uses for steel and latest developments in improving chemical composition, size, shapes, etc.

TABLE 1.

Percentage Distribution of Sheet Steel to Consuming Group[a]
1922–1933

Consuming Industry	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933
Railroads[b]	7.01	11.26	12.26	6.47	6.91	6.08	5.04	4.66	3.41	3.24	1.65	1.30
Street Railways	0.39	0.05	0.38	**	**	**	*	*	*	*	*	*
Building[c]	7.28	6.72	6.06	11.14	12.88	11.64	12.98	17.32	18.77	18.72	16.88	16.35
Highways and Highway Bridges	*	*	*	*	*	1.98	0.26	0.48	1.83	2.70	3.46	0.57
Automotive	28.28	31.73	33.25	27.48	33.24	37.54	41.36	36.54	35.98	33.56	32.78	38.24
Oil, Gas, Water	9.72	5.59	4.57	3.42	3.04	3.40	2.85	3.49	5.17	3.85	2.49	3.24
Mining, Quarrying, Lumbering	*	0.03	0.77	0.11	0.14	0.54	0.21	0.33	0.26	0.26	0.23	0.19
Agriculture[d]	1.45	1.64	1.76	1.97	2.56	1.53	1.48	3.07	2.42	1.60	1.02	1.03
Shipbuilding	0.28	0.10	0.18	0.07	0.04	0.22	0.21	0.17	0.23	0.21	0.06	0.06
Machinery, Tools[e]	0.29	2.31	3.46	1.79	1.82	0.37	5.77	6.90	6.86	6.52	4.91	6.10
Food and Packing[f]	0.07	1.56	2.88	5.54	6.71	4.22	5.04	4.28	3.83	5.82	5.64	5.23
Exports	14.34	9.11	8.76	5.24	6.10	3.28	2.64	3.95	3.82	2.84	1.68	1.77
Miscellaneous	30.89	29.90	25.67	36.77	18.74	18.01	14.53	11.50	7.60	10.63	17.71	17.83
Jobbers	*	*	*	*	7.82	11.19	7.63	7.31	9.82	10.05	11.49	8.09
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

* Indicates that no such heading was listed in the percentages for that year.

** Indicates that the amount going to that industry was less than .01 per cent and therefore ignored.

a Data taken from annual reports in *Steel* (formerly Iron Trade Review), based on reports from companies representing from 73.52 per cent in 1922 to 98.2 per cent in 1932 of the output for entire steel industry. The subdivision of type of steel was that entitled, "All Other Black Plates and Sheets except Galvanized Sheets," so that the distribution as recorded extends beyond the sheet steel industry. No subdivision represented sheet steel only.

b The Railroad industry was subdivided into the percent going to cars and locomotives, track construction, and buildings. No subdivisions were used here.

c The Building industry was subdivided into the percent going to erection materials; frame, trim, furnishing, furniture, stoves; and other products for buildings. No subdivisions used here.

d The Agriculture industry was subdivided into the percent going to implements, and all other agriculture. No subdivisions used here.

e The Machinery and Tool industry included electrical equipment.

f This classification was called "Metal Container" until 1925.

In Table 1, the last classification, that of "Jobber," is one scarcely coordinate with the other groupings, and, therefore, needing explanation. The jobber represents a middleman, as it were, and he performs an important function in the marketing of steel. He buys, in large lots, steel sheets of more or less standard analyses and sells to smaller purchasers. He is willing to handle lots in very small quantities with which the mills do not like to bother. At times the jobber has taken advantage of his position to indulge in speculation, buying when prices were low with the expectation of realizing a substantial profit later. Buying of this sort might be expected to exert a stabilizing effect on price fluctuation, but on the whole the influence on prices has proved ineffective. In times of depression when large orders are not coming in swiftly and advance orders are small, some producers are willing to sell in small quantity lots directly to the consumer. The practice has caused considerable wrangling between the jobbers and the sheet steel officials and has provoked discussion as to the size of the orders which each should handle. Many mills are not equipped to carry large stocks on hand because of the perishable nature of the goods and the amount of space needed for storage. In forming the steel code of 1933 the need for the jobbers was recognized and their functions and limitations were defined.

The sheet steel manufacturers themselves have been so active in conducting research and making known, through advertising and trade journals, the new and varied uses for their product, that one feels they, rather than spontaneous demand on the part of consumers, have been responsible for the expansion of the industry. The automobile industry, however, has itself experienced a rapid growth and has been in a position to make known its demands for specific kinds of sheet. It has absorbed an increasing amount each year. Because the automobile factories are located primarily in the middle west, one might anticipate that a large proportion of steel sheets would seek that market. This proved to be the case in 1928, at any rate, when *Iron Age* studied the distribution of sheets to various states or districts where they were further manufactured.[8] It found for the data analyzed, that the largest percentage of the nation's production was consumed in the Northeast division, and that the quantity going to the North Central states was second in importance. The Northeast group, as listed, includes Ohio and Pennsylvania, which produce quantities of steel, together with New York, New Jersey, Delaware, Maryland, West Virginia and the District of Columbia. This group used 43.8 per cent of all sheet steel produced in the year 1928. The North Central group, including the automobile manufacturing section, Michigan and Wisconsin, besides Indiana, Iowa, Illinois, Minnesota and Missouri, used 41.6 per cent. In other words, over 85 per cent of all steel sheets went to two geographical divisions covering fourteen states and the District of Columbia. The remaining fifteen per cent was distributed over the entire United States. Thus, the groups purchasing steel sheets are fairly well centralized. In general, buyers do their business with firms located where freight rates are the lowest, or where water transportation, always cheaper than rail, is available.

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8 Data are from an unsigned article entitled "Industries and States Receiving Steel in 1928," *Iron Age* volume 123, January 3, 1929, pp. 7-9. Amounts of sheet steel which were consumed in other sections of the United States were as follows: New England, 3.9 per cent; Northwestern states, 1.8 per cent; Southeastern states, 1.8 per cent; South Central states, 4.2 per cent; and Pacific coast, 2.9 per cent.

Chief Markets of Selected Plant.

The plant, whose production of sheet steel is considered here, has a long history. It grew up in the early part of the nineteenth century when the rolling of iron was beginning in this country and it has been devoted ever since to the rolling of iron and steel sheets of high quality. Favorably located, within easy access of water transportation, it has flourished. The firm gradually has expanded so that now it is able to turn out steel sheets and plates through all the stages from the blast furnace to the completed rolling.[9] For a time the entire output of the blast furnace and open hearth departments was utilized by the coordinated sheet and other mills; now the company manufactures alloy steels for general sale as well as for its own use. As stated previously, only the sheet mill is studied here.

This particular mill, a pioneer in rolling sheets, maintained and increased its output in keeping with the rising tide of demand for sheet steel until after the World War. It experienced a fine boom period during the war and the peak of production reached in 1917 was the highest which the plant ever has attained. Chart I has shown the total yearly output of the mill from 1914 to 1933 compared with similar production in the entire United States. It indicates clearly that the selected mill suffered proportionately greater recession in 1921 than the total figures show and did not recover its relative position in the field after this year. Again the diminution of activity in 1924 is more severe in this mill than in the country at large. In Table 2 the index numbers of the total yearly production of this mill are compared with the annual production of steel sheets compiled by the National Association of Sheet and Tin Plate Manufacturers, and figures for certain types of plate and sheet gathered by the American Iron and Steel Institute.[10] The year 1919 was used as the base because data from independent makers were not available prior to that time. In comparison with the other series, the 1921 depression seems to mark the turning point when the plant being studied begins to lag, and from then on, the discrepancies increase.

Both the other indexes rise more rapidly than does that for the one mill. One must be guarded in comparing data from one plant with those from the whole country, especially when the industry concerned is one in which an unusually rapid growth has been apparent in the period under analysis. Competition became increasingly keen as the markets widened and the addition of many plants to the industry served to boost the total output of the product. An individual firm could scarcely keep up with the pace set by the country. Then, too, the mill was equipped to turn out only a limited tonnage. Drastic changes in equipment and personnel would have been necessitated if this firm had indulged in industrial expansion comparable to that for the entire country. What these indexes do suggest is that this company, like others, was obliged to make certain changes in production methods in order to maintain at some profit the place which it had built up for itself in the sheet steel industry.

The addition of numerous competitors encroached on some of the mar-

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9 The distinction between plate and sheet steel is one of thickness. In the two departments of this firm number eight gauge is considered roughly the dividing line between plate and sheet; number eight and lighter gauges are rolled in the mill and heavier gauges elsewhere.

10 The type of sheets covered by these figures is explained in footnote 2 of this chapter.

TABLE 2.

Index of Production of Sheet Steel in the United States and One Mill.

1914–1933

(Base: 1919=100)

Year	One Mill	United States	
		a	b
1914	65.3	68.0	
1915	124.8	87.5	
1916	107.3	107.1	
1917	135.0	112.8	
1918	81.5	98.8	
1919	100.0	100.0	100.0
1920	131.1	137.5	145.9
1921	45.1	72.0	72.7
1922	107.3	139.0	162.4
1923	124.1	166.9	189.4
1924	99.0	155.8	187.1
1925	70.0	195.1	249.8
1926	135.0	201.8	244.5
1927	101.4	189.5	233.0
1928	112.0	236.4	280.0
1929	131.5	250.3	275.7
1930	81.5	167.3	187.5
1931	38.0	117.3	134.1
1932	21.2	70.1	79.5
1933	33.8		113.4

a The indexes are figured from statistics given in the American Iron and Steel Institute, under the heading "Black Sheets Rolled on Sheet and Jobbing Mills."

b Indexes estimated from figures of the National Association of Sheet and Tin Plate Manufacturers as given in *Iron Age*, under the heading "Steel Sheets Produced by the Independent Makers, including black, blue annealed, galvanized and tin plate."

kets which this mill supplied. As a result, purchasers came to represent many different industries. Certain ones, nevertheless, are outstanding. In an attempt to discover the important groups, individual invoices of the firm were analyzed and classified for the years 1930 and 1931.[11] The percentages taken by the firms thus catalogued were arranged in a table and compared with the percentages of sheet production taken by the same industries in the United States. In this table the more detailed classification of *Iron Age* has been employed rather than that of the magazine *Steel* which was followed in Table 1. The latter quotes figures for a longer period of time and presents an adequate picture of consuming industries, but its categories are broader than those used by *Iron Age*. Thus the more detailed classification was preferred here, that the markets might be examined the more carefully.

TABLE 3.

Comparison of Percentage Distribution to Consuming Groups United States and One Mill.[12]

1930 and 1931

Consuming Industries	1930		1931	
	U. S.	One Mill	U. S.	One Mill
Railroads	2.6	3.0	2.8	3.1
Fabricators and Building Contractors	4.9	7.5	4.2	9.7
Building Hardware and Trim	6.3	3.3	2.1	3.1
Automobile and Parts	25.7	2.7	28.6	6.2
Oil, Gas and Water Companies	2.4	25.1	2.4	12.9
Mining and Lumbering	0.3	0.7	0.3	0.6
Agriculture—Manufacturers and Distributors	3.7	0.5	2.3	0.6
Container Makers	4.9	0.0	6.1	0.0
Shipbuilding	0.1	1.2	0.1	1.3
Boiler and Tank Manufacturers	1.2	20.1	2.1	26.9
Machinery and Tool Makers	0.1	3.3	0.2	2.9
Electrical Manufacturers	6.3	1.2	6.2	2.2
Concrete and Reinforceing Companies	0.0	0.1	0.4	0.3
Pressed and Formed Metal Manufacturers	4.9	1.2	6.4	1.4
Furniture and Stove Makers	8.8	0.0	8.5	0.0
Jobbers and Warehouses	12.6	25.1	7.8	22.6
Exports	5.5	0.0	5.2	0.0
Miscellaneous	9.7	5.0	14.3	6.2
Total	100.0	100.0	100.0	100.0

11 Not all the purchasers of the products of this mill were included but only those who were the largest and most consistent buyers during these years. The amounts going to these maximum purchasers accounted for 78.2% of the total production of the mill in 1930 and 86.6% in 1931.

12 Classification of consuming industries and percentages for the United States from the annual report in *Iron Age*, volume 127, January 1, 1931, p. 7, and volume 129, January 7, 1932, pp. 11-12.

The most striking fact apparent from Table 3 is that the mill under consideration most certainly was then catering to a limited number of industries using sheet steel. Three groups of consumers took the major share of the plant's output; they were the boiler and tank manufacturers, the oil, gas and water companies, and the jobbers and warehouses. Although the automobile industry increased its purchases in 1931, as compared with 1930, and continued to do so in 1932 and 1933, still this industry, the largest single consumer of sheet steel in the United States, was relatively unimportant as regards this one mill. It may be, however, that the recent increase in its automobile trade will continue and become an important outlet. These facts emphasize that the plant is in a specialty game and depends for its purchasers on certain types of manufacturers rather than on larger, more diversified markets. The three biggest groups which it supplies have accounted for approximately two-thirds of the volume of production analyzed. The dispersion of the other third of the tonnage among the eleven other groups, however, indicates potential markets which possibly could be developed. A knowledge of other outlets is essential if one substantial market should be lost or should drop appreciably, as was the case with the oil, gas and water companies, whose purchases decreased almost one-half from 1930 to 1931.

Of the three groups of consumers mentioned above, the boiler manufacturers have been long and steady purchasers of a certain type of steel sheet produced by this mill. Sheets of standard analyses in certain sizes also have been supplied regularly in the past decade to certain jobbers and warehouses distributed about the country. The demand for sheets by oil, gas and water companies is a development of more recent years, and the company has been alert to meet the needs of such consumers by providing a type of steel especially designed for the construction of pipe lines. It has been the oil and gas companies which have been responsible for the trade on the west coast of the United States, since purchase from this firm has been stimulated by the facilities of cheap water transportation. Other consuming interests, substantial but not covering so large a proportion of the total product as the three groups previously mentioned, are the automotive industry, the steel fabricators, and the machinery and tool makers. Railroads and coal mines used to be consumers of importance, buying large tonnage of sheets for equipment purposes, but their demand has been decreasing steadily.

Geographical Location of Markets.

Since transportation charges are so important an item, a manufacturing establishment naturally would be expected to sell the majority of its output, at least, to nearby buyers, unless the product made is not duplicated by other companies. The lack of large demand from the automotive industry in this particular case is due, doubtless, to the distance of the firm from the automobile factories. The selected mill is situated near the eastern seaboard with excellent railroad connection to the seacoast from whence sheets may be transported via water to any coastal city. The proximity to water with its cheaper transportation facilities is an easily recognizable asset and has been a distinct advantage to the company's progress. The large west coast trade which has developed is due in no small measure to the

cheapness of freight by water. In Table 4 below are shown the percentages of the mill's production distributed to different parts of the country in 1930 and 1931.[13]

TABLE 4

LOCATION OF PURCHASERS OF SHEET STEEL PRODUCTS ONE MILL—1930 AND 1931.

In per cent.

Section of the Country[14]	1930	1931
Canada and Mexico	0.0	0.1
Middle Western states	0.1	1.7
New England	7.6	10.9
New York and New Jersey	20.3	23.2
Pennsylvania	29.5	34.6
Southern states	4.3	6.4
Pacific coast	38.2	23.1
Total	100.0	100.0

The states comprising the Northeast group were the largest consumers of sheets produced in the United States, and also the largest consuming center for the products of this mill. If Pennsylvania, New York and New Jersey are added together, the combined amount is approximately 50 per cent of the total in 1930 and 57 per cent in 1931. The *Iron Age* shows this district to be an active market, and it is one which is especially accessible to this mill. The large percentage of sheets going to the Pacific coast is far greater than the percentage of the sheets which go to that region from the United States, another fact which shows that this mill is catering to specific types of industries and not following the national pattern. The Middle Western states, as classified here, represent a minor consuming center for the products of the one mill.

TYPES OF SHEET ROLLED.

Inasmuch as the mill specializes in supplying certain consumers with sheet steel, it obviously must produce on the whole the type best adapted to that specific industry. The bulk of sheet production for years has been rolled into blue annealed sheets of varying sizes and analyses. The company maintains its own standard sized qualities suitable for boiler-manufacture, or whatever the ultimate product is to be, and has developed special types of sheet for certain firms which it supplies continuously. Besides the blue annealed sheets of varying chemical content, the company makes some special steels. Within the last five years also, constant effort has been exerted to promote the use of steel by perfecting the types of alloy. Important developments in the United States at large have also undergone experimen-

13 As noted in footnote 11, these percentages do not represent the entire production of the mill for the years but a significantly large proportion of the total.

14 This grouping was made advisedly instead of following the classification used by *Iron Age* in its study. The North Central states, which used the second largest percentage of the steel sheets produced in the United States, here are called the Middle Western states, although the states included are not entirely identical.

tation in this plant. Some forms of these are made here and others, manufactured by other concerns, are rolled here into the desired shape and size.

Although the volume of alloy steels rolled into sheets in this mill is increasing, it is still insignificant as compared with the total volume of sheets rolled. In 1928 the amount and number of special steels rolled became noticeable. Whether this development was thrust on the company from outside in response to the wide promotion policy of alloy steel manufacturers and trade journals, or whether it grew up within the mill, resulting from the company's own desire to enter a new field, it is difficult to tell. Doubtless pressure came from both sides. In 1930 over twenty different types of special steel sheet were manufactured in this plant alone. With such diversification, the volume of each type rolled was exceedingly small. But the significant fact is that it was necessary to roll many different types of steel and thus compensate for the decreased quantity of sheet steel required by the regular markets.

Summary.

The market for sheet steel has been a growing one and consequently has become highly competitive. Each firm, therefore, must be very alert to keep its share of the trade. To maintain markets, producers have improved the processes of manufacture exceedingly. Outlets for steel sheet have doubled, responding to improvements in chemical analyses of the sheets which permitted more flexibility in use. The largest single consumer has been the automobile industry.

In steel manufacturing, then, the position of one small firm is at best precarious; it must needs devote every effort to improving its efficiency. To this end, in order to maintain a favorable position and retain its share of the sheet steel trade, this firm has carried on a reorganization of processes and development of its markets. It was forced during the course of years to look for larger outlets and to diversify its products, paying special attention to the new developments in alloy steels. This took the form of stimulating new demands and of rolling many different kinds of special steel sheets, even though in small amounts. The old markets still took the bulk of the tonnage produced, such consuming industries as the boiler and tank manufacturers, the jobbers, and the oil, gas and water companies being foremost. Their absorption of the products was not sufficiently large to enable the firm to ignore the growth in other lines. The favorable location of the firm with water transportation facilities was an added factor in securing the oil and gas trade, most of which came from the Pacific Coast. Otherwise the largest consuming industries were located in New York, New Jersey, and Pennsylvania.

Obviously, further diversification of products might seem to check the decline in the total quantity of sheet steel sold during the depression years 1930 to 1934. If one recalls the production of the mill in these years as compared with that of the United States in the same time, one realizes that, even with such diversification as occurred, the mill scarcely retained its share of the market available. The figures for the United States, however, indicate the limitations to diversification that must arise. In such a crisis the single firm is quite helpless to stem the tide generally sweeping against the industry it represents, even though some gain might have been

achieved by increasing the variety of products which could be made, and by procuring new customers who might thus have been won. The possibilities of this program are only indicated here and are so bound up with the costs of production, equipment of the individual firm, and number of competing firms that it is difficult to say whether or not one course might be more favorable than another. In a major crisis with industry organized as it is, one firm is beset by limitations and practically is powerless to do more than be an opportunist in adopting whatever methods will aid its own survival.

From even this brief study of the market situation, the difficulties of maintaining a certain stability of production are apparent. Management is concerned primarily, when such keen competition exists, in attracting as many orders to its company as possible, and the operating mill manufactures the product in response to the orders. The wide variation in demand and the inability, in this particular industry, to store large stocks of the material makes production to order imperative. During the depression, when many purchasers were reducing the quantities ordered that they might not take any unnecessary risks, a condition of "hand-to-mouth" buying, it was almost impossible to plan a monthly output.

A firm is limited, further, by location of the industries which it feeds. If the accessible industries are affected more by outside economic conditions than are other consumers of the product located farther away, the supplying mill will suffer more than will mills supplying another locality.

To keep its position in any field, therefore, a company naturally takes advantage of producing to the maximum for which it can get the orders. It is unable to do much regulating unless it can exert some influence over the buyers. A mill seems justified in following this procedure, for if it allowed itself to be forced out of the field, not only would the owners suffer, but the employees would be thrown out of work and the purchasing power of the community be that much lowered. For its own sake as well as for that of the workers and their families, at present, it seems that the competitive struggle is necessary. It is to a plant's own advantage, too, to carry on as stable a production program as possible. As much labor is used for rolling small quantities of sheet steel as large, even with the improvements in mechanization. The constant stopping and starting of the mill for rolling small lots is costly and reduces the average of the output per man-hour. The actual situation of this one mill is examined in the following chapters, which emphasize again the limitations and difficulties inherent in achieving stability within one mill.

CHAPTER II.

Production

What then has been the course of production in the selected plant during the years between 1919 and 1933? Before 1919, more exactly before 1917, a steady growth took place in the output of the mill. During the post-war decade the situation was altered, although the market for the products of the mill was expanding in the United States. To penetrate further into these circumstances one must examine the actual production data as they vary from month to month and from year to year. This analysis is given below with sufficient scrutiny of comparable figures for the United States to note significant similarities and differences between the general trends and the specific tendencies of the one mill.

Trend of Production.

The monthly volume of steel sheets produced by the firm during the years between 1919 and 1933 is illustrated graphically in Chart 2, following.[1] The curves impress one immediately with their numerous and violent fluctuations, occurring from month to month and from year to year. The two sudden drops to the base line show that the plant was closed in the months indicated, July of 1921 and March and April of 1925. The first shut-down was due to depression when a general decrease in production took place in most industrial establishments; the other was brought about entirely by local conditions and was not duplicated by general causes affecting this or subsidiary industries.

The figures for sheet steel production in the United States as a whole are depicted similarly in Chart 3.[2] This graph shows both similarities and differences when compared with the data of the one mill as shown in Chart 2. The similarities are expressed in the general ups and downs of the two curves, swings that on the whole are explained readily by a knowledge of the general economic conditions of the fifteen year period. The low production average of 1921 following the higher peak of 1920 stands out as one would expect, considering the general recession in business activity at the time. Subsequently, one notes in both curves the upward swing of 1922 and 1923, the slight drop of 1924, the rise following to the peak of 1926. Another slight setback in 1927 precedes the high point of 1929 and the precipitous decline of the recent depression, still in evidence despite the small upturn of 1933. Even among the similar features, individual pecularities appear, as exemplified in the figures of the one mill for the year 1925.

The differences between the two curves perhaps are more significant than the likenesses. The most outstanding of these are the greater rate of growth in the United States than in the one mill, and the greater regularity

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1 The figures on which this chart is based are given in Appendix, Table 3.

2 Figures for the United States sheet steel production are given in Appendix, Table 4. These data are released by the National Association of Sheet and Tin Plate Manufacturers given in *Iron Age*.

of the seasonal fluctuations within a given year in the United States than in the individual company. Less violent changes from month to month are also evident in the total figures, not entirely explained by the difference in scale used for the two charts.

