GRAY IRON FOUNDRIES
INDUSTRY, 1954-66

INDEXES OF OUTPUT PER MAN-HOUR

BULLETIN 1636

NOVEMBER 1969
U.S. DEPARTMENT OF LABOR
BUREAU OF LABOR STATISTICS

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U.S. DEPARTMENT OF LABOR
George P. Shultz, Secretary

BUREAU OF LABOR STATISTICS
Geoffrey H. Moore, Commissioner

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Preface

The Bureau of Labor Statistics has been publishing measures of output per man-hour for selected industries for many years. These measures appear in Indexes of Output per Man-Hour, Selected Industries, 1939 and 1947-67, BLS Bulletin 1612, December 1968. This report presents indexes for the gray iron foundries industry for the first time.

The study was prepared in the Office of Productivity, Technology and Growth. The analysis and the statistical measures were developed by John L. Carey in the Division of Industry Productivity Studies. Richard W. Lyon in the Division of Technological Studies wrote the section on technological developments.

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Introduction

Measuring productivity change is one way to determine whether resources are being used efficiently—a primary requisite for improving a nation's economic well-being. If output per man-hour is increasing, then more goods are being produced per unit of labor input and the economy is potentially richer. Thus, knowledge of the degree and direction of productivity movements is essential for those responsible for encouraging economic growth.

Industry productivity measures have several valuable uses. By combining these measures with other industry data, one can study the effects of changes in manpower utilization, project future manpower requirements, analyze trends in labor costs, compare productivity progress among countries, and examine the impact of technological improvements on employment.

The measures presented in this report relate output to one input—man-hours. They do not measure the specific contribution of labor, capital, or any other single factor. Rather, they reflect the joint effect of a number of interrelated influences, such as changes in technology, capital investment per worker, capacity utilization, layout and flow of operations, skill and effort of the work force, managerial ability, and labor-management relations.

These measures are subject to certain qualifications. Because of the difficulties of measuring quality change, of maintaining consistent coverage between output and labor input, of reflecting changes in the degree of plant integration and specialization and other statistical limitations, productivity indexes should be regarded as general rather than specific indications of output per man-hour movements.

This report presents measures of output per man-hour for the gray iron foundries industry. The indexes for this industry begin with 1954 since annual data on man-hours were not available earlier; in addition, product detail for earlier years was not strictly comparable with later years. The report includes some analysis of trends in output per man-hour and related series, as well as a description of technological developments that have occurred in the industry. It also contains a detailed technical note which describes the data sources and statistical techniques utilized.

Coverage of Report

The gray iron foundries industry includes establishments that primarily manufacture gray iron castings, including cast iron pressure pipe, soil pipe, and pipe fittings. This industry is designated Industry 3321 in the 1967 Standard Industrial Classification Manual (SIC).

Two types of establishments make up the industry: (1) Commercial (jobbing) foundries; and (2) captive foundries operated as separate establishments. These two groups account for about two-thirds of the tonnage of gray iron castings made each year. The remaining production of gray iron castings represents either secondary products of establishments classified in other industries or intermediate products of captive foundries that are integrated operations of other manufacturing plants. These integrated captive foundries produce about 25 percent of the annual output of gray iron castings. Integrated captive foundries and the establishments which produce gray iron castings as secondary products are not included in this report because they are not included in the Standard Industrial Classification definition. In addition, separate employment and man-hour data directly related to the production of gray iron castings in these other establishments are not available.

General Characteristics

Over 1,100 establishments were operating in the gray iron foundries industry in 1963. (See table 1.) Most were of intermediate size—the 255 establishments whose employment ranged from 100 to 1,000 accounted for more than half of industry employment and value added. Only 14 establishments had more than 1,000 employees; this group, however, represented more than a fourth of industry employment and value added. Since 1958, establishment size has grown—the average number of employees per establishment was 106 in 1963, 86 in 1958.

Employment in gray iron foundries totaled 140,709 in 1966 and makes up a major part of employment in all iron and steel foundries—nearly 60 percent in 1966. Production worker employment in gray iron foundries has been consistently high as a percentage of total employment, ranging between 85 and 90 percent throughout the period. (The ratio for all manufacturing was 76 percent in 1966; for primary metals, it was 82 percent.)

The industry's total shipments climbed to $2.7 billion in 1966 from less than $1.5 billion in 1958. Part of this growth reflects price increases. About two-fifths of the value of shipments represents the cost of materials; the other three-fifths is value added. In turn, wages and salaries make up about three-fifths of value added.

Forty-five States had establishments classified in the gray iron foundries industry in 1963, but most of the employees worked in gray iron foundries located east of the Mississippi River. Michigan and Ohio together had about 33 percent of the employment and 39 percent of the value added in 1963. These States together with Illinois, Indiana, and Wisconsin accounted for over half of the industry's employment and value added.

Table 1. Gray Iron Foundries Industry: General Characteristics, Selected Years, 1954–66

Item	Unit	1954	1958	1963	1964	1965	1966
Establishments	Number	1,414	1,310	1,139	(1)	(1)	(1)
Total employment	--do--	133,914	112,670	120,528	126,329	134,894	140,709
Employees per establishment	--do--	95	86	106	(1)	(1)	(1)
Production worker employment	--do--	118,288	96,414	104,239	109,828	117,109	122,142
Production workers per establishment	--do--	84	74	92	(1)	(1)	(1)
Ratio of production workers to all employees	Percent	88.3	85.6	86.5	86.9	86.8	86.8
Nonproduction worker employment	Number	15,626	16,256	16,289	16,501	17,785	18,567
Capital expenditures (new)	$ Millions	49.9	32.6	64.8	75.9	171.5	221.3
Capital expenditures per employee	Dollars	373	289	538	601	1,271	1,573
Value of shipments [2]	$ Millions	1,442	1,435	1,985	2,286	2,603	2,728
Cost of materials (including electricity)	--do--	593	623	814	954	1,058	1,097
Value added by manufacture	--do--	847	811	1,168	1,354	1,559	1,646
Wages and salaries	--do--	558	531	730	825	922	978
Wages	--do--	459	419	596	680	760	803

[1] Not available.
[2] Includes resales and other miscellaneous receipts.

SOURCE: Bureau of the Census, U.S. Department of Commerce.

Trends in Output Per Man-Hour, 1954—66

Output per man-hour of all employees in the gray iron foundries industry grew 32 percent between 1954 and 1966—increasing at an average rate of 2.2 percent a year. (See chart 1 and appendix C.)[1] Over the same period, output per man-hour in all manufacturing went up at an average rate of 3.1 percent.

Productivity in gray iron foundries grew unevenly between 1954 and 1966. The largest annual change was an increase of 7.8 percent in 1955, which marked the industry's recovery from the 1954 recession. Year-to-year increases ranged from 2.1 to 5.6 percent in most subsequent years while there were small decreases in 4 years—only one decline (2.8 percent in 1957) was of significant size.

Gray iron foundries output rose an average of 2.4 percent a year over the same period. The year-to-year changes in gray iron foundries output ranged from a 17-percent decrease to a 23-percent increase.

The slow overall growth in output was matched with a comparable modest growth in output per man-hour resulting in a slight increase in man-hours—about 0.1 percent a year during the 1954-66 period.

