621.3273
B952

56

Case study data on productivity and factory performance

FLUORESCENT LIGHTING FIXTURES

PN-ABI 196
73163

Case Study Data on Productivity and Factory Performance...
621.3273 Bureau of Labor Statistics, Washington, D.C. NTIS
B952 Case Study Data on Productivity and Factory Performance: Fluorescent Lighting Fixtures.
Jan. 1952.
46 p.
Prepared for MSA.

1. Lighting. 2. Fluorescent lighting. I. Title.
II. Factory Performance: Fluorescent Lighting Fixtures.

..I.D.
nce Center
1656 NS

JANUARY 1952

PREPARED FOR THE MUTUAL SECURITY AGENCY

Productivity and Technical Assistance Division

BY THE UNITED STATES DEPARTMENT OF LABOR

Maurice J. Tobin - Secretary

BUREAU OF LABOR STATISTICS

Ewan Clague - Commissioner

The collection of the data presented in this report has been made possible primarily through the generous cooperation of American manufacturers. In addition, the advice and assistance of many individuals in the industry, in trade associations, and labor unions have been most helpful. The men who have contributed their time and technical experience deserve particular thanks. They have made available data and information on man-hours, output, factory operations, production methods, managerial practices, and machinery which represent the results of many years of research and observation.

Measures to increase the productivity of industrial enterprises and to enlarge the output of goods and services per unit of input have long been recognized as important factors in increasing the standards of living. Exchange of data on industrial productivity and factory performance has proved to be an effective approach toward improved efficiency. Suggestions for improved manufacturing techniques are most useful when they are based on the actual work experience of existing plants, as are the examples presented in this paper.

The term productivity is defined as the ratio between a given quantity of production (output) to one or another of the various input factors that are required for such production. As used in this paper the input factor concerned is labor, the most important and universal factor and the one that provides the most generally useful common denominator for comparing the efficiency of productive methods and techniques in different units of an industry or between the same industries in different geographic locations.

Low man-hours per unit are the result of many factors, most of which are difficult, if not impossible, to isolate and measure. Inherent differences in the dexterities and abilities of individual workers and in their health and strength affect their production. So may their attitudes, morale, and social purposes. These may be important, but in general the variations in man-hours required per unit among different factories are due primarily to the efficiency and condition of the equipment with which the workers are supplied, the layout of the factory which determines the efficiency of the flow of raw materials and goods-in-process, the skill of management in planning and directing production processes, the aggressiveness of management in creating consumer demand and developing effective marketing procedures, the design of the product, and the quality of the raw materials. Highest productivity can never be achieved when one or more of these factors is deficient.

The material in this report constitutes one aspect of the variety of services offered in the Technical Assistance Program.

PN-ABI-996

Case Study Data on
Productivity and Factory Performance

FLUORESCENT LIGHTING FIXTURES

(Based on reports submitted by seven selected industrial fluorescent lighting fixture plants)

Prepared for
Mutual Security Agency
Productivity and Technical Assistance Division

by

United States Department of Labor
Bureau of Labor Statistics

January 1952

b

Case Study Data on
Productivity and Factory Performance

FLUORESCENT LIGHTING FIXTURES

TABLE OF CONTENTS

Part I: General Report — Page

High Lights 1
Arrangement of the Report 2
Sequence of Operations 2
Plant and Product Characteristics 5
The plant 5
The product 7
Departmental Characteristics 7
Metal forming 7
Metal finishing 8
Assembly 8
Packing 9

Tables

Table A. Man-hours per unit by direct and indirect labor, in seven selected industrial fluorescent lighting fixture plants U.S.A., 1951 4

Table B. Man-hours per fixture, by departments, in seven selected industrial fluorescent lighting fixture plants, U.S.A., 1951 6

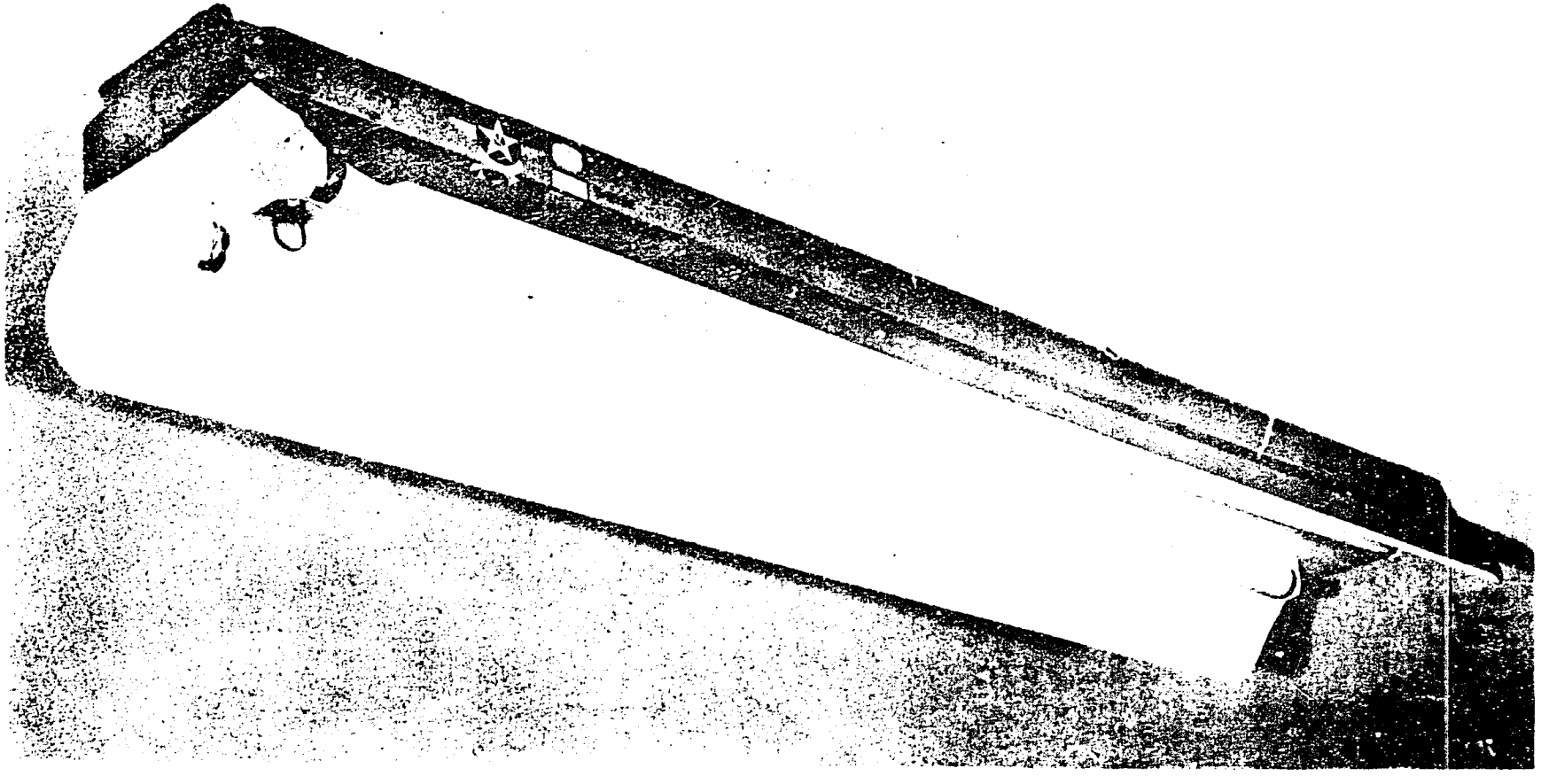
Illustrations

Fig. A. Typical material and product flow in a fluorescent fixture factory 3

Fig. B. Assembly operations in a fluorescent fixture factory 5

Part II: Detailed Report
Table of Contents 11

Part III: Supplementary Information
Table of Contents 33



Industrial fluorescent lighting fixture with two 48-inch lamps. Courtesy Electro Manufacturing Corp.

Case Study Data on
Productivity and Factory Performance

FLUORESCENT LIGHTING FIXTURES 1/

Part I: General Report

High Lights

Industrial lighting practices have undergone radical changes in the United States in the past decade. Practically all new industrial plants, and many older ones, feature "line" lighting as exemplified by various types of fluorescent lamp fixtures. High light output per watt of electricity, long service life, cool operation, and the absence of glare and dark shadows are the major reasons for the popularity of these lamps. Fluorescent lighting provides efficient factory and shop illumination and has frequently contributed to better working conditions and increased productivity.

The fluorescent light fixture manufacturing industry is characterized by the great range in size of the manufacturers. The largest electrical companies in the United States operate plants in this field and competing successfully with these large establishments are plants employing 20 persons or less.

Specialization of plants and equipment to the product, the ready availability from outside suppliers of all electrical components, and the maximum use of assembly-line type of operations enable one of the American factories included in this report to produce a fluorescent lighting fixture with 15 man-minutes of direct labor. The range of labor time requirements shown in table A is attributable chiefly to differences in the efficiency of plant layout among the various factories and to differences in the effectiveness of equipment used.