It requires no great concentration to notice that the volume of production in the United States begins to increase early in the period studied and advances more rapidly than in the individual plant, until 1929, when both the United States sheet steel manufacturers and the one mill suffer a severe decline in tonnage produced. The straight line drawn through the monthly fluctuations represents, for each curve, the secular trend for the years 1919 to 1933.[3] Although these straight lines do not fit exactly the many hills and valleys of the curves and cannot be interpreted as the best fitted curve for the data, they are sufficient to note for comparative purposes the general trend of production in the one mill and the United States. The slope of the line for the selected mill is definitely downward as contrasted with that for the United States, where the trend is still slightly upward. Thus, the decline in sheet steel production throughout the United States in the years 1930 to 1933 has not been great enough to influence downward the direction of the trend. The reverse is true of the data for the individual concern.

Despite the downward direction of the 1919-1933 trend line, however, a conclusion cannot be drawn that the mill has been in a losing game throughout the fifteen year period, inasmuch as the trend of production for the period 1919 through 1929, also shown on the chart, points definitely upward. Similarly, the trend for the whole country during the same years is upward. To be sure, that for the United States has a more decided upward slope than the 1919 to 1929 trend for the one plant, but both lines show that in this decade production was steadily increasing.

The similarity in direction and discrepancy in amount are further reinforced by the yearly changes in total production for the one plant and for the United States, together with the average annual rate of change[4], given in Table 5. From 1919 to 1929 the average annual rate of change for the individual concern was only +3.15 per cent, whereas for the United States as a whole, the yearly volume increased at the rate of 17.57 per cent. This would mean that production of sheet steel was advancing about five times as fast in the whole country as in the one mill. From 1929 to 1933, the depression era, the situation is altered and, although both sets of figures yield a decreasing rate of change which is substantially high, the difference between the diminishing rate for the one mill and for the whole is less than during the previous period. During the four years of depression recorded, the former has undergone an annual average decline in production of 18.58 per cent as compared with 14.72 per cent for the latter. This mill, then, has not suffered as much relatively, in the years of decreased industrial activity, as one might have expected from the comparison of the data for the years 1919 to 1929.

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3 The method used in calculating the straight-line trend is that described by Vanderblue, Homer B, *Problems in Business Economics*, 1929, pp. 774-776.

4 This is a simple average obtained by substracting the base year from the terminal year and dividing by the number of years in the period. It is not as refined a measure as could be obtained to express annual rate of change, but inasmuch as the comparison of the two series is the objective, and the same period is used for both, the results are sufficiently reliable for our purpose. The use of a more refined measure would serve to lower slightly the rates of annual change, but a large discrepancy would still exist, although the rate for the United States might not show quite as large a difference as five times the rate for the one mill shown here.

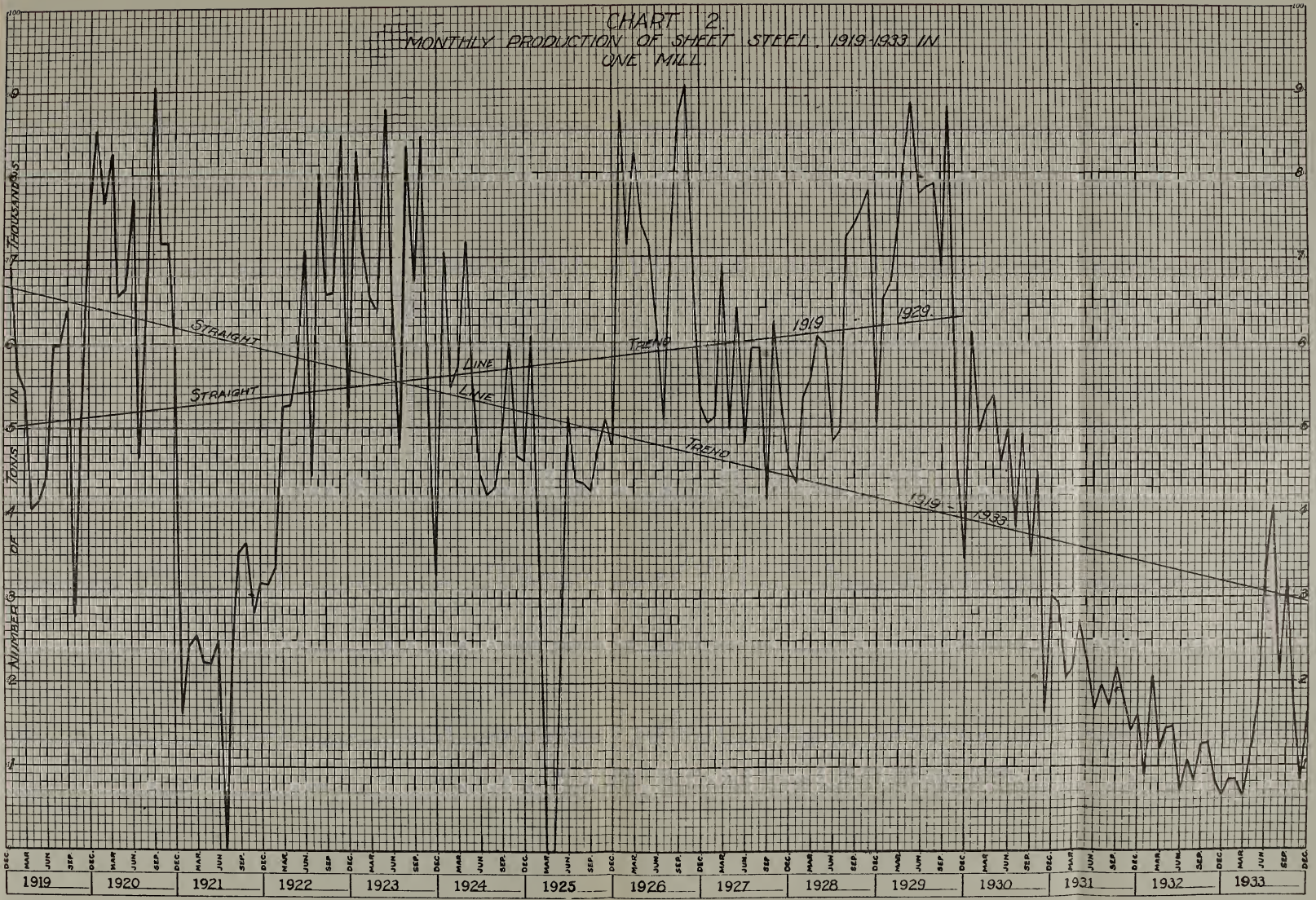
CHART 2.
MONTHLY PRODUCTION OF SHEET STEEL. 1919-1933 IN ONE MILL.
NUMBER OF TONS IN THOUSANDS
STRAIGHT LINE TREND 1919 - 1929.
STRAIGHT LINE TREND 1919 - 1933.
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933

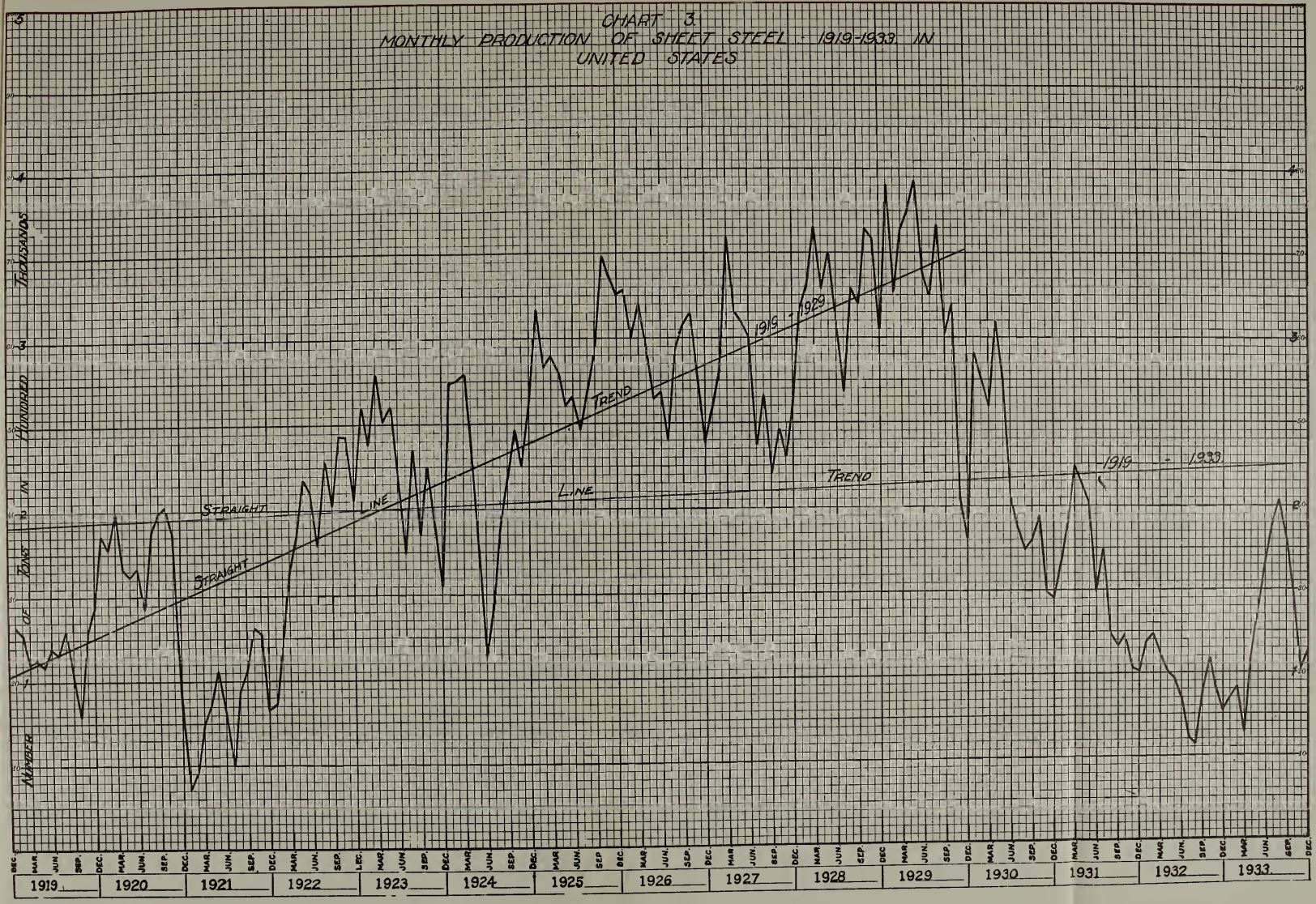
CHART 3.
MONTHLY PRODUCTION OF SHEET STEEL - 1919-1933 IN UNITED STATES
THOUSANDS
HUNDREDS
TONS
OF
IN
NUMBER
STRAIGHT LINE TREND
1919 - 1929
STRAIGHT LINE TREND
1919 - 1933
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933

TABLE 5.

Changes in the Volume of Production in One Mill and the United States.

1919–1933

Year	One Mill		United States	
	Index of Production	Year-to-Year Change (per cent)	Index of Production	Year-to-Year Change (per cent)
1919	100.0		100.0	
1920	133.1	+33.1	145.9	+45.9
1921	45.1	—66.1	72.7	—50.1
1922	107.3	+137.9	162.4	+123.3
1923	124.1	+15.7	189.4	+16.6
1924	99.0	—20.2	187.1	—1.2
1925	70.0	—29.3	249.8	+33.5
1926	135.0	+92.9	244.5	—2.1
1927	101.4	—24.9	233.0	—4.7
1928	112.0	+10.5	280.0	+20.2
1929	131.5	+17.4	275.7	—1.5
1930	81.6	—37.9	187.5	—32.0
1931	38.0	—53.4	134.1	—28.4
1932	21.2	—44.2	79.5	—40.7
1933	33.8	+59.4	113.4	+42.6
Average Annual Rate of Change				
1919-1929		+3.15		+17.57
1929-1933		—18.58		—14.72
Index of Instability of Growth				
1919-1929		22.36		21.56
1929-1933		20.35		16.57

In Table 5 may be found, also, the year-to-year changes in production for both series of figures, which indicate the general stability or instability of growth of the annual tonnage. As suggested previously, the fluctuations are sharper in the figures for the one mill than in the yearly changes for the United States; that is, the one mill shows a larger percentage loss of production in the lean years of 1921, 1924, 1927, 1930, 1931 and 1932, and, probably due to this greater drop, in several instances has undergone a higher percentage of recovery as in the years 1922, 1926, 1929 and 1933. Both series of data exhibit a great lack of stability from year to year, confirming the impression gained from looking at the charts of the raw figures that a straight line indicates only the general trend in volume of production for the two sets of data.

Mills, in his work on production trends before and after the war, has worked out a simple index of instability; the smaller the index, the more stable the conditions in the industry.[5] An index has been computed here

5 Mills, Frederick C., *Economic Tendencies in the United States*, 1932. See especially footnote p. 48.

of the percentage variation of actual yearly changes from production, increasing at the rate of the average annual increase. Even though this index is calculated from a measure of annual change which may be a bit high, the difference in the ultimate index of instability that would result from more exact figures would be slight. It is equally high for both sets of data. Again, therefore, we find the facts noted before, namely that the index of instability of growth is slightly higher for the one plant, than for the overall figures, in both pre-depression and depression years, and that the index is lower for both series during the depression. This last fact indicates that sheet steel manufacturers have lost in poor years as irregularly as they gained in the prosperous period. The indexes are large under all circumstances and indicate an absence of stability in the industry itself.

To facilitate a quick epitome of the long-time nature of the two curves under discussion, Chart 4 has been constructed showing in index numbers adjusted for seasonal variation as described below, the course of sheet steel production for the United States and the one plant, together with the index of industrial production of the Annalist.[6] The base for all these series is an average of 1923 to 1925. The three curves move similarly, reflecting the general economic conditions of the country. The curve of industrial production, however, does not recede as much as do the curves representing the steel industry. Again the relatively higher starting point for the one mill than that for the entire country is most noticeable. From 1927 through 1933, these two curves vary consistently, but prior to that year the differences are more marked. With certain outstanding exceptions, the inference is justified that the mill is fairly typical of the sheet steel industry as a whole and its fluctuations follow the course of the overall figures, even though its rate of growth is less. The striking exception is the different contour of the years 1925 and 1926. The production of the plant suffered in the former year because of the reorganization process in force at that time, necessitating a complete closing of the mill. After the reopening a spurt in production occurred so that from the situation of 1925, abnormal as compared with the total figures, the mill experienced a quick recovery in 1926. Throughout it is clear that the distance of the points from the line representing 100 is larger for the individual concern than is that for the United States.

Seasonal Influences.

Steel production of any type has never been well regularized throughout any given year, so subject is it to consumers' demand, much of which is heavier at certain seasons of the year than at others. Thus, analysis of monthly fluctuations of output reveals certain peaks and troughs of activity over a period of years. The indexes of seasonal variation for both the one mill and the United States have been calculated[7] and presented in Table 6.

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6 The indexes for the one mill are given in Appendix, Table 5, those for the United States in Appendix, Table 6.

7 The seasonal indexes were computed by the method of link relatives.

CHART 4.

INDEX OF MONTHLY PRODUCTION OF SHEET STEEL 1919-1933

ONE MILL AND THE UNITED STATES COMPARED WITH INDEX OF INDUSTRIAL PRODUCTION

Base 1923-1925=100

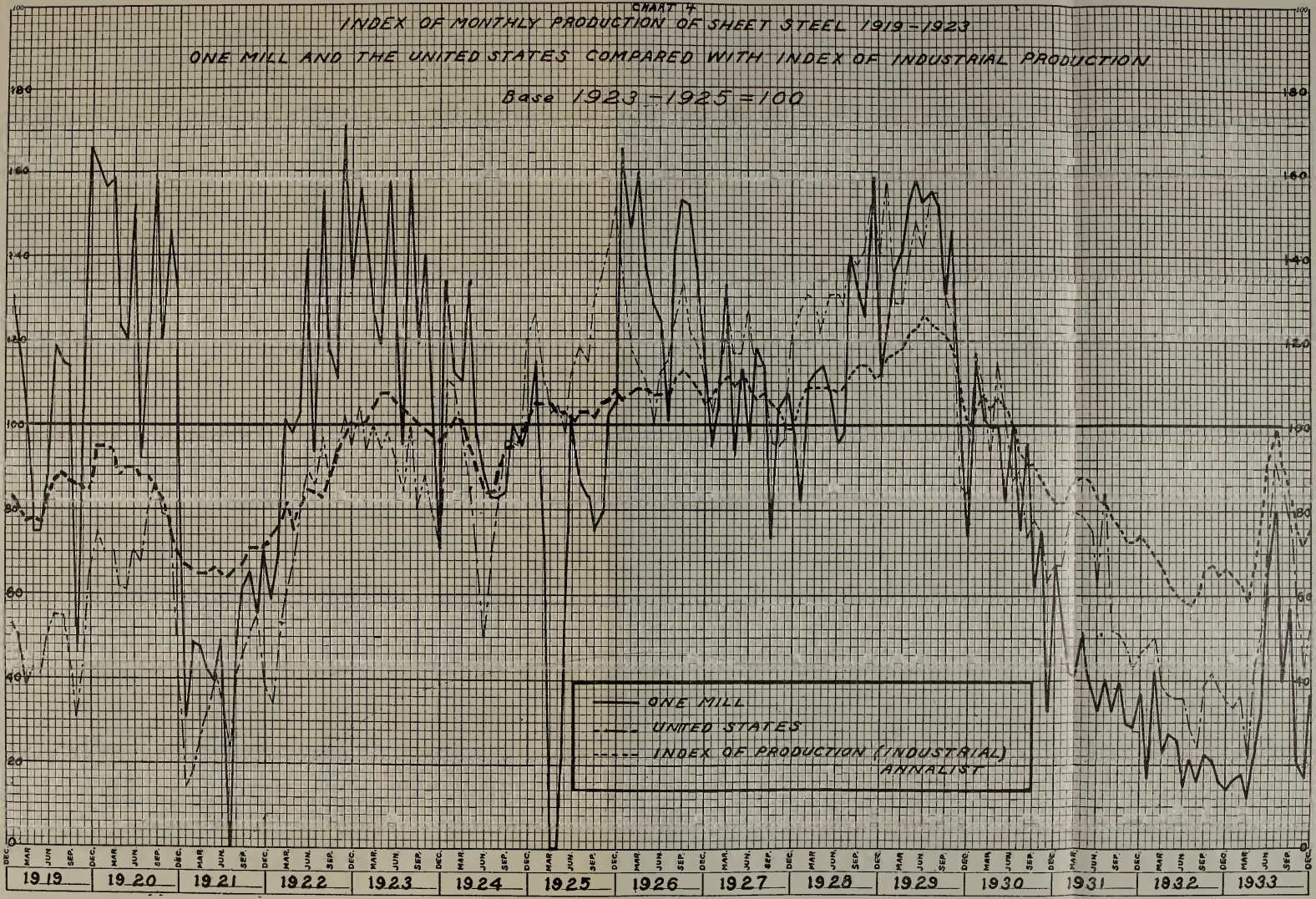

TABLE 6.

Seasonal Index of Production

1919–1933

Month	One Mill	United States
January	101	102
February	93	103
March	99	115
April	102	110
May	106	108
June	96	97
July	96	85
August	99	96
September	108	94
October	114	105
November	94	97
December	87	88
Average Deviation	5.6	7.2
Range	27	30

TABLE 7.

High and Low Points of Sheet Steel Production—One Mill and the United States.

1919–1933

(Table shows month in which high or low was reached.)

Year	One Mill		United States	
	High	Low	High	Low
1919	December	October	December	October
1920	September	July	October	December
1921	October	*July	October	January
1922	November	January	October	January
1923	May	December	March	December
1924	April	July	March	June
1925	January	*Mar., April	October	July
1926	October	July	January	December
1927	March	September	March	September
1928	November	January	March	July
1929	May	December	May	December
1930	January	November	April	December
1931	January	November	March	December
1932	February	December	February	August
1933	July	March	August	March

* Months of no production as mill was closed.

Again significant similarities and discrepancies between the two sets of figures are apparent. Both series indicate a rise of activity in the spring, a slump in the summer, another rise in the fall of the year, and a final decrease in production at the end of the year, as might be expected. The highest point in the curve for the one plant, however, is in October, and the spring peak is as late as May, whereas in the seasonal indexes for the United States, the highest point is in March and only a secondary peak comes in October. Again, in the one case, the lowest point for the year occurs in December, while in the country's figures, it appears in July. July and December are respectively other low points for the two series studied. The range of the index for the one firm and the average deviation of the monthly indexes are both less than the corresponding range and average deviation for the United States. The differences in the range are, respectively, that of 27.1 and 30.1, and in the average deviation, that of 5.6 and 7.2.

The greater stability of the seasonal fluctuations in the single mill, indicated by the comparison of the index for 1919 to 1933 with that for the United States for the same period, is somewhat misleading. The monthly volume of production for the individual company has varied a great deal over the course of the years, and it would seem that in taking so many years, many of the extreme variations had cancelled each other. Because of this possible contradiction, the seasonal changes of tonnage for the mill were examined in detail. A rough sheet was drafted showing high and low spots of production for each of the fifteen years. Wide variety was evident in these results, presented in Table 7, more in the peak months than in the low months. Three times January led in production for the year, twice each, October, November and May led, and once each of the following months was first, September, December, February, March, April and July. Thus the only two months which never showed the highest point in the course of the fifteen years for which data were examined were June and August. The low points were less scattered. July exhibited the low point of production in four different years; December in three; November and January were low months twice; and October, March and September were low once. The five months of April, May, June, August and February have never been months of lowest production. No account was taken in the above of the low point of 1925 when the plant was not operating for two months because of local conditions. A comparative study of similar movements in the raw data of the United States also given in Table 7 shows again variety in the months which have achieved the respective ratings but it is a little less scattered than in the one mill. Interestingly enough in the United States figures the low points are more consistent than the peaks. Several times the mill and the United States both have the same months of high and low production, different from that indicated by the seasonal indexes. An example may be found in 1919 when December, ordinarily a low month, is the month of highest production and October, ordinarily high, is the month which is the lowest. In all probability the cause may be assigned to the steel strike in October, 1919, which spread over many mills in the country. Doubtless the recovery from loss of business resulted in the December high point. Thus, sometimes certain conditions affect all mills alike and would be apparent in overall and individual data, while at other times the small company has special and isolated factors which affect it alone. These specific peculiarities are eradicated when a collective mass of data is studied.