The gray iron foundries' experience differed sharply between the first and second halves of the period. Between 1954 and 1961, output declined at an annual rate of 2.4 percent despite a substantial gain between 1954 and 1955. The annual rate of gain in output per man-hour was only 1.4 percent. In 1955, output rose 23 percent from the recession level of 1954, only to drop by 1958 to 13 percent below the level of 1954. Output increased 23 percent again in 1959; subsequent decreases were substantial but less severe than those of previous years. Total man-hours also declined during 1954-61, averaging 3.7 percent a year. Sharp declines between 1956 and 1958 and in 1960 and 1961 more than offset increases in 1955 and 1959.

The decline in the industry's output during the 1955-61 period was, for the most part, related to the general business cycle. From 1955 to 1958, the period in which the most severe drop in output occurred, the output of four major gray iron consuming industries—machinery, construction, steel, and automobiles—fell substantially. For example, the number of passenger cars produced in 1958 was 47 percent below the 1955 level. The decline in the output of these industries no doubt affected the production of gray iron castings. The decrease in residential construction in 1960 contributed to the decrease in the output of gray iron castings during that year, while downturns in steel, autos, residential and nonresidential construction, and machinery in 1961 helped to continue the decline in the production of gray iron castings. Relatively low capital expenditures were also a factor contributing to the low productivity gain. Capital expenditures per gray iron foundry employee were less than the average per manufacturing employee in every year from 1954 to 1961.

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[1] Average annual rates in this report are based on the least squares trend line fitted to logarithms of the index numbers.

In sharp contrast to the earlier half of the period, gray iron foundries output increased at an average annual rate of 10.3 percent between 1961 and 1966. At the same time, output per man-hour rose at an average annual rate of 3.4 percent—more than twice the earlier rate. Man-hours went up at the rate of 6.7 percent. The increase in gray iron output reflects the extended economic boom, particularly in producers' durable equipment. Output for this component of Gross National Product increased considerably faster than for the economy as a whole. The four major gray iron consuming industries mentioned previously all enjoyed large increases in output. (The number of passenger cars produced increased 56 percent from 1961 to 1966.)

Other factors associated with the growth in output and productivity in gray iron foundries were quality improvements and increased attention to the specific needs of the customers. In addition, more resources were allocated to research, market development, advertising, and promotion. Capital expenditures per employee more than tripled between 1961 and 1966 and surpassed the manufacturing average for the first time in 1965. Because of the usual lag between capital expenditures and resultant productivity increases, this rapid increase in expenditures may lead to further gains in productivity. The trend toward fewer but larger and more mechanized foundries undoubtedly has had a positive effect on productivity.

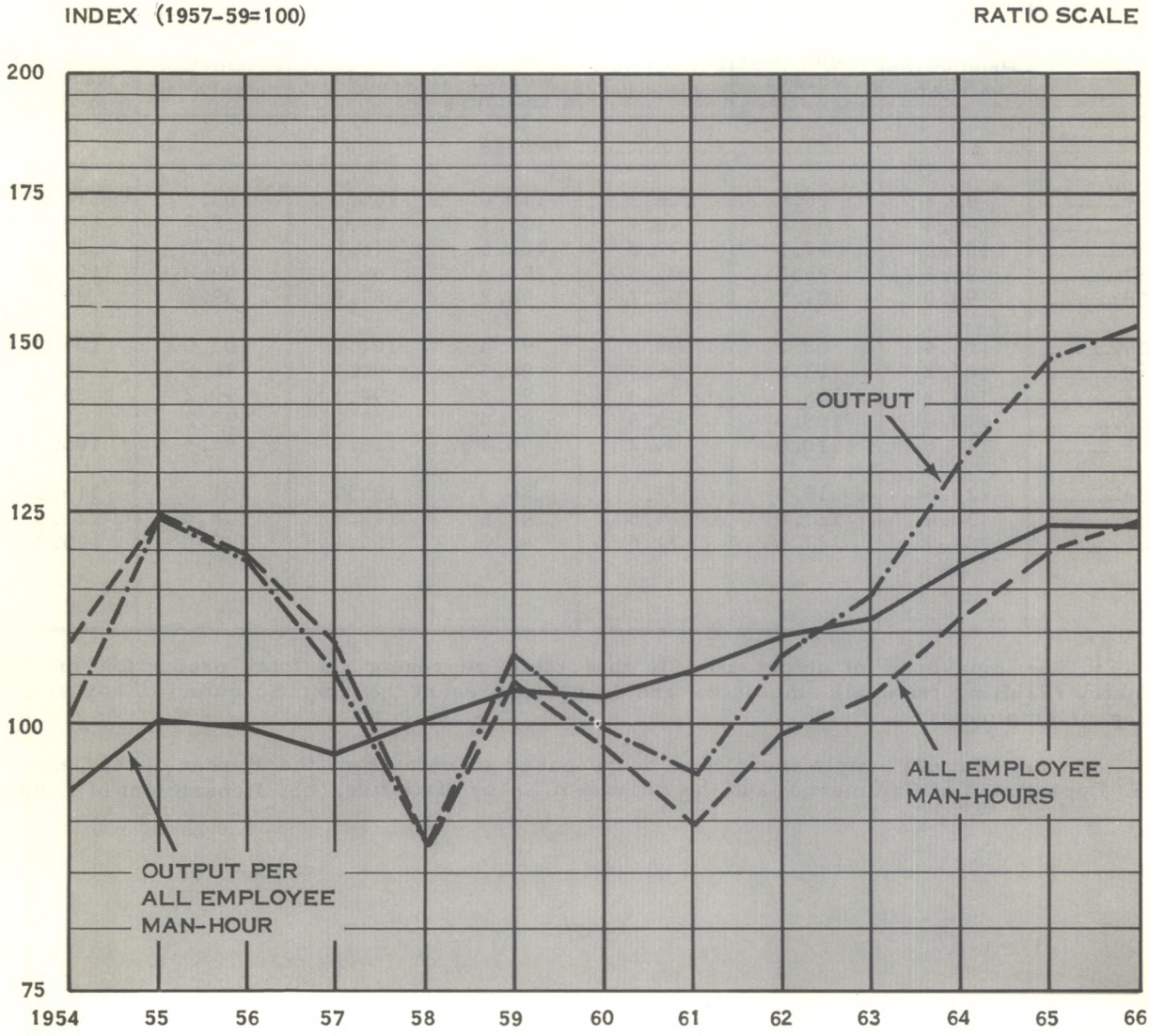
Table 2. Gray Iron Foundries Industry: Output Per Man-Hour, Unit Labor Requirements, and Related Data, All Employees, 1954–66

(Indexes 1957–59 = 100)

Year	Output per—		Unit labor requirements in terms of—		Related data		
	All employee	All employee man-hour	All employees	All employee man-hours	Output	All employees	All employee man-hours
	Indexes						
1954	94.0	92.8	106.3	107.7	100.9	107.3	108.7
1955	107.2	100.1	93.3	99.9	124.2	115.9	124.1
1956	103.8	99.4	96.4	100.6	118.6	114.3	119.3
1957	96.4	96.6	103.7	103.5	105.1	109.0	108.8
1958	96.9	100.1	103.2	99.9	87.4	90.2	87.3
1959	106.6	103.4	93.8	96.7	107.5	100.8	104.0
1960	102.5	102.8	97.6	97.3	99.7	97.3	97.0
1961	103.7	105.4	96.4	94.9	94.5	91.1	89.7
1962	112.7	109.5	88.8	91.4	107.6	95.5	98.3
1963	118.8	111.8	84.2	89.4	114.6	96.5	102.5
1964	130.1	118.0	76.8	84.7	131.7	101.2	111.6
1965	136.6	123.0	73.2	81.3	147.5	108.0	119.9
1966	134.4	122.9	74.4	81.4	151.5	112.7	123.3

Source: Output, employment, and hours based on data from the Bureau of the Census, U.S. Department of Commerce; and the Bureau of Labor Statistics, U.S. Department of Labor.