Fluorescent light fixtures are manufactured in plants devoted exclusively to the purpose. Most manufacturers fabricate the metal fixture and other metal parts, and do their own enameling and finishing, but purchase all the electrical components from outside suppliers. Some of the smaller manufacturers have the enameling done by outside contractors since enameling equipment requires an elaborate installation for efficient low-cost operation. Similarly, many of the larger plants, which are equipped to do enameling, accept contract enameling jobs for any product for which their equipment can be readily adapted.

Continuous conveyors, carefully timed to enable operations to be performed without removing the units from the conveyor, may be used from the metal forming department to the packing department. Some

---

1/ Prepared by Arthur Lentz, Economic Analyst, Division of Productivity and Technological Developments, Bureau of Labor Statistics, U.S. Department of Labor.

plants remove the unit for spraying, but the conveyor is so timed that the product may be removed, sprayed, and replaced without interrupting the flow of the conveyor line.

Arrangement of the Report

Part I of this report, written primarily for readers with a broad interest in productivity in the fluorescent lighting fixture industry, presents an outline of the basic work flow in a typical plant, a table showing man-hour requirements per unit in the seven plants selected for study, and describes briefly some characteristics of the plants and their products.

Part II, designed principally for use by production technicians, presents man-hour requirements of the departments and of the operations performed in the manufacture of fluorescent lighting fixtures. Detailed information on plant characteristics is also included.

Part III of the report contains a brief account of some outstanding features of the industry as a whole, a set of production control forms typical of those used by the industry, and a glossary of terms.

Sequence of Operations

The production of fluorescent lighting fixtures begins with the receipt of the sheet steel, small stock items, paint, and electrical components required to manufacture the finished product. The steel is piled beside the presses while the various other parts are moved to special storerooms.

The metal forming or fabrication department blanks out the long strips of sheet steel into appropriate sizes and shapes on large presses. The blanks are then pierced with punch presses, and cut to final shape with power shears. The final operations in the metal forming department are performed on press brakes which bend the sheet steel parts into proper form. The reflectors move from the fabrication department directly to the finishing department. The components of the channel, which is the strength-member or backbone of the fluorescent lighting fixture and which houses the electrical parts, are sent from fabrication to the channel subassembly department, usually by hand trucks.

In the channel subassembly department, the finished parts reach the assembly benches where the channel body, end plates, connectors, stiffeners, and saddles are welded together to become the completed channel. The completed channel moves by conveyor to the finishing department.

The metal finishing department receives the reflector and the assembled channel for final finishing. The parts are first dipped into a rust-resistant solution, in a process called bonderizing. After drying, the parts are dipped into a paint base or ground coat and

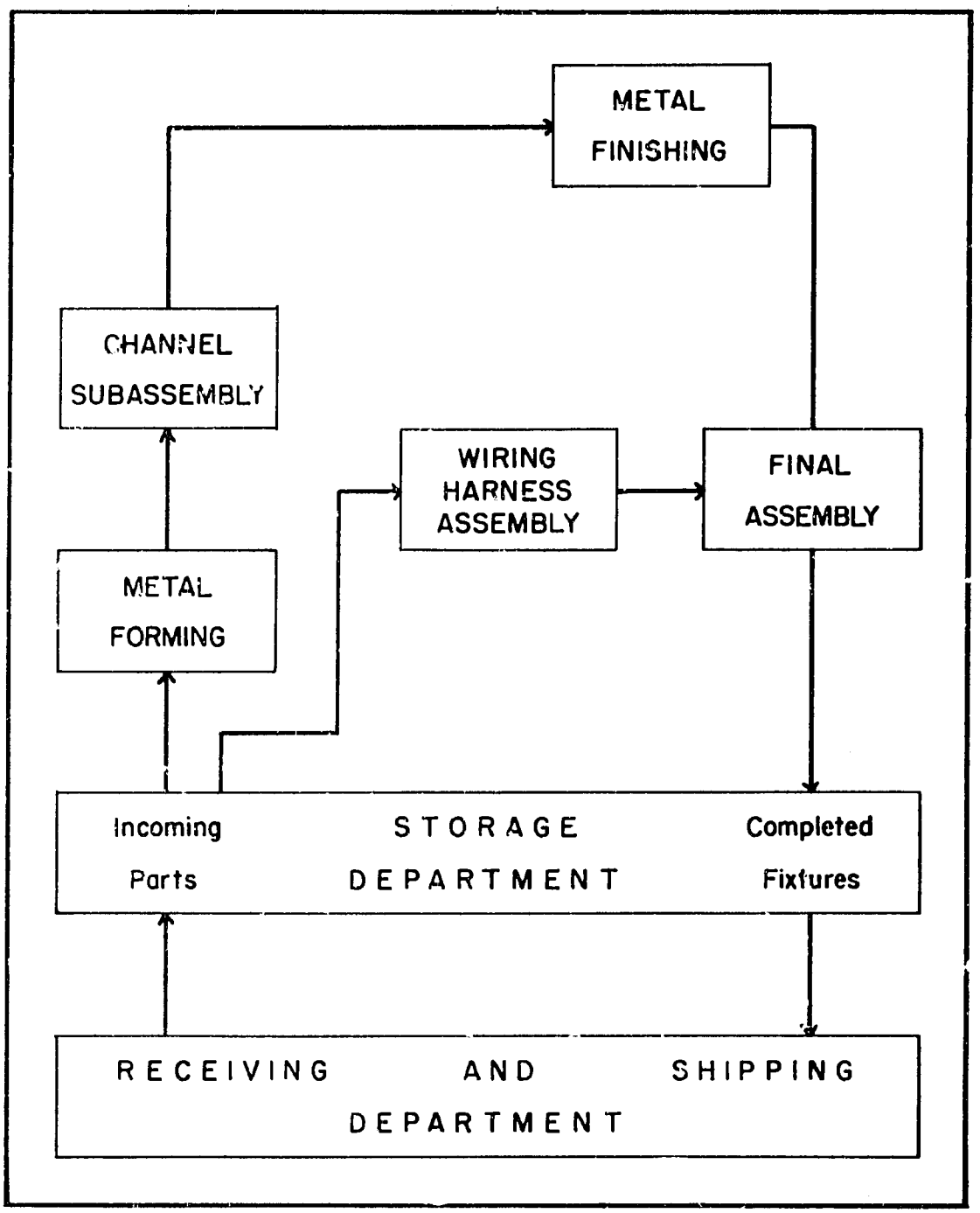


Fig. A Typical material and product flow in a fluorescent fixture factory.

baked in an oven at a temperature of about 1500 degrees Fahrenheit. Finally, the parts are sprayed with enamel, white for the inside surfaces of the reflector and gray for the channel and the outside of the reflector, and baked again. In the best equipped plants, the units travel through the baking oven on conveyors which continue through the drier. The reflectors are sent to the packing department and the channels to the final assembly department.

In the meantime, the wiring harness, composed of the starter, ballast and other electrical parts, is wired together by workers along assembly benches. These benches usually include endless belt conveyors which carry the growing assembly along the line of work stations. The completed wiring harness moves directly to the final assembly department.

The last steps of the actual manufacturing process take place in the final assembly department. There the wiring harness is installed

Table A. Man-hours per unit of direct and indirect labor, in seven selected industrial fluorescent lighting fixture plants, U.S.A., 1951

Plant	Number of man-hours per fixture 1/			Percent of indirect to total	Number of production employees
	Total	Direct	Indirect		
A	0.43	0.28	0.15	34.8	25-50
B	.31	.25	.06	19.4	400-450
C	.98	.38	.60	61.2	400-450
D	.83	.72	.11	13.3	25-50
E	1.60	1.06	.54	33.8	100-150
F	1.25	1.06	.19	15.2	200-250
G	.65	.49	.16	24.6	200-250

1/ See page 15 for variations in products for which data were reported.

Notes on Table A

A considerable range exists, among the plants surveyed, in the number of man-hours expended per fixture. These differences in man-hour requirements among the plants are due to the characteristics of the plants and products which are pointed out in the text. An explanation of the differences in the percent of indirect to total man-hours appears in Part II of this report. The code letter for each plant is retained throughout the report.

in the finished channel. A thorough inspection for appearance, mechanical fitness, and electrical soundness is part of the final assembly procedure.

In the packing department, the assembled channel is packed separately from the reflector to minimize damage to both and to reduce the size of the shipping carton. From the packing department, the cartons of completed fluorescent lighting fixtures move to the shipping dock, ready to be installed and put into service.

Plant and Product Characteristics

The plant. The seven plants covered in this survey differed from each other in number of production employees, in degree of integration of the manufacturing process, in the specifications of the product for which data were reported, and in the number of different products produced in the plant. All of these factors undoubtedly affect the number of man-hours required to produce a fluorescent lighting fixture.

