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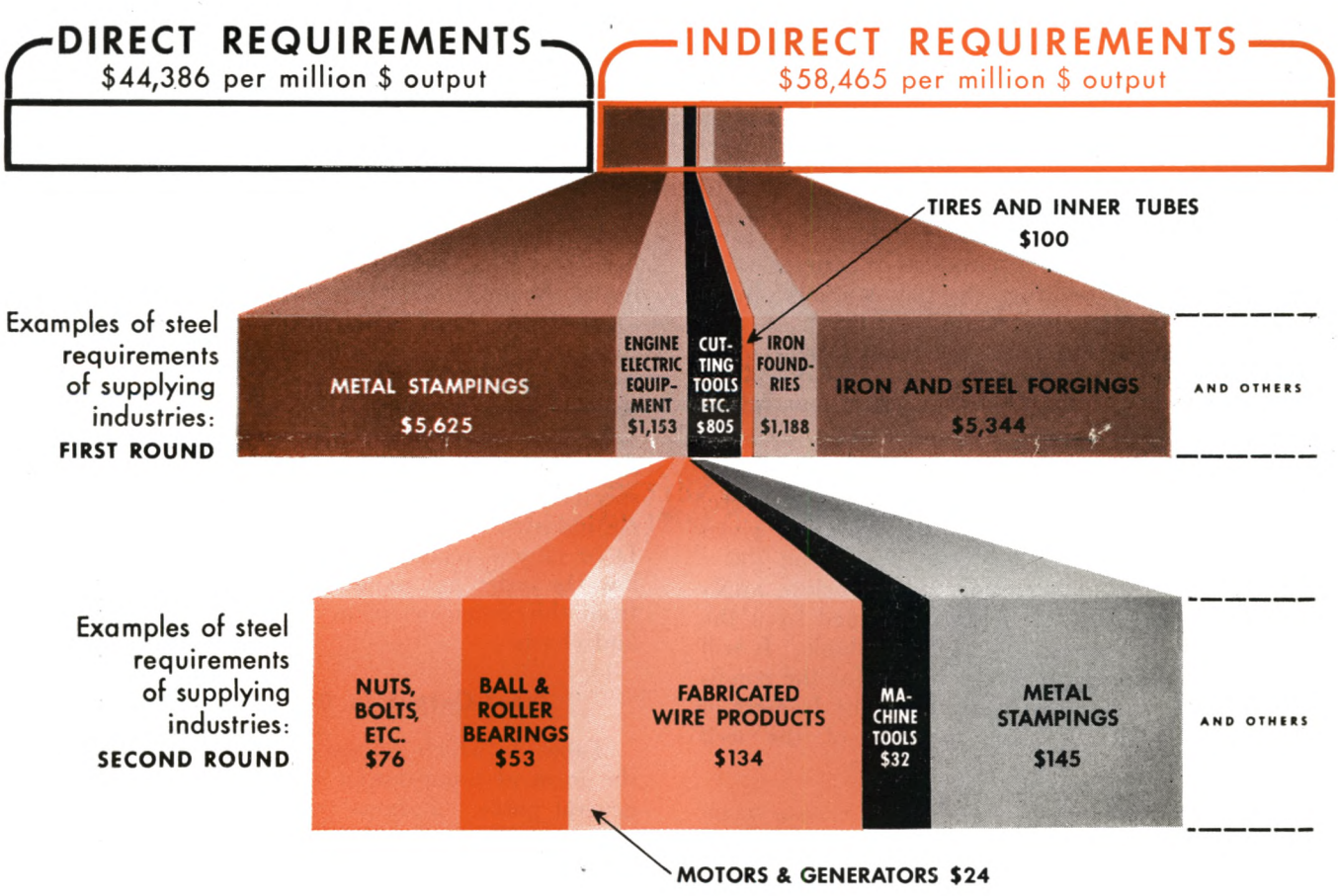
DIRECT AND INDIRECT REQUIREMENTS OF STEEL BY THE MOTOR VEHICLE INDUSTRY

(in dollar production of steel per million dollar output of motor vehicle industry)



(Chart is illustrative of article on "input-output"; for explanation see page 10.)

Input-Output Relations of Steel-Using Industries

INTERPRETATION of current or prospective business situations frequently calls for information about the probable impact of changes in a given industry upon a series of other industries, related to the first either as suppliers or as customers. Currently, for example, a good deal of attention is being paid to the question of the probable effects of changes in the pace of automobile production upon other specific industries, and upon the business economy generally. Ordinary business statistics do not give much help at this point. What has come to be known as "input-output" analysis may, however, be a useful statistical tool in this connection.

Input-output analysis represents an attempt to portray in quantitative terms the nature of the interindustry transactions which are characteristic of the nation's business during a period of time.(1) More specifically, it tells how much in dollar value, or in what proportions, each named industry sells to, and buys from, the other named industries as well as the sum of its transactions with final consumers and the government. Input-output data of this sort have for a number of years been intensively used in some aspects of governmental and military activity, but only recently have come into notice in business circles.

Until very recently, most of the published input-output tables were limited in scope to broad industry groups, such as, for example, 50-sector tables; that is, tables which show the purchase and sales transactions of each of 50 industrial groups with each of the others. During the past summer, however, the Bureau of Labor Statistics of the U. S. Department of Labor has published three input-output tables of a 200 x 200 type, i.e., showing the interrelations of 200 industrial or business classifications. This presents the material in a form which is much closer to the everyday needs of business.

Any given input-output table is, by its nature, static. It applies to the transactions during a given period of time, usually a calendar year. The 200 x 200 tables referred to here, and utilized below, apply to the year 1947, for which data obtained from the 1947 Census of Manufacturers are available. It will be asked, of what use is a 1947 table for the conditions of 1953? The answer given by the framers of input-output tables is that, in spite of the well known fact of technological change, the basic technical relations of one industry to another as shown in the tables does not change so rapidly from year to year as to preclude the current usefulness of tables based on data several years old.

Without attempting to enter the theoretical controversies which have developed around this point, we are nevertheless presenting a sample of the input-output type of information on the assumption that the 1947 data do throw some light on significant aspects of the 1953 situation. All of the accompanying tables and charts should be understood as having been derived from the 1947 data.

The material below represents a selection from the 200 x 200 input-output tables just identified. Attention is pointed mainly to interindustry relations involving steel-fabricating industries, which are especially important to Ohio and the Fourth Federal Reserve District. The selection of certain data for emphasis involves consolidation of other material, — otherwise the results would be much too bulky for presentation here. In the explanations which follow, the nature of the official input-output tables is explained briefly along with the steps taken here to simplify them and adapt them to the purpose at hand.

The three 200 x 200 input-output tables recently published by the Bureau of Labor Statistics may be distinguished as follows: Table I is a transactions table, showing inputs and outputs of the various industries in millions of dollars. Table II is a ratio table, showing direct purchases or requirements by each of the stated industries, per million dollars of its output, from each of the others. Table III shows the results of adding indirect requirements to direct requirements. Our selections from, and adaptations of, these three tables are captioned, respectively, tables A, B and C. In addition, Table D provides specific illustrations centering about the motor vehicle industry. The two charts are drawn from Table D or closely related information. Explanations follow the order just named, although some departures from this order occur in the spacing of the tables and charts.

Input-Output In Dollars (Table A)

Table A, which appears on pages 8-9, represents the form of input-output table most familiar to the general public; it shows transactions between industries in millions of dollars, based on the relations of the year 1947. This table is a selective condensation of the official BLS Table I.