In another attempt to see how the various years from 1919 to 1933 differed in the seasonal fluctuations, the depression years were eliminated and the remaining years divided into two periods, from 1919 to 1924, and from 1924 to 1929. Seasonal indexes in both series were computed,[8] and in each instance showed October as the high month of production, but during the former years, July was the month of lowest production, while for the latter period of time, December was low. The months of April, May and June vary most. The rest of the seasonal curve follows the same pattern as that for the whole period; that is, the index recedes in February from January, and rises in March, then, (omitting here April, May and June) drops in July, rises slowly in August and September to the October peak and falls in November and December. In contrast to the pattern of the one mill with its October high point, the production of steel sheets in the United States has a pattern with a March peak and an October secondary peak. Although no indexes were calculated for the United States figures for periods of time corresponding to those used for the mill, similar seasonal indexes have been computed by Kuznets with his more elaborate method[9] for the years 1919 to 1924 and 1924 to 1928 covering sheet steel production in the country.[10] The low point in his indexes is reversed from December to July in the latter period, and the secondary low point is likewise reversed from July to December. In general the index of seasonality shown in Table 6 for the United States follows the same pattern exhibited by the two sets of indexes which Kuznets presents. In connection with his analysis of these indexes, Kuznets draws the conclusion regarding steel and steel ingots, that a two-peak seasonal pattern prevails for semi-finished goods, the peaks clustering around March and October and the troughs around July and December.[11]

An explanation of the different primary and secondary peaks and troughs of the one concern as compared with those for the United States is to be found in the markets which each supplies. The high March point for the overall data is due, in large part if not entirely, to the fluctuations in demand from the automotive industry. Since the figures are those representing the independent manufacturers who supply the automobile factories even more than do the large steel corporations, they would thus be influenced by the variations in automobile production. The lack of large demand from this industry in the one plant explains the small spring rise. The special markets which the one mill supplies obviously place their orders in the fall. The consuming industries are varied and individually, as far as can be ascertained, lack distinct seasons, so that only general industrial tendencies seem to account for the peaks and troughs. For the two years of 1930 and 1931, when the purchasers of the products of the mill were analyzed, October was not a high month, and thus no peak was evident in any of the groups of consuming industries. The mill manufactures entirely on demand, although orders from some customers are spread throughout the year. Thus, the market demand causes the fluctuations of production, even if data on hand are insufficient to show which industries are more responsible.

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8 The indexes are given in Appendix, Table 7.

9 Kuznets, Simon, *Seasonal Variations in Industry and Trade*, 1933,pp. 25-29.

10 These indexes are included with those for the one mill in Appendix, Table 7.

11 Kuznets, Op. Cit., p. 251.

Evidence of Cyclical Influences.

One would anticipate that a series of production statistics such as we have just been analyzing would show certain cyclical reactions over as long a period as fifteen years. The movements which are due to the so-called business cycle are apparent in the two sets of sheet steel data after the secular and seasonal fluctuations discussed previously have been eliminated. Chart 4 indicates the influence of cycles even though the influence of the long-time trend is still present. In the figures for the one mill, four distinct crests are noted, occurring in 1920, 1922-23, 1926 and 1929, with troughs in between. The low points are most conspicuous in 1921 and in the years 1930 to 1933. The corresponding figures for the entire country show the same general situation but the depression of 1921 stands out less prominently due to the smaller relative size of the indexes for these years as compared with later years.

Chart 5, however, shows the two curves with the trend influence eliminated. It is evident that the two curves are similar in their general movements, each, as brought out before, reflecting economic conditions in the country at large. Here the 1921 depression does stand out in the United States data. The amplitude of the swings is greater in the cycles of the individual company than in those of the United States, but the length is similar. As one might expect, the one concern is much more subject to changes in demand occasioned by sharp monthly fluctuations, than are the many mills included in a collective mass of data.

Other points of dissimilarity between the two curves are apparent. The 1920 peak is more distinct in the figures for the one mill than in those for the United States. Likewise the crests of the waves in 1922-1923 and in 1929 rise higher in the data of the one plant than in that covering the country. Again, the former curve has a peak appearing later in 1926 than does the latter curve, a phenomenon explained, however, by the diminished production of 1925 in the mill. From 1929 on, both series suffer, showing a large trough whose upturn is not as yet marked clearly.

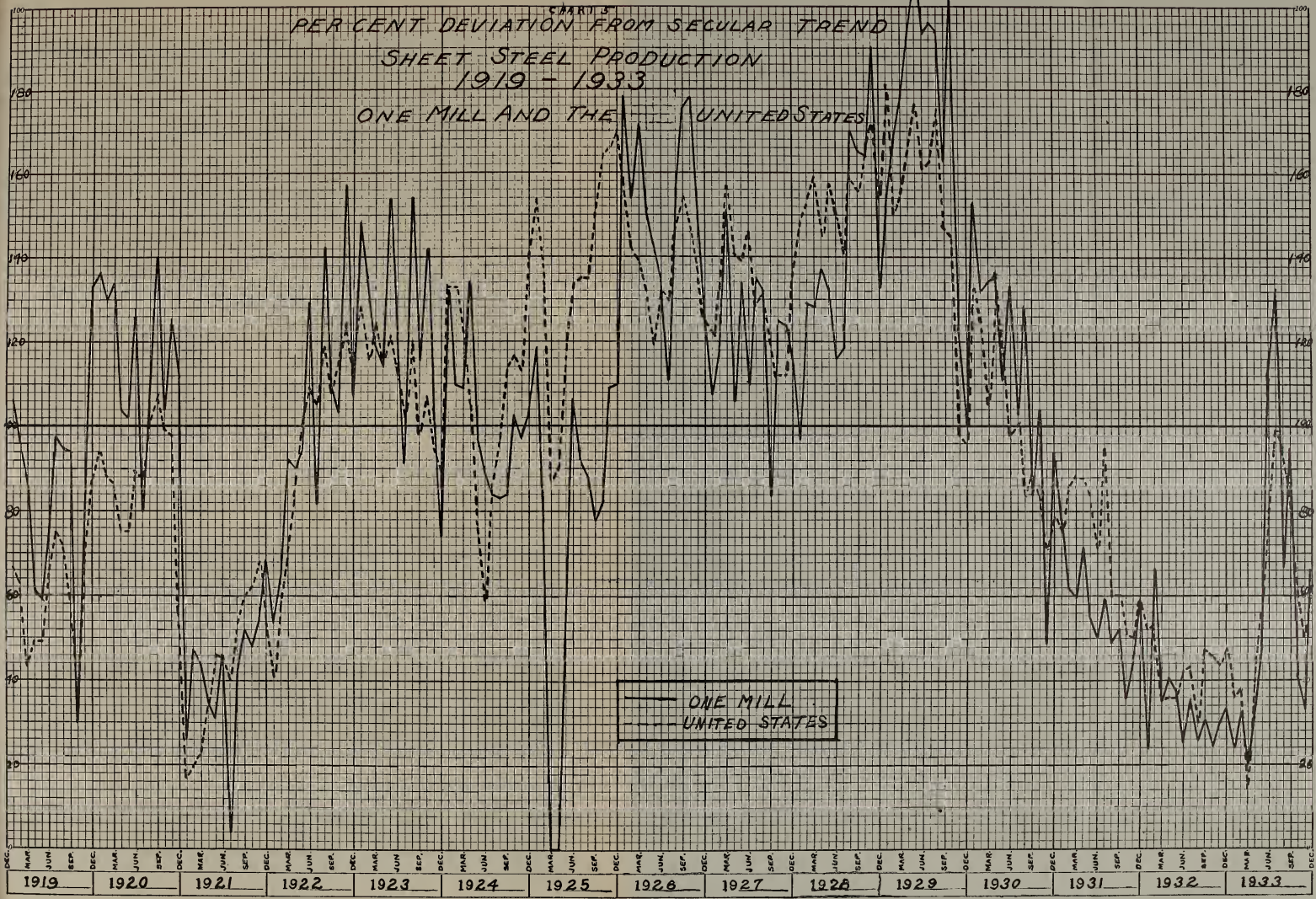
The cycles for both sets of data are typical of known economic conditions. Exceptions are due to random and specific situations in an individual concern, which would be lost entirely in a large mass of data. The chief significance of this comparison lies in the similarity of the two curves. The likeness indicates, first, the extent of outside influences upon the life of the single enterprise. Differences from general movements have their origin in some phase of local activity and, therefore, possibly might be subject to control. In the second place, the comparison reveals the degree to which the selected mill is typical of sheet steel production in this country.

Efforts of Mill to Maintain Production.

The detailed examination of the statistics of production for the period 1919 to 1933 adds emphasis to the point made in the previous chapter that although the market for sheet steel was increasing rapidly, the one mill was not able to increase its output proportionately. The company, therefore, has had to bend its energy toward maintaining its competitive position. This energy has been expended in two main directions: first in expanding its markets by diversification of its products in order to serve a more varied demand, and second, by increasing its productive efficiency, that its bargaining advantage might be the more favorable.

CHART 5

PER CENT DEVIATION FROM SECULAR TREND
SHEET STEEL PRODUCTION
1919 – 1933
ONE MILL AND THE UNITED STATES



Although this particular mill had a long history of favorable recognition for the high quality of its sheet, only a few standard types had been rolled. When the demand for these types began to slacken and at the same time, scientific developments in the industry brought forth new types and new uses for steel sheets, the mill was quick to initiate changes in its plant. Special steel sheets, adapted to a greater variety of uses, were rolled. The actual amount of sheet other than "Blue Annealed" rolled each year was less than one per cent of the total until the year 1929, when it jumped to 3.7 per cent. Nor has the demand been decreasing in the present depression. From 1929 to 1931, for example, the total production of the mill dropped but the production of special steel sheets increased. Percentages are given in Table 8 for the years 1924 to 1933.

TABLE 8.

PERCENTAGES OF TYPES OF SHEETS ROLLED IN ONE MILL
1924–1933

Year	Blue Annealed	All Others	Total
1924	99.3	0.7	100.0
1925	99.7	0.3	100.0
1926	99.5	0.5	100.0
1927	99.8	0.2	100.0
1928	99.4	0.6	100.0
1929	96.3	3.7	100.0
1930	82.3	17.7	100.0
1931	79.4	20.6	100.0
1932	85.9	14.1	100.0
1933	89.1	10.9	100.0

During the past decade, and more particularly during the previous five years, as has been emphasized above, great importance has been given to the new high speed and special steels which have been manufactured to meet the growing demand for metal of greater flexibility, high polish, and resistance to heat and stain. More and more uses for such steel have been found and technological improvements are still being made. The movement for streamlined trains and automobiles has stimulated further experimentation. To date, it is expensive to prepare and to roll these special steels because of the care which has to be exercised in their quality. Most of the lots sold are in small quantities and for many sheet steel mills tonnage production on a large scale has not been attempted. The types of alloy steel have been numerous. Many of them were not manufactured by the company but merely were rolled in its mill. As many as twenty different trade names appear in the invoices, most lots rolled in amounts well under a ton.

This marked effort on the part of the management to keep abreast of the times and to capture new markets where old ones were dwindling might have had a more noticeable effect on improving the stability of production if the country-wide depression had not occurred. As it was, the discrepancy between the one mill's loss of business and the decrease noted in the production of sheet steel in the whole country, was not as great as existed

when both trends were rising. Just how much the diversification of markets saved the situation, it is impossible to estimate, but it seems obvious that the development of other markets has served to lessen the effect of the depression.

The second manner in which the firm attempted to improve its competitive position was to increase its efficiency in producing sheets. The management introduced changes in machinery and equipment and in methods of manufacture, toward the end of reducing costs of production. It was attended with marked success, at least until the depression set in, (see tables in Chapter IV.) Buildings were scrapped and obsolute machinery was discarded. At the same time, the processes of manufacture were so improved that, as the later analysis shows, many employees were eliminated while the same volume of production was maintained. The reorganization of the mill was begun in 1924 and continued until 1928. The sharp decline in production already noticed in 1925 accompanied the new installations.

Although the point has been mentioned several times that the mill was not growing as rapidly as sheet steel production in the whole country, it must be borne in mind that a limit to the physical capacity of any mill must exist. When that point is reached, it could be argued that other buildings and additional equipment might be added to increase its output, but again the question of whether or not additional product would justify the expense must be considered. At any time, however, there is a maximum amount which each firm can turn out with all machinery running the customary number of hours. The rating of the capacity of a mill is difficult because of the many variables involved, and the term cannot be regarded as well or technically defined, although it is often used. Production exceeding capacity exists in a boom period when much overtime is worked, and in times of decreased business activity mills operate at a small percentage of the capacity.

The mill studied here had a rated capacity of 100,000 tons in 1929, which executives said really had been attained after the reorganization. Thus after 1926 or 1927, one might safely say that annual tonnage might reach this figure. At no time in the eight years since 1926, however, has the mill achieved this maximum. The highest actual tonnage produced was 86,994 tons in 1926, which would be approximately 87 per cent of the capacity rating of 1929. The mill had exceeded even this figure in 1917, when 87,246 tons were manufactured. This occurred before the reorganization was contemplated and when equipment was old, but it was during a time of high demand. Obviously productive capacity was no less in the later period.

If the mill can manufacture 100,000 tons of sheet steel a year, an average monthly tonnage capacity of 8,333 tons throughout the year could be maintained. This figure has been achieved by the mill several times, although never consistently. Once in 1922 twice each in 1920, 1923 and 1929 and three times in 1926 has this monthly average been surpassed by the actual monthly production, and five additional times, 8,000 tons monthly have been exceeded. Twice over 9,000 tons actually were manufactured, showing that it is possible to operate the plant at excess capacity. If orders for steel sheets could be obtained by the mill steadily and in large enough volume, the yearly average of 100,000 tons of sheet steel could be made easily.

SUMMARY.

The facts presented in this chapter bear out the preceding discussion of markets. While typical in many respects, the mill has not been keeping pace with the rapidly expanding market for sheet steel. The growth of the whole industry has been so pronounced up until the year 1929 that one would scarcely expect an individual firm to increase its production at the same pace. But the difference between the annual rates of change, as large as that between 17.57 per cent and 3.15 per cent, the rates of growth for the United States production and that for one mill, is greater than would be anticipated if the mill were keeping its competitive place.

Long before the depression, the mill had taken steps to regain its relative position in the industry. It had increased its productive efficiency by 1929, a procedure which obviously was essential if it were to continue in an overcrowded field. It had shown itself resourceful, further, in keeping up if not stimulating markets by diversifying the products, and developing increased demand. As a result it was able to withstand the depression better than one might have expected.

The general nature of the curves for the industry and the plant is similar. This is especially true of the larger economic conditions which account for the so-called "business cycles," whose influences are directly reflected in the data presented here. No doubt exists but that the selected mill exhibits the same major movements as the industry which it represents. The discrepencies are significant because they indicate wherein each concern differs from the trend for one reason or another, and show individual limitations which are lost sight of when aggregate figures are examined.

One differentiating factor in the selected mill accounts for the peculiarities of the data for the year 1925. By that year, the position in the field had been realized and steps had been taken to place the firm on a better competing basis by a thorough reorganization of the equipment of the plant. In this development the mill was forced to close for two months and then make up this loss and forge ahead. Again, the seasonal indexes show the effects of specialization on any plant. Although the seasonal influences are similar in that the two sets of figures for the United States sheet steel manufacturers and the one mill have spring and fall peaks and July and December low points, the fall peak is greater in the one instance than the spring peak. This is explained by the small volume of trade from the automotive industry which itself has a spring peak and so influences the overall figures. The monthly fluctuations of the two sets of data show larger variations in the one mill than in the whole country. The firm has reflected also a greater instability of growth but it has not lost more business during the depression than the overall figures show.

The effects of the course of production on other factors involved are brought out later. Since, however, production is the basic factor, it is important to keep in mind the many limitations placed on any plant in maintaining its output from year to year.

CHAPTER III

Employment.

Inevitably no body of labor is static. Besides the voluntary movements on the part of the worker and the elimination of the inefficient worker on the part of the management, reduction results also from seasonal variations in employment created by the difference in intensity of demand throughout the year, and from spasmodic and periodic upsets. These latter may be caused by random and unexpected events, strikes, for example, or by widespread, interrelated economic conditions such as an industrial depression. Permanent displacement of labor occurs due to increased efficiency in performance of the task and technological improvements in manufacturing processes. All these influences may be apparent in any employment figures covering a period of years. Data of the sheet steel mill under discussion illustrate, in some instances rather strikingly, the effect of these major disturbances upon employment stability.

Fluctuations of Employment.

Chart 6 throws into pictorial form the employment status of the sheet mill from 1919 to 1933.[1] The heavy black line depicts the fluctuation in average numbers employed each month throughout these years. The dotted black line brings into focus the number of men-hours actually worked. It appears with several breaks, since data are not available throughout. The straight line flung through the chart shows the long-time trend.[2] A study of these two curves and the straight line reveals the employment situation in the mill during the fifteen year period.

Three striking facts are apparent at once. In the first place, even without the insertion of the trend, a marked decrease in the number of employees from 1919 to 1933 is noticeable. This diminution of working force is particularly remarkable as it was definitely established in 1928 and 1929 before the recent depression had time to exert its influence. In the second place, tremendous monthly fiuctuations occur throughout each year. Even if the two periods are ignored when the mill was entirely closed, enormous monthly changes still appear. In 1919, for expamle, the monthly average of employees drops from 791 in September to 282 in October, and in 1923, it decreased again from 640 workers in November to 401 in December. In the third place, a marked growth in stability of working force appears from 1928 to 1933, (more especially between 1928 and 1931) a stability which appears remarkable considering the low business activity of 1930 and 1931.

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1 The figures for numbers employed are given in Appendix, Table 8. The raw data were given in bi-weekly figures from which the monthly average was calculated. Man-hour figures are to be found in Appendix Table 9.

2 The straight-line trend is calculated by the method described in Vanderblue, Op. Cit., pp. 774-776.

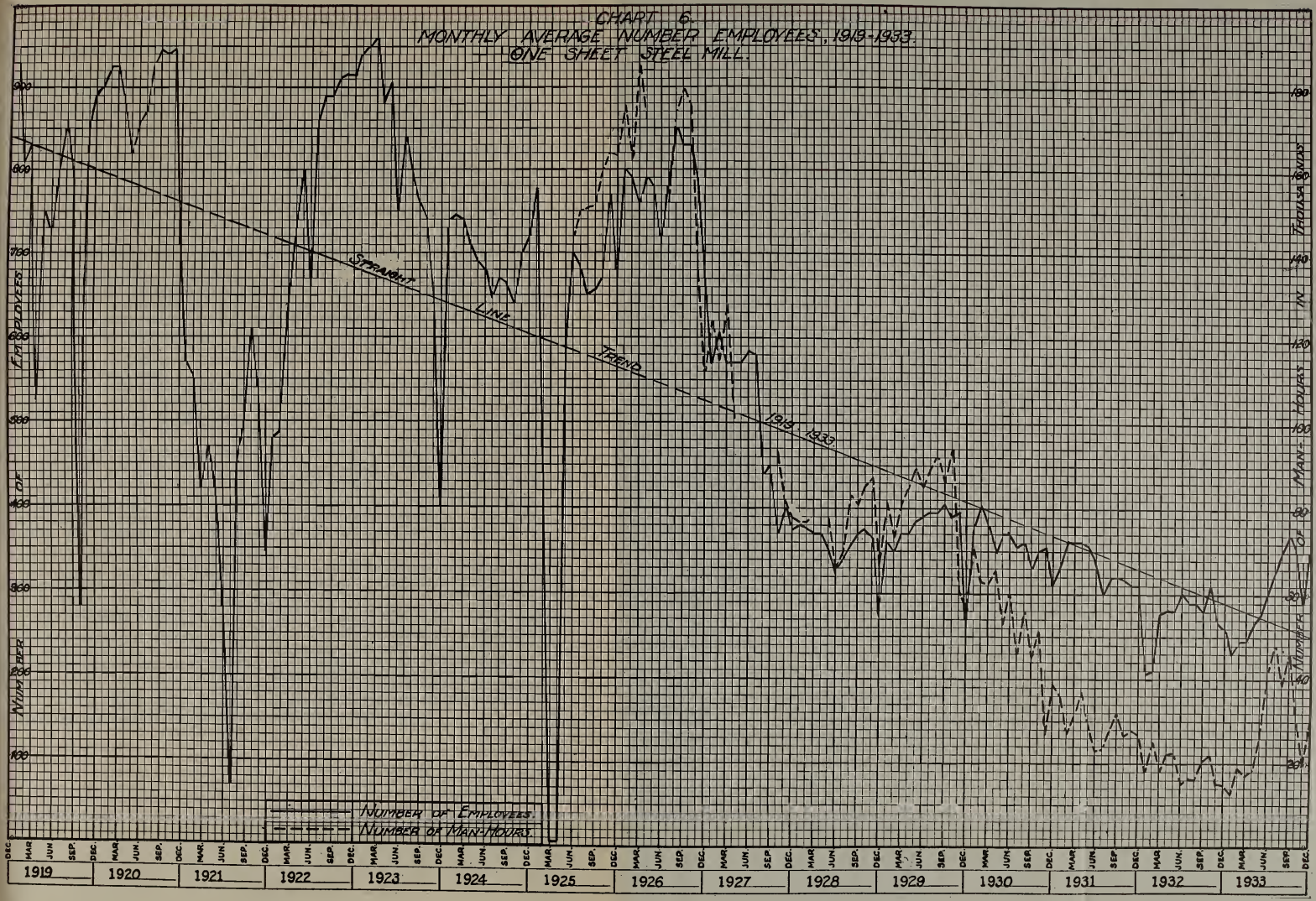
CHART 6.
MONTHLY AVERAGE NUMBER EMPLOYEES, 1919-1933.
ONE SHEET STEEL MILL.
STRAIGHT LINE TREND 1919-1933
NUMBER OF EMPLOYEES
NUMBER OF MAN-HOURS
NUMBER OF EMPLOYEES
THOUSANDS OF MAN-HOURS
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933

Secular Trend of Employment.

The first significant point brought out by data pictured on Chart 6 is the unmistakable downward movement, indicating a diminution of the numbers employed from 1919 to 1933. Since the earlier year, literally hundreds of men have beeen droppd from the mill. With the exception of 1921, a depression year, the average number of employees each month from 1919 to 1923 was frequently above 800. This number was reduced so that from 1930 to 1933 it averaged around 300, a decrease of about 500 men. As a matter of fact, the decline was apparent as early as 1928, when the number averaged 354 for the year. From an average of 887 men in 1920, the force was reduced by 515 men to an average of 372 in 1929. Both 1920 and 1929 were peak years from the point of view of production; lowered labor force was not accompanied by a similar decrease in tonnage produced. One might have expected a recession by 1931 with its well-known employment difficulties, but the averages for the years of 1929 and 1930 indicate only a loss of 41 men. Although the yearly average shrank somewhat further as the depression progressed to 1932, still the reduction was not excessive, only 102 from the 1929 figures. Thus, quite obviously, the bulk of those eliminated had severed their connection with the firm before the general business depression began.

By contrast, the depression of 1921 reflects abrupt changes in the numbers employed. From 1920 to 1921 the yearly average slumped to 435 from 887, a difference of 452 men. Normal employment was revived in 1922 by an increase of 330. The rather low average in 1925 may possibly give a somewhat misleading picture. It is based on a twelve month year as are the other averages, but in this year no production was carried on for two months. If these two months are omitted and an average calculated on the basis of ten months, the result is 684, probably a fairer estimate, as the cessation of production was due to purely local conditions. After the year 1926, the downward trend becomes rapid, distinct and permanent, at least as far as data now at hand disclose.