The number of production employees reported by the seven plants varied from 30 to 425. In 1947, the latest year for which census data

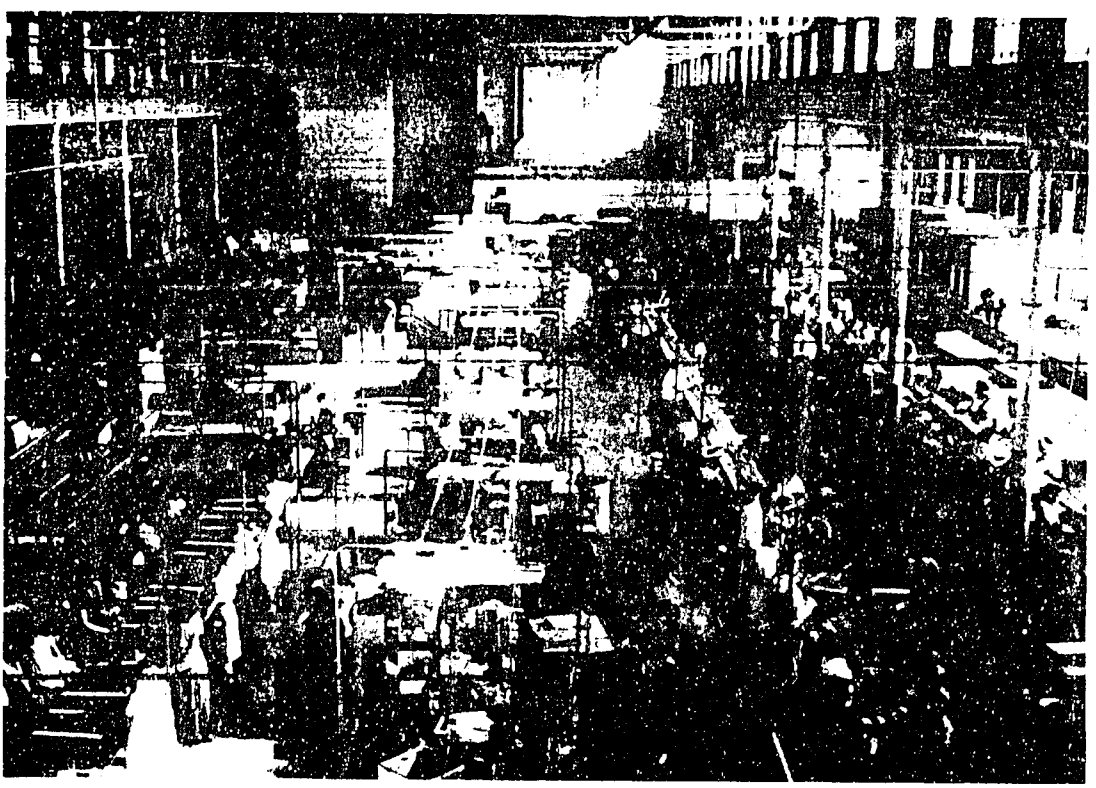


Table B. Man-hours per fixture, by departments, in seven selected industrial fluorescent lighting fixture plants, U.S.A., 1951

	Direct man-hours per unit 1/			
Plant	Metal forming	Channel assembly	Wiring assembly	Final assembly
A	na*	0.0333	0.0833	na
B	0.1531	.0372	2/ .0585	0.0446
C	.0710	.0471	.0551	.0869
D	.0404	.0378	.1350	na
E	na	.0424	na	na
F	.1350	.0291	.0600	.0875
G	.0768	na	na	na

* na Not available.

1/ The figures in table B will not total to direct man-hours per unit as shown in table A because not all departments are included.

2/ Includes packing.

is available, the 1,206 establishments engaged in manufacturing lighting fixtures and equipment of all types employed an average of 33 production and related workers for each plant. Four of the seven plants surveyed for this study employed 200 or more production workers. The number of production workers for each plant is indicated in table A.

All plants fabricate the metal body of the fixtures from sheet steel purchased in bulk, purchased all electrical components, and assembled the product. The principle variations in the integration of the manufacturing process occur in connection with the finishing operations. The smaller plants usually subcontract the finishing operations to outside firms. These plants find that their output is too small to warrant the installation of enameling and baking equipment. Therefore, when the metal parts are fabricated and ready for finishing and assembling, they are sent to the subcontractor for finishing and then brought back to the plant for assembling and wiring. The two smallest plants in this study subcontract all finishing operations; the other plants have their own finishing department, and plant B reported that it does some enameling work on contract for other firms.

The product covered by this report is an industrial type fluorescent lighting fixture. All of the plants in this report manufactured both industrial and commercial (office and store) fluorescent lamp fixtures. Plants B, C, E, F, and G also make incandescent lighting

fixtures, and Plant C devotes a small part of its efforts to items not connected with lighting.

The product. The product covered by this report is an industrial fluorescent lighting fixture with two 48-inch, 40-watt lamps. The reflector is an open-end model 12 to 13 inches wide and 48 to 54 inches long, made of sheet steel and finished in white porcelain enamel for the interior surfaces with a gray porcelain enamel exterior. The complete fixture weighs 25 to 30 pounds and is priced at the factory at $25 to $30. Each plant making fluorescent light fixtures manufactures several models differing in body style, number of lamps, length of lamps, and auxiliary equipment.

Several of the plants surveyed reported data for models which vary slightly from the description given above. Plant A reported upon a one-lamp, slim-line fixture; plant C reported data for a model with a closed-end reflector; the model reported upon by plant E includes a louver for ventilation; the model reported by plant F varies from the "standard" product in having a closed-end reflector and a smaller channel.

All types of accessories, such as chains and cords for mounting, clamp hangers, longitudinal louvers, end-plates, and connectors are manufactured for stock and supplied to customers as extra items or for replacement.

Departmental Characteristics

The general procedure in the manufacture of industrial fluorescent fixtures includes the fabrication of the metal parts composing the channel, the fabrication of the reflector, the finishing of these metal components, and the final assembly and packing of the fixture. All electrical components are purchased from specialized outside sources, and are assembled and installed in the fixture by the manufacturer. The industrial fluorescent fixture is composed of the parts listed below.

Parts stamped and formed from sheet metal to make the channel:

1 channel body	saddles
2 end plates	stiffeners
2 connectors	1 reflector

Electrical parts:

ballast	sockets
lampholder	starters
	wire

Metal forming. The sheet-metal parts are stamped out on a press using dies especially made for the purpose. Different sets of dies are required for each of the parts. After the blanks have been stamped

out, three basic operations are performed; shearing, piercing, and forming. The metal blanks are squared off on a power shear. The parts require piercing at various points for mounting and connecting. The average fixture has about 24 holes and louvers for ventilation. A variation from the practice of piercing and drilling holes is to flange the top of the channel so that the fixture can be mounted by a clamp hanger strap rather than with bolts and nuts. The shaping of the metal parts, such as the channel body, is done on a press brake where the edges are bent at an angle to the main body.

All the plants in the survey have die departments for the maintenance of specially designed dies required for stamping, piercing, and shaping. These departments also do a limited amount of die manufacturing.

Metal finishing. The shaped parts are finished by either dipping or spray painting. The metal is first cleaned and bonderized. A high bake enamel is used to provide a chip and peel resistant finish. The metal pieces are dipped into the ground coat and baked by passing through the enameling furnace at a temperature of about 1500° F. The outside and inside coats are applied by spraying and the part is passed through the oven again. The channels and reflector are usually finished gray outside with the inside of reflectors done in white of high reflecting ability. The finishing process requires a large percentage of the direct labor time. Two of the smaller plants in the survey subcontract the finishing operation to outside firms since this operation requires expensive equipment.

Assembly. The channel must be rigidly constructed since it carries the reflector, the wiring, the lamps, and the mounting. Connectors are inserted in the channel body to provide rigid alignment, continuous wire way, and electrical ground. The socket saddles and stiffeners are welded into the channel body. Finally the end-plates and the studs for attaching the reflector are welded to the body to form the channel sub-assembly.

All the electrical components bought from outside sources are assembled to form the wiring sub-assembly. The wire-ends are stripped and connected, and the starters and ballasts are assembled.

The fluorescent lamp is supported in the fixture by an insulated lampholder through which connections are made from the operating circuit to the contact pins on the end of the lamps. The lampholder is attached to a base with a socket for holding a starter switch and making the necessary electrical contacts to the switch. The switches are enclosed in small cylindrical metal shells with contact pins on the end that go into the socket. A separate starter is required for each lamp. The starter and lampholder sub-assembly is installed into the channel.

The ballast is installed in series with one side of the line. The ballast is an inductance or choke coil which adjusts the voltage to the lamp. In fluorescent lighting the ballast supplies a voltage higher than that from the line at the instant of starting, and a

voltage lower than that from the line while the lamp continues in operation. To start a fluorescent lamp, a momentary voltage higher than that from the 110-125 volt lines is necessary to establish the electronic discharge through the gas inside the tubing.

Packing. The finished channel, completely wired with the ballast and sockets, is packed carefully. The reflector is wrapped separately from the channel, but both are placed in the same carton.

The industrial fluorescent fixture comes in many styles and sizes. The models differ in body style (glass enclosed, shape of reflector, louvered, etc.), number of lamps, and the length of fixture and auxiliary equipment, all of which complicate the packing operation.

PARTS II AND III

Parts II and III of this report are intended for the use of technical readers in comparing plants in their experience with the American plants included in this survey. Part II presents detailed information on the plant and product characteristics, production practices, and an analysis of man-hour requirements per unit by departments and by selected operations. Part III of the report includes an account of the industry in economic terms, a detailed description of typical features of the product, an example of the production control forms used by this industry, and a glossary of selected technical terms.