Eight steel-using industries, ranging from special industrial machinery to motor vehicles have been

(1) Input-output analysis was largely pioneered by Professor Wassily Leontief of Harvard University. The laborious computations required are now being carried out by several governmental and private agencies; the chief source of final data available to the public is the Division of Interindustry Economics, Bureau of Labor Statistics, U. S. Department of Labor.

For other footnotes, see page 14.

selected for inclusion. These eight lead off on both the left-hand stub and the top caption of the table; on the left, they appear in the role of producing industries, with their outputs read in a horizontal direction to the right; at the top, they appear in the role of purchasing industries with their inputs read vertically below. (Use of red and black type for industry captions is employed in this as in other tables to indicate the distinction between purchase and output meanings; red indicates a purchase role, and black, an output role.)

Following the eight steel-using industries are listed the steel industry itself (in two sections) and other industries providing important industrial materials (nonferrous metals, glass, lumber, rubber) as well as electric light and power. From this point on, in the table, the entries reflect drastic consolidation of the corresponding entries in the larger BLS table. Thus, 140 industries as shown in BLS Table I are consolidated into the item shown on our Table A as "All Other Industrial Sectors." (Such consolidation has been effected entirely for purposes of practicability of presentation here.) Likewise, 31 sectors of a service character, separately enumerated in BLS Table I, are here consolidated under the title "Transportation, Trade, Services and Construction Sectors."

The "Final Demand" sector shown near the top-right corner of Table A includes more than purchases by consumers. It comprises foreign trade (the net "take" by foreigners of our goods and services) government purchases, gross private capital formation, and purchases by households, — each of which is itemized in BLS Table I, but not shown separately here.[2] The figures of the final column of Table A, called "Gross Domestic Output," are seen to be identical in magnitude with the corresponding industry figures in the final row called "Gross Domestic Outlays."

Example Drawn from Table A. To illustrate the meaning of Table A, take industry No. 79, Steel Works and Rolling Mills, and follow through on the horizontal, and then the vertical. Reading on the horizontal it appears that in 1947 the distribution of the steel industry's *output* included $57.7 million of products to the special industrial machinery industry, $363.1 million to structural metal products, $64.9 million to iron foundries, etc. The large figure of $1,641.2 million represents intra-industry sales within the steel industry, itself.[3]

Following further to the right along the steel industry row, it is seen that relatively smaller dollar totals of steel output go, respectively, to the nonferrous, glass, lumber, and rubber industries. "All other industrial sectors," which are not itemized here but which appear in BLS Table I, account for a total of $2,813 million, while a consolidation of the transportation, trade, services and construction sectors accounts for $909.5 million.[4]

The various forms of "Final Demand," including net exports of steel and inventory build-up, accounted for $818.3 million. Finally, at the extreme right of the row, appears the grand total of "Gross Domestic Output," amounting to $7,700.3 million, which remains to be explained in terms of inputs.

Reading now on the vertical in order to see the *input* distribution of industry No. 79, Steel Works and Rolling Mills, the *column* for that industry shows, among other entries, that steel works took $1,535.3 million of products from the blast-furnace industry, $136.7 million of nonferrous metals and products, $47.2 million of products of iron foundries, etc. Intra-industry purchases of steel amounted to $1,641.2 million, the identical item previously mentioned in connection with distribution of sales.

Purchases by the steel industry from the consolidated group "All other industrial sectors" amounted to $682.9 million. The latter includes $39.1 million of purchases from industry No. 16, "Coal Mining," and $25.9 million of purchases from industry No. 63, "Coke and Products," as would be seen in BLS Table I which is more extensive than our Table A.

Payments by the steel industry to the entire group of "transportation, trade, services and construction sectors" amounted to $1,047.3 million. Included here are such transactions as $183.4 million paid to railroads and $25.6 million paid for all banking, finance and insurance services, combined.

"Charges against Final Demand," amounting to $2,486.9 million, and not itemized here, include payments of wages and taxes as well as corporate profits.[2] The importance of such sectors for the input side of the steel industry, or of any other industry, is not to be minimized, but an analysis of them is beyond the scope of this article.

Finally the grand total of the *column* for the steel works and rolling mills industry shows "Gross Domestic Outlays" of $7,700.3 million, which checks with the total of the *row* representing "Gross Domestic Output" as previously noted.

Direct Purchases; Ratios (Table B)

For many purposes, input-output tables are more useful when the information is expressed in the form of *ratios,* rather than dollar amounts. When, for example, a problem dealing with the year 1953 is under consideration, the percentage relationships (or other ratios) obtained from the 1947 input-output table may be applied to various forms of current 1953 dollar data, providing the assumption mentioned earlier is maintained, i.e., that the shape of technical interindustry transactions does not alter substantially over fairly short periods. (It is certain in any event that these relationships do not change nearly as rapidly as the raw dollar totals.)

(For outputs read down; for inputs read across)

TABLE B. DIRECT PURCHASES PER MILLION DOLLARS OF OUTPUT

Each entry shows (per million dollars of output by industry named at left) the direct purchases from industry named at top.

	Steel Works and Rolling Mills (79)	Iron Foundries (80)	Nonferrous Metals and Products (82-85) (87-90)	Nonferrous Foundries (91)	Glass (70)	Lumber and Wood Products (37-40)	Rubber Products (65-66)
104 Fabricated Wire Products	475,207	1,518	57,898	1,015	3	3,608	958
93 Tin Cans and other Tin Ware	461,033	3	11,157	.....	.....	7,885	433
92 Iron and Steel Forgings	395,402	20,562	20,481	2,014	.....	461	2,395
105 Metal Barrels, Drums, etc	331,155	5	29,214	738	.....	.....	1,481
108 Steel Springs	255,479	1,909	31	.....	.....	633	1,266
99 Structural Metal Products	220,152	2,488	42,820	863	1,017	2,141	2,195
100 Boiler Shop Products and Pipe Bending	215,686	4,474	6,759	380	.....	1,740	2,652
109 Nuts, Bolts and Screw Machine Products	204,944	1,978	50,201	387	.....	11,462	2,561
101 Metal Stampings	155,709	2,439	55,984	1,336	855	2,886	3,001
113 Farm Equipment	104,515	52,486	5,790	5,427	.....	11,062	31,782
42 Metal Furniture	90,907	.....	.....	.....	1,429	27,812	3,579
95 Tools and General Hardware	82,747	18,238	5,248	4,374	.....	20,473	2,694
81 Steel Foundries	75,532	70,103	13,781	6,018	.....	3,709	1,086
98 Heating Equipment	74,845	26,672	15,794	13,628	932	11,528	2,593
125 Refrigeration Equipment	58,014	10,897	24,392	4,311	4,886	12,321	6,308
114 Construction and Mining Machinery	54,948	18,970	1,465	3,999	101	2,349	15,185
131 Motors and Generators	54,476	42,610	30,088	9,999	48	3,175	3,596
149 Ships and Boats	47,557	825	2,386	2,662	681	10,453	1,421
145 Motor Vehicles	44,386	28,037	8,581	7,094	8,539	3,421	41,204
112 Farm and Industrial Tractors	43,309	72,585	2,305	3,889	.....	2,224	31,970
135 Electrical Appliances	39,307	12,812	16,532	36,172	562	9,961	12,138
118 Special Industrial Machinery	28,616	45,091	11,085	12,174	504	9,384	15,569
103 Lighting Fixtures	27,566	2,735	23,316	5,935	38,544	7,964	2,091
116 Machine Tools and Metalworking Machinery	21,014	50,713	2,406	12,610	152	2,488	10,944

SOURCE: Based on "Table II" published by Bureau of Labor Statistics, U. S. Department of Labor, applying to the 1947 Interindustry Relations Study.