The course of employment year by year is quite different from that of annual production, as seen in the previous chapter. The dissimilarities are shown in Table 9 containing index numbers of production and of employment, and are more sharply brought out in Chart 7, following. Although the two curves are not unlike until 1927, a marked divergence is apparent for the remaining years. The curve representing numbers of employed declines in the years 1926 and 1927, then becomes relatively stable, whereas the production curve rises to a peak in 1929, and then declines precipitously to 1932, with a slight upturn in 1933. Obviously, the loss in employment precedes the decrease in volume of production by two years.

TABLE 9.

INDEX AND PER CENT CHANGE OF PRODUCTION AND EMPLOYMENT IN ONE SHEET STEEL MILL.

1919–1933.

(Base: 1919=100.)

Year	Employment		Production	
	Annual Average	Year-to-Year Change	Total Tonnage	Year-to-Year Change
1919	100		100	
1920	118	+18	133	+33
1921	58	—51	45	—66
1922	102	+76	107	+138
1923	106	+ 4	124	+ 16
1924	92	—13	99	— 20
1925	73	—20	70	— 29
1926	104	+42	135	+ 93
1927	67	—36	101	— 25
1928	47	—30	112	+ 11
1929	49	+ 5	132	+ 17
1930	48	— 3	82	— 38
1931	44	— 8	38	— 53
1932	36	—19	21	— 44
1933	40	+11	34	+ 59

Table 9 also shows the percentage change from year to year. The variations of employment data, although usually less than the corresponding advances and declines of production statistics, move in the same direction as the latter until the year 1928. After 1927, the changes in employment decrease each year until 1933, with the exception of a small increase in 1929. When the whole span of years, 1919 to 1933, is considered without regard to intervening alterations, a net decrease in both number of employees and volume of production appears, amounting to 60 per cent and 66 per cent respectively, or an average annual decline of 4.3 per cent and 4.7 per cent. The situation is quite different if the years 1919 to 1929 are considered. Here the number of workers shows a drop of 51 per cent while the yearly tonnage increases by 32 per cent. From 1929 to 1933, on the other hand, production shrank 74 per cent as compared with a loss of only 18 per cent in employment. These and other per cent changes between ev eral of the years are contained in the following table.

TABLE 10.

PERCENTAGE CHANGE IN INDEXES OF EMPLOYMENT AND PRODUCTION IN ONE SHEET STEEL MILL.

(Base for Indexes: 1919=100.)

Intervals	Per Cent Change	
	Employment	Production
1919–1933	—60	—66
1919–1929	—51	+32
1929–1933	—18	—74
1919–1926	+ 4	+35
1926–1929	—53	— 2

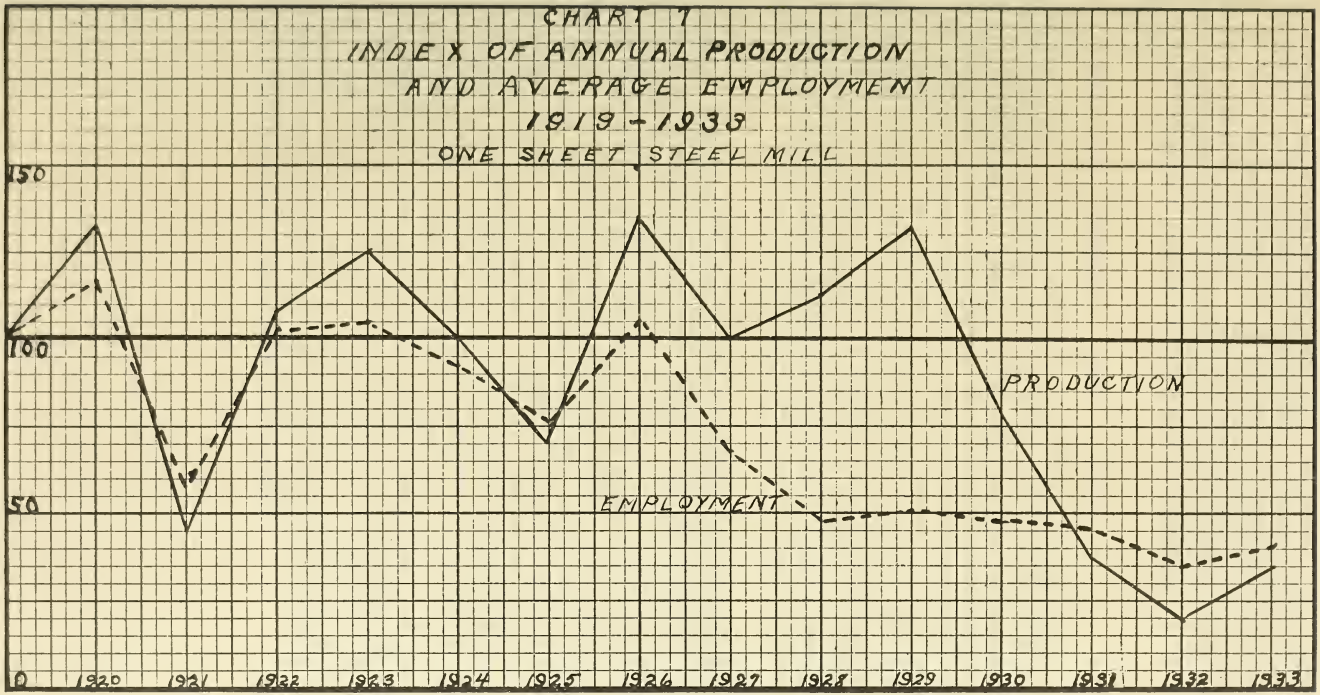
CHART 7
INDEX OF ANNUAL PRODUCTION
AND AVERAGE EMPLOYMENT
1919 - 1933
ONE SHEET STEEL MILL
150
100
50
0
PRODUCTION
EMPLOYMENT
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933

This discussion surely indicates that the number of employees is not correlated directly with volume of production. In the early part of the fifteen year period, the movement of production and employment is similar but the likeness exists no longer. The reasons behind these relationships are discussed elsewhere,[3] but the reorganization of the mill and the introduction of new processes, by which workers were displaced, account for the major changes.

Monthly Fluctuations: Seasonal and Cyclical.

In the second place, Chart 6 indicates tremendous monthly fluctuations in the curve of employment from 1919 to 1931. Primarily, the causes are to be found in the seasonal movements within the industry and in the cyclical variations occasioned by the changes in the volume and character of the business. In addition, there are certain sporadic and exceptional influences which are not repetitive nor universal, but do account for specific low and high points of the curve. In this category may be placed the decrease in employment noticed in October, 1919, a sudden drop appearing in other industrial curves of employment and production, and due to the widespread steel strike of that year. Again, in March and April, 1925, a decline occurs due to purely local conditions and not duplicated in data covering wider areas.

Examination of the employment curve reveals that throughout the years the numbers employed in the month of December consistently tend to be lower than those employed in other months, and the numbers employed in the fall months tend to be slightly higher. Otherwise no uniformity appears in the high and low points from year to year, even though fluctuations are apparent in abundance each year until 1928. In order to examine the effect of seasonal influence, indexes have been calculated, based on the data for the entire period. They are given in Table 11 together with those for production data, examined before. The two series are quite dissimilar, although from June until December the low and high points are somewhat comparable. The range of the employment indexes is but 12 as compared with 27 for the production data, and the average deviation for the former is 2.75 per cent, much less than the 5.6 per cent of the latter. From the evidence of these figures it would seem that seasonal employment has been more regular than seasonal volume of production. Certainly less seasonal instability occurs in the monthly numbers employed than appears in the production figures, and the working force seems to have achieved a greater stability than the amount of steel rolled each month.

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3 See Chapter IV on changes in productivity.

TABLE 11.

Indexes of Seasonal Variation for Numbers of Workers and Volume of Production in One Sheet Mill

(Based on data for years 1919–1933.)

Months	Employment	Production One Mill
January	97	101
February	98	93
March	99	99
April	99	102
May	100	106
June	98	96
July	100	96
August	104	99
September	104	108
October	104	114
November	104	94
December	92	87
Average Deviation	2.75	5.6
Range	12	27

TABLE 12.

Seasonal Variation in Employment in Different Years One Sheet Mill.

Months	Index 1919-1933	1920	1926	1929
January	97	101	102	96
February	98	104	101	95
March	99	104	97	100
April	99	99	101	100
May	100	93	99	103
June	98	97	90	105
July	100	98	101	106
August	104	104	108	106
September	104	106	106	109
October	104	106	106	104
November	104	107	101	106
December	92	80	88	70
Average Deviation	2.75	5.8	4.3	6.5
Range	12	27	18	39

The index of seasonal variation in employment shows a low point in December, another less sharp drop in June, with two plateaus, one in the spring and one in the fall, the fall rise being higher than the spring. Except for the two low points in June and December, and the summer recession is not great, the figures give the impression of a fairly stable group of employees during any one year. It is an impression not wholly borne out by facts. It is probable that the variations in high and low points during the fifteen year period tend to cancel out in the calculation of the index. When one selects a year at random and compares the data of employment for each month with the seasonal index obtained, one notices marked differences in the configuration of the curves. This has been done for 1920, 1926 and 1929, and the results are incorporated in Table 12.[4] These three years were chosen since they were free from disturbances either within the mill or without, except in the fall of 1929. In them also, production was high, when one might expect that seasonal demand would be apparent if it were an important factor. The year 1929 also followed the reorganization of the mill when the elimination of the great number of workers had been effected.

The indexes of all years suffer a decided drop in December, and in 1920 and 1926 they decline also in the early summer, although in 1920, employment is lower in May than in either June or July. In 1929, the index climbs gradually to a peak beginning in March and culminating in October. The one common characteristic in all the curves representing the various seasonal indexes is the rise in the autumn, which is definitely comparable to the distinct peak of production noted before. On the whole, the pattern, with variations, is that of a recession after a slight rise, followed by a higher rise, and ending with a distinct retardation.

The change in the average number of employees which resulted in a much smaller force than previously employed during the years 1928 to 1933, does not affect greatly the seasonal movement. Seasonal indexes have been calculated for the two periods, 1919 to 1927 and 1928 to 1933, to see if significant differences appeared between the time of the large and that of the diminished working force.[5] These indexes like those for the total period exhibit very little fluctuation; the ranges and deviations are small throughout the months. The range is 12 and 13 respectively and the average deviation is 2.6 per cent for the former period as compared with 2.4 per cent for the latter period, indicating a slightly greater stability during the years 1928 to 1933. The fall peaks, though not well-marked, again may be noticed, and the usual low point occurs at the end of the year. Within rather large limits, therefore, the increase in productive activity in the fall necessitates a slight addition to the number of employees, and the slump of year-end business required the laying off of a substantial number.

The cycles of employment as shown by the per cent deviations from the straight-line trend are somewhat different from those of production. Chart 8 displays the effect of cyclical and random changes on the average number employed from 1919 to 1933.

Three cycles appear, varying in length and amplitude with many irregu-

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4 The indexes for the different years are computed by taking the average for each year as 100.

5 The figures are given in Appendix, Table 10.

larities. The first cycle has a crest in 1920, followed by a trough in 1921. Another distinct crest is noted in the latter part of 1922 and early in 1923 with a most irregular, indecisive trough in 1924. Finally, from 1925 to May, 1933, occurs the third cycle with an unstable rise to the high point of 1926 ending in an abrupt drop to a prolonged trough, with a definite upturn indicated as far as available figures show. With the exception of the year 1925, when the plant was beset with its own troubles, the cyclical nature of the employment figures up until 1926 seems not unlike business conditions as we know them. A peak is found in 1920 when business activity was brisk, a trough in 1921 when industrial conditions suffered a severe decline, and so on until 1926. After this the curve shows individual traits; the percentage deviations from the trend turn unmistakably downward, and do not turn up again until 1933. The abrupt decline occurs, furthermore, well before the closing months of 1929, when the present major depression began. Moreover, the curve attains a slight upturn in the depression years. Again it is indicated clearly that the volume of employment had been permanently reduced prior to 1929.

That there was no large drop in employment figures from 1930 to 1933 with general industrial depression has been obvious. Even though production in the mill declined perceptably, those regularly employed retained a partial stability. This was caused to some extent by the company's policy of spreading the available work, and by the nature of the work itself. As processes of manufacture were improved, a certain minimum number of workers were required for rolling the sheets. Approximately the same number would be required in turning out the orders, whether the mill was operating two days a week or six. Thus the average employment figures would not be much curtailed in a short week. Cyclical fluctuations may be more significant for figures of production, where the volume of goods produced is correlated with business conditions, than for employment data, where other influences interfere with the natural course of economic events, as for example the technological improvements with the resulting elimination of workers. It is significant here, however, that in Chart 8 the depression of 1921 stands out so clearly while the recent and more severe depression is less well marked. To understand thoroughly the conditions throughout an industry, therefore, it would seem an advantage to study the subject plant by plant, lest factors influencing individual establishments materially be overlooked in the larger collection of data.

The employment figures discussed so far have all referred to the total number of workers and have not taken into consideration the amount of time worked by each. When the number of hours is considered as a measure of employment, the results of the last four years are strikingly different from the picture presented here. This will be brought out subsequently in this chapter.

Growth in Stability of Employment.

In the third place, when the graph of the numbers employed from 1919 to 1933 was studied, it was noted that apparantly a relative stability had been developed during the later years in the working force. The size of the monthly fluctuations beginning with 1928 is considerably less than in the

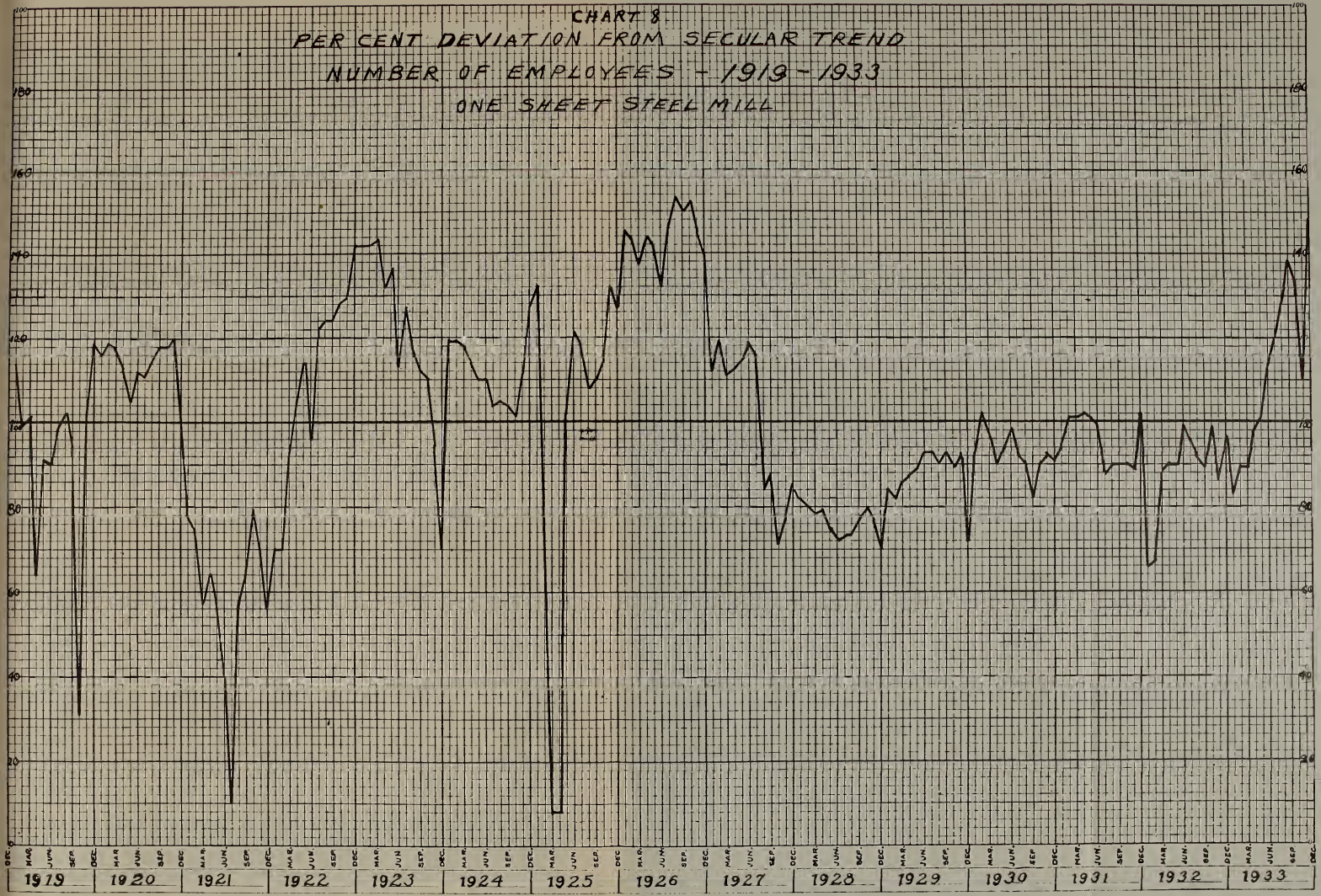
CHART 8
PER CENT DEVIATION FROM SECULAR TREND
NUMBER OF EMPLOYEES - 1919 - 1933
ONE SHEET STEEL MILL
180
160
140
120
100
80
60
40
20
DEC.
MAR.
JUN.
SEP.
1919
1920
1921
1922
1923
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933

earlier period. Chart 8, which shows the per cent deviations from the secular trend, also brings out the fact that the monthly fluctuations are less in the years 1928 to 1932 than before. The curve from 1928 to 1932 is distinctly more regular and its movements are less abrupt. The figures in Table 13 present further proof that the range is narrower in the latter period than in the eariler. From 1928 to 1932 the range of the per cent deviations from the yearly average is never greater than 39 and the average deviation varies from five per cent for 1930 to nine per cent for 1932. The year 1933 shows less stability because of the increase in employment in the summer months accompanying the larger orders at that time. In three previous years, 1920, 1924 and 1926, the per cent deviations in employment were fully as low as for the period from 1926 to 1932, when continued stability is marked. In 1920 and 1926 production was high and one might therefore infer that with a more regular monthly output the employment from month to month would show fewer fluctuations. Nineteen twenty-four is the year of greatest average stability in employment but it is not unusual even in tonnage produced. The number of employees each month has a range of 15 in the per cent deviations, however, the lowest appearing in any year and an average deviation of four per cent.

TABLE 13.

AVERAGE DEVIATIONS OF PRODUCTION AND EMPLOYMENT
ONE SHEET STEEL MILL.
1919–1933.

Deviations from Monthly Average for Year.

(In per cent.)

Year	Production		Employment	
	Average Deviation	Range	Average Deviation	Range
1919	20	89	16	86
1920	13	62	5	27
1921	25	150	24	123
1922	23	92	18	57
1923	19	83	15	70
1924	15	56	4	15
1925	39	162	37	139
1926	14	55	4	20
1927	13	51	17	47
1928	17	58	6	29
1929	17	76	7	39
1930	22	102	5	26
1931	17	74	6	16
1932	28	125	9	38
1933	49	188	14	44

Without more discussion, the point is clear that less variation in the working force has occurred since the reorganization, more specifically from 1928 to 1932. This increased stability, moreover, has not been upset by the depression which began the last part of 1929, a condition directly con-

trary to the situation in the former depression of 1921. Production does not present a picture similar to the employment data, but moves erratically from year to year; the range of the deviations from the average is large and the average deviations are likewise large. For three years, between 1926 and 1928, the figures show a steadier movement, but this steadiness is not maintained and is not great. The reduction and stabilization of the number employed has resulted from changes in machinery and processes, which, by standardization of working procedure, have served to limit the workers required to keep up an efficient production schedule. The stability of labor force has been prolonged even in the depressed years by the company's attempt to spread the available work.

Discrepancy Between Numbers Employed and Number of Hours Worked.

Employment may be measured in a variety of ways. Here, as mentioned before, monthly number of workers was obtained by averaging the bi-weekly figures. In these, two major factors of employment statistics are not to be taken into account, namely, the number of men who are added to or substracted from the rolls each month, and the number of hours worked by those employed.

If just the average number of men per year is considered, it is not quite clear in any year whether those employed are always the same men or whether some 50 or more are dispensed with and another 50 are taken in their place. Additional information, to make the picture more complete than otherwise, is found in the labor turnover. Unfortunately in this firm the record of accessions and separations is available only after 1929. These figures are not detailed enough to add much to the impression already gained from the average numbers. The labor turnover figures for the years available show an increase of accessions over separation in 1929, and an increase of separation in 1930 and 1931. In the latter years the number of separations is as high as 53. Although this decrease is somewhat gradual, a loss of 17 men occurred in June, 1931, and a further loss of 20 men in July. With a few exceptions, between 1929 and 1931, those laid off balanced those taken on.

In regard to labor turnover prior to 1929, the statement was made that many of the men had been in the employ of the company for a long time and that, on the whole and in the long run, relatively little turnover had taken place. Upon close examination this statement hardly seems to cover the case. While, doubtless, a considerable nucleus of old and skilled employees remains upon the rolls, the figures for employment from 1919 to 1929 shows more than casual and negligible fluctuations. For example, in 1920, a banner year in production, differences as great as 235 appeared in the number of men employed in the various months. In 1923, a variation of 556 men occurs between the month of highest employment, March, and that of lowest employment, December. Over the whole span of years, furthermore, well over 500 men gradually had been eliminated, mostly between 1926 and 1928. All this can be seen from preceding tables. How-

ever accounted for, many employees have been permanently released from this mill.

The actual number of hours worked by the men employed is an important addition to the picture of any industrial establishment, and necessary to give an accurate idea of the productivity and business activity of the firm. For this reason, one needs a measure of man-hours worked, where one man-hour represents the work of one man for one hour. Figures are not available in the sheet steel mill studied to show the total man-hours worked throughout the entire period from 1919 to 1933, but they are available after June, 1925. Since in 1925 major changes and reorganization of equipment were still in process, the figures cover the most important part of the period studied, in that the reduction in working force was taking place. After the re-opening of the mill in May, 1925, the new program was well launched. Thereafter, except for short periods, the records of man-hours worked is complete. Appendix Table 9 gives the figures, and the dotted black line of Chart 6 at the beginning of this chapter pictures these graphically.

A comparison of the data for the number of men employed and for the total man-hours worked shows a very close similarity between the two curves from June, 1925, until January, 1930. From 1930 to 1933 the two curves separate and the distance between them widens. The curve of total man-hours drops decisively in the depression years, while the curve of numbers employed deviates little from its trend for 1928 and 1929. The rapid decline in the number of hours worked shows the effects of the diminished production of the mill on employment. The decrease in operating time which must have accompanied the lessened output was not evident from the figures of numbers employed.

TABLE 14.

Annual Changes in Production, Employment, and Man-Hours One Sheet Steel Mill.

1925–1933.

(Base: Mo. Av. 1925=100.)