Chart 1. Gray Iron Foundries Industry: Output Per All Employee Man-Hour, Output, and All Employee Man-Hours, 1954-66



Note: The measures of output used in this chart represent the total production of the industry resulting from all employees and do not represent the specific output of any single group of employees.

Table 3. Gray Iron Foundries Industry: Output Per Man-Hour, Unit Labor Requirements, and Related Data, Production Workers, 1954–66

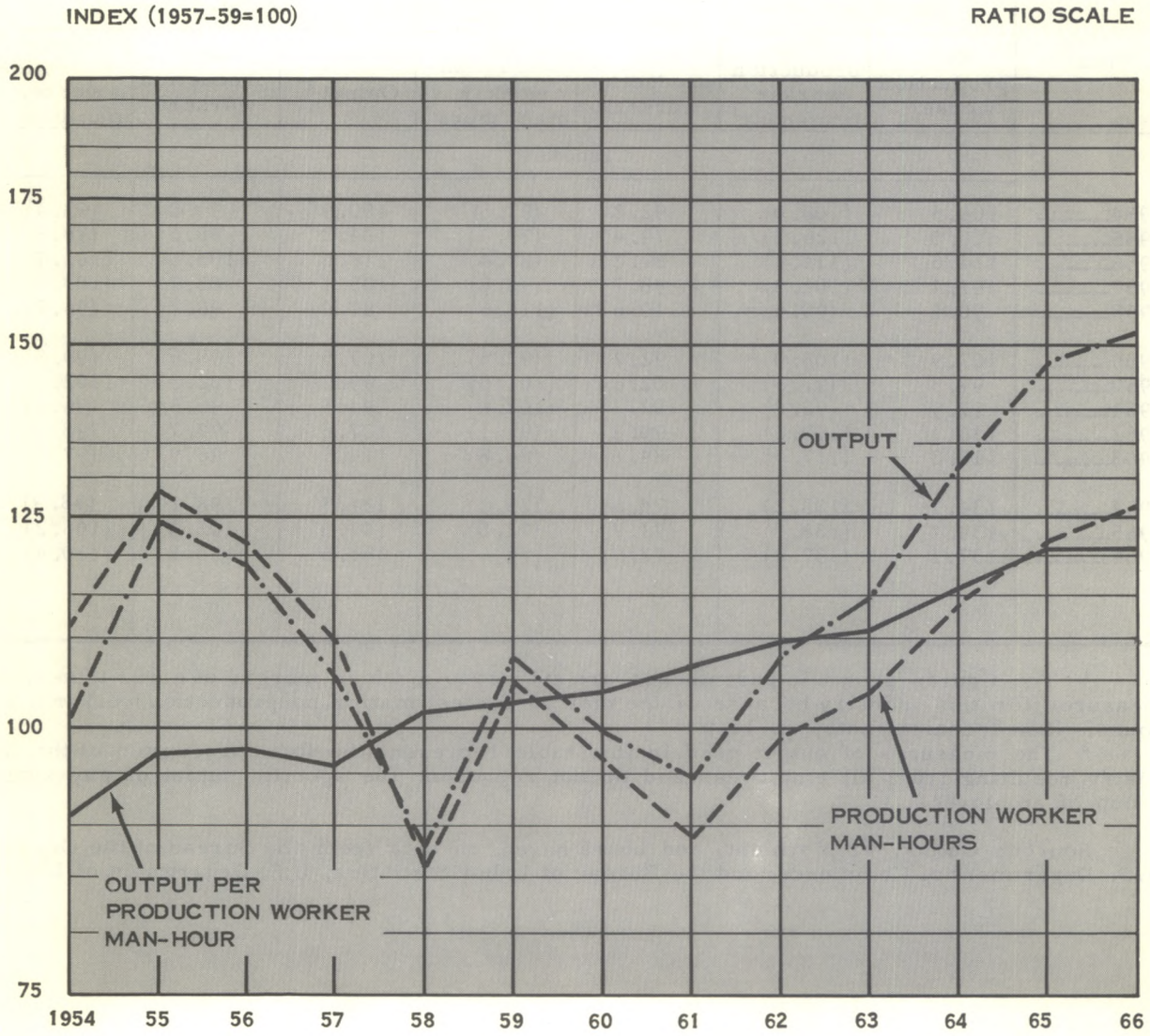
(Indexes 1957–59 = 100)

Year	Output per—		Unit labor requirements in terms of—		Related data		
	Production worker	Production worker man-hour	Production workers	Production worker man-hours	Output [1]	Production workers	Production worker man-hours
	Indexes						
1954	92.1	90.9	108.5	110.0	100.9	109.5	111.0
1955	104.8	97.0	95.4	103.1	124.2	118.5	128.0
1956	102.2	97.5	97.8	102.6	118.6	116.0	121.7
1957	95.7	96.0	104.5	104.2	105.1	109.8	109.5
1958	98.0	101.9	102.1	98.2	87.4	89.2	85.8
1959	106.4	102.7	94.0	97.4	107.5	101.0	104.7
1960	103.2	103.6	96.9	96.5	99.7	96.6	96.2
1961	104.8	106.7	95.4	93.8	94.5	90.2	88.6
1962	113.0	109.3	88.5	91.4	107.6	95.2	98.4
1963	118.8	110.9	84.2	90.1	114.6	96.5	103.3
1964	129.6	115.9	77.1	86.3	131.7	101.6	113.6
1965	136.1	121.0	73.5	82.6	147.5	108.4	121.9
1966	134.1	121.0	74.6	82.6	151.5	113.0	125.2

[1] The measures of output used in this table represent the total production of the industry resulting from all employees and do not represent the specific output of any single group of employees.

Source: Output, employment, and hours based on data from the Bureau of the Census, U.S. Department of Commerce; and the Bureau of Labor Statistics, U.S. Department of Labor.

Chart 2. Gray Iron Foundries Industry: Output Per Production Worker Man-Hour, Output, and Production Worker Man-Hours, 1954-66



Note: The measures of output used in this chart represent the total production of the industry resulting from all employees and do not represent the specific output of any single group of employees.

Table 4. Gray Iron Foundries Industry: Output Per Man-Hour, Unit Labor Requirements, and Related Data, Nonproduction Workers, 1954–66

(Indexes 1957–59 = 100)