Table B is an example of such a ratio table; it expresses in units per million dollars of output of the industry named at the left, the latter's direct purchases from industries shown at the top.[5] The material for Table B is selected from Table II of the BLS series. Arrangement of Table B differs from that of the previous Table A, as well as from that of BLS Table II from which it is abstracted,[6] insofar as outputs are on the vertical dimension and inputs on the horizontal. (Such a transposition is merely for reasons of space, and should not confuse the reader, especially if the red captions are taken as the clue to *input* relationships.)

It will be seen from Table B that, judged by the interindustry relationships of 1947, the "Fabricated Wire Products" industry purchases $475,207 per million dollars of its own output (or 47.5% of the value of its output) from the steel works and rolling mills industry. Likewise, the industry producing "Tin Cans and Other Tin Ware" purchases $461,033

per million dollars of its own output (or 46.1% of the value of its output) from the steel industry. Proceeding downward in the first column, certain important customer industries of the steel industry are listed *in order of the importance of steel in their own purchases,* — not in order of their importance to the steel industry as customers of the latter.[7]

For another illustration from Table B, take the final industry named on the left, "Machine Tools and Metalworking Machinery," and trace its purchases from various other industries along a horizontal direction. Thus, the machine-tool industry purchases, per million dollars of its own output: $21,014 from steel works and rolling mills, $50,713 from iron foundries, etc. (Purchases by the machine-tool industry from other industries not selected for inclusion in Table B are also important, and can easily be ascertained by reference to BLS Table II.)

Direct and Indirect Requirements (Table C)

From what has already been shown, it may be inferred that input-output tables have the potentiality of showing the indirect demands on a given industry, as well as the direct demand. For example, if the steel industry is called on by the auto industry to supply directly a certain total of steel, how much additional steel must be provided *indirectly* to the auto industry by way of the various auto-parts industries?

To answer this type of question, a table like Table B (although presumably more extensive in coverage) could be examined for a cumulation of successive demands pointing in the desired direction, in order to arrive at a total of direct and indirect requirements impinging on the industry in question. The Bureau of Labor Statistics has, in fact, conducted such an operation, although the method em-

(For outputs read down; for inputs read across)

TABLE C. DIRECT AND INDIRECT REQUIREMENTS

Each entry shows (per million dollars of output by industry named at left) the total dollar production directly and indirectly required FROM industry named at top.

	Steel Works and Rolling Mills (79)	Iron Foundries (80)	Machine Tools and Metalworking Machinery (116)	Special Industrial Machinery (118)	Structural Metal Products (99)	Metal Stampings (101)
104 Fabricated Wire Products	629,456	7,485	1,573	853	4,018	5,780
93 Tin Cans and Other Tin Ware	610,488	5,726	2,300	833	9,369	14,912
92 Iron and Steel Forgings	523,351	26,725	2,441	808	683	843
105 Metal Barrels, Drums, etc	490,937	5,824	2,830	833	3,138	103,064
100 Boiler Shop Products and Pipe Bending	321,932	13,702	6,987	5,760	42,341	9,167
98 Heating Equipment	146,035	34,736	4,957	2,980	17,123	26,888
131 Motors and Generators	103,521	48,394	2,771	2,455	1,157	11,170
149 Ships and Boats	99,860	8,593	5,771	2,218	42,095	3,573
145 Motor Vehicles	102,851	33,970	4,135	2,105	2,506	39,594
112 Farm and Industrial Tractors	118,682	91,132	7,936	11,807	2,259	21,748
118 Special Industrial Machinery	72,853	55,619	21,519	(a)	2,267	3,981
116 Machine Tools and Metalworking Machinery	60,574	60,801	(a)	18,751	2,870	4,226
128 Machine Shops	72,352	78,516	9,378	43,668	1,227	1,406
119 Pumps and Compressors	84,907	76,163	20,904	18,838	4,107	4,262
147 Automobile Trailers	75,330	9,683	3,169	2,445	50,134	11,380
111 Internal Combustion Engines	80,347	105,381	8,959	14,992	1,990	8,504
117 Cutting Tools, Jigs and Fixtures	83,348	22,647	76,398	12,747	2,401	47,127

(a) $1,000,000 by definition.

Source: Based on "Table III" published by Bureau of Labor Statistics, U. S. Department of Labor, applying to the 1947 Interindustry Relations Study.

ployed was based on a solution of simultaneous equations in preference to the almost infinite series of arithmetic additions which would be involved in tracing items through the various levels of the industrial flow.

The results are contained in BLS Table III entitled "Direct and Indirect Requirements Per Million Dollars of Final Demand". From the latter is drawn the material for our accompanying Table C, which differs from BLS Table III in the following respects: (a) only a few of the items have been selected from the BLS table, (b) conversion has been made from a unit "per million dollars of deliveries to final demand" to a unit "per million dollars of *output*". Such conversion was effected in order to make for greater comparability with the preceding Table B, and also to provide the groundwork for the charts shown here.[8]

Table C shows, for each million dollars of output by the industry named on the left, the total dollar production directly and indirectly required from the industry named at the top. (As previously, this means in accordance with the interindustry relations which prevailed in 1947.) The "Fabricated Wire Products" industry, for example, requires $629,456 of steel products, both directly and indirectly, for each million dollars of its own output. (Such a ratio may be compared with the $475,207 per million of *direct* requirements as shown previously in Table B.) For another example, the item entered in the first column, sixth row, shows that the "Heating Equipment" industry requires $146,035 of steel products, both directly and indirectly, for each million dollars of its own output, or a ratio equal to nearly 15 percent of the value of its output. The corresponding figure for direct requirements is only about 7 percent, as seen from Table B, first column, 14th row.

It should be explained that the first 12 of the 17 industries named at the left of Table C have previously been included in the showing of Table B, while the other five are added in order to bring out a range of relationship not previously shown. Likewise, the industries included along the top of Table C are not the same as those at the top of Table B, although steel works and iron foundries are common to both tables. The choice of industries to be included in Table C was guided in part by an aim to bring out the mutual inter-relationships among some important steel-using industries.

Motor Vehicle Example (Table D and Charts)

With the general layout of the input-output tables before us, it becomes possible to focus on an example, or set of examples, drawn from one particular industry in relation to other industries. The motor vehicle industry has been selected for this purpose, and all the information which follows has been drawn from Tables A, B, or C, previously discussed, or from the BLS tables upon which they are based.