Year	Production		Employment		Man-Hours	
	Index	Per Cent Change	Index	Per Cent Change	Index	Per Cent Change
1925[a]	100		100		100	
1926[b]	158	+58	115	+15	105	+ 5
1927[a]	117	—26	72	—37	67	—36
1928[c]	129	+10	52	—28	50	—25
1929	151	+17	54	+ 4	52	+ 4
1930	94	—38	52	— 4	35	—33
1931	44	—53	48	— 8	19	—46
1932	24	—45	39	—19	12	—37
1933	39	+62	44	+13	19	+58

a Based on average of seven months.
b Based on average of ten months.
c Based on average of eleven months.

In Table 14 an attempt has been made to compare the changing conditions of employment and production as expressed in numbers of hours worked, number of employees and volume of output. The average number of hours worked each month has been calculated for the years 1925 to 1933. Series of index numbers have then been computed, using 1925 as a base, to show the changes in the monthly averages for each year. Also, the percentage change of each succeeding year from the preceding one has been estimated. The significant years are 1928 and 1930 through 1933. From 1925 to 1928 it is evident that employment has decreased by approximately the same amount, whether measured by numbers employed or hours worked. By 1928, numbers employed had decreased 48 per cent from 1925, and man-hours worked had declined 50 per cent, while production had advanced 29 per cent. In 1929, the two former indexes increased slightly, but production considerably more. In 1930 appears another important discrepancy. The index of man-hours and production is less then than the year 1929 by approximately the same amount, 33 per cent, as compared with 38 per cent, but the number of employees has been reduced only four per cent. In 1931 and 1932 a similar condition prevailed, with the index for employment dropping much less rapidly than that for man-hours and production. All three indexes show an advance in 1933 as compared with 1932; the index for numbers employed shows but a nominal rise, whereas the other two indexes increase substantially. That the mill was affected by the depression of 1930 to 1933 is thus shown clearly by the distinct decline in number of man-hours worked. The number of employees, however, suffered its major reductions in 1927 and 1928, well before the depression, and, in contrast to production, was maintained at the same relative amount.

Type of Employee Displaced.

The type of work required of the employees in the sheet steel mill today varies from skilled to manual labor. Most jobs might be classified as semi-skilled, for, due to improved machinery and technique, the skill required from the men rests mostly in the handling of the sheets and in directing their passage over the rollers. The cutting and shearing of a sheet require skill also. Some manual labor still exists, although, roughly speaking, much of it was eliminated during the reorganization of machines and processes. The planning office schedules and routes the work with allowance for all the specifications, thus leaving to the foreman and his workers the problem of rolling the specified sheets in the designated order. Much responsibility rests with the foremen, who must be men of experience in making and rolling sheet steel.

In keeping its records the company has divided the employees into groups according to the type of work done, such as those engaged in operating the cranes, the so-called "rollers" and others handling the sheets directly, or the necessary manual labor. With these classifications in mind, data on number of man-hours were kept from June, 1925, to January, 1931, when reductions in the clerical force made it impossible to continue such detailed records. Even with these curtailed data one can discover in which type of labor, as classified, the greatest reductions have taken place. The figures are given in terms of man-hours worked, and no corresponding roster showing the number of men in each department is available. Thus our evidence

presents only in what classification of workers, over the period in question, have occurred important reductions in the time worked. It is reasonable to assume, at the same time, that in these categories where there has been a tremendous diminution in number of hours worked, a certain loss in the number of men employed must have occurred also. This assumption seems legitimate for the years 1925 to 1929 since, as seen in Table 14, the reduction in number of hours worked and that in number of employees for these years was nearly the same, and since output was maintained.

The classifications used by the mill were regrouped to correspond as nearly as possible to those suggested by the United States Department of Labor in a study of productivity in rolling mills.[6] The two lists are not identical but the similarity is close. Due to changes in the classification system of the sheet steel mill, some error may have crept in, but hardly enough to affect seriously the changes of each group, unless special mention is made of the fact. Several departments, such as carpenter shop, were omitted as unimportant. Figures for the annealing and pickling departments were also discarded because the data were incomplete. The groupings used are as follows:

1. *Tonnage Labor*, the largest group, including the rollers, rollers' helpers, heaters, roughers, catchers, and turn labor.
2. *Inspection Groups*, including those engaged in inspection, weighing and shipping. (The United States classification included here superintendents, but corresponding data were not recorded for the mill.)
3. *Dynamo and Power Group*, included those engaged in work in the power plant. This group was designated "Electric Power and Light" throughout 1925 and until April, 1926, but seems to refer to the same type of workers.
4. *Boiler House Workers*, including those working in the boiler house and pulverized coal plant.
5. *Yard Labor.*
6. *Mechanical Repair Workers.*
7. *Electrical Repair Workers.*
8. *Crane Operators.*
9. *Miscellaneous Labor, including those laborers not taken care of elsewhere.*
10. *Mill Engineers*, a separate classification begun in April, 1926. (The United States included "Engineers" in Group 3, but the classification did not seem to correspond to this particular group.)

6 "Productivity of Labor in the Sheet Department of the Iron and Steel Industry," *Monthly Labor Review*, volume 34, January, 1932, p. 23.

TABLE 15.

Average Monthly Man-Hours Worked by Different Departments One Sheet Steel Mill.

1925–1930

Year	1 Tonnage Labor	2 Inspection	3 Dynamo and Power	4 Boiler House	5 Yard Labor	6 Mechanical Labor	7 Electrical Labor	8 Crane Operators	9 Miscellaneous Labor	10 Mill Engineers
1925[a]	85,411	*	705	4,301	12,363	10,171	2,545	3,815	18,378	*
1926[b]	72,419	20,687	730	4,583	11,096	12,111	3,201	3,895	26,971	2,684
1927[a]	32,894	12,218	727	2,724	9,782	11,562	2,398	3,651	17,882	1,280
1928[c]	27,920	10,417	733	2,291	3,365	7,902	2,071	3,360	13,030	219
1929	30,699	12,614	745	2,619	2,445	7,519	1,975	3,317	14,007	256
1930	19,522	8,531	709	1,668	1,750	5,236	1,355	2,334	7,584	203
Per Cent Change.										
1925-1929	—64	—39[d]	+6	—39	—80	—26	—22	—13	—24	—90[d]
1929-1930	—36	—32	—5	—36	—28	—30	—31	—30	—46	—21

* Data lacking.

a Based on average of seven months.

b Based on average of ten months.

c Based on average of eleven months.

d Per cent change, 1926-1929.

Monthly averages of the number of man-hours worked have been computed for the ten categories. These are presented in Table 15, together with the percentage change in each group from 1925 to 1929, and from 1929 to 1930. The table reveals such pronounced decrease in hours worked that it seems reasonably evident they were accompanied by decrease in number of workers in these groups. Lack of similar abrupt reduction in hours in the other groups leads one to assume that the groups one, five and ten particularly, account for the bulk of the displacement of workers noticed from 1925 to 1929. Of these groups the "Mill Engineers" group suffers the greatest reduction in number of hours worked, but the reduction is especially sharp from 1927 to 1928, and, therefore, seems to indicate a change in classification. Following the year 1927, a continuous and steady decline occurs in the "Yard Labor" group, leading to the conclusion that in the process of reorganization, more labor as such was decreased extensively. Statements of officials who assert that the greatest reductions in operating force have been among the unskilled workers bear out this evidence.

The percentage change from 1925 to 1929 would indicate the type of worker more or less permanently eliminated from the mill, inasmuch as by that year the force was fairly static; the major changes had been established in 1928 and carried on for a year. At once one sees that the total man-hours worked by the "Yard Labor" group have been reduced 80 per cent from the 1925 average. A second great percentage diminution is found in the data for the "Tonnage Labor" group, with 64 per cent decrease in hours worked. The decline in hours of 39 per cent for the workers in the boiler house, doubtless is due to the introduction of oil burning furnaces, requiring fewer workers in attendance. The group showing the least change is the "Dynamo and Power" which shows no reduction but rather a small increase, six per cent, between 1925 and 1929. The table brings out further the great decline in hours worked by unskilled laborers from 1925 to 1929. To reiterate what has been pointed out before, one finds that the major reductions in working force occurred prior to the present depression. This also has been apparent in the number of man-hours worked by the employees, and has been most noticeable in groups of workers employed at more or less manual tasks.

Summary.

The whole evidence presented from the examination and discussion of the sheet steel mill points to a very fluctuating number of employees throughout the years 1919 to 1933. The net change has been a considerable decrease in the number of employees retained by the company. The downward trend of employment is very clear both from the graph and the figures. Furthermore, the great reduction in numbers occurred before the year 1929, so that it has not been caused by the recent depression; in fact, the figures have not shown more than temporary additional decrease from 1930 to 1933.

Seasonal fluctuations do not appear to have played an important role so varied are the peaks from year to year. A rise in the late spring, a recession in June and July, a gradual rise in the fall and a decided drop in December in the numbers employed are evident throughout the data. The variations from year to year have reflected general business depression and prosperity, with the exception of the years since 1929. An absence in the

employment data of the 1929 peak, apparent in production, and the rapid decline noted in business activity which follows, make the exception striking. The effects of the depression are shown, however, in the number of man-hours worked in the mill. From 1930 to 1933 a marked decrease in total man-hours is apparent. But even in the latter figures, there is no great peak in 1929, which shows that whatever increase in production may have occurred was taken care of with little change in the numbers employed and hours of work.

The great reduction in total number of men employed from about 800 to approximately 325 has been accompanied by a greater regularity in working force from month to month, pointing to the establishment of a more static group of employees. The deviations of 1929 to 1932 are markedly less in size from month to month than are the deviations of any of the previous years. This apparent stability has been maintained in 1930 and 1931 partly by the personnel policy of the plant in spreading the available work among the regular force, and partly by the reorganization of the processes. Thus it has not been duplicated in the curve showing number of man-hours worked.

Although no record of the number of workers actually displaced was available, from a study of the data on man-hours, which showed the number of hours worked by types of workers, some idea of the kind of employees eliminated was obtained. The laboring group appears to have been reduced the most, and the number of men required in the process of rolling the sheets was also largely decreased. The effect of the reduction in men and hours worked on the output per hour is set forth in the next chapter.

CHAPTER IV.

Productivity and Labor Costs.

Any measure of productivity is dependent on three factors, actual output, number of workers, and a limit or unit of time. All three may vary together, or change with different rates. In previous chapters, inferences were made that, since the number of workers had been reduced materially from 1925 to 1929 and yet the amount produced was not decreased, the men must have been able to turn out more sheets than in earlier years. The other alternative, that these men were working more hours, is disproved at the start with the decline in total man-hours already revealed. The evidence presented here, then, is that the employees have been able to increase their output. Whether measured in terms of output per man-hour or number of hours required per ton of product, the mill was improving its efficiency from 1925 to 1929. The high point of productivity reached during that time was not sustained between 1929 and 1933, but the slight decline is less significant than the earlier advance. For purposes of analysis 1925 was taken as a base, solely because no statistics for man-hours were available prior to that date. It proves an interesting time to begin the study, however, inasmuch as the modernization of the mill was just well started in 1925, and the effects of the changes in methods and processes being introduced proved important in the succeeding years.

Increase in Productivity per Man-Hour.

Chart 9, which follows, shows the rapid growth in productivity for the entire mill in terms of output per man-hour, compared with similar changes in volume of production, number of employees, and number of man-hours worked.[1] Unfortunately omissions appear in some of the data, but they do not affect the general upward direction of the productivity curve. This curve forms an interesting comparison with that of production, and, with those of employment and man-hours, a striking contrast. The first, starting slowly, rises to a peak in 1929 and then declines slightly in 1930, 1931 and 1932, whereas the second has a peak in both 1926 and 1929, followed, of course, by the decisive drop in recent years. The last two items, excluding seasonal fluctuations, pursue a course between 1925 and 1930 directly opposite to that of the first. The efficiency of the workers had improved so greatly by 1929 that the same quantity of goods was produced as in 1926, and with a noticeably smaller working force. Even from 1930 to 1933, the rate of production diminished little as compared with actual tonnage. The number of man-hours worked follows the curve of output more closely in these years than do the productivity and employment curves, and exhibits the direct effects of the depression which resulted in curtailed operating time.

1 Data for this chart are to be found respectively in Appendix, Tables 11, 3, 8, and 9.

TABLE 16.

Indexes of Production, Productivity, Employment and Man-Hours—One Sheet Steel Mill.

1925–1933

(Base: Mo. Av. 1925 = 100.)

Year	Production	Productivity Tons per Man-Hour	Number of Employees	Man-Hours
1925[a]	100	100	100	100
1926[b]	158	113	114	105
1927[a]	117	135	74	67
1928[c]	129	193	52	50
1929	151	215	54	52
1930	94	200	52	35
1931	44	175	48	19
1932	24	153	39	12
1933	39	158	44	19
Per Cent Change				
1925-1929	+51	+115	—46	—48
1929-1932	—84	—29	—28	—77
1932-1933	+63	+ 3	+13	+58

a Based on average for seven months.
b Based on average for ten months.
c Based on average for eleven months.

Perhaps the interrelationship of these four curves can be kept in mind better if yearly figures are examined to see what advances or retrogressions occurred each year and what was the net change of the period. Table 16 gives yearly data in index numbers for the four factors considered. No figures were available prior to June, 1925, so the average of the seven months of 1925 is taken as the base. In addition to the yearly changes, the percentage increase or decrease has been calculated from 1925 to 1929, and for subsequent years, showing significant changes due to the depression. While volume of production increased 51 per cent from 1925 to 1929, output per man-hour advanced by 115 per cent. Obviously, then, number of man-hours must have declined during this time. It did so by 48 per cent and, simultaneously, the number of employees was reduced 46 per cent. The recession in business activity in 1929 occurred with accompanying diminution in output. Nineteen thirty-two is the low year for production. From 1929 to 1932 a drop of 84 per cent is noted. The productivity rate of the workers, however, although declining in these years, does so less extensively. The amount of time worked by the men also shows considerable decrease due to the part-time employment in these years. The great drop in employment had occurred before the depression set in; the figures do not show another spectacular decline after 1929, but, rather, a small one. Employment indeed suffers the least reduction of all four series considered in this table. From 1929 to 1932, the index is lowered by only 28 per cent. In 1933 all four factors exhibit an upturning in their respective indexes. Pro-

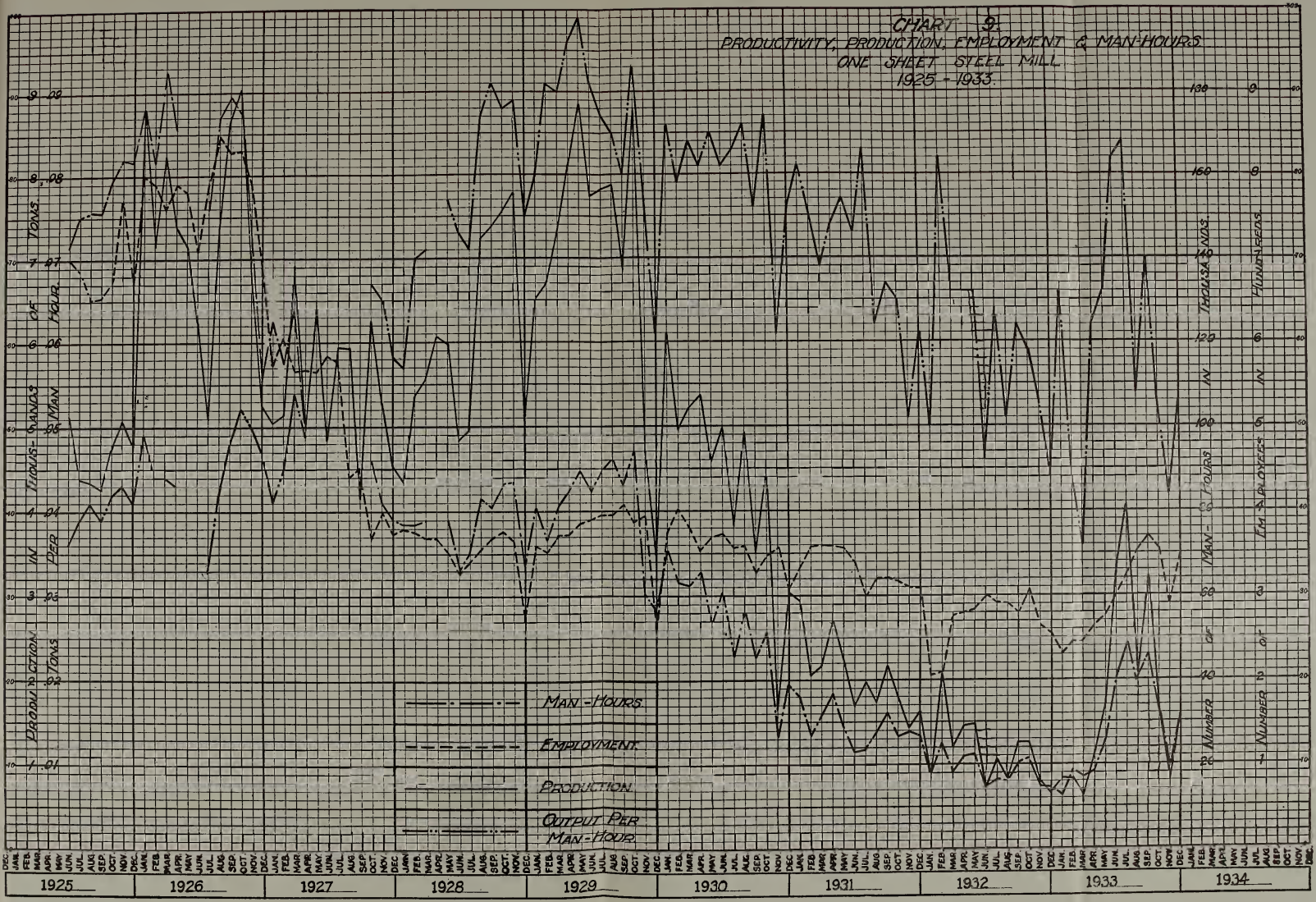
CHART 9.
PRODUCTIVITY, PRODUCTION, EMPLOYMENT & MAN-HOURS.
ONE SHEET STEEL MILL.
1925 - 1933.
PRODUCTION TONS
OUTPUT PER MAN-HOUR IN TONS-THOUSANDTHS
MAN-HOURS IN THOUSANDS
EMPLOYEES IN HUNDREDS
NUMBER OF MAN-HOURS
NUMBER OF EMPLOYEES
MAN-HOURS
EMPLOYMENT
PRODUCTION
OUTPUT PER MAN-HOUR
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934

ductivity and employment do not rise greatly, but production increases 63 per cent.

The above indexes are shown graphically in Chart 10. It emphasizes the points made above, bringing out more distinctly than the monthly figures of Chart 9, the increase in the productivity of workers, the decrease of employment in the years 1926 to 1928 with the subsequent relative stability, and the difference between the curves of employment and man-hours. With resumption of normal production one would expect the curve of productivity and man-hours to rise, with little or no change in the employment figures.

Productivity in One Mill and in the United States.

A question naturally arises, from contemplation of the above data, as to whether or not the firm is keeping pace with progress in productivity in similar sheet mills in the United States. The Bureau of Labor Statistics has studied this problem for a limited number of sheet mills from 1925 to 1929.[2] Table 17, following, sets forth the comparisons of the productivity of the one mill and the United States. The figures are not obtained in an identical fashion, but the differences in method of calculation are not significant for this comparison.[3]

TABLE 17.

Productivity of Sheet Mills.[4]

1925–1929

Year	Tons per Man-Hour		Man-Hours per Ton	
	Several Mills	One Mill	Several Mills	One Mill
1925	.072	.040	13.817	25.167
1926	.076	.045	13.138	22.449
1927	.076	.053	13.235	19.041
1928	.078	.078	12.805	13.197
1929	.077	.087	12.961	11.820

The striking fact, at once apparent after only slight scrutiny of the above table, is the rapid rise in the productivity of the one mill, so that by 1928 the rate is equal to that for the representatives of the industry as a whole, and in 1929 has surpassed the latter's average. These figures tend to strengthen the contention which seemed evident from the comparison in volume of production between the United States and the one mill, namely, that the mill was losing in competitive position in an expanding market. By 1924 and 1925, if not earlier, the company had realized this fact and had set about remedying the condition by improving machinery and processes. The marked increase in productivity and the elimination of many workers are due largely to innovations. Doubtless the inefficiency of antiquated

2 "Productivity of Labor in the Sheet Department of the Iron and Steel Industry," Op. Cit., pp. 18-25.

3 The figures for the one mill are averages of the productivity figures for the months when data were available. The United States figures are obtained by direct calculation from the total production and man-hours data for each year.

4 The figures for the several mills are taken from "Productivity of Labor in the Sheet Department of the Iron and Steel Industry," Op. Cit., p. 23. The mills examined rolled light sheets, the average guages being numbers 23 and 24.

machinery and outworn methods accounted in large part for the low productivity of the workers. In 1925, after some initial changes had been introduced, it was only .040 tons per man-hour. In this same year many firms produced as much as .072 tons per man-hour. The high mark of .087 set in 1929 was not maintained by the mill thereafter. The rate dropped to .080 tons per man-hour in 1930 and still lower in the years following. Similarly the number of man-hours required to produce one ton of sheet steel decreased from 25.167 in 1925 to 11.820 in 1929, but rose to 12.526 in 1930 and still higher in 1931 and 1932.

No other figures so directly comparable are available after 1929. In a brief paper entitled "Dispersion in Man-Hour Productivity Since 1929",[5] however, Arthur Beal gives some interesting indexes of productivity for the whole steel industry and for rolling mills, indicating what has happened to the industry in 1930 and 1931. His figures reveal a condition in the country at large similar to that of this mill, although they do not correspond directly to the more special phase of the steel industry treated here. Beal used the year 1914 as his base. Since that time his data show the greatest increases occurring between the years 1921 and 1923, when the index advances from 106 to 129, and from the year 1924 to 1925, when the index climbs from 128 to 150. Changes in productivity subsequently are less abrupt. This evidence reinforces the belief that the selected mill was behind the trend of the country in 1925 but since then has been able to approximate the estimated average for the United States and even to exceed it. In the table below, the index numbers for the one mill and the index numbers obtained by Beal for "Steel Works and Rolling Mills" are compared. Beal's data are transferred to a base year of 1925.

TABLE 18.

INDEXES OF PRODUCTIVITY OF ONE SHEET STEEL MILL AND STEEL WORKS AND ROLLING MILLS.

1925–1931.

(Base: 1925 = 100.)

Year	One Sheet Mill	Steel Works and Rolling Mills[6]
1925	100	100
1926	113	103
1927	135	104
1928	193	113
1929	215	112
1930	200	105
1931	175	107

The significant facts here are, first, the tremendous increase in productivity in the one mill from 1925 to 1929, and, second, the greater percentage decrease from 1929 to 1931 than Beal's figures set forth. In the first instance,

5 Beal, Arthur F., "Dispersion in Man-Hour Productivity Since 1929," *Proceedings, American Statistical Association*, volume 29, March, 1934, pp. 66-71.