Case Study Data
Productivity and Factory Performance

FLUORESCENT LIGHTING FIXTURES

TABLE OF CONTENTS

Part II: Detailed Report — Page

Comparative Plant Performance 13
Man-hours per unit of product 13
Metal forming 17
Metal finishing 19
Assembly 21
Production Practices 25
Materials, parts and components 26
Scheduling 26
Standardization 28
Design 28
Methods improvement 29
Inspection 30
Production control 30

Tables:

Table 1. Man-hours expended per fixture in seven selected industrial fluorescent light fixture plants, U.S.A., 1951 13

Table 2. Man-hours expended per 100 fixtures in the metal forming department in seven selected industrial fluorescent light fixture plants, U.S.A., 1951 17

Table 3. Man-hours expended in machining 100 channel bodies, in six selected industrial fluorescent light fixture plants, U.S.A., 1951 18

Table 4. Man-hours expended in machining 100 end plates in four selected industrial fluorescent light fixture plants, U.S.A., 1951 19

Table 5. Man-hours expended in machining 100 reflectors in five selected industrial fluorescent light fixture plants, U.S.A., 1951 19

Table 6. Man-hours expended to finish and enamel 100 channels and reflectors in four selected industrial fluorescent light fixture plants, U.S.A., 1951 22

Table 7. Man-hours expended per 100 fixtures, by operations in seven selected industrial fluorescent light fixture plants, U.S.A., 1951 25

Table 8. Components and materials purchased by typical industrial fluorescent light fixture plants, U.S.A., 1951 . . . . . Page 26

Table 9. Parts and accessories manufactured in seven selected industrial fluorescent light fixture plants, U.S.A., 1951 27

Table 10. Production methods and production of fixtures in seven selected industrial fluorescent light fixture plants, U.S.A., 1951 28

Table 11. Number of employees in design and engineering departments in seven selected industrial fluorescent light fixture plants, U.S.A., 1951 29

Illustrations:

Fig. 1 Power press blanking the channel body 14

Fig. 2 Press brake shaping the channel 16

Fig. 3 Spraying enamel on assembled fluorescent lighting reflector 20

Fig. 4 Fluorescent lighting reflectors ready for baking in an oven 21

Fig. 5 Installing wiring in channel. Note pneumatic nut-runners used to fasten parts to channel 22

Fig. 6 Detail drawing of an industrial fluorescent lighting fixture 23

Fig. 7 Monorail conveyor carrying fluorescent reflectors from oven to drier 24

Case Study Data on
Productivity and Factory Performance

FLUORESCENT LIGHTING FIXTURES

Part II: Detailed Report

Comparative Plant Performance

The man-hours expended per unit of output by the seven plants selected for study, shown in Part I of the report and repeated for convenience below, may be usefully analyzed in terms of the man-hour requirements of departments and of operations within departments. The first half of Part II is devoted to such as analysis. The second half presents information on production practices in fluorescent lighting fixture manufacture.

The "Case Study" method of presentation is used in this report. Unless otherwise noted, figures refer to actual plants, departments, and operations. Averages which may be computed from the data should be handled with caution because production figures have not been reduced to a common unit of output.

Man-hours per unit of product. Total, direct, and indirect man-hours per fixture, and the percent of indirect to total man-hours, are shown for each plant. In the next section of the report, man-hours expended per 100 fixtures (or pieces) are shown by department and by operation for each plant. The individual plant data are based on a representative

Table 1. Man-hours expended per fixture in seven selected industrial fluorescent light fixture plants, U.S.A., 1951

Plant	Man-hours per fixture			Percent indirect to total man-hours
	Total	Direct	Indirect	
A 1/ 2/	0.43	0.28	0.15	34.8
B 2/.	.31	.25	.06	19.4
C	.98	.38	.60	61.2
D 2/.	.83	.72	.11	13.3
E	1.60	1.06	.54	33.8
F	1.25	1.06	.19	15.2
G	.65	.49	.16	24.6

1/ Single-lamp fixture; all other plants reported on a double-lamp fixture.
2/ Enameling operations not included.

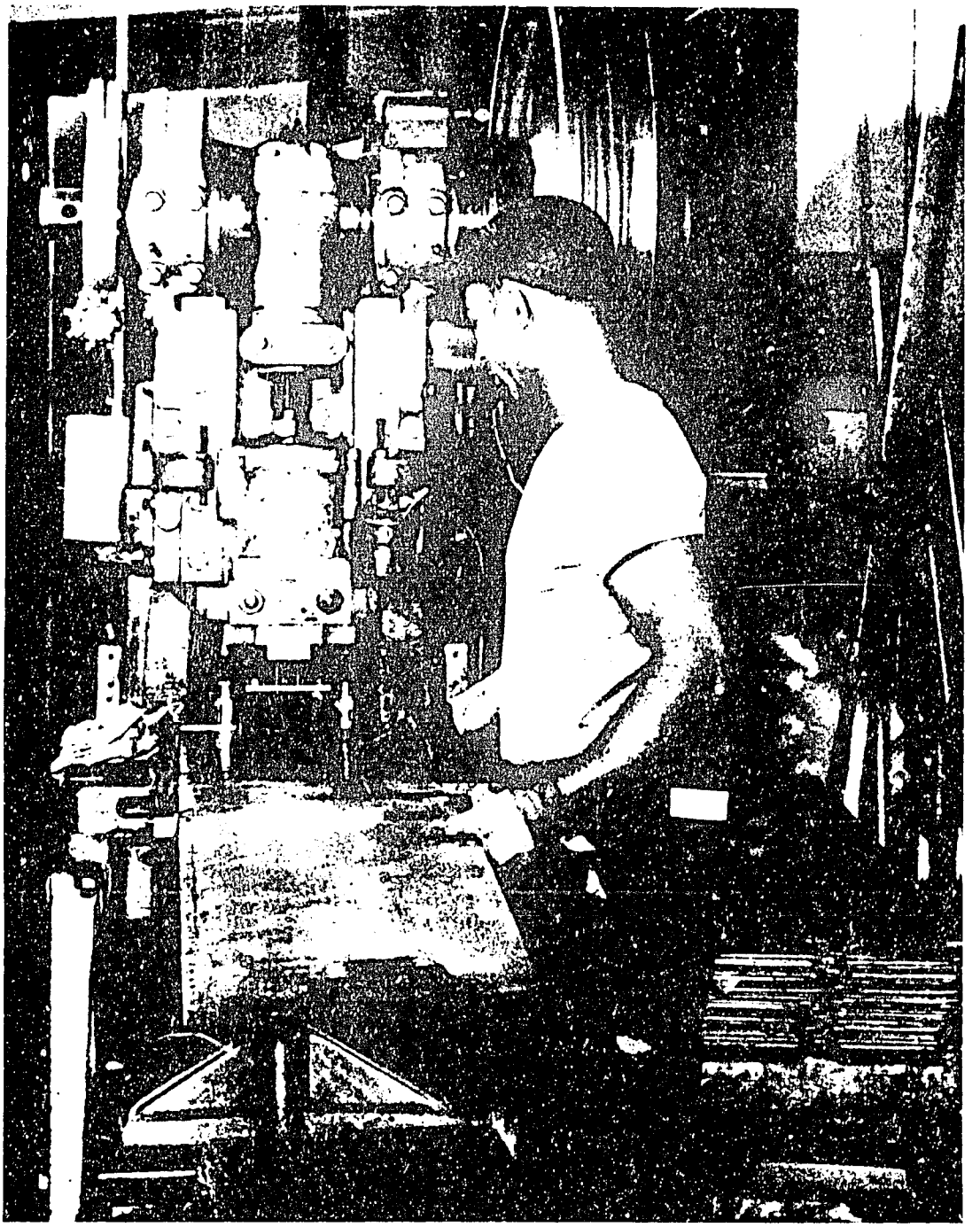


Fig. 1 Power press flanking the channel body.

period, usually a month, selected from the first six months of 1951. The plants are designated by the first seven letters of the alphabet. This letter code is used consistently throughout the report.

The seven plants surveyed follow similar patterns in purchasing materials and fabricating parts. The electrical components of the fluorescent lighting fixture, which include the ballasts, lampholders, starters and wire, are purchased from outside sources, while the metal parts of the fixtures are fabricated in the plants. A difference appears between plants in the number of processes included in man-hours per fixture because plants A, B, and D do not report enameling as a part of the total man-hours per fixture. Plant G reported man-hours below the average for the seven plants although enameling is included in its total man-hours per fixture.

Plant A reported on a one-lamp slimline model which is a simpler design than the two-lamp unit reported by the other six plants. This may be a contributing factor to the low man-hours per fixture reported by plant A. Plants C and F report on a closed-end reflector which requires more man-hours than the open-end model. Plant E makes a louvered style channel which contributes to its higher man-hour requirements. Similar methods of manufacturing are followed by all the plants regardless of style or model.

The factory price range for the fluorescent fixture reported for these plants is $25.00 to $30.00. Labor cost is a minor part of the total cost of the fixture.

The classification of labor into direct and indirect functions is about the same in all the companies in the study. One of the smaller manufacturers classified all his workers as direct and allocated a certain percent as indirect labor since the employees do their own set-up, maintenance, and inspection. A difference of opinion appears among the plants in classifying packing. Because the product is fragile and secure packaging is essential to successful transportation, a majority of the companies classify packing as a direct labor function. The following occupations are reported by the manufacturers as accounting for the indirect factory labor in the plants:

Shipping	Timekeeper
Maintenance	Supervision
Repair	Trucking
Stockkeepers	Material-handlers
Receiving	Firemen
Tool and die	Janitor

Packing - two plants

Plants C, A, and E have the highest percentages of indirect labor. These three plants, respectively are large, medium, and small in size, and hence show that the amount of indirect labor per unit reported is not entirely a matter of size of plant. Indirect labor per unit seems to be due chiefly to the decisions of each firm as to what functions will be classified as indirect labor, to the extent of mechanization of

Fig. 2 Press brake shaping the channel.