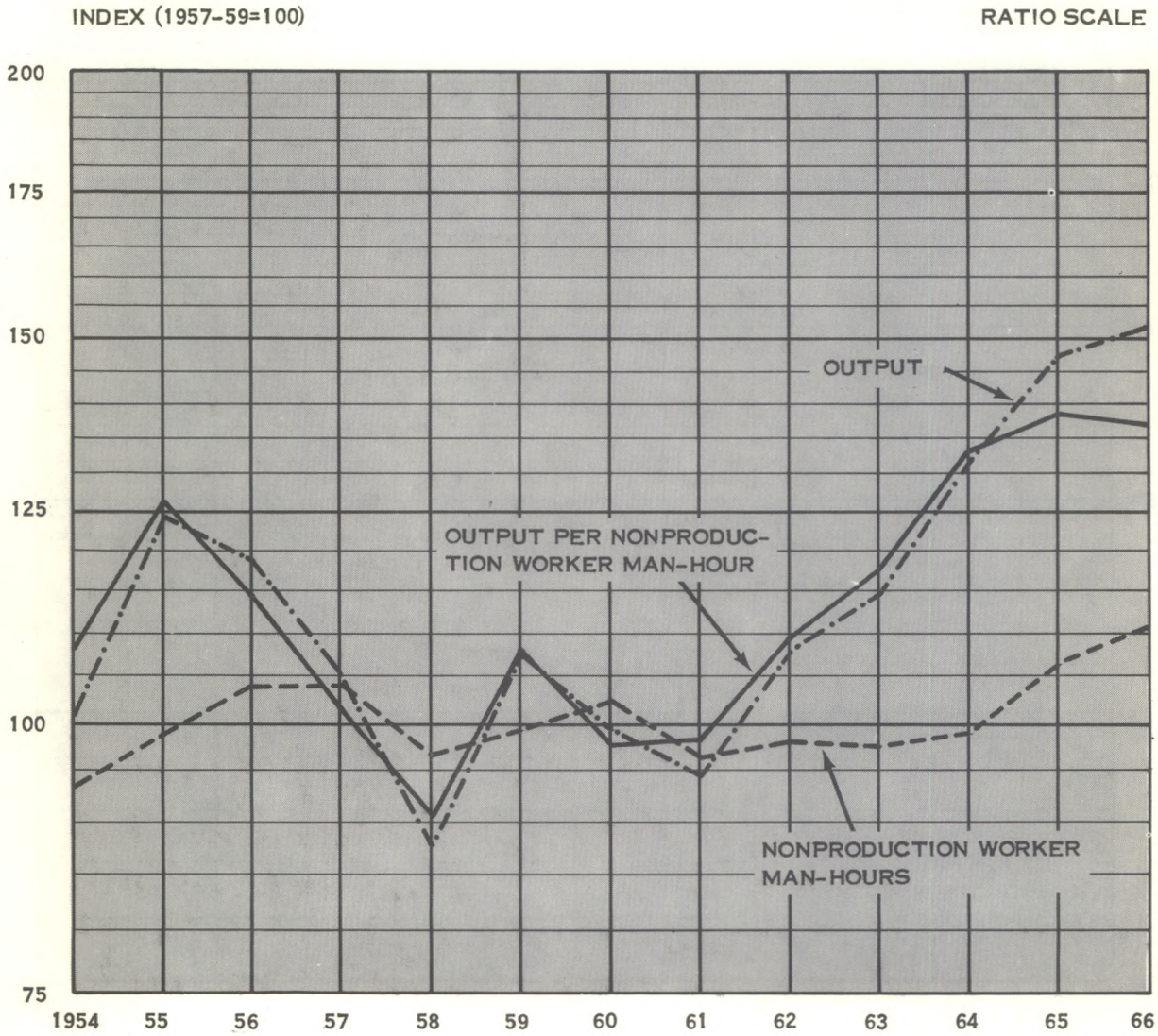
Year	Output per—		Unit labor requirements in terms of—		Related data		
	Nonproduction worker	Nonproduction worker man-hour[1]	Nonproduction workers	Nonproduction worker man-hours[1]	Output[2]	Nonproduction workers	Nonproduction worker man-hours[1]
	Indexes						
1954	108.5	(108.0)	92.2	(92.6)	100.9	93.0	(93.4)
1955	126.0	(126.1)	79.4	(79.3)	124.2	98.6	(98.5)
1956	114.6	(114.4)	87.3	(87.4)	118.6	103.5	(103.7)
1957	101.4	(101.3)	98.7	(98.8)	105.1	103.7	(103.8)
1958	90.4	(90.4)	110.6	(110.6)	87.4	96.7	(96.7)
1959	107.9	(108.0)	92.7	(92.6)	107.5	99.6	(99.5)
1960	97.5	(97.5)	102.6	(102.6)	99.7	102.3	(102.3)
1961	97.9	(98.0)	102.1	(102.0)	94.5	96.5	(96.4)
1962	110.1	(109.8)	90.8	(91.1)	107.6	97.7	(98.0)
1963	118.3	(117.9)	84.6	(84.8)	114.6	96.9	(97.2)
1964	134.1	(133.2)	74.6	(75.1)	131.7	98.2	(98.9)
1965	139.4	(138.9)	71.7	(72.0)	147.5	105.8	(106.2)
1966	137.1	(137.2)	72.9	(72.9)	151.5	110.5	(110.4)

[1] The figures shown in parentheses are subject to a wider margin of error than other measures for this industry because of the method for estimating nonproduction worker man-hours. (See technical note, p. 14.)

[2] The measures of output used in this table represent the total production of the industry resulting from all employees and do not represent the specific output of any single group of employees.

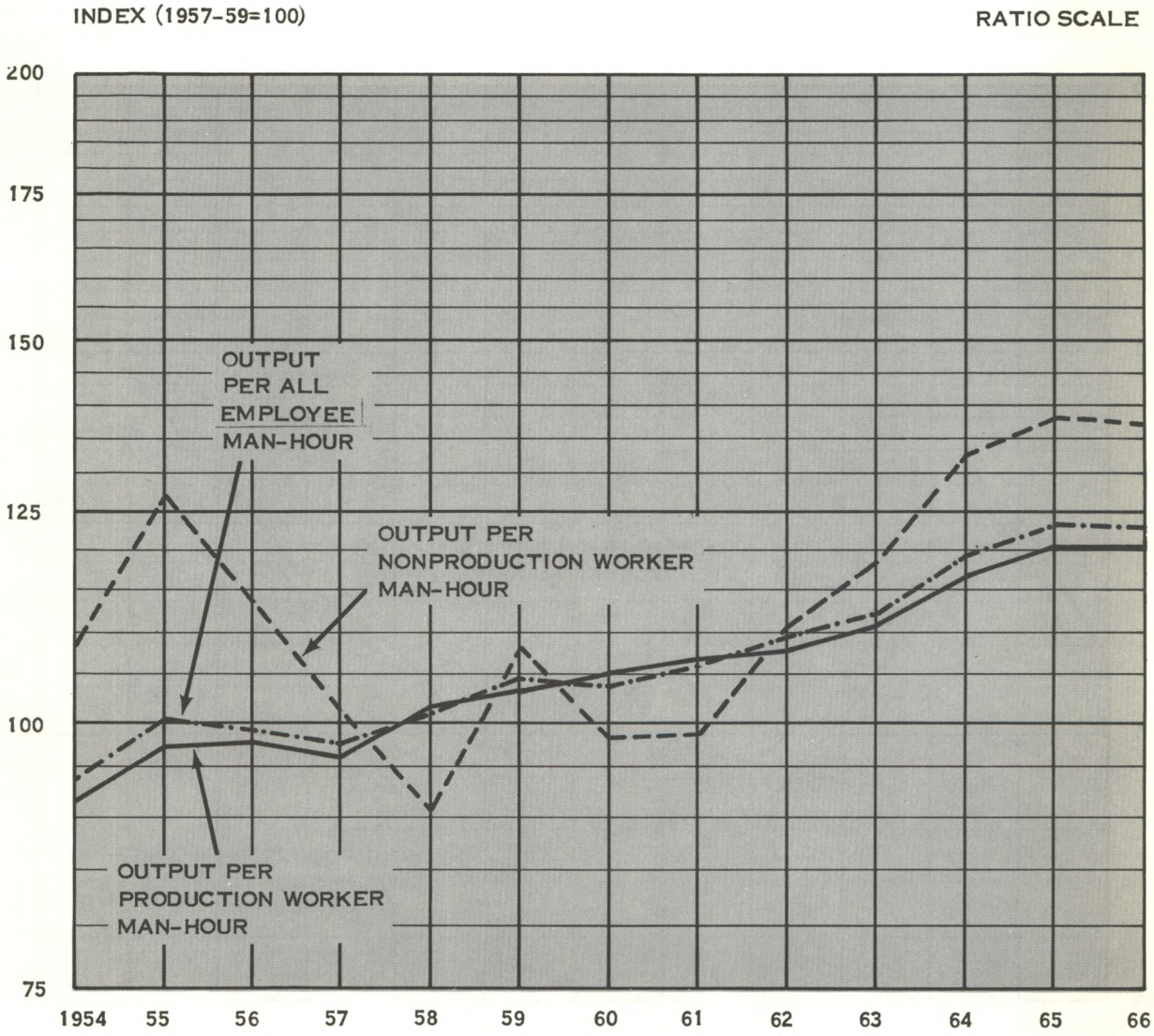
Source: Output, employment, and hours based on data from the Bureau of the Census, U.S. Department of Commerce; and the Bureau of Labor Statistics, U.S. Department of Labor.