6 See ibid., p. 67, for data from which these indexes were computed.

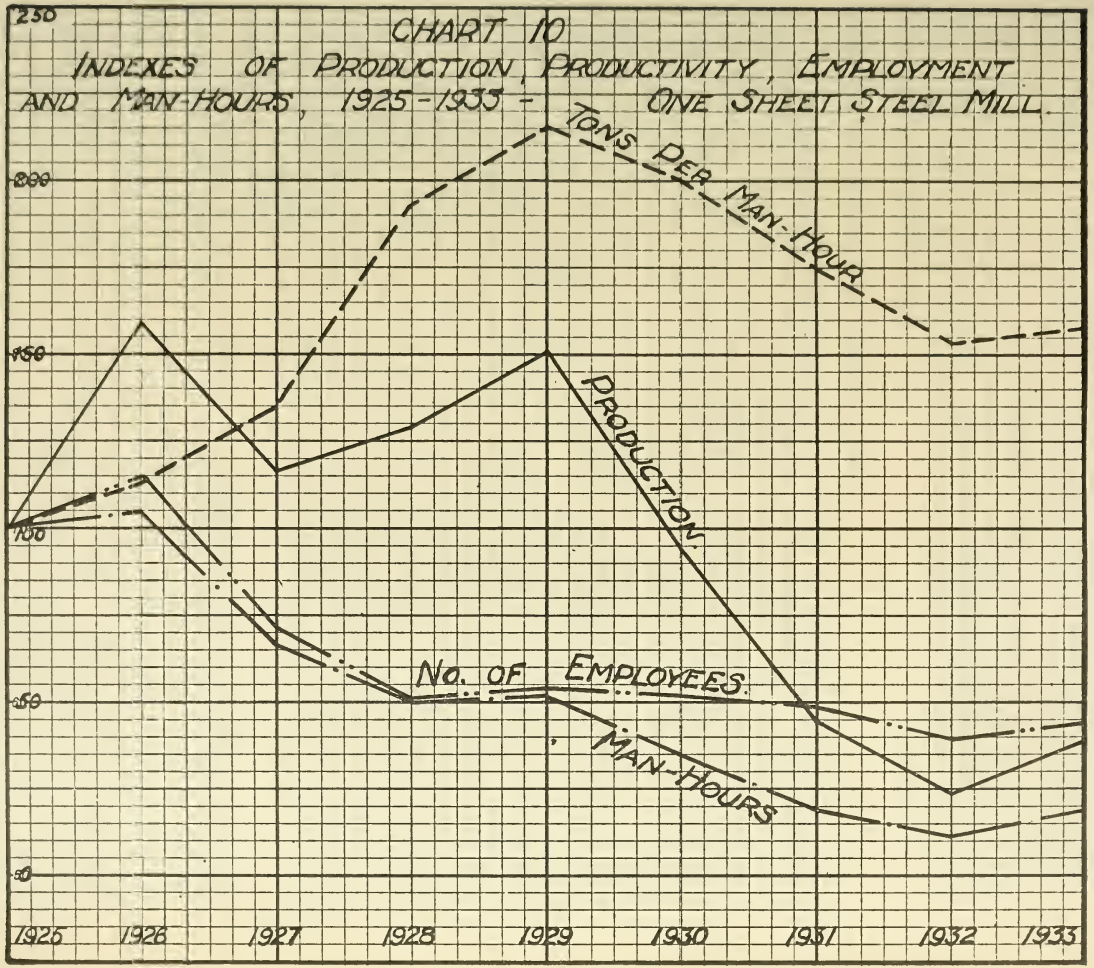
CHART 10
INDEXES OF PRODUCTION, PRODUCTIVITY, EMPLOYMENT AND MAN-HOURS, 1925-1933 - ONE SHEET STEEL MILL.
250
200
150
100
50
0
TONS PER MAN-HOUR
PRODUCTION
No. OF EMPLOYEES
MAN-HOURS
1925
1926
1927
1928
1929
1930
1931
1932
1933

productivity for the mill has risen 115 per cent as against 12 per cent for the larger group. But from 1929 to 1931 the index for the one mill decreased 18.6 per cent as against 4.5 per cent for the steel industry.[7] Beal also considered the effect of diminished output on the productivity rate for the various industries and compared the decrease noted in volume of production with that of employment. In the steel works and rolling mills he noticed a decline of 53.9 per cent in production and of 32.9 per cent in employment.[7] This situation is quite different from the figures for the selected mill, which show a reduction in production of 70.9 per cent, but only a loss of 11.1 per cent in employment. Again the evidence indicates that the firm did not lay off workers in proportion to the diminished activity of the mill during the depression years.

Reasons for Increased Productivity.

It was obviously imperative for the mill to increase its productivity in order to place itself on an equal footing with competitors. The measures decided upon followed several different directions. The major changes were those in buildings and equipment, consisting in modernization of machinery, scrapping of antiquated models, and general rebuilding of the plant. At the present time, the sheet department consists of four modern buildings equipped for rolling steel of varying gauges,[8] usually from No. 16 to No. 8, though recently lighter sheets have been rolled in large volume. In one building, sheets less than 56 inches wide are rolled and in another, sheets between 56 and 72 inches wide. Still another building is reserved for work of special quality. All are motorized. In 1919, the beginning of the period selected for study, seven buildings comprised the sheet works, housing old-fashioned, steam-driven machines, used for years and decidedly outdated. Four of these were scrapped and discarded; three were modernized; one new building was erected. The changes were spread over a period from 1924 to 1928, but the major work was done before 1927. The result has been the gratifying increase in productivity shown. The changes included elimination of steam in favor of motorization, introduction of up-to-date heating and rolling machinery, enabling the billets and sheet bars to go directly to the rollers without a re-heating process such as had been necessary previously. Installation of oil-burning furnaces to replace pulverized coal also took place in 1929.

Coincident with the changes in machinery and equipment were improvements in methods of performing certain tasks, particularly developments of the technique of handling sheets with a minimum of waste motion. The innovations in processes were introduced after careful sutdy of the operations necessary in the production of sheets with the maintenance of the high quality on which the company prides itself. Changes in management and methods of routing and scheduling the work played their part in bringing up the productivity rate. Incentives were offered to the men in the form of piecework and payment systems based on tonnage produced. These allowed men to earn more than they had earned previously, when production was steady. All the efforts toward increasing productivity resulted

7 Beal, Op. Cit., p. 69.

8 Guages refer to the thickness of the sheet, technically classified by weight per square foot; the higher the guage the lighter the sheet.

in the ability to maintain the same quantity of output with less equipment and fewer men. Particularly was the number of employees engaged in manual labor eliminated by the introduction of new machinery which facilitated the continuous process without the necessity of reheating and consequent duplication of transporting material about the mill. It is impossible to estimate the amount of increase which might be laid to any of the above factors. We can but summarize them as follows: (1), modernization of machinery and equipment; (2), improvements in methods and processes; (3), greater efficiency in management and organization; and (4), increased incentives to the workers in payment method.

In passing, a word seems necessary about the productivity rate in the depression years. Output per man-hour decreased from 1929 to 1932. This does not mean that any of the above improvements were eliminated, the explanation is to be found, rather, in the factors determining the rate. From 1929 to 1932, volume of production declined. If the workers had continued to turn out the product at the rate of 1929, either considerably fewer workers would have been required, or the time put in would have been reduced substantially. Although the latter circumstance did occur, two additional influences prevented the productivity of the workers from retaining its high level. In the first place, rolling in small amounts requires approximately as large a crew as rolling large tonnage. Even with careful planning to avoid unnecessary duplication of labor, the same number of men will be needed for short as for long periods. In other words, when a mill is running a full week, the continuous operation of the machinery does away with the waste involved in starting the furnaces and rollers again and again. Steady output, therefore, insures a high productivity rate, if the methods are efficient. Inevitably some labor must be lost in rolling inconsiderable quantities. In the second place, the plant has been turning out alloy steel sheets in unusually small lots. These sheets must be rolled much more carefully than the usual variety, and it is impossible to maintain, at the same time, as high a productivity rate as can be done with a product requiring less care. Production in larger quantities thus would increase one productivity factor while the others remained approximately the same.

Maximum Capacity to Produce.

In Chapter II it was pointed out that the firm had a rated capacity of 100,000 tons per year, or an average of 8,333 a month. Twice in the year 1929 was this monthly estimated average surpassed by the actual production figures. In May, 8,837 tons and in October, 8,790 tons were produced. From the productivity figures of these two months, .099 tons per man-hour in May and .093 tons per man-hour in October, it is evident that the workers were turning out goods at the greater rate in May. Naturally when there is a considerable pressure of work, high productivity results. Taking the highest yearly average productivity for this mill, we find it was .087 tons per man-hour even in 1929. If the months of November and December of 1929 are omitted, months when production suffered a sudden decline which was reflected in the productivity rate, we find that the rate rises to .089 tons. For the four months of August to November in 1928, also, this rate was sustained. Again in 1930, after readjusting to diminished production, productivity increased from the low figure of November and December, 1929,

to .083, .084, .085 and.086 tons per man-hour. Thus, it would seem that one might assign to the mill a capacity productivity rate of at least .087 tons per man-hour. This rate would allow some 96,895 man-hours per month to produce 8,333 tons, the maximum estimated capacity. As a matter of fact, that number of man-hours rarely has been put in during the last few years; but, on the other hand, production at maximum capacity never has been attained. Since the actual maximum productivity achieved is .099 tons per man-hour, it seems reasonable to suppose that with a steady demand for goods, productivity could be maintained at a figure higher than .087 per man-hour.

Productivity by Departments.

With the fact indisputably established that this firm increased its productivity per man-hour materially from 1925 to 1929, one wonders in which departments the output per man-hour has increased the most. Table 19 has been compiled to show the changes year by year in productivity for the same ten groups of workers which were discussed previously in regard to reduction of employment. These data cover only the years 1925 to 1930, and no departmental statistics are available subsequently. In Table 19 also has been calculated the percentage increase or decrease from 1925 to 1929 and from 1929 to 1930. Little variation appears from 1929 to 1930 as compared with earlier movement.

Not one of the ten classifications shows a decrease from 1925 to 1929, and several show phenomenal rises in productivity. Excluding for the moment the "Mill Engineers," the two groups showing the largest advance are the "Yard Laborers" and those working on tonnage production. The former, which had suffered the greatest reduction in number of hours worked, shows here a rise in out-put per man hour of 472 per cent. In other words, the productivity of this group has been multiplied many times. The "Tonnage Labor" group added to its rate by 215 per cent. This group is the largest of all and includes all those handling the sheets directly in their passage over the rollers. Improvement in methods and pay incentives have doubtless been responsible for the advance noted here. Other groups exhibiting substantial betterment in rate of output are those designated "Boiler House" and "Inspection," whose percentages are respectively +81 and +62. The figures for the "Mill Engineers" present erratic tendencies from year to year. Although this classification was followed through the data consistently, obviously some change in the grouping must have occurred even if it cannot be accounted for specifically. A gain of 1224 is indicated, which seems quite out of proportion, and conversely, the loss in 1930 is 33, considerably larger than in most other classifications.

From 1929 to 1930 two groups show slight increases, but most show only negligible declines from the previous high productivity achieved. The "Boiler House" workers gained one per cent, and the "Miscellaneous Laborers" three per cent. The greatest loss was in the "Power House" group, of 35 per cent. "Yard Labor" also suffered a reduction of 14 per cent, inconsiderable, however, when compared with the tremendous former advance in the group. Several, the "Mechanical Laborers," "Cranemen," and "Electrical Laborers," show a rise in 1929 which is appreciable even if not as large as that indicated in other groups, and small losses in 1930. The

TABLE 19.

Average Output per Man-Hour in Different Departments One Sheet Steel Mill.

1925–1930.

Year	1 Tonnage Labor	2 Inspection	3 Dynamo and Power	4 Boiler House	5 Yard Labor	6 Mechanical Labor	7 Electrical Labor	8 Cranemen	9 Miscellaneous Labor	10 Mill Engineers
1925[a]	.073	*	7.73	1.443	.507	.623	2.490	1.628	.340	*
1926[b]	.108	.342	10.02	1.608	.672	.623	2.299	1.920	.284	2.643
1927[a]	.168	.449	7.49	2.002	.605	.476	2.368	1.582	.327	5.272
1928[c]	.214	.532	7.59	2.624	1.925	.765	2.893	1.772	.457	65.691
1929	.230	.553	9.50	2.606	2.900	.881	3.531	2.102	.498	34.990
1930	.223	.501	6.14	2.623	2.494	.819	3.194	1.836	.511	23.41
Per Cent Change										
1925-1929	+215	+62[d]	+23	+81	+472	+41	+42	+29	+46	+1224[e]
1929-1930	— 3	— 9	—35	— 1	— 14	— 7	—10	—13	+ 3	— 33

* Data lacking.

a Based on average of seven months.

b Based on average of ten months.

c Based on average of eleven months.

d Per cent change, 1926-1929.

e This figure seems abnormally large. See discussion in text

number composing the "Cranemen" and the "Power House" group is small. Thus, lack of cumulative change, which would be found in a large body of workers, is missing, and serves to make the changes insignificant in these groups. In every instance, however, output per man-hour has been on the upturn from the beginning year to 1929, and suffers little from then until 1930.

Technological Displacement of Labor.

Workers have been eliminated from the mill and productivity has increased quite obviously from foregoing tables. We know, too, that throughout the mill considerable reorganization in equipment and methods of manufacture was taking place. Thus, here an attempt is made to estimate how much of the displacement can be laid to technological improvements. The latter concept should first be defined or limited, as it lends itself too readily to general interpretation. Boris Stern, in a study for the Bureau of Labor Statistics, puts the meaning succinctly:

> "....technological improvements....include any and all changes in the nature of the product, method of production, type of labor, hours of work, machinery and equipment used, etc., which result either in improvement in the qualtiy of the article produced or in an increase in the output per unit of labor time."[9]

In this instance it is the rise in output per unit of labor time which has come out most clearly. The product has increased in quality, to be sure, but the firm always has turned out a product of a high grade.

To measure the reduction in the employment situation, Stern employs data fot the total man-hours and total output. By dividing the latter by the former, he gets for each year a unit of productivity in terms of output per man-hour. (Compare Table 20, column 3.) He then notes the increase or decrease, as the case may be, of successive production figures, and calculates the corresponding change in man-hours which would be necessitated if the employees were working at the rate of the given year. Actual variations in man-hours data is also computed. He then has his two vital factors from which he measures changes due to technological improvements: (1), the change in man-hours caused by variation in total output, and (2), the actual change in man-hours each year. The difference between these two series represents the man-hours displaced for technological reasons.[10] Table 20 following is made according to this system, with one exception. Stern deals with totals throughout, but inasmuch as the monthly figures are lacking in several instances in our figures, monthly averages each year have been used. The years 1925 to 1929 are the only ones covered, as these are the significant years in which the results of the technological improvements are most clearly shown. The effects of the depression obscure any influence after this year.

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9 Stern, Boris, *Labor Productivity in the Automobile Tire Industry*, United States Department of Labor, Bureau of Labor Statistics Bulletin No. 585, 1933, p. 16.

10 Ibid., pp. 17-20.

TABLE 20.

Volume of Technological Displacement One Sheet Steel Mill.

1925–1929.

	1	2	3	4	5	6	7
				Increase or Decrease from Previous Year caused by change			
Year	Output Mo. Av.	Man-Hours Mo. Av.	Output per Man-Hours	Output	Man-Hours	Net Change in Man-Hours	Tech. Displacement in Man-Hours
1925	6,212	154,624	.040				
1926	7,325	162,118	.045	+1,113	+24,766	+ 7,494	17,272
1927	5,453	102,992	.053	—1,873	—35,332	—59,126	23,794
1928	6,002	77,239	.078	+ 549	+ 7,035	—25,753	32,788
1929	7,053	81,135	.087	+1,052	+12,089	+ 3,896	8,193
Cumulative Total 1925-1929				+ 841	+ 8,558	—73,489	82,041
				+ 841	+ 9,678	—73,489	83,167

It will be seen from the table that in the year 1926, average monthly production increased 1,113 tons. To produce this increase at the rate of .045 tons per man-hour, the average productivity per worker for that year, an average of 24,766 man-hours monthly would have been required. Actually, man-hours were increased 7,494. The difference between this figure and the former, which is 17,272 average monthly man-hours, represents the volume of labor displaced because of technological changes. In 1927, output suffered a loss of 1,873 tons per month, although the productivity rate rose to .053. At this rate, 35,332 fewer man-hours per month should have been put in, but actually the net reduction was 59,126 man-hours, a greater diminution than was called for, showing a net displacement due to technology of 23,794 man-hours. In 1928 occurred another large decrease in the actual number of man-hours, but a slight increase is indicated by the changes in productivity and production figures. It can be seen by looking at the column of displacement that the years 1927 and 1928 show the greatest net displacement due to technological progress.

The cumulative effect is also given in Table 20. This indicates that with a net increase in average monthly output of 841 tons, a corresponding advance in monthly man-hours of 8,558 was necessary. Actually, however, the average monthly man-hours worked was 73,489 less in 1929 than in 1925. This results in a displacement of 82,041 monthly man-hours for the period, due to technological changes. Approximately the same result is obtained if the two years 1925 and 1929 are compared without regard for the intervening years. In the latter case the monthly man-hour displacement for technological reasons is 83,167, as compared with 82,041. In this instance the difference is negligible, but, in general, the year by year method is more representative than the comparison of two separate years. Since the numbers are all averages, it is difficult to estimate a certain number of

men which might be said to be displaced. Assuming a work week of 48 hours, or 208 hours per month, approximately 400 men would then have been eliminated in the course of the five year period. This is slightly higher than the drop in employees indicated from the monthly average for the year, where the difference is 315 men, between the average of 687 for 1925 and 372 for 1929. In terms of man-hours, however, the average monthly number reduced because of technological changes amounts to 82,000.

If the above table were continued during the depression, it would be shown that no more technological changes had occurred, and in fact that more men were being employed than were necessary according to the amount of production and the productivity rate. For example, in 1930, average monthly output decreased 2,696 tons from the 1929 average. Productivity was .082 tons per man-hour. The man-hours decrease called for from these two figures is 32,874, but actually man-hours worked was only 27,802 below the preceding figure. Thus, the firm allowed 5,072 man-hours more during this year than was necessary. In other words, if the table were continued the figure in the last column would be negative. As a similar situation occurs in the years 1931 to 1933, it is evident that no technological change has taken place in the depression years.

The computations show that the unemployment arising in the selected mill prior to 1929 was technological in nature; that which occurred since 1929 has been due to the decrease in business activity.

Reduction in Labor Costs.

The factors are such that, if output is increasing and numbers employed decreasing, one might expect an accompanying reduction in labor costs per ton. This was the case here. In the following discussion, unless very definitely stated otherwise, labor costs are implied. Two sets of figures were available in this connection. One set covered cost per ton calculated in conjunction with the productivity studies and with the same data missing. The other gave total pay-rolls. Although the latter were given from 1927 to 1929 bi-weekly, it was possible to compute a monthly figure, so that some of the gaps omitted in the labor cost series were supplied from the payroll material. Chart 11 depicts the course which the curve on labor costs per ton follows, together with corresponding curves of production, productivity, and number of employees.[11] The line depicting costs shows a distinct downward tendency, closely paralleling that of employment. The other curves are the same as noted previously.

In 1929, with a large volume of output, expenditures per unit had been reduced to $9.50 from $13.32 in 1925 and $14.84 in 1926, a year when the goods turned out were practically equal in amount to the total of 1929. In 1930 and 1931, however, the average cost per ton rose slightly, probably due to the decreased efficiency in operation. It will be recalled readily that in these years, the number of employees remained about the same, but the amount of time put in was cut perceptibly. In 1932 and 1933, on the contrary, another period of low production and lessened productivity, the cost per ton declined to $8.16 and $8.15 respectively. Despite the diminution

11 Figures for labor costs per ton are to be found in Appendix, Table 12, production figures are given in Appendix, Table 3, productivity in Appendix, Table 11, and employment in Appendix, Table 8.

in operating time of the mill, management had planned very carefully so that a further reduction in costs was possible. Since the reorganization of the mill, the bulk of the workers had been paid on a basis of tonnage produced. Thus the amount of time worked is less important than the quantity of output. In the last two years of the depression, 1932 particularly, production was very small, and would therefore affect the earnings of the workers. In 1933, goods turned out increased and yet the costs per ton remained the same as the preceding year. Considering that such curtailed schedules were maintained in the two latter years, efficient operation evidently has succeeded in keeping down expenses for labor.

Yearly changes in data frequently bring out more strikingly points obscured in chart form. Thus Table 21 has been constructed, in which indexes are compared for average labor costs per ton and average total costs, together with the actual figures. Although both indexes grow steadily smaller, that for average monthly payroll shrinks as low as nine in 1932, and exhibits throughout more rapid declines than the other index. The elimination of workers as well as improved methods of manufacture have made this decrease possible. The situation is a direct result of the company's efforts to improve productivity and at the same time to lower labor costs. The decline shown by the actual numbers is also remarkable. Monthly payrolls fell from an average of $100,000 in 1925 to $9,000 in 1932. And from 1926 to 1929, both years of great activity, a difference of almost $35,000 appeared. When compared with unit of production, the costs are cut directly in half, from 1925 to 1932.

In order to bring together some of the various factors to facilitate comparison, Table 22 has been constructed with indexes of the two series above and those for production, productivity, and man-hours. Chart 12 accompanying the table shows all these series graphically. As early as 1926, though average hours and monthly costs had advanced, cost per ton showed a reduction. Up until the year 1929 the three series of average cost per ton, monthly payrolls, and number of hours worked, declined by similar percentages, 42, 35, and 48, respectively, while production and productivity increased. In the years 1929 to 1932, the low point of production, all indexes dropped lower. No change from 1932 to 1933 occurred in the cost series, although all the other indexes rose. Evidently the management had succeeded in establishing operations so that the costs were not excessive, despite curtailed production. On the other hand, a rise of 56 per cent was noticed for total payroll, a movement like that for output. It should perhaps be reiterated here before going on, that although the year 1929 marked the maximum of achievement in production, costs per ton were not as low as they became subsequently. If production could be maintained, therefore, the apparent stabilization of costs should have profitable results.

Even though costs per ton have decreased so appreciably throughout the years, the employees were not being paid a lower rate. The pay was less in total amount, because such small tonnage had been rolled; but rates were high. In 1929 when production was up, wages based on tons produced were likewise good. It must be borne in mind, too, that fewer workers were employed after 1928, and hence labor costs would be less.