Table 2. Man-hours expended per 100 fixtures in the metal forming department in seven selected industrial fluorescent light fixture plants, U.S.A., 1951

Plant	Direct man-hours per 100 units	Number of operators (metal forming dept.)
A	na*	15
B	15.31	150
C	7.10	110
D	4.04	15
E	na	55
F	13.50	55
G	7.68	40

* na Not available.

handling operations, to the performance by some plants of indirect functions such as trucking which are a contract item in others, and to the difficulties of imputing indirect labor to one product of a multi-product plant.

Direct man-hours expended for each fixture in the plants may be further analyzed by comparing the man-hour requirements of the departments and of the operations performed. For the purpose of this analysis, the data are presented in the order of the department and operation sequence in the plants.

Metal forming. The metal forming department includes all the operations involved in making the metal parts of the fixture. Three basic working operations are performed, shearing, piercing, and forming. The direct man-hours for each operation are shown for each metal part, making possible comparisons between plants for machining the channel, the reflector, and the end plates.

Table 2 presents direct man-hours expended per 100 fixtures for fabricating the lighting fixture, and the number of operators employed in each department.

Differences in the man-hour requirements of fabrication among the various plants may be partially explained by the differences in the number of parts machined and in the style of the fixture. Plant B machines a reflector bracket, a part of the reflector; other plants do not. However, subtracting the time for machining a reflector in plant B, still results in high man-hours for this firm.

Table 3 presents data on machining the channel body which includes the shearing operation generally done on a power shear, piercing accomplished by various sets of dies on a punch press, and forming done on a press brake. Many operations are involved in piercing, shearing, and forming. In order to compare these performances, the time used for the total number of operations in each procedure is shown. Plant F uses a different construction for its channel body, as compared with the other plants, which is reflected in a higher man-hour figure. The channels of the other plants are of comparable design.

Table 4 presents man-hours expended per 100 pieces for machining the end plates, one of the major components of the channel. Each channel requires two end plates that are sheared, pierced, and formed into the proper shape. The power shear, the press brake, and the punch press with various sets of dies are used for this machining job. The four plants which have data on this operation have a range from 1.13 man-hours to 2.00 man-hours per 100 pieces. These data indicate that machining of the end plates is a highly standardized operation.

Table 5 presents the direct man-hours per 100 pieces for machining the reflector. The level of illumination of the fluorescent fixture is greatly affected by the construction and finish of the reflector. Extreme care is essential in bending the sheet steel to the proper lateral shielding angle to eliminate glare. The press brake is used in this forming process. The same kind of shearing, piercing, and forming operations are used in making the reflector as in making the channel and end plates. A considerable range is apparent between plant D and plant F, the plants with the lowest and the highest man-hour requirements. Some of the difference can be explained by variations in design of the reflector.

Table 3. Man-hours expended in machining 100 channel bodies, in six selected industrial fluorescent light fixture plants, U.S.A., 1951

Plant	Direct man-hours per 100 pieces			
	Shearing	Piercing	Forming	Total
B	1.03	0.60	3.19	4.82
C	.58	.36	.80	1.74
D	.32	.81	1.62	2.75
E	.99	1.04	.99	3.02
F	1.60	1.60	2.04	5.24
G	.82	(1)/	1.45	2.27

1/ Piercing and forming combined.

Metal finishing. After the metal parts of the fluorescent fixture have been fabricated, the parts must be finished either by painting, plating, or enameling. The product specifications for this study include a porcelain enamel finish on the inside and outside of the channel and reflector. Five of the plants in the survey have finishing departments. The general process is similar in these plants but the individual operations differ. A typical procedure starts by dipping the reflector and channel in the ground coat, baking the reflector and channel, spraying on gray enamel, putting them on the conveyor line to fire the enamel, spraying on the white enamel, firing the enamel, and finally inspecting the reflector and channel to R. L. M. standards.

Table 6 presents direct man-hours per 100 fixtures for enameling the channel and the reflector - the two principal parts - and the number of operators in each finishing department. Plants C and F report complete enameling man-hours and the total finishing time compares

Table 4. Man-hours expended in machining 100 end plates in four selected industrial fluorescent light fixture plants, U.S.A., 1951

Plant	Direct man-hours per 100 pieces			
	Shearing	Piercing	Forming	Total
C	0.14	0.72	0.27	1.13
D	.32	.32	.54	1.18
F	na*	na	na	1/ 2.00
G	.82	(2)/	.36	1.18

* na Not available.
1/ Includes all 3 operations.
2/ Piercing and forming combined.

Table 5. Man-hours expended in machining 100 reflectors in five selected industrial fluorescent light fixture plants, U.S.A., 1951

Plant	Direct man-hours per 100 reflectors			
	Shearing	Piercing	Forming	Total
B . . .	1.55	0.62	2.74	4.91
C . . .	1.62	.46	.64	2.72
D . . .	.47	.81	.81	2.09
F . . .	1.60	1.98	1.50	5.08
G . . .	.82	.64	2.18	3.64

favorably for these two plants. However, the breakdown for enameling the reflector and the channel shows wide variations. Plant C bonderizes and enamels the metal parts before they are assembled. Plant F assembles the channel and reflector completely and then enamels these subassemblies. Thus the individual operations on the channel and reflector differ between the plants but the total man-hour requirements for finishing are practically the same in spite of the different methods involved.

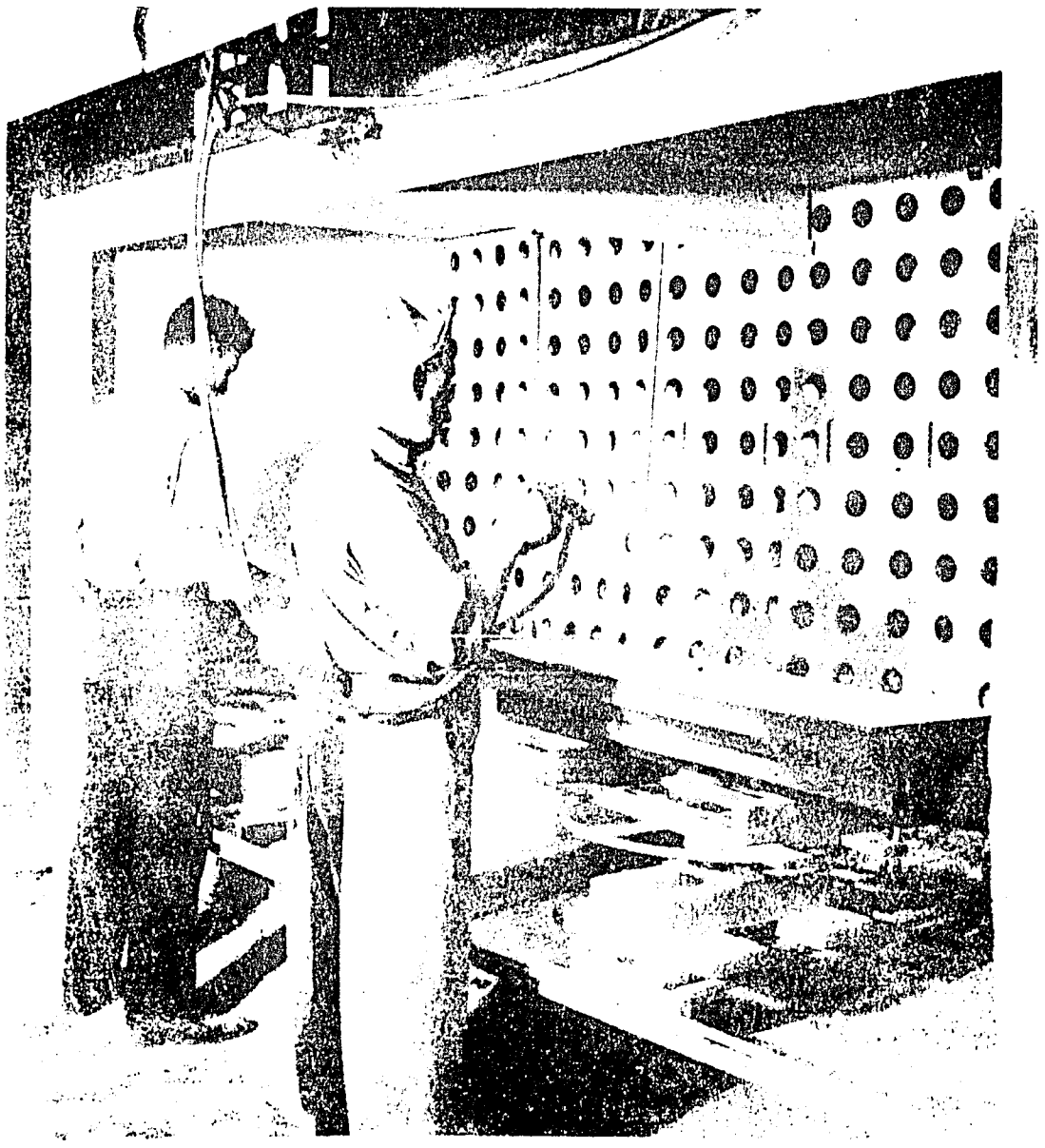


Fig. 3 Spraying enamel on assembled fluorescent lighting reflector.