Chart 3. Gray Iron Foundries Industry: Output Per Nonproduction Worker Man-Hour, Output, and Nonproduction Worker Man-Hours, 1954-66



Note: The measures of output used in this chart represent the total production of the industry resulting from all employees and do not represent the specific output of any single group of employees.

Chart 4. Gray Iron Foundries Industry: Output Per Man-Hour for All Employees, Production Workers, and Nonproduction Workers, 1954-66



Technological Developments[2]

Although changes in output greatly influence short-run productivity movements, long-term trends are affected by additional, interrelated factors—technology, capital investment, research and development, skill and effort of the work force, managerial ability, and labor-management relations. Changes in technology are especially important, although their precise impact cannot be measured.

Automation in gray iron foundries reduced labor requirements in materials handling and other key foundry operations over the period covered by this report. However, diffusion of technology was retarded to some degree by the relatively large number of small plants in the industry and the substantial volume of production in small lots.

Materials Handling

Mechanization of materials handling, involving increased use of cranes, hoists, lift trucks, loaders, and conveyors was a major factor in the reduction of industry man-hour requirements. Of particular importance was the extension of conveyorization from high volume production foundries to smaller, jobbing foundries for functions such as sand delivery, mold handling, shakeout, and casting finishing. The availability of low-cost modular conveyor systems facilitated this extension of conveyorization.

Molding and Coremaking

Improved molding machines reduced unit labor requirements in this operation which engages about one-fifth of all production workers. Faster mold cycles, more machine-controlled functions, and larger flasks characterize this new equipment. One new machine, for example, accommodates four patterns per flask instead of two but does not require additional operators. Moreover, automatic molding equipment suited to high volume production in smaller foundries was installed on a limited basis. Newer coremaking equipment introduced featured rapid operating cycles, simultaneous production of several cores, and adaptability to improved coremaking materials.

A gradual increase in the use of the shell, carbon dioxide, and other specialized molding and coremaking processes also improved efficiency and casting quality. Their greatest application was in coremaking where they greatly reduced or eliminated the time and labor consuming baking operation. These new processes lend themselves to mechanization and were introduced most widely in high volume production.

Metal Melting

Cupolas continued to undergo improvement and remained the principal melting units in the industry. However, electric melting, which affords closer control and permits greater utilization of scrap metal, came into increased use. Enactment of air pollution control laws was another factor which encouraged a shift to electric melting. Generally greater purchase and operating costs of electric furnaces, on the other hand, retarded their introduction in some foundries.

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[2] See appendix A, p. 20, for a discussion of foundry operations and appendix B, p. 21, for a glossary of terms.

Instrumentation

Increased emphasis on product quality and operating efficiency resulted in more instrumentation for measurement and control. Radiographic (X-ray), supersonic, pyrometer, and radioisotope units were introduced more widely in melting, sand preparation, inspection, and other major operations. Computers were installed in several larger foundries for accounting and production control.

Cleaning of Castings

Technological advances have been introduced in the labor intensive operation of cleaning castings—a bottleneck in foundry operations—and have reduced unit labor requirements. A significant number of higher speed grinding wheels have been put into service in foundries of all sizes. However, the application of continuous blast cleaning to replace batch methods has been limited to high volume production foundries.

Metallurgy

Advances in metallurgy strengthened the industry's competitive position relative to other types of metal forming. Most important has been the development of nodular (ductile) iron which accounted for about 5 percent of total gray iron shipments in 1966. Nodular iron possesses many properties of steel, including high strength and ductility, that enables many metal parts to be cast instead of forged, stamped or welded. Automobile crankshafts, for example, now can be cast instead of forged.

Technical Note

Output Per Man-Hour Indexes

The indexes of output per man-hour presented in this report have been developed according to procedures followed by the Bureau of Labor Statistics[3] for measuring change in the relation between industry output and the man-hours expended on that output.

For an industry producing a single uniform product or performing a single uniform service, the indexes simply measure the change over time in the ratio: Units produced/man-hours. For an industry producing a number of products, the indexes represent the change over time in the ratio: Weighted output (of a specified composite of products)/man-hours. The simplest procedure for developing an index of output per man-hour is to divide the output index by a man-hour index. The indexes have been constructed for this industry beginning in 1954, since annual data for man-hours were not available earlier; in addition, product detail for earlier years was not strictly comparable with later years.

Output Index

For constructing indexes of output per man-hour, the ideal output index weights (multiplies) the quantities of all products produced in the industry by the man-hours required to make one unit of each product in a specified year. Thus, those products which require more labor time are given more importance. Although unit man-hour weights are preferable for combining product data, they are

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[3] For a more detailed description of the general concepts and procedures, see Chapter 23, "Output Per Man-Hour Measures: Industries," BLS Handbook of Methods for Surveys and Studies, Bulletin 1458, October 1966.

frequently not available. Therefore, it is often necessary to substitute weights believed proportional to unit man-hour weights—usually unit value weights. Both unit man-hour weights and unit value weights were used at different stages in constructing the output index for gray iron foundries.

The output indexes rely heavily on comprehensive data collected for the Census of Manufactures for 1954, 1958, and 1963. Indexes were computed from the detailed quantity and value data for 1954-58 and 1958-63 and are referred to as benchmark indexes. Annual indexes for intercensal years are based on less detailed information and are adjusted to the benchmark levels.

The 1954-58 and 1958-63 benchmark indexes were constructed in the following manner:

1. Physical quantity of shipments indexes were computed for each of the primary product classes in this industry.

SIC 33211	Molds and stools for heavy steel ingots
SIC 33212	Cast iron pressure pipe and fittings
SIC 33213	Cast iron soil pipe and fittings
SIC 33214	All other gray iron castings

For each product class, the quantities of individual products (SIC 7-digit level) were weighted with 1958 unit values to obtain the physical quantity indexes. These indexes reflect shipments of castings from the gray iron foundries industry and also castings shipped as secondary products from other industries. (The quantities and values of gray iron castings made by completely integrated captive foundries of plants classified in other industries are excluded.) Because the gray iron foundries industry accounts for about 88 percent of the total value of these primary product shipments, it was assumed that these product (wherever made) indexes were representative of shipments of primary products in the industry.