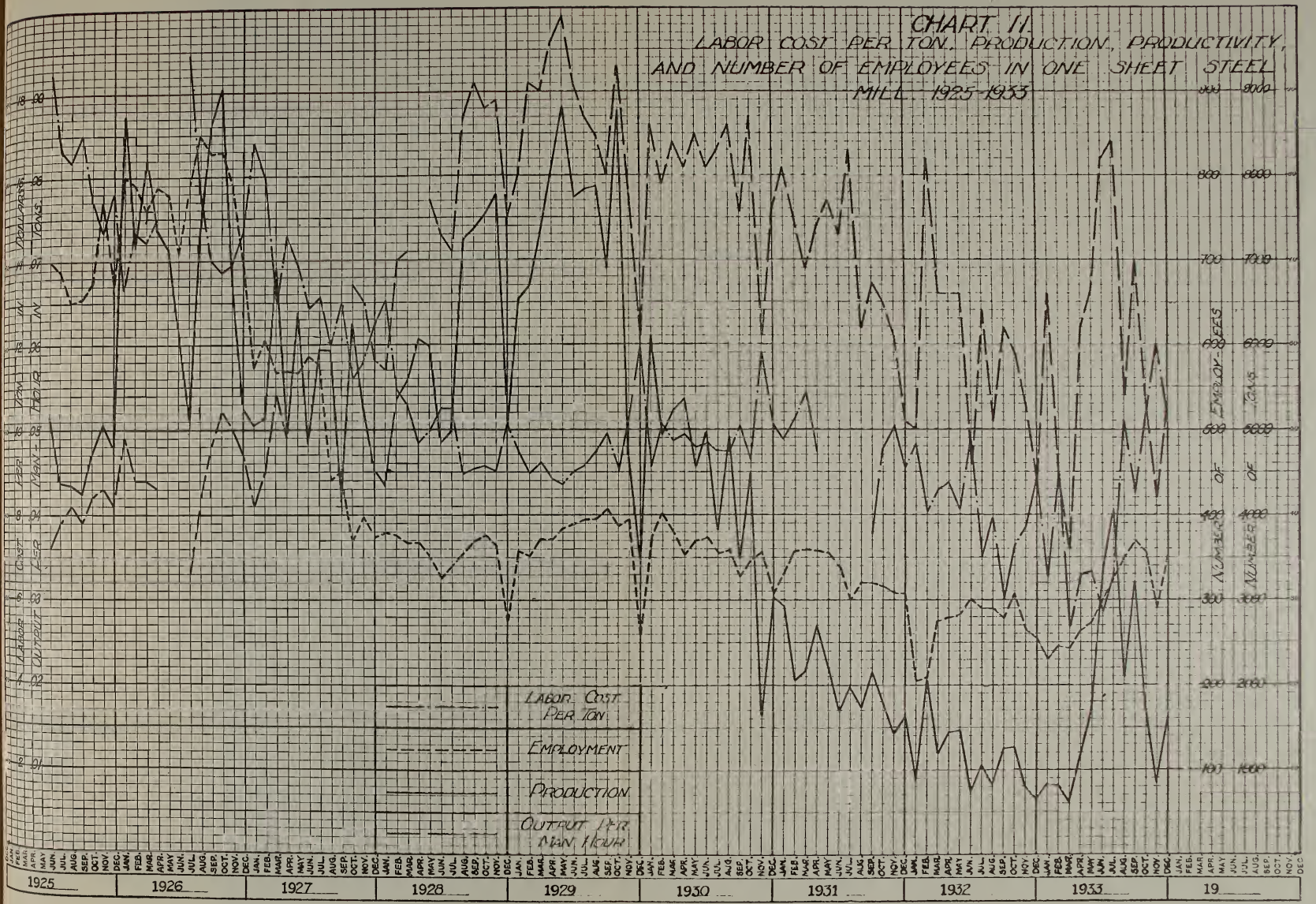
CHART II.
LABOR COST PER TON, PRODUCTION, PRODUCTIVITY, AND NUMBER OF EMPLOYEES IN ONE SHEET STEEL MILL 1925-1933
LABOR COST PER TON
EMPLOYMENT
PRODUCTION
OUTPUT PER MAN HOUR
NUMBER OF EMPLOYEES
1925
1926
1927
1928
1929
1930
1931
1932
1933

TABLE 21.

Total Labor Costs and Labor Costs per Ton One Sheet Steel Mill.

1925–1933.

(Mo. Av. 1925 = 100.)

Year	Total Labor Costs		Labor Costs per Ton	
	Monthly Average	Index	Monthly Average	Index
1925[a]	$100,657	100	$16.32	100
1926[b]	107,348	107	14.84	91
1927	72,597	72	13.37	82
1928	59,767	59	10.31	63
1929	65,841	65	9.50	58
1930	42,434	42	9.87	60
1931[c]	20,129	20	9.57	59
1932	9,283	9	8.16	50
1933	14,457	14	8.15	50

TABLE 22.

Comparison of Indexes of Total Costs, Costs per Ton, Productivity, Man-Hours and Production One Sheet Steel Mill.

1925–1933.

(Mo. Av. 1925 = 100.)

Year	Cost per Ton	Total Cost	Man-Hours	Productivity	Production
1925[a]	100	100	100	100	100
1926[b]	91	107	105	113	158
1927[a]	82	72	67	135	117
1928[d]	63	59	50	193	129
1929	58	65	52	215	151
1930	60	42	35	200	94
1931	59[c]	20[c]	19	175	44
1932	50	9	12	153	24
1933	50	14	19	158	39
Per Cent Change					
1925-1929	—42	—35	—48	+115	+51
1929-1932	—14	—86	—77	—29	—84
1932-1933	0	+56	+58	+ 3	+63

a Based on an average of seven months.
b Based on an average of ten months.
c Based on an average of eight months.
d Based on an average of eleven months.

Variation in Labor Costs in the Different Departments.

From 1925 to 1930, the period for which detailed statistics of productivity were recorded, labor costs per ton have been calculated and divided into the same groupings used previously. The same omissions noted before are seen again in these figures.

Table 23, following, gives the average yearly costs per ton for the ten categories. As before, the percentage change from 1925 to 1929 and from 1929 to 1930 is computed. Doubtless if further figures were available for the depression years, some of the groups would show reductions in 1932 and 1933 corresponding with those noted in the data covering the whole mill. From the data available here, however, they all decrease in costs per ton from 1925 to 1929 and most increase slightly in the latter period, except that "Miscellaneous Labor" shows a further decline. The two groups which gained most in output per man-hour also exhibit diminution in costs. The loss amounts to 71 per cent in the "Yard Labor" group and 48 per cent for "Tonnage Labor." "Boiler House" workers, "Inspection" and "Miscellaneous Labor" also show some reductions. The lowering of costs for the tonnage labor has probably saved the company most money as this is the largest group and the actual expense is far greater per ton than for the others. Actual figures of costs are given, as done before for output per man-hour, that the several classifications may be contrasted within themselves. The price of each category is then apparent, as well as the percentage of change noted above. The impression is again that of gradually decreasing expenditures per unit of output in all departments. One would expect this, since the whole mill had reduced expenses so greatly.

Comparison of Price and Cost.

The task of treating price adequately or even reliably is rendered difficult, if not impossible, because prices of sheet steel vary widely as to locality, type, and guage of sheet. The price used in the one table inserted here is that of blue annealed sheets, number ten guage at Pittsburgh. It will be remembered that the company tends to make guages lighter than number ten, so the prices given cannot be considered to apply to all the output of the selected mill. The comparison of the yearly changes in price and cost reveal, however, one interesting fact, even though it would be more significant if the price figure were more generally applicable. The data show that the decline in costs per ton is much greater than the decline in price. Table 24 gives the comparisons of the selling price and costs in index numbers and also as measured in terms of constant purchasing power. From 1925 to 1929, the critical period for the mill, the price declined 13.5 per cent as against 42 per cent for costs. When measured in terms of constant purchasing power,[12] the difference is even more striking; costs decrease 37 per cent from 1925 to 1929 and prices only six per cent.

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12 This procedure follows a scheme used by Mills, Op. Cit., in his discussion of changes in various series.

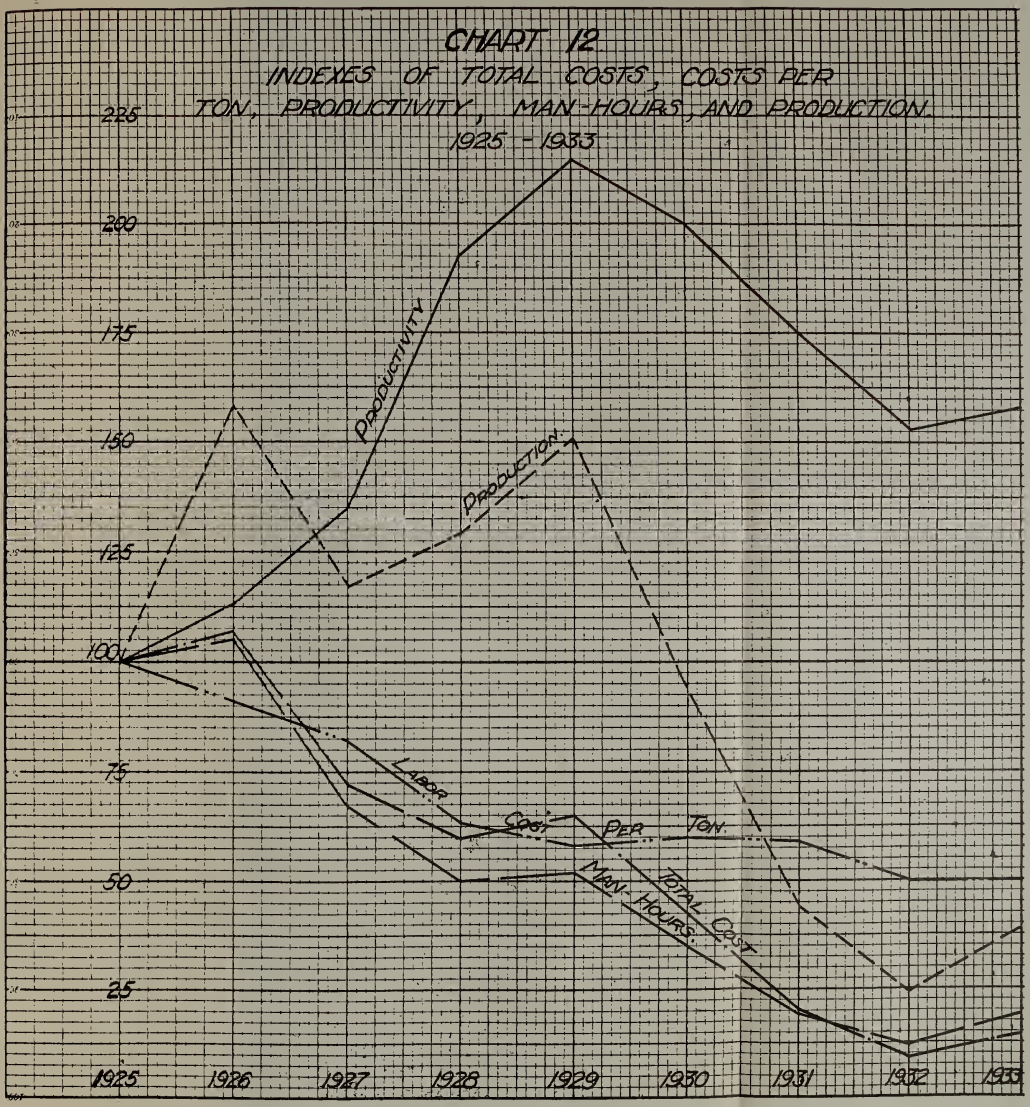
CHART 12
INDEXES OF TOTAL COSTS, COSTS PER TON, PRODUCTIVITY, MAN-HOURS, AND PRODUCTION. 1925 - 1933
225
200
175
150
125
100
75
50
25
PRODUCTIVITY
PRODUCTION
LABOR COST PER TON.
MAN-HOURS.
TOTAL COST.
1925
1926
1927
1928
1929
1930
1931
1932
1933

TABLE 23.

AVERAGE MONTHLY LABOR COST PER TON IN DIFFERENT DEPARTMENTS ONE SHEET STEEL MILL.

1925–1930.

(In Dollars.)

Year	1 Tonnage Labor	2 Inspection	3 Dynamo and Power	4 Boiler House	5 Yard Labor	6 Mechanical Labor	7 Electrical Labor	8 Cranemen	9 Miscellaneous Labor	10 Mill Engineers
1925[a]	10.344	*	.056	.338	.716	1.079	.214	.295	1.656	*
1926[b]	8.224	1.336	.051	.322	.698	1.166	.233	.261	1.935	.2163
1927[a]	6.638	1.020	.069	.280	.837	1.418	.252	.308	1.671	.1353
1928[b]	5.474	.855	.065	.218	.310	.958	.211	.300	1.186	.0231
1929	5.385	.815	.058	.216	.211	.820	.178	.266	1.008	.0188
1930	5.374	.890	.095	.217	.236	.946	.193	.296	.908	.0265
Per Cent Change										
1925-1929	—48	—39[c]	+ 4	—36	—71	—24	—17	—10	—39	—91[c]
1929-1930	0	+ 9	+64	0	+12	+15	+ 8	+11	—10	+41

* Data lacking.

a Based on an average of seven months

b Based on an average of ten months.

c Per cent change 1926-1929.

TABLE 24.

Comparison of Labor Cost per Ton and Selling Price in Actual Figures and Constant Purchasing Power.[13]

1925–1933.

(1925 = 100.)

Year	Selling Price a	Selling Price b	Cost per Ton a	Cost per Ton b
1925	100	100	100	100
1926	97	100	91	94
1927	90	97	82	89
1928	83	89	63	68
1929	87	94	58	63
1930	81	97	60	73
1931	76	108	59	83
1932	70	108	50	77
1933	70	107	50	76
Per Cent Change 1925-1929	—13	—6	—42	—37

a Index based on actual data.
b Index in terms of constant purchasing power.

These figures refer only to labor costs. No account is taken in this section of overhead costs carried by the firm, because figures were not available. Several million dollars were expended in the modernizing of the mill. This expense had to be met by increased capital and overhead charges over a number of years. Thus it is probable that a total record of costs might not show so great a disparity with prices as appears here.

Summary.

The period 1925 to 1929 has been significant when changes occurring in the mill are considered. New equipment and processes increased the average output per man-hour from .040 to .087 tons per man-hour. This advance brought the mill well above the average productivity at that time for sheet steel mills in the United States. It is the more remarkable in that the mill came up from behind the field, as it were, rescuing itself from an unfavorable competitive position and achieving a foremost place. Furthermore, productivity gained 115 per cent as against a corresponding advance of 51 per cent in production and a reduction in average man-hours of 48 per cent. Until 1932 in the depression years, the productivity of workers declined only slightly, whereas man-hours and production exhibited a marked diminution. In 1933 all factors showed an increase.

13 Labor costs were given originally in dollars per ton. Selling price was given originally in cents per pound. Data for price, etc., that of Blue Annealed Sheet Steel at Pittsburgh, No. 10 guage. Data are corrected for constant purchasing power by wholesale price index of United States Department of Labor.

When the various departments are considered, the group "Yard Labor" rose most in productivity, with the "Tonnage Labor" group second. The reduction in the "Yard" and "Miscellaneous Labor" groups show that the elimination of manual workers, noted before, had advanced the output per man-hour of this group. Other groups which showed great improvement in productivity were the workers in the boiler house and the inspection group. All of these changes indicate a concerted effort for better planning on the part of management and are a direct result of the campaign to make the position of the plant more secure. From 1925 to 1929 technological improvements occurred which resulted in displacement of employees. Each year during this period the productivity increased so rapidly and the number of man-hours worked so diminished that much labor was displaced as measured in terms of man-hours. After 1929, what loss of man-hours and employees occurs is a direct result of the depression and not technological in any sense. Until the production becomes more regulated, further improvements in output per man-hour cannot take place. The tendency to roll special steels is time consuming, and as yet high productivity in this branch has not been achieved by the workers.

Not only has this plant been increasing its efficiency in terms of output per man-hour, but it also has reduced its labor costs per ton. Again the great decrease occurred in the period 1925 to 1929, but here, although a slight rise is apparent from 1929 to 1931, the succeeding years show a further reduction to the lowest point of all. All of the figures point to a general increase in efficiency and elimination of unnecessary expenditures for labor. A large part of the reduced expenses can be traced directly to the smaller number of employees in 1929 than in 1925. This phase is emphasized in examination of labor costs for the various groups of workers. Those classifications which showed great diminution in costs per ton have also gained in productivity and suffered reduction in man-hours. The laborers about the plant and those working directly on rolling the product are the ones who showed greatest improvement in efficiency.

Any comparison of costs and prices in this field must be inaccurate and the comparison given has much that could be said against its validity. From the figures given in Table 24, however, it is evident that prices have not decreased in the years 1925 to 1929 in anything like the degree to which costs have been reduced, even less when measured in terms of constant purchasing power. Labor costs only are considered and the effect of overhead and capital costs is absent. No information is at hand as to the relation between costs and prices prior to 1925. It may be that this firm has been operating on a slim margin of profit, or even at a loss in earlier years, so that the great decrease in cost per ton merely shows the firm attaining profitable operation. To complete the picture, data on overhead costs and profits are essential which have not been available.

CHAPTER V.

Summary and Implications.

The underlying motive for the analysis of one individual plant or a number of plants over a period of years is the acquisition of information which may be of practical assistance in planning future action. Here, the specific problems revolve about chances for improvement in stability of operation; for all factors of production depend on maintenance of output. It is impossible, of course, from so limited a study to attempt to draw conclusions which will be valid for an industry. The same factors which distinguish the particular problem of a small plant also set it apart as an individual with specific characteristics not applicable to other or all firms turning out the same products. Pecularities inherent within certain units in a broader field emphasize difficulties and limitations which have far-reaching effects but are not indicated from collective data. Even though caution must be exercised in interpreting the results of the study, certain implications follow logically from the analysis.

Specifically, what has been the fate of the industry and the sheet steel mill here examined? In a rapidly expanding field, the plant was outbid by its competitors and forced to take measures to insure its place among them. These measures had definite effects on production, employment, productivity, and labor costs. Throughout the struggle, grave limitations presented themselves beyond the control of the single, small company. Various expedients necessitated by economic pressure, point to problems which affect not only the plant but the community in which it is located. The manner in which this company coped with its problems is a matter of record. Implications which may be carried over from this study present thoughts for further reflection.

Experience of Sheet Mill Summarized.

First, let us take the measure of the mill's competitive place in the sheet steel industry. Prior to 1919, when the study began, the plant had held for a long time a well established place, supplying many firms with quality products meeting standard requirements. The industry itself was well-developed and had many outlets. From 1919 to 1929, however, the demands increased yearly and a rapid expansion took place. Indeed sheet production advanced at an average rate of 17.57 per cent a year. As consumers increased, more firms entered into the field. Competition was immense. The industry catered to a diversified purchasing group but its largest buyers were from the automobile industry which utilized many tons of sheets each year. In fact it has been the largest single consumer of sheet steel and, since 1922, has taken between 30 and 40 per cent of that steel produced in the country. In all this picture of industrial activity, the selected mill, with its limited capacity for output was losing its favorable place. Its production increased only 3.15 per cent in the years from 1919 to 1929. But long before the latter year was reached, the company had realized the forces

against it and had launched a program of reorganization to regain its standing. These undertakings were initiated in 1924 and completed in 1928. In 1929 the mill was operating most efficiently. What would have happened in this plant if the depression had not set in, is interesting to conjecture for the stage seemed set for further advance in production. As it was the mill was able to keep from slumping too desparately, and its average rate of decrease from 1929 to 1933 was only 18.58 per cent as compared with 14.72 per cent for the entire industry.

To improve its competitive position, the firm took two major decisive steps, one in the direction of acquiring new and wider markets for its goods and the other, improving its productive efficiency. Any manufacturing establishment tends to supply consumers located within easy accessibility, eliminating freight rates. This is a procedure imperative in steel where goods are bulky and transportation charges for long distances are high. Situated as our mill is near the eastern seaboard, it is far from the automobile center of the middle west and consequently has little trade with that industry. Those it does supply are primarily the boiler and tank manufacturers, the oil, gas and water companies, and jobbers and warehouses, for whom it has manufactured blue annealed sheets of varying analyses. Keeping abreast with the trends in sheet steel, the company also began both the manufacture and rolling of alloy sheets. Improved technical and metallurgical developments had given so great flexibility to the composition of special steels that the variety of uses was multiplied many times. Although blue annealed sheets remained the largest type rolled, distinct advance was made in diversifying its products to provide substitutes for lagging consumer demand.

The achievements of the firm in improving its productive efficiency were even spectacular. In the first place, productivity of the workers was doubled, and in the second place, labor costs were cut almost one half, in the period from 1925 to 1929. These results practically had been accomplished by 1928, but conditions were bettered slightly from then to 1929. Well before the depression had cast its shadow on general business activity, the results of the carefully planned innovations were apparent in this mill.

The simple statement, "productivity of the workers was doubled," carries with it several far-reaching consequences. How was the greater efficiency brought about? Primarily two factors may be said to cover the reasons for the increase in output per man-hour; (1), modernization of machinery and equipment, and (2), changes in methods of manufacture. For seven steam-driven mills with obsolete machinery, four modern buildings with newer and electrically controlled equipment were substituted without altering the capacity of the mill. Considerable money was invested in these physical changes. Simultaneously, attention was turned to operating procedure. Duplication of effort was eliminated and excessive handling of the materials was removed. In so doing, average productivity for the whole mill increased from .040 in 1925 to .087 tons per man-hour in 1929. The rate exceeded by 13 per cent the average for the group of mills in the United States previously studied by the United States Bureau of Labor Statistics. Although all workers improved in productivity, certain types of workers showed a larger percentage rise than others. The two groups in which output per man-hour advanced most, were the manual laborers, most of whom had been engaged in the now superfluous transportation of

goods about the mill, and the men directly engaged in rolling sheets, for whom innovations in processes had enabled higher speed of output to be attained.

Coincident with such improvement in turning out goods, occurred a diminution in working force. From an average of 572 employees in 1925, the number was reduced to 372 by 1929. Or comparing 1926 and 1929, two years of approximately equal production, an average of 684 men were required in 1926 as contrasted with 372 in 1929. Previously many men had been dropped from the mills for one reason or another, but here a large reduction of about 300 took place in the short space of two years. By 1928 the average employment was 354.

The labor displacement in the period of reorganization from 1926 to 1929 was distinctly due to technological improvements. Once the mill had achieved its productive efficiency, however, the force remained relatively stable in number throughout the years 1930 to 1933, even though less time was put in by individual workmen. In so far as possible, the policy of spreading the available work among employees was practiced. Productivity declined, due in part to the personnel policy described above, in part to lack of pressure for production, but mostly to the nature of the manufacturing process and the painstaking care required in rolling the newly developed alloy sheets. Part-time work rather than unemployment has been the result of depression in this mill. Capacity consequently, so far exceeds production today that output comparable to that of 1929 probably could be maintained with little additional employment.

Lowered labor cost per ton is apt to accompany increased productivity especially if, as here, the latter has resulted in reduction in number of employees. So, we have seen, the average expenses of producing a ton of sheet steel decline from $16.32 to $9.50 between the years 1925 to 1929. Total payrolls were also reduced, and revealing in their size the effects of the diminished output. Wage rates were not lessened and in fact were raised as a part of the reorganization, but based as they are on tonnage, the actual earnings have been low in the last years. Labor costs per ton did not rise in 1932 and 1933 as productivity dropped again, but shrank to $8.15 and $8.16 per ton.