The size of department as shown by number of operators has little effect on man-hours per unit. Plant F has 78 percent more workers in its finishing department than plant C but the total man-hour requirement is about the same. Plant E with only 17 employees shows low man-hour requirements in enameling the channel, but the absence of data on reflectors precludes comment on the effect of the number of operators on total man-hour requirements.

Assembly. Fabricating and finishing metal parts forms one of two sub-flows of production, while the assembly of purchased electrical components form the other. The fabricated metal parts are assembled into the channel sub-assembly while the sockets, ballasts, and starters are assembled and wired. The two sub-assemblies meet in final assembly where the wiring harness is installed into the channel.

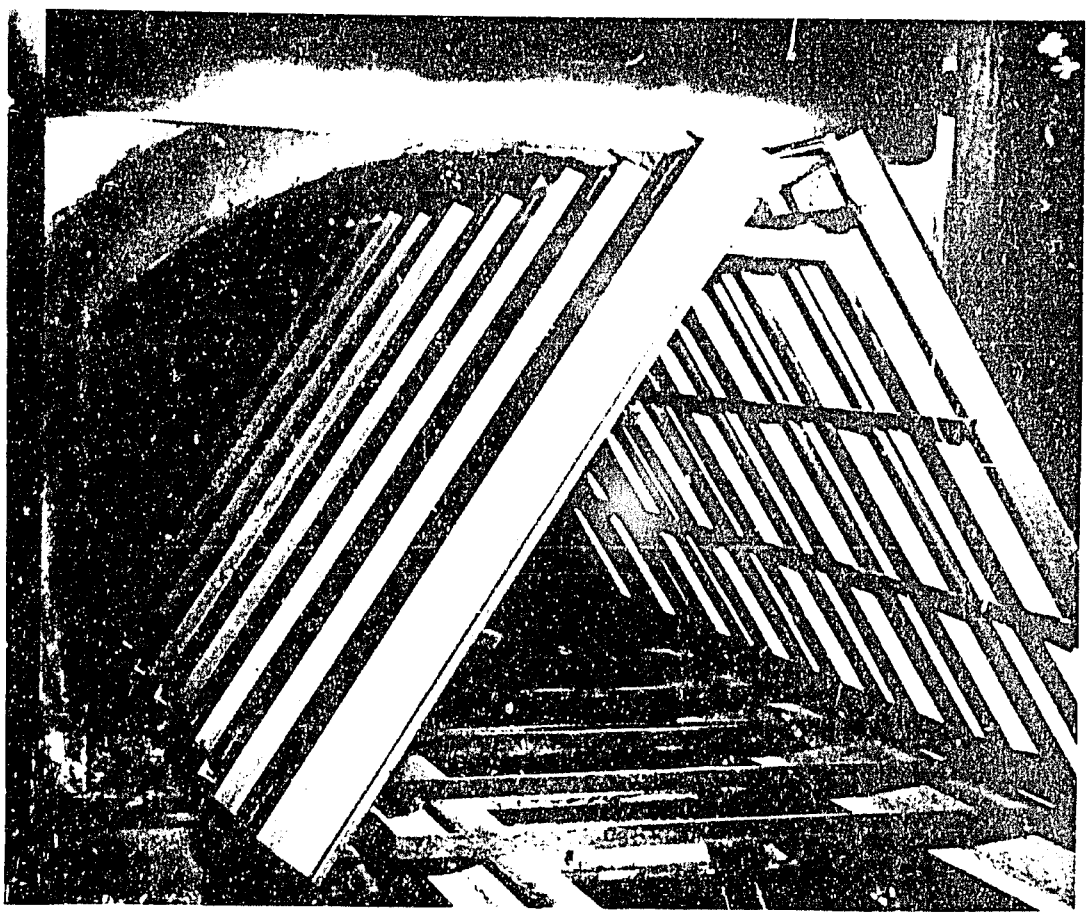


Fig. 4 Fluorescent lighting reflectors ready for baking in an oven.

Fig. 5 Installing wiring in channel. Note pneumatic nut-runners used to fasten parts to channel.

Table 6. Man-hours expended to finish and enamel 100 channels and reflectors in four selected industrial fluorescent light fixture plants, U.S.A., 1951

Plant	Direct man-hours per 100 units			Number of operators (Finishing dep't.)
	Total finishing time	Enameling channel	Enameling reflector	
B	na*	na	na	64
C	8.52	6.32	2.20	41
E	na	2.37	na	17
F	8.68	4.34	4.34	73

* na Not available.

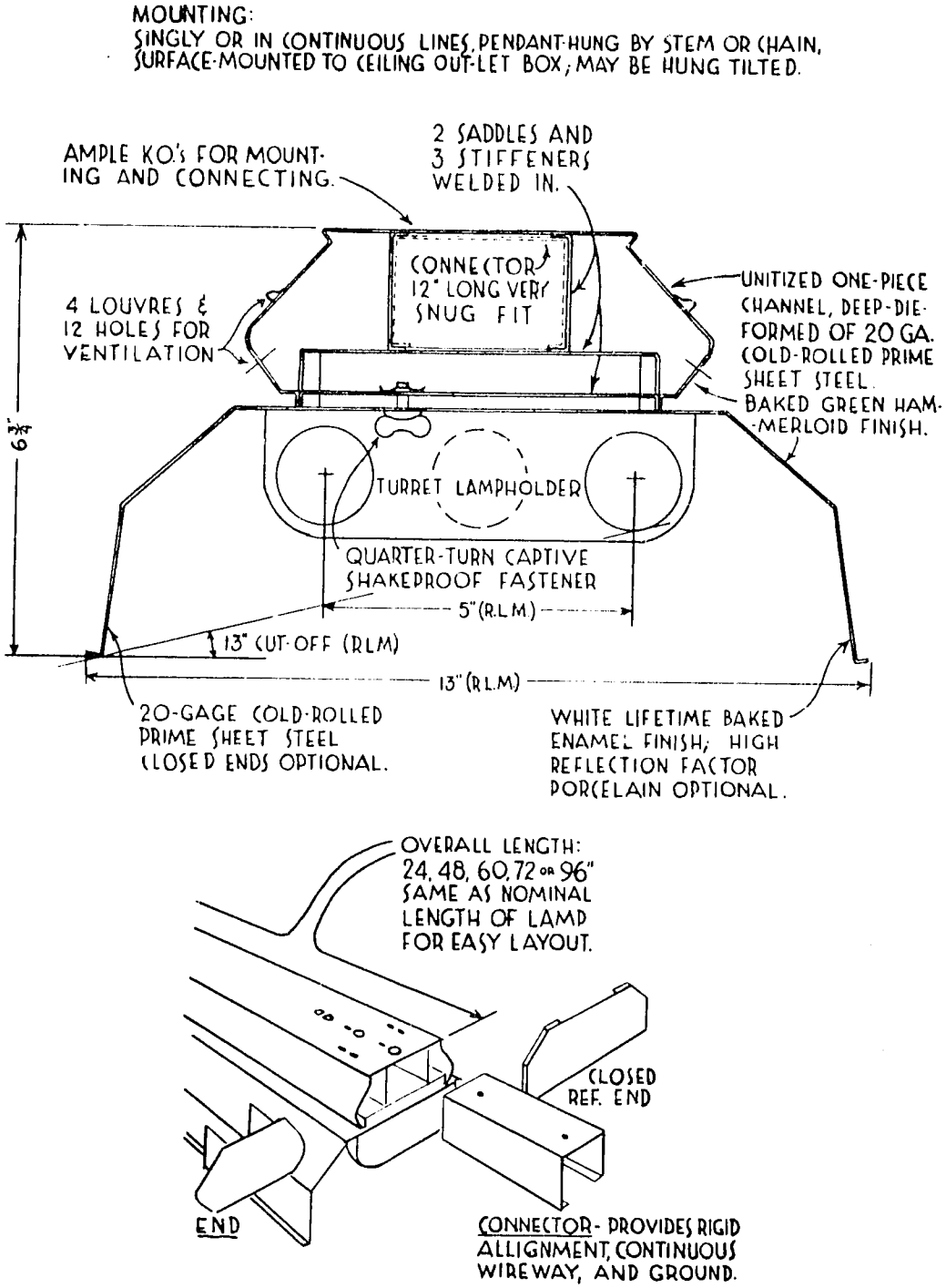


Fig. 6 Detail drawing of an industrial fluorescent lighting fixture.