2. The physical quantity indexes for SIC 5-digit primary product classes were combined with appropriate 1958 man-hour weights for all employees to obtain an output index of the industry's primary products. Man-hour weights for 1958 were used for both 1954-58 and 1958-63 benchmarks because man-hour estimates for 1954 were not available at the 5-digit product level. These man-hour weights were developed as follows:

(a) Total man-hours for plants specializing in each 5-digit product class were derived from data on production worker man-hours and nonproduction worker employment reported in the Census of Manufactures and from data on average hours for nonproduction worker man-hours estimated in this study.

(b) Ratios of man-hours to value of shipments were computed for each class of specialized plants.

(c) The ratios were multiplied by the corresponding value of primary products shipped by the whole industry to obtain the man-hour weights. (This procedure assumes that man-hours per dollar for each product class shipped by the whole industry are the same as those for plants specializing in that product class.)

3. The index of primary products of the industry is finally multiplied by a "coverage" adjustment to represent the total output of the industry. This "coverage" adjustment is the ratio of the index of value of industry shipments (after exclusion of resales and inclusion of net additions to inventories) to the index of value of shipments of primary products. The final industry output index thus reflects inventory buildups and changing proportions of secondary products. The latter effect tends to be minimal since secondary products represent only about 5 to 7 percent of total shipments.

Annual production indexes for intercensal years were constructed from deflated values. Although estimates of physical quantity are available, they either understate or overstate industry output. The shipments data reported in Current Industrial Reports published by the Bureau of the Census and Bureau of Mines include captive foundry operations which are integrated completely with the operations of establishments classified in other industries so they overstate industry production. The data on "shipments for sale" exclude interplant transfers, and understate industry shipments.

For 1958 and the years following, the value of shipments of each primary product class (wherever made) was deflated by the appropriate Wholesale Price Index (tables 5 and 6). Indexes of these deflated values were combined into a wherever made product index by weighting them with man-hour weights. Man-hour weights for 1958 were used from 1958 to 1963, while 1963 man-hour weights were used after 1963. The indexes were linked in 1963 to maintain a continuous series.

In each year a special coverage ratio (total value of industry shipments/ total value of primary products wherever made) was used to adjust the wherever made index to an industry index. This industry index was adjusted to reflect changes in inventories by the ratio: Total value of industry production to total value of industry shipments. The result was the estimated industry index of production.

For the 1954-58 period, value data were not available annually for the separate primary product classes so the total value of shipments was deflated by an appropriate price index. The Wholesale Price Indexes for the 5-digit primary products were weighted with corresponding 1958 primary product shipments (wherever made) to obtain a primary product price index. This price index was used to deflate the total value of the primary products (wherever made). The index of deflated value was adjusted to an industry basis by the special coverage ratio described earlier. This index was adjusted for changes in inventories to obtain the annual production index.

The annual indexes for the two periods were adjusted to the indexes for the benchmark years by linear interpolation. The adjustment factors were small; between 1954 and 1963, the cumulative adjustment was 1 percent.

Table 5. Gray Iron Foundries Industry: Wholesale Price Index and Product Descriptions

WPI Code	WPI Description
10-15-01-11	Standard ingot mold, 7,000 pounds and over.
10-15-01-26	Pressure pipe, cast iron, 6 inches to 24 inches inclusive, 18-foot lengths (conforming to Federal specifications W. W-P-421 class 150 or class 250 or American Water Work Association, Class B specification).
10-15-01-31	Soil pipe, cast iron, 4 inches, single hub, extra heavy weight, averaging 60 pounds per 5-foot length.
10-15-01-32	Soil pipe, cast iron, 4 inches, single hub, service weight, averaging 40 pounds per 5-foot length.
10-15-01-01	Gray iron castings. (Other than ingot molds, cast iron pressure pipe and cast iron soil pipe.)

Table 6. Gray Iron Foundries Industry: Product Groups and Weights

SIC code	SIC title-product description	WPI code	Man-hour weights (percent of total)		Value weights (percent of product class)	
			1963	1958	1963	1958
3321	Gray iron foundries industry		100.0	100.0		
33211	Molds and stools for heavy steel ingots	10-15-01-11	2.4	3.2	100.0	100.0
33212--	Cast iron pressure pipe and fittings	10_15-01-26	9.1	9.7	100.0	100.0
--21	6 inches and under (inside diameter)				34.8	
--23	Over 6 inches to 8 inches inclusive (inside diameter)				23.8	84.5
--25	Over 8 inches to under 14 inches (inside diameter)				24.4	
--31	14 inches to 24 inches inclusive (inside diameter)					13.4
--51	Over 24 inches (inside diameter)				17.0	2.1
33213--	Cast iron soil pipe and fittings, including special fittings	10-15-01-31, 32	8.9	10.4	100.0	100.0
--21	Up to 3 inches (inside diameter)				27.8	
--31	Over 3 inches to under 5 inches (inside diameter)				55.2	100.0
--41	5 inches and over (inside diameter)				16.9	
33214--	All other gray iron castings	10-15-01-01	79.6	76.7	100.0	100.0
--31	Rolls for rolling mills				4.3	3.8
--98	All other gray iron castings				95.7	96.2

Employment and Man-Hour Indexes

Employment and man-hour indexes measure change in these categories over a period of time. Employees and employee man-hours are treated as homogeneous and additive. Thus, the indexes do not reflect changes in qualitative aspects of employment such as skill, efficiency, health, experience, age, and sex of persons constituting the aggregate. The man-hour data relate to total time expended by employees in establishments classified in the industry. These data include hours spent not only on production of primary products but also on secondary products and miscellaneous production.

Six labor input indexes have been developed for the gray iron foundries industry: All employees, production workers, nonproduction workers, all employee man-hours, production worker man-hours, and nonproduction worker man-hours.

"Production workers" cover working foremen and all nonsupervisory workers (including leadmen and trainees) engaged in fabricating, processing, assembling, inspecting, receiving, storage, handling, packing, warehousing, shipping, maintenance, repair, janitorial and watchman services, product development, auxiliary production for plant's own use (e.g., powerplant operations), recordkeeping, and other services closely associated with production activities. The term thus includes some indirect as well as direct plant labor.

"Nonproduction workers" include employees engaged in the following activities: Executive, purchasing, finance, accounting, legal, personnel, cafeteria, medical, professional and technical, sales, sales delivery, advertising, credit, collection, installation and servicing of own products, routine office functions, factory supervision (above the working foreman level); and force account construction employees on the payroll engaged in construction of major additions or alterations to the plant who are utilized as a separate work force.

"All employees" represent the sum of production workers and nonproduction workers.

Employment and Production Worker Man-Hours. The indexes of total employment, production workers, production worker man-hours, and nonproduction workers were based on data published by the Bureau of the Census. Data for 1954, 1958, and 1963 were obtained from the Census of Manufactures, and data for the remaining years from the Annual Survey of Manufactures.[4] Production worker man-hours include all the hours at the plant, worked or paid for, and exclude paid time for vacations, holidays, and sick leave. Overtime and other premium pay hours are included on the basis of actual time at the plant.

All Employee Man-Hours. The index of all employee man-hours for this industry is derived from three components: (1) production worker man-hours (from Census data); (2) number of nonproduction workers (from Census data); and (3) an estimate of average annual hours at work for nonproduction workers (prepared by the Bureau of Labor Statistics for this report and derived primarily from Department of Labor studies).

Average annual hours for nonproduction workers were derived by multiplying estimated scheduled weekly hours by the number of weeks in the year. Time away from the job, as represented by various types of leave, was subtracted from total annual hours to obtain annual hours at work.