Table D throws additional light on the nature of *purchases* by the motor vehicle industry, as judged by the interindustry relations discovered for 1947. The first column shows the direct purchases by the motor vehicle industry from a list of 35 supplying industries, expressed in each case as a percentage of *total outlays by the motor vehicle industry*. (Total outlays include wages, taxes, etc., and are taken from the final column or row of Table A, or its source, BLS Table 1.) The first entry shows that the motor vehicle industry purchases from the steel works and rolling mills industry the equivalent of 4.4 percent of *total* motor vehicle outlays, a figure which is identical with the item of $44,386 per million dollars already shown in Table B, first column, 19th row. Similarly, the motor vehicle industry's direct purchases of metal stampings is listed as 3.6 percent of the motor vehicle industry's total outlays. Proceeding down the first column, there is a diminishing of percentages which are small in any event, for reasons easy to understand when considering the nature of the total motor-vehicle outlays (or output) used as the common denominator.[9]

However, what may be a relatively small outlay to the motor vehicle industry may easily become a relatively large sale or supply item, when viewed in the context of the supply industry's business. This is shown by the second column of Table D, which portrays the same purchases as the first column, but expresses them in each case as a percentage of the supplying industry's total output. (Again, total outputs are derived from the final row or column of Table A, or BLS Table I.)

In the second column, then, it appears that the direct steel "take" of the motor vehicle industry accounts for 7.2 percent of the gross domestic output of the steel works and rolling mills industry. Likewise, metal stampings taken directly by the motor vehicle industry account for 32.4 percent of the metal stampings industry's output. Some of the percentages in the second column are seen to be quite high, as in the case of "Steel Springs" with 71 percent.

When indirect requirements are considered along with direct requirements (utilizing information drawn from Table C or BLS Table III) the percentages become even larger. This is shown in the third column of Table D. For example, the direct and indirect purchases of the motor vehicle industry from the steel works and rolling mills industry appears to account for 16.7 percent of the total output of steel works and rolling mills.[10] In some cases the contrast between the entries in the second and third columns is particularly marked. For example, "Coke and Products", next to last on the list, car-

TABLE D

THE MOTOR VEHICLE INDUSTRY AND SELECTED SUPPLYING INDUSTRIES

	Direct Purchases as % of total outlays by m.v. industry	Direct Purchases as % of total output of named industry	Direct and Indirect Purchases as % of total output of named industry
.79 Steel Works and Rolling Mills	4.4%	7.2%	16.7%
101 Metal Stampings	3.6	32.4	35.5
65 Tires and Inner Tubes	3.0	22.4	24.4
80 Iron Foundries	2.8	22.9	27.8
117 Cutting Tools, Jigs and Fixtures	2.1	34.4	39.7
137 Engine Electrical Equipment	2.1	67.4	71.6
142 Storage Batteries	1.9	80.4	80.6
51-66 Synthetic Rubber and Misc. Rubber Products	1.5	11.7	23.7
92 Iron and Steel Forgings	1.4	35.8	39.9
96 Hardware (not otherwise classified)	1.3	26.4	29.6
128 Machine Shops	1.1	29.4	33.2
103 Lighting Fixtures	1.0	23.8	25.5
104 Fabricated Wire Products	.9	13.1	17.0
70 Glass	.9	9.2	11.4
82-85 87-90 Nonferrous Metals and Products	.9	2.2	16.4
76 Asbestos Products	.8	26.7	31.3
127 Ball and Roller Bearings	.8	27.1	33.1
35 House Furnishings and Other Non-apparel	.8	5.3	5.8
56 Paints and Allied Products	.8	6.0	10.7
122 Power Transmission Equipment	.8	19.8	23.5
111 Internal Combustion Engines	.7	10.8	13.4
91 Nonferrous Foundries	.7	14.5	20.4
108 Steel Springs	.7	71.0	73.5
30 Spinning, Weaving and Dyeing	.7	1.1	3.9
136 Insulated Wire and Cable	.6	8.0	10.6
109 Nuts, Bolts and Screw Machine Products	.5	7.7	13.9
167 Electric Light and Power	.3	.8	3.3
46 Converted Paper Products	.2	.8	2.7
17, 62 Petroleum, Petroleum Products and Natural Gas	.2	.2	2.4
47 Printing and Publishing	.2	.3	2.2
116 Machine Tools and Metalworking Machinery	.1	1.3	4.6
16 Coal Mining	.1	.5	4.6
49 Industrial Organic Chemicals	.1	.5	6.8
63 Coke and Products	.02	.2	12.7
78 Blast Furnaces	.....	.....	17.3

SOURCE: As explained in text.

ries a figure of 0.2 percent in the second column and 12.7 percent in the third column. This means that the coke purchased directly by the motor vehicle industry is a relatively negligible part of the coke industry's business, but when added to the coke indirectly required by the motor vehicle industry, accounts for an appreciable fraction of the coke industry's output.

(For outputs read across, for inputs read down)

TABLE A. INPUTS AND OUTPUTS OF SELECTED INDUSTRIES AND SECTORS
Continental United States, 1947, in millions of dollars

Each row shows distribution of output of producing industry named at left; each column shows input distribution for purchasing industry named at top.

	Special Industrial Machinery (118)	Structural Metal Products (99)	Iron Foundries (80)	Electrical Appliances (135)	Heating Equipment (98)	Metal Stampings (101)	Machine Tools and Metalworking Machinery (116)	Motor Vehicles (145)	Steel Works and Rolling Mills (79)	Blast Furnaces (78)	Nonferrous Metals and Products (82-85, 87-90)	Nonferrous Foundries (91)	Glass (70)	Lumber and Wood Products (37-40)	Rubber Products (65-66)	Electric Light and Power (167)	All other Industrial Sectors	Transportation, Trade, Services and Construction Sectors (a)	Final Demand(b)	Gross Domestic Output (999)
118 Special Industrial Machinery	42.7	0.3	7.1	9.5	0.5	1.5	17.5	1.0	.....	.....	3.0	0.6	4.0	21.1	2.0	.....	299.2	13.3	1,591.4	2,014.7
99 Structural Metal Products	1.4	44.5	6.9	.....	20.4	28.7	1.5	8.1	1.5	.....	.....	.....	.....	1.0	.....	1.0	181.6	1,214.7	137.9	1,649.2
80 Iron Foundries	90.8	4.1	1.0	19.5	37.9	3.4	57.5	351.0	47.2	.....	1.2	17.7	2.1	.....	.....	.....	627.7	171.8	99.6	1,532.5
135 Electrical Appliances	9.1	.....	.....	47.1	28.3	14.0	4.1	.....	.....	.....	.....	.....	.....	0.5	.....	.....	91.1	96.9	1,234.3	1,525.4
98 Heating Equipment	0.2	12.2	7.0	32.4	41.6	13.2	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	118.4	658.5	535.7	1,419.2
101 Metal Stampings	2.6	30.6	.....	65.7	29.9	11.9	0.7	452.3	.....	.....	.....	.....	.....	.....	.....	.....	475.5	57.2	268.3	1,394.7
116 Machine Tools and Metalworking Machinery	36.5	2.1	4.9	5.1	3.8	5.7	37.3	15.6	9.0	.....	4.1	0.8	.....	4.0	.....	.....	178.9	11.1	815.7	1,134.6
145 Motor Vehicles	.....	1.2	.....	.....	1.1	13.4	.....	3,294.0	2.0	1.0	5.0	1.0	.....	5.8	9.3	7.5	393.7	1,504.3	7,280.4	12,519.7
79 Steel Works and Rolling Mills	57.7	363.1	64.9	60.0	106.2	217.2	23.8	555.7	1,641.2	.....	10.2	21.5	2.1	13.2	13.6	9.1	2,813.0	909.5	818.3	7,700.3
78 Blast Furnaces	9.3	.....	181.0	0.5	12.6	.....	4.5	.....	1,535.3	11.3	0.5	2.9	0.5	.....	.....	6.7	60.0	58.9	—2.8	1,881.2
82-85, 87-90 Nonferrous Metals and Products	22.2	70.6	39.0	25.2	22.4	78.2	2.7	107.4	136.7	.....	2,111.1	154.8	2.9	2.8	0.1	0.7	1,669.1	452.9	—102.6	4,796.2
91 Nonferrous Foundries	24.5	1.4	7.6	55.2	19.3	1.9	14.3	88.8	0.2	.....	2.1	1.4	.....	.....	.....	.....	292.1	54.4	47.5	610.7
70 Glass	1.0	1.7	.....	0.9	1.3	1.2	0.2	106.9	.....	.....	.....	.....	76.0	14.2	3.0	.....	492.4	188.6	265.0	1,152.4
37-40 Lumber and Wood Products	18.9	3.4	2.3	15.2	16.4	4.0	2.9	42.8	27.6	.....	8.4	1.6	12.3	986.5	9.4	1.5	1,126.5	2,392.7	393.6	5,066.0
65-66 Rubber Products	31.3	3.6	1.9	18.5	3.7	4.1	12.5	515.8	.....	0.7	2.2	1.1	3.0	16.6	275.7	0.5	729.2	355.9	1,022.4	2,998.7
167 Electric Light and Power	8.7	6.7	14.6	4.8	5.8	7.4	6.2	36.4	82.5	18.6	49.8	4.4	12.2	20.1	24.7	395.5	851.5	2,618.0	268.6	4,436.5
All other industrial sectors	463.5	231.6	149.4	492.2	350.5	273.0	257.5	3,081.0	682.9	1,089.3	881.7	36.8	243.6	815.8	1,197.6	578.9	83,691.6	25,331.6	77,795.8	197,644.3
Transportation, Trade, Services and Construction Sectors(a)	103.9	114.4	215.1	100.5	98.7	75.1	64.0	600.5	1,047.3	373.4	778.9	60.3	104.6	491.3	175.4	405.7	18,245.5	33,510.3	131,531.3	188,096.2
Charges against Final Demand(c)	1,090.4	757.7	829.8	573.1	618.8	640.8	627.4	3,262.4	2,486.9	386.9	938.0	305.8	689.1	2,673.1	1,287.9	3,029.4	85,307.4	118,495.6	73,071.3	297,071.8
999 **Gross Domestic Outlays**	2,014.7	1,649.2	1,532.5	1,525.4	1,419.2	1,394.7	1,134.6	12,519.7	7,700.3	1,881.2	4,796.2	610.7	1,152.4	5,066.0	2,998.7	4,436.5	197,644.4	188,096.2	297,071.7	734,644.3