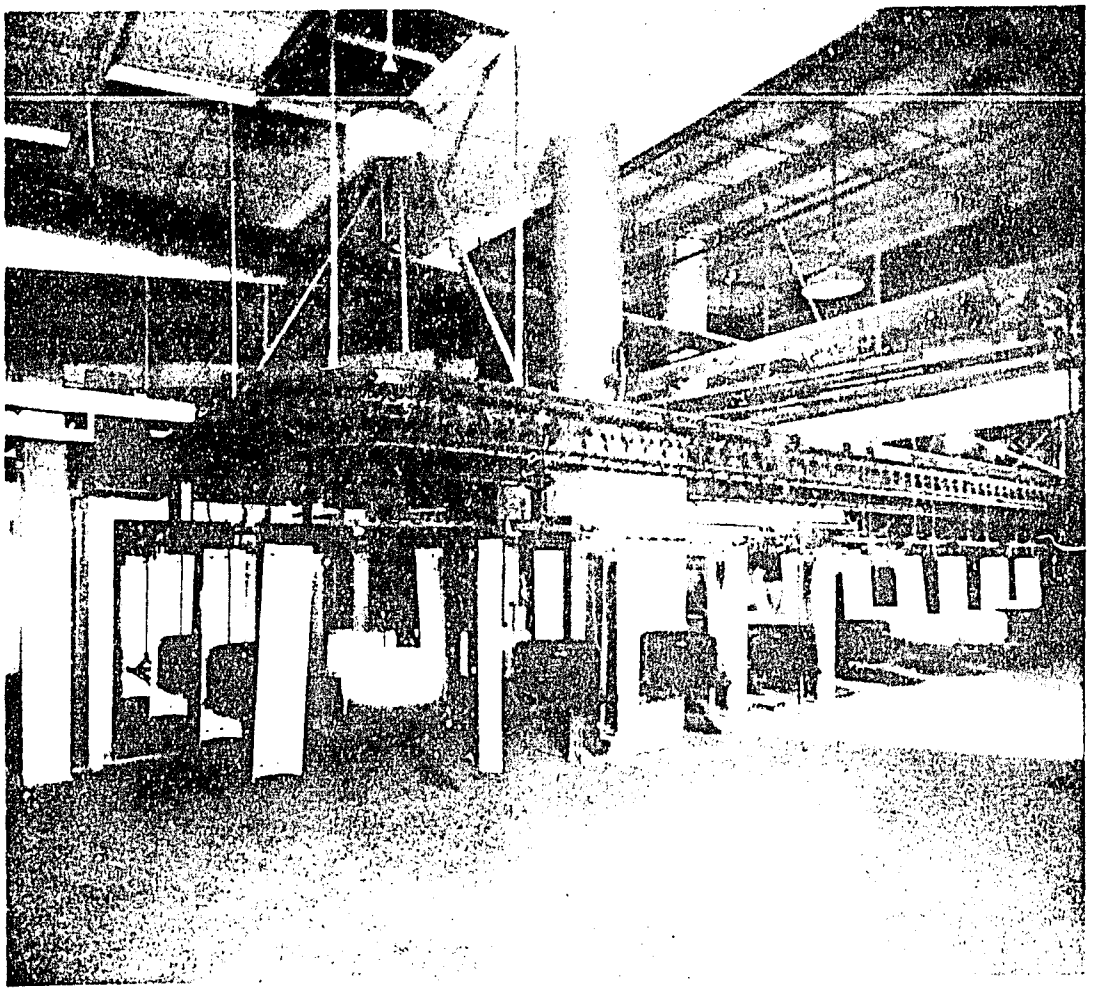


Fig. 7 Monorail conveyor carrying fluorescent reflectors from oven to drier.

Channel subassembly consists of inserting the connectors, welding the socket saddles and stiffeners into the channel body, and welding on the end-plates. This operation is basically a welding operation and is done in the machine shop. In table 7 direct man-hours per 100 fixtures are presented for this channel subassembly process. The man-hours ranged from 2.91 man-hours to 4.71 man-hours for six of the plants. The narrow range indicates that the operation is standardized. All companies use the spot welding process.

In the wiring subassembly the electrical components are prepared and integrated in preparation for installation in the assembled channel. This small parts assembly requires much detail work in such operations as stripping and connecting wires and assembling small parts. Plants A and D have high man-hour requirements for this operation. The assembly departments in these two plants are not mechanized and consist

Table 7. Man-hours expended per 100 fixtures, by operations in seven selected industrial fluorescent light fixture plants, U.S.A., 1951

Plants	Direct man-hours per 100 fixtures			Number of operators
	Wiring sub-assembly	Channel sub-assembly	Final assembly	
A	8.33	3.33	na*	6
B	5.85	3.72	1/ 4.48	84
C	5.51	4.71	8.69	55
D	13.50	3.78	na	9
E	na	4.24	na	2/ 23
F	6.00	2.91	8.75	42
G	na	na	na	3/ 45

* na Not available.
1/ Includes packing.
2/ Packing operators included.
3/ Enameling, assembling, and packing personnel included.

only of assembly benches. The operators usually get their own parts from the stock room and carry their assembled parts to the packing department. Plants B, C, and F show low man-hour requirements for the wiring subassembly. These plants employ full mechanization with conveyor belts carrying the assemblies along the line of production. Material-handlers keep the operators supplied with parts and components, and magnetic screwdrivers and other specialized tools are used to reduce the man-hours required for the operation.

The final assembly consists of installing the wiring harness into the channel. The lampholder, starter socket, and ballast must be attached, positioned, and secured in the channel. Touch-up operations, inspection, and testing for shorts and grounds is included in the final assembly. Plants B, C, and F have reported man-hours separately for this operation. The other plants either do not have these man-hours available or combine them with packing and shipping man-hours.

The larger plants, which are more mechanized, have a man-hour advantage over the smaller, less mechanized plants.

Production Practices

This section on production practices includes a description of scheduling, designing, standardization, and control practices, and a list of materials, parts, and components used in the fluorescent light fixture plants covered in this study.

Materials, parts and components. Table 8 presents a listing of the typical items purchased by a manufacturer of fluorescent lighting fixtures. Table 9 lists the parts manufactured in a typical fluorescent light fixture plant. The items under the heading "Parts" are made by all the plants surveyed. Plant E made all the items under the heading "Accessories." Plants B, C and F manufactured some of the items classified as accessories that represent extra mechanical features incorporated in the construction of the company's own design of a fluorescent lighting fixture.

Scheduling. Scheduling in the fluorescent light fixture industry may be divided into three parts: (1) The problem of what to make, when to make it and quantity to be made. (2) The assignment of work and the correlation of this assignment with work in process. (3) The purchase of components and supplies.

The assignment of work to department heads, specifying requirements and dates for completion of specific items by part numbers, is generally done by the plant superintendent. In one of the plants, scheduling is based on man-hours required to produce 100 units. Another plant figures its production schedule according to the amounts in inventory plus orders on hand, since all shipments are made out of inventory. In one of the smaller plants, shop orders are issued to the fabrication department designating the number and size of parts needed. Upon receipt of the customer's order, a corresponding shop order goes to the assembly department designating the number, type, and style of fixtures to prepare for shipment. Orders are handled on a priority basis.

Table 8. Components and materials purchased by typical industrial fluorescent light fixture plants, U.S.A., 1951

Typical purchased parts for fluorescent fixtures			
Structural components	Electrical components	Materials	Small stock items
20 gauge sheet steel 48'x96'	Ballast	White enamel	Wire clip
Tubing	Sockets	Cartons	Screws
Springs	Starter socket	Metal cleaning chemicals	Nuts
Bushing	18 gauge wire	Boro-silicate	Carriage bolts
	Starter box	Plastic side frame	Washers
	Lampholder		Seams fastener
	Wire retainer		Die cast wingnuts
			RIM and Underwriter labels
			Rivets

Table 9. Parts and accessories manufactured in seven selected industrial fluorescent light fixture plants, U.S.A., 1951

Items manufactured in reporting plants	
Parts	Accessories
Channel body	Reflector bracket
Reflector	Cross brace
End plates	Wire clip
Socket saddle	Cover lug
Stiffeners	Latch mechanism
	Channel cover
	Socket bracket

The assurance that parts will be at their proper place at the proper time is an important factor in scheduling. In one of the plants surveyed, a coordinator at the office of the parent company issues blanket orders for purchased materials for all plants through the company purchasing department. The plant production manager requisitions his material requirements from the blanket order, and sets a specific date, coordinated with his schedule of production, for delivery of the parts and materials requisitioned.

One of the plants employs a "maximum-minimum" inventory system to control purchases of parts and materials. The essence of this system is the predetermination, on the basis of past experience, of a maximum and a minimum number of units to be stocked of each required item. A separate maximum and minimum must be set for every part and material needed by the plant. An inventory control card is kept for each item on which a record of quantities received and issued is made and which always shows the balance of supply on hand. Whenever the balance falls below the predetermined minimum, an order for a new supply of the item is placed for a quantity calculated to return the balance to the level of the predetermined maximum figure. The maximum and minimum figures are shown on the inventory control card for easy reference. The maximum and minimum figures are reviewed periodically to be sure that neither figure is larger or smaller than required for the most efficient and economical operation of the plant.

Table 10 presents the production practices in the seven plants analyzed according to the method used, the number of units in an average continuous run, and the average actual production for the regular eight-hour shift during the reported period.

Many plants in the fluorescent lighting fixture industry will accept orders for fixture models that are different from their standard

model. Two types of special orders can be distinguished, variations on the plant's standard model and special custom models. Variations on the standard model usually consist of wiring the unit with a special voltage transformer, equipping it with a special cord or plug, punching for special knockouts, arranging for special types of mountings, or giving it a special finish. All of these things may be done without adding materially to the unit man-hour requirements. Custom model is a term applied to a fixture that differs radically from the standard model in either design or internal construction. Of the five plants surveyed which responded to this question, all but one will make variations on their standard model; only two plants reported they were willing to make custom models. Plant G is owned by a multiplant company which uses it to make only standard models. Another plant of the company handles all special orders.