Because seasonal demand for goods exerts unequal pressure on the manufacturer, steel production shows considerable fluctuation within the year, and has a spring and fall peak followed by periods of low demand. In the selected mill, the fall is the time of greatest activity, where, as in the United States, the high point occurs in spring. The latter is occasioned by the influence of the automobile industry which it supplies. Employment in the one mill is consequently subject to an increase in the autumn, but varies little throughout the other months showing in general more stability than does tonnage.

This then has been the history of one plant in the fifteen years of prosperity and depression. The mill is sufficiently typical of the industry to be worth our study but it has its own unique problems and specialties. It has shown itself resourceful in meeting its many competitors and has kept up with changing market requirements. It has managed to sustain itself in the depression. Most pronounced of all its achievements are the increased productivity and lowered labor costs brought about largely by the introduction of new processes and elimination of workers.

Significant Implications.

The outstanding implication of this analysis is that one firm in a highly competitive industry is unable to maintain production and the factors involved therein with a fair degree of stability over a period of years. It is beset with limitations some of which it can partially control while others are beyond it entirely. It must above all hold its place among its competitors if it is to survive in the struggle, and this implies efficient production and low costs.

At the outset any firm is limited by the locatity in which it is situated if transportation charges play an important role. In the present instance, the company is unlikely to have customers in sections of the country at some distance from the plant, unless water transportation is at hand, because of the high freight rates for delivering the goods by rail. With products which could be shipped in smaller quantities, the situation might not serve as such a deterrent to purchasers. A firm, therefore, must adapt itself and its equipment to the manufacture of goods for consuming interests at hand. This can be done by careful observation of locally available markets. It frequently happens, too, that the growing industry will expand to new or different areas, especially if it can be supplied with the material which it needs. So we may see a movement eastward in automobile manufacture.

An industrial plant, of course, can keep market demand under control by being alert to present requirements and future trends. An ability to diversify products so that new outlets may be substituted for losing ones is essential. In times of depression, too, some varied types may sustain production appreciably. Developments in uses should be met with an awareness on the part of the manufacturers. But even with keen insight into future market tendencies, serious obsticles to the planning of one small factory may be encountered if considerable expense is involved in keeping up with the latest achievements. For example, improvement in the chemical composition of sheet steel has been enormous and the flexibility and diversity of use for alloys have become phenomenal. But attempts to keep pace with developments have led to inventions like the continuous strip rolling process, the installation expense of which is very great, although the capacity to produce is advanced tremendously. Small companies must meet, with their machinery and labor, competition of larger firms to whom the capital charges may not be so great a burden.

Widespread economic conditions affect many mills alike and exert an outside influence which it is difficult for the individual to combat. The recent depression has given a notable example of this, with the extensive recession in all lines of activity. More specific disturbances within an industry alone may further challenge the ingenuity of a company, striving to keep its competitive place. Ability to substitute new markets for losing ones and to have as wide a stock as profitable help to ease the effects in the first instance.

If competition is keen, efficient production must exist. So a plant must keep up with new machinery and equipment and improved processes of manufacture. Labor productivity similarly can be increased, although this may not be accompanied necessarily by labor displacement as it was in the selected mill. Obviously the profit motive enters into any of the above expedients. Innovations and bettering of the output per man-hour

will be sought to lower the unit cost of the product, both in overhead charges and labor expense. In lowering these, profits may be maintained, but outlay for improvements at too great an expense to permit a return from the investment is precarious. In all this, prices act as the determining factor, one which is hard to measure.

Question has arisen repeatedly as to the relation between technological change and the present unemployment. The analysis of this mill, even if it is typical of the steel industry, gives one no exact answer. It may lead one, however, to significant inferences. The technological unemployment of this mill will become apparent before 1929 and prior to the years of mass unemployment. If it bears any relation to the great depression, it must be an indirect one, resulting from lowered purchasing power and curtailed demand, following a pre-depression volume of unemployment. At the same time, if the mill is in any way typical of the industry, the rate of displacement was high in the latter part of the decade between 1920 and 1929. Reabsorption could be accomplished only by rapidly expanding industrial activity. The recession and depression following 1929, whatever the totality of its cause, must have led to vast unemployment under these circumstances. The unprecedented number of idle workers experienced in recent years well may find some explanation in these figures. The decline in productivity during the depression would indicate in this instance, as stated, a retardation in the rate of advance for the time being. This may not be typical of the industry as a whole. The figures, nevertheless, give one little reason for expecting reemployment on an extensive scale before business activity exceeds the levels of 1929. Total wage rolls, even so, may be expected to improve with every advance in output.

Finally certain social and economic implications evolve. No effort to study them has been made here. These lie in the effect of curtailed production on the owners and workers in the mill and on the community in which it is situated. Thus, in this one instance, technological displacement probably has a marked effect on the community as well as the mill. The loss of consuming power in the city if these men were not able to be reabsorbed would be tremendous. Since the reductions occurred before the recession in business activity it is possible that the men may have obtained employment elsewhere. In times of depression, however, when earnings are halved, the community suffers, in that the collective consuming power is distinctly lowered. Similarly in any year buying capacity may vary seasonally with production, an irregularity which makes saving and planning with a limited income difficult. All classes feel the losses of depression, but for the workers the losses are most acute because the resources are least.

Stability, the writer must conclude, if it is to be attained or even increased to an appreciable extent, requires far more than the will or effort of the single plant. Further pursuit of programs already initiated in this mill might lessen seasonal fluctuations. Both cyclical and technological changes, obviously, are dependent upon the movements and trends of the entire industry. While the conclusion is in no way novel, the ultimate helplessness of the individual employer in the present situation is demonstrated forcibly. The problem is one of aggregate action and control, based upon particularized data.

APPENDIX A.

TABLE I.

Annual Production of Sheet Steel in the United States and One Mill.

1913-1933.

(In tons.)

Year	Volume of Production		
	One Mill	United States	
		a	b
1913	42,931	1,716,968	
1914	42,117	1,427,627	
1915	53,342	1,836,786	
1916	56,837	2,249,597	
1917	87,246	2,367,752	
1918	80,425	2,073,639	
1919	64,449	2,099,840	1,410,239
1920	85,786	2,886,401	2,057,867
1921	29,074	1,511,817	1,024,913
1922	69,137	2,917,236	2,290,370
1923	80,008	3,503,071	2,671,916
1924	63,815	3,266,430	2,638,026
1925	45,121	4,096,832	3,521,985
1926	86,994	4,237,479	3,447,452
1927	65,368	3,979,037	3,285,276
1928	72,175	4,962,410	3,947,953
1929	84,756	5,254,998	3,887,377
1930	52,560	3,511,557	2,643,721
1931	24,475	2,461,494	1,890,254
1932	13,663	1,471,532	1,121,077
1933	21,785	3,092,410	1,593,836

a Data for "Black sheets rolled on sheet or jobbing mills" from American Iron and Steel Institute, *Annual Statistical Report for* 1933.

b Data released by the National Association of Sheet and Tin Plate Manufacturers and published in *Iron Age* annually.

TABLE 2.

Percentage of Principal Forms of Finished Steel Consumed.[a]

1922–1933.

Form of Steel	1922	1923	1924	1925	1926	1927	1928	1929	1930	1931	1932	1933
Rails	8.5	9.0	8.9	8.5	9.3	8.7	7.1	6.7	6.4	6.1	3.9	2.5
Plates	13.4	12.9	11.5	11.5	12.0	11.5	10.5	12.4	12.6	10.4	8.0	7.0
Black Plate for Tinning	5.0	4.6	5.2	5.0	5.1	5.1	4.8	4.2	5.8	7.5	9.7	11.8
Other Sheets	12.7	11.8	12.8	13.4	13.1	13.1	14.2	14.1	12.8	13.9	15.6	18.6
Strips[b]	....	....	....	....	3.5	4.1	5.8	6.2	6.7	8.5	11.4	11.6
Wire Rods	10.4	9.5	9.2	8.7	7.8	8.5	8.3	7.7	8.0	9.7	11.4	12.2
Shapes	10.6	10.5	12.0	11.0	11.2	11.6	11.1	11.8	12.0	10.9	9.0	6.7
Bars, Merchant	14.3	15.0	14.7	16.4	15.0	14.5	16.4	15.5	13.8	12.6	12.4	13.5
Bars, Concrete	2.3	2.1	2.4	2.5	2.3	2.5	2.6	2.3	2.9	3.4	3.7	2.2
Skelp[c]	10.3	10.9	11.0	9.4	12.9	12.9	11.9	11.7	13.1	11.4	9.3	9.3
Hoops, Bands, Cotton Ties[b]	1.9	1.8	1.7	1.7	1.5	1.5	1.5	1.4	0.4	0.6	0.8	....
Track Accessories	2.2	2.3	2.2	2.4	2.6	2.6	2.0	2.2	2.0	2.0	1.4	1.2
Other Finished Products	8.4	8.7	8.6	9.5	3.7	3.4	3.8	3.8	3.5	3.0	3.4	3.4
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

a Figures from *Iron Age;* 1922-1925, volume 131, January 5, 1933, pp. 9-10; 1926-1933, volume 135, January 3, 1935, p. 202.
b For the year 1933, the classification "Hoops, Bands, Cotton Ties" has been abandoned and the amount going into this group has been included under "Strips."
c Since 1926, "Tube Rounds" have been included in this classification, hitherto listed under "Other Finished Products."

TABLE 3.

Monthly Production of Sheet Steel—One Mill

1919–1933.

(Unit—1 long ton.)

Year	January	February	March	April	May	June	July	August	September	October	November	December	Total	Annual Average
1919	6,903	5,687	5,432	4,021	4,144	4,401	5,973	5,990	6,455	2,772	5,122	7,548	64,448	5,371
1920	8,545	7,688	8,254	6,563	6,646	7,659	4,635	6,379	9,046	7,195	7,198	5,978	85,786	7,149
1921	1,615	2,431	2,544	2,224	2,207	2,481	.....	2,408	3,522	3,646	2,805	3,192	29,075	2,423
1922	3,160	3,340	5,242	5,265	5,742	7,096	4,432	8,004	6,576	6,595	8,461	5,224	69,137	5,761
1923	8,275	7,012	6,534	6,377	8,767	6,449	4,768	8,313	6,709	8,422	5,159	3,264	80,009	6,667
1924	7,070	5,477	5,708	7,196	5,421	4,448	4,203	4,281	4,764	5,982	4,664	4,601	63,815	5,318
1925	6,078	3,628	.....	.....	2,712	5,137	4,388	4,344	4,257	4,729	5,086	4,764	45,123	3,760
1926	8,728	7,153	8,222	7,360	7,134	6,244	5,098	7,377	8,654	9,040	6,753	5,253	86,996	7,250
1927	5,051	5,126	6,913	4,983	6,399	4,832	5,941	5,925	4,150	6,247	5,271	4,532	65,370	5,448
1928	4,351	5,359	5,587	6,071	5,992	4,826	4,961	7,247	7,376	7,547	7,794	5,066	72,177	6,015
1929	6,518	6,696	7,329	8,127	8,837	7,735	7,819	7,874	6,894	8,790	4,672	3,464	84,755	7,063
1930	6,102	4,948	5,218	5,365	4,563	4,991	3,813	4,910	3,498	4,487	1,641	3,024	52,560	4,380
1931	2,935	2,051	2,171	2,704	2,239	1,684	1,974	1,724	2,163	1,780	1,429	1,621	24,475	2,040
1932	877	2,069	1,197	1,456	1,484	714	1,058	816	1,264	1,278	803	648	13,663	1,139
1933	831	824	621	1,144	1,715	3,365	4,060	2,075	3,210	1,699	826	1,615	21,985	1,832

TABLE 4.

Steel Sheets Produced in the United States.[a]

1919–1933

Year	January	February	March	April	May	June	July	August	September	October	November	December	Year	Average
1919	132,796	127,168	110,339	112,720	108,739	119,363	115,324	129,861	102,035	79,872	128,617	143,405	1,410,239	117,530
1920	185,271	177,410	198,606	165,811	161,645	166,819	142,023	188,458	198,467	202,703	185,450	85,204	2,057,867	171,489
1921	37,011	45,520	74,239	85,592	106,969	83,374	49,096	94,900	106,454	131,577	127,983	82,198	1,024,913	85,409
1922	86,130	122,439	166,244	184,979	218,739	210,464	179,100	228,398	202,600	243,476	242,562	205,239	2,290,370	190,864
1923	260,520	237,919	279,475	251,808	260,006	218,432	174,910	234,112	185,577	225,714	188,144	155,299	2,671,916	222,660
1924	274,097	275,118	278,767	234,000	176,582	114,807	144,291	190,439	217,978	247,222	224,931	259,794	2,638,026	219,836
1925	317,424	283,290	290,308	280,082	260,470	266,290	246,404	270,212	295,810	348,714	336,021	326,960	3,521,985	292,665
1926	328,639	299,557	319,132	294,811	264,539	268,450	239,764	293,703	307,459	314,598	278,455	238,345	3,447,452	287,288
1927	256,856	282,172	359,339	316,100	309,360	300,706	237,239	266,649	220,919	245,767	230,039	260,130	3,285,276	273,773
1928	316,539	330,567	366,127	327,909	349,368	311,629	267,684	329,396	318,907	364,239	358,406	302,182	3,947,953	328,996
1929	391,404	326,468	364,202	375,256	393,432	337,839	323,905	366,734	302,490	319,660	204,071	181,916	3,887,377	323,948
1930	291,529	275,952	259,658	308,988	274,220	205,675	186,206	173,956	179,928	193,934	148,550	145,125	2,643,721	220,310
1931	167,865	192,218	224,323	213,609	201,848	147,839	174,890	123,752	116,839	122,739	102,758	101,570	1,890,250	157,521
1932	118,921	124,157	110,559	101,559	96,180	85,232	60,956	57,417	89,817	108,111	90,679	77,489	1,121,077	93,423
1933	85,337	91,723	64,724	111,942	139,696	166,272	188,143	203,893	180,304	146,106	102,585	113,111	1,593,836	132,820

a Figures given in *The Iron Age* from statistics of Independent Makers compiled by the National Association of Sheet and Tin Plate Manufacturers. In this category are included black, blue annealed, galvanized sheets and tin plates.

TABLE 5.

Index of Sheet Steel Production in One Mill

1919–1933.

(Base: 1923–1925=100).

(Adjusted for Seasonal Variation).

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1919	131	117	104	75	75	88	119	115	114	46	104	166
1920	161	157	159	123	120	152	92	122	159	120	146	131
1921	31	49	48	42	40	49	0	46	62	65	56	70
1922	59	69	101	98	103	141	94	155	117	111	171	134
1923	156	143	125	119	158	128	95	100	119	140	104	71
1924	133	112	110	134	97	89	83	83	84	100	95	101
1925	115	74	0	0	49	102	86	83	75	79	103	105
1926	164	146	159	137	128	124	101	141	153	152	137	116
1927	95	105	135	93	113	96	118	114	73	104	107	99
1928	82	110	113	114	108	96	99	139	131	126	159	112
1929	123	137	141	152	158	153	155	152	121	146	94	76
1930	115	101	100	100	82	99	76	95	62	75	33	67
1931	55	42	41	51	41	33	40	33	38	30	29	36
1932	17	42	23	27	26	15	21	16	22	21	16	14
1933	16	17	12	22	31	67	80	40	57	21	17	36

TABLE 6.

Index of Sheet Steel Production in the United States.[a]

1919–1933.

(Base: 1923–1925=100).

(Adjusted for Seasonal Variation).

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1919	53	50	39	42	41	50	55	55	45	31	54	66
1920	75	70	70	62	61	70	68	80	86	79	78	40
1921	15	18	26	32	41	35	24	41	46	51	54	38
1922	34	49	59	68	82	89	86	97	88	94	102	95
1923	104	94	99	94	98	92	84	99	80	88	79	72
1924	110	109	98	86	67	48	69	81	96	96	95	120
1925	126	112	103	104	98	112	118	115	129	135	141	151
1926	131	118	113	109	100	112	115	125	133	122	118	110
1927	103	112	127	117	117	127	114	114	96	95	97	120
1928	126	131	130	122	131	131	128	140	138	141	151	140
1929	157	129	129	139	148	142	155	155	131	124	86	84
1930	117	110	92	115	104	87	89	74	78	75	63	67
1931	67	76	80	79	76	62	84	52	51	48	43	47
1932	48	50	39	37	36	36	29	24	39	42	38	36
1933	34	36	22	42	53	70	91	86	79	57	43	52

a These indexes are computed from figures from the United States given in Appendix Table 4.

TABLE 7.

Seasonal Index of Sheet Steel Production.

Month	One Mill		United States a	
	1919-1924	1924-1929	1919-1924	1924-1928
January	108	102	109	109
February	95	94	109	104
March	99	103	115	115
April	91	113	107	106
May	93	113	103	98
June	102	97	92	98
July	76	95	83	85
August	105	97	103	97
September	115	97	91	95
October	117	115	109	104
November	105	95	100	96
December	96	79	81	93
Average Deviation	8.4	7.8	9.0	6.3
Range	41	36	34	30

a Seasonal index for the United States taken from Kuznets, Op. Cit., Appendix, p. 399.

TABLE 8.

Average Number of Men Employed in Sheet Steel Mill.

1919–1933.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly Average
1919	930	807	833	525	750	724	798	862	791	282	853	887	754
1920	899	926	924	881	821	859	868	924	944	941	945	710	887
1921	569	554	419	471	424	278	73	451	494	608	530	345	435
1922	483	485	639	733	802	661	856	890	886	912	914	915	765
1923	942	950	957	880	906	739	840	796	761	741	640	401	796
1924	741	745	739	711	692	677	645	673	664	639	697	718	695
1925	775	433	4	4	602	699	686	650	655	673	771	672	552
1926	800	790	758	788	780	709	791	848	828	830	789	691	784
1927	572	606	567	569	567	585	577	440	451	368	397	374	506
1928	380	376	368	368	351	326	340	355	369	376	364	276	354
1929	358	352	372	372	385	390	395	396	407	387	395	260	372
1930	374	402	380	353	370	373	356	359	327	347	356	308	359
1931	332	358	360	358	356	339	300	320	320	316	309	308	331
1932	205	210	276	280	283	300	291	290	278	307	265	255	270
1933	231	246	245	265	276	300	325	352	370	355	290	352	301

TABLE 9.

Total Man-Hours Worked in Sheet Steel Mill.

1925–1933.

Year	January	February	March	April	May	June	July	August	September	October	November	December
1925	*	*	*	*	*	143,133	149,874	151,081	151,405	159,264	164,141	163,472
1926	175,722	162,750	185,060	170,984	*	*	152,124	173,548	179,417	175,199	135,283	111,088
1927	124,609	114,827	127,877	100,981	*	*	*	*	*	92,967	81,822	77,862
1928	76,742	76,746	78,491	*	77,805	66,077	69,827	82,999	80,869	85,634	87,333	67,111
1929	81,171	73,431	81,090	84,619	89,503	84,694	89,402	92,474	86,084	94,157	60,432	56,558
1930	70,727	62,996	62,311	65,522	53,144	60,946	45,818	56,416	45,353	51,440	26,760	39,157
1931	36,009	27,243	31,629	36,784	28,948	23,002	23,644	27,774	32,142	26,473	27,812	26,802
1932	17,470	25,157	18,203	22,070	22,475	15,359	16,402	16,021	20,403	21,768	15,156	14,702
1933	12,628	18,866	17,147	18,378	26,044	41,096	48,369	38,643	46,003	31,979	19,828	30,197

* Data lacking.

TABLE 10.

Seasonal Indexes of Employment One Sheet Steel Mill.

Month	1919-1927	1928-1933
January	99	96
February	99	100
March	99	100
April	99	99
May	100	101
June	97	102
July	99	100
August	103	103
September	104	104
October	104	104
November	105	101
December	93	91
Average Deviation	2.6	2.4
Range	12	13

TABLE 11.

Tons Produced per Man-Hour in One Sheet Steel Mill

1925–1933.

Year	January	February	March	April	May	June	July	August	September	October	November	December	Aver.
1925	*	*	*	*	*	.036	.039	.041	.039	.042	.043	.041	.040
1926	.049	.044	.044	.043	*	*	.033	.042	.048	.052	.050	.047	.045
1927	.041	.045	.054	.049	*	*	*	*	*	.067	.065	.058	.054
1928	.057	.070	.071	*	.077	.073	.071	.087	.091	.088	.089	.075	.077
1929	.080	.091	.090	.096	.099	0.91	.087	.085	.080	.093	.077	.061	.086
1930	.086	.079	.084	.081	.085	.081	.083	.086	.076	.087	.061	.076	.080
1931	.081	.075	.069	.074	.077	.073	.083	.062	.067	.065	.051	.061	.070
1932	.050	.082	.066	.066	.066	.046	.064	.051	.062	.059	.053	.044	.061
1933	.066	.044	.036	.062	.066	.082	.084	.054	.070	.053	.042	.053	.063

* Data lacking.

TABLE 12.

Labor Cost per Ton of Product One Sheet Steel Mill.

1925–1933.

(In dollars per ton).

Year	January	February	March	April	May	June	July	August	September	October	November	December
1925	*	*	*	*	*	18.52	16.63	16.36	17.01	15.45	14.65	15.59
1926	13.36	14.66	14.43	15.03	*	*	18.92	15.61	14.00	13.74	13.91	14.73
1927	16.82	16.00	12.97	14.56	13.90	12.86	13.14	11.97	12.97	11.17	11.59	12.50
1928	13.06	10.95	10.57	9.66	9.95	10.48	10.48	8.95	9.06	9.16	9.03	10.16
1929	9.54	8.98	9.23	8.84	8.70	9.02	9.17	9.48	9.91	9.00	10.22	11.93
1930	9.16	10.13	9.75	9.89	9.59	9.70	9.52	9.49	10.08	9.25	11.80	10.13
1931	9.75	10.25	10.90	9.43	*	*	*	*	7.58	9.54	10.07	9.07
1932	9.67	8.03	8.60	8.78	8.13	9.80	7.02	7.96	6.04	7.26	7.72	8.85
1933	6.56	8.97	5.37	6.60	6.67	5.67	6.57	10.23	8.49	10.33	12.01	10.30

* Data lacking.

APPENDIX B.

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VITA

I, Jennette Rowe Gruener, was born in New Haven, Connecticut, October 5, 1901. My father, Alfred George Gruener, and my mother, Nettie Adele Rowe Gruener, were both American born.

I attended the public grammar schools and prepared for college at the Fitchburg High School, Fitchburg, Massachusetts. I was graduated from Wellesley College, Wellesley, Massachusetts, with the degree of Bachelor of Arts, in 1923. A member of Phi Beta Kappa. I held an assistantship in the Department of Education at Wellesley College from 1923 to 1925 and was granted a degree of Master of Arts in 1925. Some credits for the Degree were given for courses in the Graduate School of Education of Harvard University, Cambridge, Massachusetts.

During 1929-1930 and 1931-32 I attended Bryn Mawr College as Carola Woerishoffer Fellow in the Carola Woerishoffer Graduate Department of Social Economy and Social Research. In 1930-31, I served as Research Assistant in the department.

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