SOURCE: Based on "Table I" published by Bureau of Labor Statistics, U. S. Department of Labor. Numbers identifying industries or sectors are as in BLS tables.

(a) Includes sectors No.: 169-192, 951, 961, 212, 211, 265-267.

(b) Includes demand stemming from foreign trade, federal government purchases, state and local government purchases, gross private capital formation, inventory change in finished products, and purchases by households.

(c) Includes **outlays** on same accounts listed in footnote (b) except for net inventory changes, already treated in output rows.

Similar examples drawn from Table D are illustrated in an accompanying chart with reference to the metal stampings industry and the paint industry, —both in relation to the motor vehicle industry.

Chart on the Cover. To show more clearly the nature of the "indirect requirements" discussed above, a specific illustration may be drawn from the steel requirements by the motor vehicle industry, as depicted in the chart on the front cover.

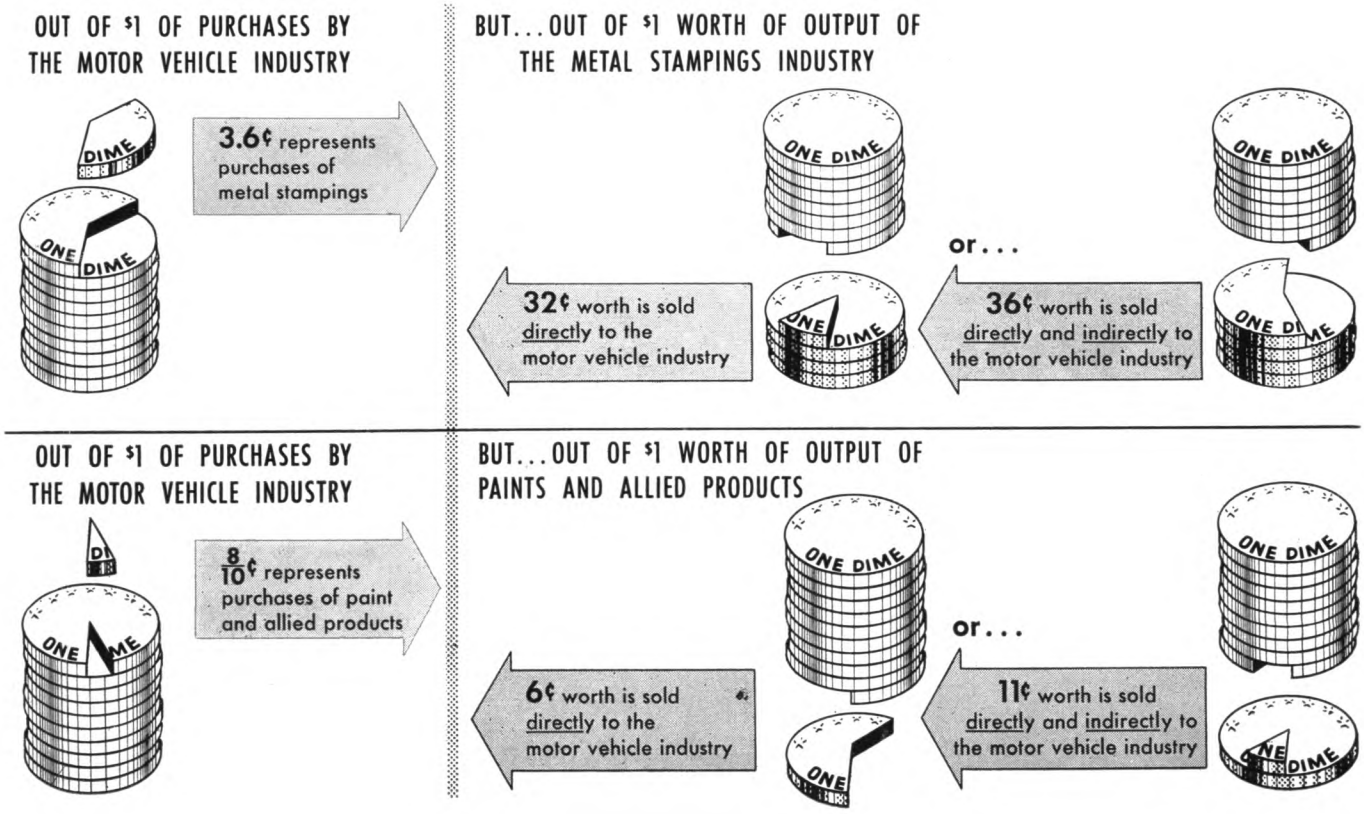
The direct requirements from the steel works and rolling mills industry made by the motor vehicle industry amount to $44,386 per million dollars of motor vehicle output, as has already been shown by Table B. Similarly, the total of direct and indirect requirements amounts to $102,851 per million dollars of motor vehicle output, as previously shown by Table C. The difference, or $58,465 per million dollars of motor vehicle output, represents the indirect steel requirements. Such direct and indirect requirements of steel are depicted at the top level of the chart.