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[4] Employees in central administrative offices and auxiliaries of gray iron foundries companies are not included.

Scheduled weekly hours for nonproduction workers were estimated from unpublished data collected in BLS surveys of employer expenditures for selected supplementary remunerative practices. These were available for SIC Group 33, Primary Metals Industries, of which the gray iron foundries industry is a part.

The average annual hours worked by nonproduction workers in this industry for selected years were estimated as follows:

Year	Average hours
1954	1,884
1958	1,876
1963	1,882
1966	1,874

These estimates were multiplied by the number of nonproduction workers to obtain the man-hour indexes for nonproduction workers shown in table 4. Since employment trends for nonproduction workers largely determine their man-hour trends, any reasonable alternative estimates of paid time off would result in only minor differences in the nonproduction worker man-hour indexes and in no significant changes in the all employee man-hour indexes.

Appendix A. Foundry Operations

Founding or casting is the process of forming metal objects by pouring molten metal into a mold and allowing it to solidify. The shape of the object is determined by the shape of the cavity in the mold. The most common method of casting makes use of molds constructed of sand. Molding sand mixed with a binding material, generally a type of clay, is compressed around a pattern or model of the object to be cast which has been placed in a flask or frame for containing the sand. The pattern then is withdrawn leaving a cavity in the sand into which molten metal from a furnace is poured and allowed to solidify. If the casting is to be hollow or to contain passages, baked sand forms, called cores, in the shape of the desired hole or cavity are placed in the mold before the metal is poured. When the casting has hardened, it is shaken free of the mold and core sand and put through any necessary cleaning and finishing operations.

Appendix B. Glossary of Terms

Baking. The development of desired properties in a core through the action of heat on its binder.

Binder. A material which serves to hold molding or core sand grains together.

CO_2 Process. A specialized molding and coremaking method employing a binder of sodium silicate which is "set" by passing carbon dioxide gas into the mold or core.

Cleaning and Finishing. The removal of excess metal and remaining mold material from a casting. The casting may be buffed or polished to improve its finish or appearance.

Core. A body of sand placed inside a mold to form an interior opening in or a hole through a casting.

Cupola. A fuel-fired furnace for melting iron.

Flask. A frame or box of wood or metal for containing a sand mold.

Gray Iron. The most widely used cast iron. So called from the appearance of its fractured surface.

High Production Foundry. Characterized by relatively long production runs of a limited number of cast shapes. Highly mechanized.

Jobbing Foundry. Characterized by relatively small lot production. Less mechanized, as a group, than high production foundries.

Mold. A body of sand or other heat resistant material containing a cavity into which molten metal is poured to obtain a casting.

Mold Cycle. The series of steps completed in the production of a mold.

Nodular Iron. A specially treated iron possessing ductility and having greater strength than gray iron.

Pattern. A form, usually of wood or metal, used to shape the mold cavity into which a casting is formed.

Shakeout. The removal of mold and core materials from a casting after it has solidified.

Shell Process. A specialized coremaking and molding method employing a heated metal pattern and a thermosetting plastic binder. Well suited for high production work.

Appendix C. Average Annual Rates of Change (Percent)[1]

(To obtain annual rates of change between any 2 years shown, find row for initial year at left of table and read figure in that row under the terminal year shown on top)

Initial year	Terminal year											
	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
	Output per all employee man-hour											
1954	7.8	3.5	1.1	1.2	1.5	1.4	1.4	1.6	1.7	2.0	2.2	2.2
1955	-	-.7	-1.8	-.3	.7	.8	1.0	1.4	1.6	1.9	2.2	2.2
1956	-	-	-2.8	.4	1.5	1.4	1.5	1.8	1.9	2.2	2.5	2.5
1957	-	-	-	3.6	3.4	2.2	2.0	2.2	2.3	2.6	2.8	2.8
1958	-	-	-	-	3.2	1.3	1.5	2.0	2.2	2.6	2.9	2.8
1959	-	-	-	-	-	-.6	1.0	2.0	2.2	2.8	3.1	3.0
1960	-	-	-	-	-	-	2.5	3.2	2.9	3.4	3.7	3.3
1961	-	-	-	-	-	-	-	3.9	3.0	3.7	3.9	3.4
1962	-	-	-	-	-	-	-	-	2.1	3.8	4.1	3.3
1963	-	-	-	-	-	-	-	-	-	5.6	4.9	3.3
1964	-	-	-	-	-	-	-	-	-	-	4.2	2.0
1965	-	-	-	-	-	-	-	-	-	-	-	-.1
	Output											
1954	23.1	8.4	0.8	-4.4	-2.4	-2.2	-2.4	-1.5	-0.6	0.6	1.7	2.4
1955	-	-4.5	-8.0	-11.1	-5.8	-4.4	-4.0	-2.5	-1.2	.3	1.7	2.5
1956	-	-	-11.4	-14.2	-4.7	-3.2	-3.1	-1.3	0	1.6	3.0	3.7
1957	-	-	-	-16.8	1.1	.5	-.8	.8	2.0	3.5	4.8	5.3
1958	-	-	-	-	23.0	6.8	1.6	2.9	3.8	5.3	6.4	6.7
1959	-	-	-	-	-	-7.3	-6.2	-.5	2.1	4.6	6.3	6.7
1960	-	-	-	-	-	-	-5.2	3.9	5.6	7.8	9.0	8.7
1961	-	-	-	-	-	-	-	13.9	10.1	11.2	11.5	10.3
1962	-	-	-	-	-	-	-	-	6.5	10.6	11.5	9.8
1963	-	-	-	-	-	-	-	-	-	14.9	13.4	10.0
1964	-	-	-	-	-	-	-	-	-	-	12.0	7.3
1965	-	-	-	-	-	-	-	-	-	-	-	2.7
	All employee man-hours											
1954	14.2	4.8	-0.4	-5.5	-3.8	-3.5	-3.7	-3.0	-2.3	-1.3	-0.5	0.1
1955	-	-3.9	-6.4	-10.8	-6.4	-5.2	-5.0	-3.8	-2.7	-1.5	-.5	.2
1956	-	-	-8.8	-14.5	-6.1	-4.5	-4.5	-3.0	-1.8	-.6	.5	1.2
1957	-	-	-	-19.8	-2.2	-1.7	-2.8	-1.4	-.3	.9	1.9	2.4
1958	-	-	-	-	19.1	5.4	.1	.9	1.6	2.6	3.4	3.8
1959	-	-	-	-	-	-6.7	-7.1	-2.4	-.2	1.8	3.0	3.6
1960	-	-	-	-	-	-	-7.5	.7	2.6	4.2	5.1	5.2
1961	-	-	-	-	-	-	-	9.6	6.9	7.2	7.3	6.7
1962	-	-	-	-	-	-	-	-	4.3	6.6	7.0	6.3
1963	-	-	-	-	-	-	-	-	-	8.9	8.2	6.5
1964	-	-	-	-	-	-	-	-	-	-	7.4	5.1
1965	-	-	-	-	-	-	-	-	-	-	-	2.8

See footnote at end of table.