The problem now is to break down the indirect requirements, at least partially, in order to see where they come from. This is done in two steps, i.e., with reference to two rounds of supply industries, with the second round even more indirect than the first. In each case, only the most important supply industries are named, since a complete list of scattered supplying industries would be impractical. (All information for this illustration is drawn from BLS Table II.)

Taking the first round of industries which supply the motor vehicle industry, *and which themselves have important steel requirements,* we see at the middle level of the chart that the steel required by the "Metal Stampings" industry in order to supply the motor vehicle industry amounts to $5,625 per million dollars of motor vehicle output, and that the steel required by the "Engine Electrical Equipment" industry in order to supply the motor vehicle industry amounts to $1,153 per million dollars of motor vehicle output, etc. The six industries shown at the middle level of the chart are, with one exception, the most important suppliers of the auto industry, together with the steel industry itself.[11]

Two of the six industries are selected for further analysis in order to obtain the second round of steel

THE MOTOR VEHICLE INDUSTRY AS DIRECT AND INDIRECT CUSTOMER OF TWO SELECTED INDUSTRIES



requirements by the motor vehicle industry; these are "Engine Electrical Equipment" and "Cutting Tools, Jigs and Fixtures".

Take first the engine electrical equipment industry. In addition to the steel requirements of this industry, directly, in order to supply the motor vehicle industry (which are shown at the middle level of the chart to be $1,153 per million dollars output of the motor vehicle industry) the question arises as to the steel requirements of the various industries which in turn supply the engine electrical equipment industry. Examples of the latter are shown at the lowest level of the chart, i.e., the "Nuts, Bolts and Screw Machine Products" industry, "Ball and Roller Bearings", "Motors and Generators", and "Fabricated Wire Products". The largest of these in terms of steel requirements is "Fabricated Wire Products", an industry which requires steel amounting to $134 (per million dollars output of the motor vehicle industry) in order to supply the engine electrical equipment industry with the necessary products for the latter to supply the motor vehicle industry.

Likewise, the "Cutting Tools, Jigs and Fixtures" industry, an important supplier of the motor vehicle industry, is analyzed in order to find the steel requirements of other industries which are suppliers of products to the cutting-tools industry. These results are also illustrated at the bottom level of the chart, including the steel requirements of "Machine Tools and Metalworking Machinery" and of "Metal Stampings." (The latter is the same industry as appeared in another context at the middle level of the chart.)

By means of the above excursion into the steel requirements of two layers of supplying industries, at least some idea of the composition of the aggregate indirect requirements of steel for the motor vehicle industry may be obtained. Other supply industries not shown on the chart are numerous, usually involving relatively small requirements of steel. At all points of the illustration, a common unit of measurement is necessarily preserved, which in this case is "per million dollars of output of the motor vehicle industry".[12]

If the indirect character of some of the relationships shown above should be thought to resemble "The House That Jack Built", it should not on this account be considered any the less a faithful representation of the technical inter-relations of American industry. The latter are known to be complicated. Many specialized considerations and qualifications have, in fact, been omitted here.

If the material shown above can be helpful toward appraising the possible uses of input-output information for practical business or economic problems, it will have served its purpose. Translation of the material into more specific projects or problems would go beyond the limitations imposed here.

Farm Management for Bankers

With the huge legitimate credit demands of a modern heavily capitalized agriculture, bankers are finding it increasingly necessary to recognize the elements of a soundly managed farm organization. Farm credit is generally a useful tool and a profitable one for bankers and farmers alike, when applied in ways which actually boost farm income to repay the loan. On the other hand, the use of credit only creates a worrisome burden if used excessively for nonproductive purposes or if factors other than adequate capital are impeding profits from a farm operation.

Banker Farm Tours With a view to identifying factors accounting for success on individual farms, banker-farm tours are gaining in popularity. By studying relevant facts on past operations and by detailed discussion with the farm operator, bankers are able to see at first hand the results of past use of credit as well as examples of how credit can be used profitably in the future.

Bankers' associations, usually in cooperation with other groups, sponsor meetings of this nature in the Fourth District each year. Eight such meetings have been held in recent weeks, including:

(a) three meetings in eastern Kentucky, sponsored jointly by the Kentucky Bankers Association, the College of Agriculture of the University of Kentucky, and the Federal Reserve Bank of Cleveland,

(b) two meetings in Ohio, one sponsored by the Ohio Bankers Association, and the other by the Northeastern Ohio Bankers Association in cooperation with the Agricultural Extension Service, the Soil Conservation Service, the Production and Marketing Administration of the counties involved, and the Federal Reserve Bank of Cleveland,

(c) two meetings in western Pennsylvania, each sponsored by bankers of three counties in cooperation with the Agricultural Extension Service of Pennsylvania State College and the Pittsburgh Branch of the Federal Reserve Bank of Cleveland, and

(d) one meeting in northern West Virginia, sponsored by Group One of the West Virginia Bankers Association in cooperation with the Agricultural Extension Service of West Virginia University and the Pittsburgh Branch of the Federal Reserve Bank of Cleveland.

General Observations Discussion and observation at these various meetings encompassed a wide variety of factors associated with successful use of credit. Perhaps the most valuable opportunity common to each of these meetings was that of obtaining "benchmarks" for management evaluation in the various areas. Neighboring farms which once were similar may follow widely different paths in respect to profits, depending upon adequacy of capital in the hands of a capable manager.

Heavy applications of lime and fertilizer and proper soil management in sections of eastern Ohio, for example, were observed to have brought about yields of grass and grain which would put the more fertile areas of the nation to test. The point was made that fertile lands often become unprofitable because of poor management, while many farms with soil structures of inherently low productivity are thriving under more enterprising husbandry. Evidences of sound management were seen in the awareness and understanding of the findings of experiment stations and the following of up-to-date techniques in conservation, marketing, and selection of adapted seeds.

Scale of operation likewise came to light as becoming increasingly significant for maximum efficiency. Either through greater productivity on existing land or actual physical expansion of acreage, both cattle numbers and the volume of crops produced were boosted, not only in total but on a per-unit and per-man basis. Fuller use of machinery and a lower investment per acre were consequent advantages.

Development of a balanced long-range farm plan appeared basic to success on the farms observed by bankers on the tours. A certain degree of flexibility is desirable, but farming is too risky for the "plunger" or "in-and-outer." Each year, acreages of the various crops in the rotation should be about the same. Major shifts in the livestock operation should occur only after careful deliberate study. Insofar as possible, existing labor supplies should be utilized through the entire year with a minimum of peaks and valleys. Types of farming should be geared to soil, topography, markets, and the desires and capabilities of the operator.

A procedure followed in one series of meetings (Kentucky) involved the group study of actual loan applications and financial statements (of unidentified applicants) each of which presented some special problem typical to livestock financing in that area. They were selected to show difficult but important decisions which both bankers and farmers must make in meeting current and prospective situations.

The use of various credit forms and the development of permanent credit files were also emphasized as an important aid in rendering constructive credit decisions.

SUMMARY OF NATIONAL BUSINESS CONDITIONS

Released by the Board of Governors of the Federal Reserve System

Industrial production declined slightly in September following substantial recovery in August from the usual vacation let-down in July. Construction activity declined slightly further from earlier peaks. Crop prospects declined in August and on September 1 the crop was forecast somewhat below last year's large harvest. Retail sales declined somewhat in August and, at department stores, dipped further in early September but subsequently advanced. Consumer prices rose slightly further in August, while wholesale prices in August and September showed little change.

Industrial Production

The Board's index of industrial production rose 4 points in August to 236 per cent of the 1935-39 average, as activity in nondurable goods and minerals industries recovered to about June levels after showing the usual July vacation curtailments. Output of durable goods in August remained below earlier high levels and in September is estimated to have declined moderately. Reflecting mainly an easing in some durable goods industries, the total index for September is estimated at 234.

Steel output was reduced in the first three weeks of September to about 90 per cent of capacity, as compared with 94 in August, but increased again in late September. Passenger auto assembly has declined moderately in August and September from earlier exceptionally high rates, while television set production began a strong seasonal rise. Activity in producers' machinery lines has declined somewhat, owing mainly to curtailment of farm machinery output.

Activity at textile mills showed somewhat less than the usual seasonal pick-up in August, while output of paper and paperboard rose substantially and continued at advanced levels in early September.

Minerals production was at a high level in August and early September. Iron ore mining continued in exceptionally large volume, and coal output increased somewhat. Beginning in September, crude petroleum output has been curtailed moderately from earlier advanced levels.

Construction

Value of construction contract awards declined substantially in August from the unusually high July total which had included several large awards. The number of nonfarm housing units started declined further to 94,000, as compared with 96,000 in July and 99,000 in August 1952. Value of all new construction work put in place, after allowance for seasonal changes, declined somewhat further during August and was about 6 per cent below the early spring peak.

Employment

Seasonally adjusted employment in nonagricultural establishments at 49.3 million in August was moderately below the record mid-year level, as employment in a number of durable and nondurable manufacturing industries showed somewhat less than the usual seasonal increases. The average workweek at factories of 40.5 hours was little changed from July and below levels reached earlier this year. Average hourly earnings continued at $1.77. Unemployment at 1.2 million in early August was as low as at any time in the postwar period, but in early September, initial claims for unemployment compensation were rising and were well above year-ago levels.

Agriculture

Hot, dry weather in important growing areas in August reduced somewhat over-all crop prospects for the year. As of September 1 they were forecast at 1.5 per cent below the large crop last year, owing primarily to reductions in wheat, corn and tobacco harvests. Output of livestock and products this year, however, is expected to exceed last year's volume. Meat production through September has increased about 9 per cent from the corresponding period in 1952, with an increase of close to one-third in beef production more than offsetting a decline of about one-eighth in pork output.

Distribution

Seasonally adjusted retail sales declined somewhat in August and sales for the month at most retail outlets other than auto dealers were at about their year-ago levels. In September, sales at department stores continued to lag early in the month but subsequently advanced and in the third week exceeded year-ago levels by 6 per cent. Seasonally adjusted stocks at department stores are estimated to have changed little in August following a substantial rise from April through July.

Commodity Prices

Wholesale prices have generally continued to change little from mid-August through September. Steel scrap prices have dropped sharply and some declines have occurred in nonferrous metals and textiles. Prices of a few manufactured products such as paper products and television, have been advanced. Dairy products and eggs have risen, while prices of most other farm products and foods have shown little net change.

Consumer prices advanced again in August as foods increased further, average rents rose by 1.1 per cent, and services continued to advance.

Bank Credit and Reserves

Total loans and investments at banks in leading cities changed little from mid-August to mid-September. Banks continued to sell U. S. Government securities. Business loans increased but the increase was considerably less than in the same period last year, reflecting in part a smaller volume of seasonal borrowing by commodity dealers and food processors. Real estate loans also continued to increase moderately but "other loans", largely consumer, showed little change in contrast to substantial increases prior to mid-summer.

Member bank reserve positions eased considerably in the first three weeks of September. Reductions in Treasury deposits at the Reserve Banks and Federal Reserve purchases of U. S. Government securities provided reserves to banks. Part of these funds were

drained off through a currency outflow. During most of the period member bank excess reserves exceeded member bank borrowing at the Federal Reserve.

Security Markets

Yields on Government securities held steady during the first half of September and declined sharply in the following week. Yields on other high-grade bonds increased somewhat during the first three weeks on the month. Common stock prices declined sharply in mid-September and then recovered somewhat.

The Treasury offered 1-year 2⅝ per cent certificates of indebtedness or 3½ year 2⅞ per cent notes in exchange for 8 billion dollars of bonds maturing on September 15. Subscriptions totaled nearly 5 billion dollars for the certificates and 3 billion for the notes. On September 25 the Treasury discontinued sales of Series B savings notes and announced that a new savings note would be offered on October 1.

FOOTNOTES FOR INPUT-OUTPUT RELATIONS

(Continued from page 2)

(2) The "household" sector especially requires further explanation. As part of "Final Demand" (upper right caption of Table A) it refers to purchases by households, including personal consumption expenditures and direct personal taxes, and also expenditures by farm households for personal living requirements.

As part of "Charges against Final Demand" (lower left caption), the "household" item (not shown separately here) includes outlays in the form of wages, corporate profits after taxes, and certain additional items which the listed industry "pays out" in a form other than a payment to a supplying industry. In a sense, "household" plays the role of a balancing item in the totaling of inputs on the vertical scale to match outputs on the horizontal scale.

For further details on these points, as well as additional explanations of the BLS input-output tables, see "General Explanations of the 200 Sector Tables; The 1947 Interindustry Relations Study", BLS Report No. 33, Bureau of Labor Statistics, U. S. Department of Labor.

(3) Corresponding items of intra-industry sales for other industries (located in a diagonal position on input-output tables) are also relatively large, although not always as large as in the steel industry. Such intra-industry items can be eliminated from input-output tables, but to do so in this case would not have been consistent with some of the purposes at hand.

(4) It may be noted that in all input-output tables, wholesale and retail trade components represent the proceeds of the trade margins earned by the distributors, not the value of goods passing through the distributors' hands. Thus, in the case of the steel industry, only a part of the value of steel handled through the steel-warehouse distributors finds its way into this item.

So far as construction is concerned, it is considered probable that the input-output tables tend to understate the values which flow through the construction industry in all its ramifications, mainly, or perhaps entirely, due to deficiencies in the quality of the underlying raw data. (For further details on this important point, see 'New and Maintenance Construction; Construction in the 1947 Interindustry Study", BLS Report No. 2, Bureau of Labor Statistics, U. S. Department of Labor.

(5) The choice of "per million" instead of percent units by the framers of BLS Table II appears to be simply in order to handle some of the smaller figures which would have required fractions when dealing on a percentage basis. This practice is carried over into our Table B, even though the items selected for the latter tend to be the larger ones. The basic unit in either case is similar to a percentage, and can readily be converted to the latter by the appropriate shift of a decimal point.

(6) The underlying link which connects Table B with Table A is one of simple division. That is, the ratios or "technical coefficients" of BLS Table II (on which Table B is based) were obtained by dividing the appropriate items within the table by the "gross domestic output" items of the final column of Table I (or our Table A) in order to obtain a "per million" relationship. (Certain minor technical adjustments, involving byproducts, were also made by the BLS.)

To take an example, our Table A shows that the "Structural Metal Products" industry took $363.1 million of products from steel works and rolling mills, as shown by the item in the second column, ninth row. Table A shows also that the gross domestic output of structural metal products was $1,649.2 million,—final column of second row. The first sum divided by the second yields 0.220167, or $220,167 per million dollars. This may be compared with the figure of $220,152 which appears in the first column, sixth row of our Table B. (The slight difference represents a small technical adjustment made by the BLS.)