(To obtain annual rates of change between any 2 years shown, find row for initial year at left of table and read figure in that row under the terminal year shown on top)—Continued

Initial year	Output per all employee											
	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
	Output per all employee											
1954	14.0	5.0	0.4	−0.5	0.7	0.6	0.7	1.2	1.7	2.3	2.7	2.9
1955	-	−3.2	−5.1	−3.7	−.8	−.4	−.1	.8	1.4	2.2	2.8	2.9
1956	-	-	−7.1	−3.4	.9	.8	.8	1.6	2.3	3.1	3.6	3.6
1957	-	-	-	.5	5.2	2.8	2.0	2.7	3.3	4.0	4.4	4.3
1958	-	-	-	-	10.1	2.8	1.7	2.8	3.5	4.4	4.8	4.5
1959	-	-	-	-	-	−3.9	−1.4	1.8	3.1	4.4	5.0	4.6
1960	-	-	-	-	-	-	1.2	4.9	5.4	6.3	6.4	5.5
1961	-	-	-	-	-	-	-	8.6	7.0	7.6	7.2	5.8
1962	-	-	-	-	-	-	-	-	5.4	7.5	6.9	5.1
1963	-	-	-	-	-	-	-	-	-	9.6	7.2	4.3
1964	-	-	-	-	-	-	-	-	-	-	4.9	1.6
1965	-	-	-	-	-	-	-	-	-	-	-	−1.6
	Output per production worker man-hour											
1954	6.7	3.5	1.7	2.2	2.1	2.0	2.0	2.0	2.0	2.1	2.3	2.3
1955	-	.4	−.5	1.3	1.6	1.6	1.7	1.8	1.9	2.0	2.2	2.2
1956	-	-	−1.5	2.2	2.2	1.9	2.0	2.1	2.1	2.2	2.4	2.4
1957	-	-	-	6.1	3.4	2.4	2.3	2.3	2.2	2.4	2.6	2.5
1958	-	-	-	-	.8	.9	1.5	1.8	1.9	2.2	2.5	2.4
1959	-	-	-	-	-	.9	1.9	2.2	2.1	2.4	2.7	2.6
1960	-	-	-	-	-	-	2.9	2.7	2.3	2.7	3.0	2.8
1961	-	-	-	-	-	-	-	2.5	2.0	2.7	3.2	2.8
1962	-	-	-	-	-	-	-	-	1.5	3.0	3.5	2.9
1963	-	-	-	-	-	-	-	-	-	4.5	4.4	3.1
1964	-	-	-	-	-	-	-	-	-	-	4.4	2.2
1965	-	-	-	-	-	-	-	-	-	-	-	.0
	Production worker man-hours											
1954	15.3	4.7	−0.9	−6.5	−4.5	−4.1	−4.3	−3.4	−2.6	−1.5	−0.6	0.1
1955	-	−4.9	−7.5	−12.2	−7.2	−5.9	−5.6	−4.2	−3.0	−1.6	−.5	.2
1956	-	-	−10.0	−16.0	−6.7	−5.0	−4.9	−3.3	−2.0	−.6	.6	1.3
1957	-	-	-	−21.6	−2.2	−1.9	−3.0	−1.5	−.2	1.1	2.1	2.7
1958	-	-	-	-	22.0	5.9	.1	1.1	1.9	3.0	3.9	4.2
1959	-	-	-	-	-	−8.1	−8.0	−2.6	0	2.1	3.4	3.9
1960	-	-	-	-	-	-	−7.9	1.1	3.2	5.0	5.8	5.8
1961	-	-	-	-	-	-	-	11.1	8.0	8.3	8.1	7.3
1962	-	-	-	-	-	-	-	-	5.0	7.4	7.7	6.7
1963	-	-	-	-	-	-	-	-	-	10.0	8.6	6.7
1964	-	-	-	-	-	-	-	-	-	-	7.3	5.0
1965	-	-	-	-	-	-	-	-	-	-	-	2.7

(To obtain annual rates of change between any 2 years shown, find row for initial year at left of table and read figure in that row under the terminal year shown on top)—Continued

Initial year	Terminal year											
	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
	Output per production worker											
1954	13.7	5.3	0.9	0.3	1.3	1.2	1.2	1.6	2.0	2.5	2.9	3.0
1955	-	−2.5	−4.4	−2.6	−.1	.2	.4	1.1	1.7	2.4	2.9	3.0
1956	-	-	−6.4	−2.1	1.5	1.3	1.2	1.9	2.5	3.2	3.6	3.6
1957	-	-	-	2.4	5.4	3.1	2.4	2.9	3.3	4.0	4.4	4.2
1958	-	-	-	-	8.6	2.6	1.7	2.7	3.4	4.2	4.6	4.4
1959	-	-	-	-	-	−3.0	−.8	2.0	3.1	4.3	4.8	4.5
1960	-	-	-	-	-	-	1.5	4.6	5.1	6.0	6.1	5.3
1961	-	-	-	-	-	-	-	7.9	6.5	7.1	6.8	5.5
1962	-	-	-	-	-	-	-	-	5.1	7.1	6.7	4.9
1963	-	-	-	-	-	-	-	-	-	9.2	7.0	4.2
1964	-	-	-	-	-	-	-	-	-	-	5.0	1.7
1965	-	-	-	-	-	-	-	-	-	-	-	−1.5
	Output per nonproduction worker man-hour											
1954	16.7	2.9	−2.9	−5.6	−3.1	−3.0	−2.6	−1.6	−0.5	0.6	1.4	1.8
1955	-	−9.3	−10.4	−10.6	−5.3	−4.4	−3.5	−2.0	−.6	.8	1.7	2.1
1956	-	-	−11.5	−11.1	−2.8	−2.5	−2.0	−.4	.9	2.3	3.1	3.4
1957	-	-	-	−10.7	3.3	.6	.1	1.6	2.7	4.0	4.6	4.6
1958	-	-	-	-	19.5	3.8	1.4	3.0	4.0	5.3	5.8	5.5
1959	-	-	-	-	-	−9.8	−4.7	.5	3.0	5.1	5.7	5.4
1960	-	-	-	-	-	-	.6	6.1	7.1	8.4	8.2	7.1
1961	-	-	-	-	-	-	-	12.0	9.7	10.4	9.3	7.4
1962	-	-	-	-	-	-	-	-	7.4	10.1	8.6	6.3
1963	-	-	-	-	-	-	-	-	-	12.9	8.5	5.1
1964	-	-	-	-	-	-	-	-	-	-	4.3	1.5
1965	-	-	-	-	-	-	-	-	-	-	-	−1.2
	Nonproduction worker man-hours											
1954	5.5	5.4	3.8	1.2	0.8	0.8	0.3	0.1	0	0	0.3	0.5
1955	-	5.3	2.7	−.5	−.5	0	−.5	−.5	−.5	−.4	0	.4
1956	-	-	.1	−3.4	−1.9	−.7	−1.1	−.9	−.9	−.7	−.1	.3
1957	-	-	-	−6.8	−2.1	−.2	−.9	−.8	−.7	−.5	.1	.6
1958	-	-	-	-	2.9	2.9	.2	0	−.2	−.1	.6	1.1
1959	-	-	-	-	-	2.8	−1.6	−1.0	−.9	−.5	.5	1.2
1960	-	-	-	-	-	-	−5.8	−2.1	−1.4	−.6	.7	1.6
1961	-	-	-	-	-	-	-	1.7	.4	.7	2.0	2.7
1962	-	-	-	-	-	-	-	-	−.8	.5	2.6	3.3
1963	-	-	-	-	-	-	-	-	-	1.7	4.5	4.6
1964	-	-	-	-	-	-	-	-	-	-	7.4	5.7
1965	-	-	-	-	-	-	-	-	-	-	-	4.0

[1] Average annual rates are based on the least squares trend line fitted to the logarithms of the index numbers.

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