(7) It may be noted that a number of the steel-using industries near the top of the list are so close to the steel industry itself that plants or subsidiaries of integrated steel companies are engaged significantly in the named industries alongside the more specialized producers. Examples are wire products, tin cans, structural metal products. The test of classification of manufactures in input-output tables, as in the Census of Manufacturers, is the productive nature of the "establishment" rather than company affiliation or ownership.

(8) The method of conversion from units of "per million dollars of deliveries to final demand" to units of "per million dollars of output" was in accordance with the instructions given in the BLS publication, "General Explanations of the 200 Sector Tables", *op. cit.*, p. 15.

(9) Another important reason why the percentages shown in the first column of Table D are so small lies in the fact that important parts of the output of many industries are assigned in the BLS tables to "private capital formation" within the general heading of "final demand," as distinct from allocation to other industrial sectors. In the case of the "Machine Tool and Metalworking Industry," for example, about half of its gross output is assigned to private capital formation. For the reasons for this treatment, see BLS "General Explanations," etc., *op. cit.*, p. 28.

(10) Any divergences between these figures and widely published figures of the steel industry, showing breakdowns of steel distribution by industry classifications, would be due either to: (a) differences in the scope of the classifications involved, (b) the fact that in 1947, the year to which the detailed input-output analysis applies, the motor vehicle industry had not entirely completed its transition from wartime to peacetime types of operations. The latter fact might affect the relative importance of the motor vehicle industry as customer of the steel industry, but it would not be likely to affect all of the important technical inter-relations between the motor vehicle industry and other industries.

(11) The six industries, together with the steel industry, account in the aggregate for approximately 20 percent of total outlays of the motor vehicle industry,—using "outlays" in the broad sense identified earlier. This figure is not depicted on the chart, which is confined exclusively to purchases of steel, either directly or indirectly.

(12) Conversion into dollars could be accomplished by using as a multiplier the figure of $12,519.7, which represents the gross domestic output of the motor vehicle industry in millions of dollars. (See Table A.) From this point on, conversion could be made into a ratio to output of any desired industry.

Glass Processing Forges Ahead

By CLYDE WILLIAMS, *President and Director, Battelle Memorial Institute, Columbus, Ohio*

The making of ordinary glass—the type used for window and plate glass, bottle containers, and light bulbs—is based on the same fundamental process handed down through the centuries. "Batch" ingredients, usually sand, soda, and lime, are mixed with small amounts of other earthy materials and melted by heat until they fuse and flow. The molten material is drawn, molded or otherwise fabricated, and cooled to a rigid condition.

During the past fifty years, the fundamental process for making glass and the techniques for fabricating glass products have been studied in microscopic detail. A better understanding of the physical and mechanical properties of glass and of the chemistry of glass making has been achieved. The application of this knowledge has brought outstanding growth in the variety of glass products made, in the development of mass production methods, and hence, in glass usage. A quick review of highlights of the growth will help us to see why executives are convinced that the full potentialities of this interesting material are far from reached.

From the almost exclusive domain of the skilled craftsman, glassmaking has been built into one of our most important, most highly mechanized industries. Production in a recent year was valued at around $1.5 billion, or about one-third of the value of the nation's total output of ceramic products. In spite of increasing competition with other materials, the number of glass containers made each year is now about two-and-one-half times the prewar annual average. From 1930 to 1950, plate glass showed a tenfold increase in annual volume, and the production of sheet or window glass tripled. Glass-fiber output, expanding rapidly in recent years, has risen to 75 thousand tons annually.

Perhaps the most basic factor contributing to continued growth in glass usage is the ever-expanding versatility of the material itself. One leading glass manufacturer is said to have developed 50,000 formulas for the making of glass, which comprise combinations of practically all of the earth's 99 elements. From these formulas, it is possible to make glass products that are "lighter than cork or almost as heavy as iron, as strong as steel or as fragile as an eggshell, as soft as cotton, or hard as precious stones". Glass products can also be made to resist corrosive acids, exceptional heat, and violent, sudden changes in temperature; to transmit or absorb infrared, ultraviolet or X-ray bands of the spectrum, and to conduct or stop electricity.

Thus, in addition to the ordinary or lime-soda-silica glasses that make up the bulk of glass tonnage, we now have: (1) *borosilicate glasses* for ovenware, insulating material, chemical laboratory glassware, and hundreds of other uses including pipelines for hot corrosive liquids, boiler gage glasses, and centrifugal pumps; (2) *lead glasses* for neon tubing, electronic tubes, crystal glassware, and some optical prisms and lenses; (3) *opal glasses* for lighting globes, tableware, and decorative building panels; (4) *optical glasses* for most lenses and prisms used in microscopes, cameras, binoculars, rangefinders, and giant telescopes; (5) *colored glasses* used in signalware, light filters, and for colored incandescent lamps, tableware, and drinking glasses; and (6) *ninety-six per cent silica glasses* for chemical-laboratory ware, thermocouple sheaths, high-frequency furnace linings, and glass burner plates.

The development of glass fiber has brought revolutionary applications for glass. Glass fiber, in various forms of glass wool, is now used primarily for thermal insulation, sound control, air filters, and pipe wrap. However, glass fiber, further processed into filament fiber to form the base of a product, or to reinforce other materials such as textiles and plastics, has many growing or potential markets. Among these markets may be included, for example, draperies and curtains, window screens, boat and auto bodies, fishing rods, cable covers, twine, washing machine baskets, and upholstery cushions.

Among the highlights in the development of mass-production techniques during the past half-century, one might point to the adoption of continuous processing in practically all phases of glass manufacturing. Strides have been made in improving methods for the purification and handling of raw materials. The engineering of instruments and equipment to control various aspects of melting operations and to permit use of the most efficient fuels has been a key factor in progress.

One might also point to great improvements in fabrication and finishing equipment. Light bulbs, once blown by hand, are being produced at rates of around 60,000 per hour. Glass can be fabricated into fibers thinner than human hair and into 1600-pound windows for supersonic wind tunnels. Plate-glass rolling speeds of 80 to 90 inches per minute, in common practice ten years ago, are climbing toward 300 inches per minute, and the limit is not yet in sight. Strips of glass eight feet wide and up to 900 feet long can be ground and polished simultaneously on both surfaces. The development of techniques for coloring glass in thousands of different color tones, sealing metals to glass, and for metallizing glassware has been indispensable to expanded glass usage for certain applications.

According to a prediction of the President's Materials Policy Commission, the country's total consumption of glass by 1975 is expected to be double that of 1950. As in the past, a large part of the growth will result naturally from expansion of the nation's economy. Upward trends in the amount of glass used for a given application, as, for example, automobile windows, will continue to be an important factor. Increasing usage of relatively new products such as glass fiber and foam glass is seen in spite of their entrance into "unconventional" fields of application where competition with other materials is keen. Perhaps most important, however, will be the genius of the glass industry itself, whose unquenchable thirst for more knowledge about the properties of glass and the techniques of glass-making continues to extend the range of applications for glass in industry, science, and the home.

Editor's Note—While the views expressed on this page are not necessarily those of this bank, the *Monthly Business Review* is pleased to make this space available for the discussion of significant developments in industrial research.