Standardization. Manufacturing methods and general design of fluorescent lighting fixtures have become fairly standardized throughout the industry, however, individual companies have distinctively designed parts and components in their fixtures. New developments in standardization are being made continually. In 1950, changes were made from the regular to the turret-type socket. One company redesigned its channel body to a shorter, wider, and more shallow form so that either one or two lamps could be used. Another company redesigned its end plates so that they could be used on two, four, six, or eight-foot fixtures.

Design. Much research has been done to determine what constitutes an adequate level or amount of illumination for various seeing tasks. The footcandle is the unit used for measuring the level of illumination and

Table 10. Production methods and production of fixtures in seven selected industrial fluorescent light fixture plants, U.S.A., 1951

Plants	Production method	Number of fixtures	
		Average continuous run	Average actual production for 8 hour day during reported period
A	Job lot	1000	500
B	Line and job lot	2000	2000
C	Line	500	200
D	Job lot	50	15
E	Job lot	5000	1100
F	Job lot	1500	500-600
G	Line	500	575

instruments that read directly in footcandles are available. Within any factory there are many operations with a wide variety of seeing tasks. Each seeing task requires a certain amount of illumination which can be expressed in footcandles. A level of illumination of 100 footcandles is necessary for exacting and prolonged fine bench and machine work, fine finishing, and discrimination of fine detail or low contrast as in weaving dark fabrics. Designers and illumination engineers provide specified footcandle levels for each illumination problem.

Every plant in the survey, whether large or small, has a design department. Table 11 indicates the number of employees in the design department for each plant. One of the plants reported that its design department was fully occupied in designing new and improved lighting fixtures, and was working in cooperation with architects and builders in designing lighting layouts for new buildings. In addition to these functions, the plants surveyed indicate that improvement in level of illumination, surface distribution of light, mechanical improvements for ease of installation, and improvements in appearance constitute the basic objectives in design. One of the companies consults with outside electrical testing laboratories from time to time to check their products for design effectiveness.

Methods improvement. The engineering aspects of management such as methods analysis, time and motion study, etc., are considered important enough in some of the plants to rate specialized personnel. Table 11 indicates the number of engineers employed in the seven plants surveyed. Two plants do not have specialized personnel in engineering; the plant superintendent and other general management personnel perform engineering

Table 11. Number of employees in design and engineering departments in seven selected industrial fluorescent light fixture plants, U.S.A., 1951

Plants	Number of employees		Time standards used
	Design dept.	Engineering department	
A	1/ 1-1/2	2	No
B	11	3	Yes
C	10	4	Yes
D	3	1	No
E	2	2	Yes
F	2	0	Yes
G	1	0	No

1/ The general manager devotes one half of his time to the design department.

tasks in addition to their other duties. Plants A and D, the small plants in the survey, employ engineers who have proved effective in cutting man-hour requirements in the production process according to statements by the management of both companies.

One plant reported that the engineering department was an element in the reduction of costs by inaugurating changes in materials or equipment, elimination of operations, and changes in materials handling. Time standards are checked once a year. Another plant reports that its engineering department has been most effective in developing efficient plant layout and flow of production, and the management of several of the companies reported that an efficient engineering department was essential for survival in a highly competitive industry. Four of the seven plants in this survey use time standards (See table 10).

Inspection. Inspection practices follow about the same pattern from company to company. All the plants perform basic electrical inspection such as testing for grounds and short circuits. A visual inspection for mechanical fitness and the appearance of the lighting fixture is made during the final assembly operation. The thickness of the paint and the reflectance factor are important elements of the final inspection.

A thorough control on quality is maintained by inspection during manufacturing operations, with final inspection and testing at the end of the assembly operation.

One of the plants maintains a complete laboratory testing department where purchased items such as ballasts, sockets, starters, etc., are analyzed and tested periodically.

Production control. The methods of production control vary from plant to plant but all follow a general outline. In the following paragraphs a system of control is described and illustrated by reference to actual forms in use appearing in Part III.

When the customer's order is received by one company, a customer's requisition (figure 8, Part III) is filled out in octuplicate with copies for the shop, office, shipping room, records, customer, salesman, territorial files, and consignee. The purpose of this form is to notify these people about the incoming order, especially the promised shipment date. After the customer's requisition specifies the type of product wanted, a production order (figure 9, Part III) is sent to the manufacturing departments. The production order list includes part number, drawing number, required operations, and special instructions if needed. Since the various materials must be on hand for processing, the materials requisition is the next form in the control procedure (figure 10, Part III). Some firms use the production order as a routing slip. In other firms special forms are used to follow the part from department to department.

An illustration of a different method used by some firms is seen in the three cards (figure 11, Part III) having similar headings. Figure 11a is the production order which remains in the hands of the

plant superintendent. Figure 11b is the routing slip which follows the part through the manufacturing process. On this card the operator's number, data, actual time required and quantity produced are entered by the foreman or timekeeper. Figure 11c is the material requisition. When the product is finished, the three cards are brought together to form the basis for the cost accountant's entries and the plant superintendent's production records.

At the end of each week the direct labor is recorded according to job orders on a payroll summary form (see figure 12, Part III). At the completion of the job, the materials, labor, and burden must be accumulated to obtain total cost. A production summary (see figure 13, Part III) is used to show the total cost, and to present a comparison of estimated cost and actual cost.

JOB NUMBER	DATE PROD. ORDER ENTERED	PART NUMBER	OPR'S NO.	DATE	TIME	QUANTITY
QUANTITY		DRAWING NUMBER				
COST PER OPERATION PER PART		PER UNIT			IN / OUT	
PART NUMBER	PART NAME	PCF PER UNIT				
MATERIAL					IN / OUT	

OPR. NO.	OPERATION DESCRIPTION	DEPT. NO	[illegible]	MACHINE NUMBER	QUANTITY FINISHED

O CIRCLE OPERATION PERFORMED ROUTE CARD

Fig. 11a Typical information on a production order card.

FLUORESCENT LIGHTING FIXTURES

TABLE OF CONTENTS

Part III: Supplementary Information — Page

The Industry in the United States 35
Description of the Product 35
Machinery and Equipment 36
Glossary 46

Tables:
Table 12. Value of products shipped by the lighting fixture industry, U.S.A., selected years 1899 to 1949 36

Table 13. Value of products shipped by the lighting fixture industry, by type of equipment, U.S.A., 1947 37

Table 14. Domestic shipments of industrial fluorescent lighting units by size and type by 29 leading manufacturers, U.S.A., 1950 38

Illustrations:
Fig. 8 Customer's requisition manifold, showing copies to different departments 40

Fig. 9 Production order form 41

Fig. 10 Material requisition form 42

Fig. 11a Typical information on a production order card . . 42

Fig. 11b Production route card 43

Fig. 11c Material requisition card 43

Fig. 12 Production summary form 44

Fig. 13 Payroll summary form 45

Fig. 14 Inventory control card 45

Case Study Data on
Productivity and Factory Performance

FLUORESCENT LIGHTING FIXTURES

Part III: Supplementary Information

The Industry in the United States

There are several types of industrial lighting equipment of which fluorescent and incandescent lighting fixtures are the most important. The product selected for this study is the industrial fluorescent lighting fixture.

The first public showing of an experimental fluorescent lamp was made at the Illuminating Engineering Society Convention in Cincinnati, Ohio, in 1935. Fluorescent lamps were commercially introduced in 1938 when they were used to light the New York World's Fair. Multiple-lamp industrial fluorescent units were introduced this same year. The circline and slimline fluorescent models were first marketed in 1944. The industry continued its progress in the post-war years with the development of more efficient models, including new emphasis on the 96-inch fluorescent lamp and fixture.

In 1947, 1,206 establishments were engaged in manufacturing lighting fixtures and equipment. The total number of all employees in the industry for 1947 was 47,596, bringing the average number of employees per establishment to 39. Of the total employment, 84 percent were production and related workers. The total salaries and wages paid in the industry in 1947 was $132,858,000. The cost of materials, fuel, electricity, and contract work was $227,140,000.

The value of product shipped amounted to $474,759,000, 10 percent of which was shipped by firms normally classified in other industries. Establishments classed in the lighting fixture industry shipped $423,000,000 worth of lighting fixtures and $45,000,000 worth of other products such as gray-iron castings, wiring devices, vitreous-enameled products, etc.

Table 12 in this section indicates the growth of the lighting fixture industry from 1899 to 1949. Fluorescent lighting equipment was 26% of the lighting fixture industry in 1947 according to table 13. This table also presents the other major components of the lighting fixture industry. Table 14 presents the production for 1950 by 29 leading fluorescent manufacturers of the eight basic types of industrial fluorescent lighting fixtures.

Description of the Product

The basic specifications for the product included in this study are as follows: The industrial fluorescent fixture, with two 48-inch lamps, 40-watt rating each. The reflector is an open-end model with a width

Table 12. Value of products shipped by the lighting fixture industry, U.S.A., selected years, 1899 to 1949

Year	Value of 1/ products shipped (thousands)	Year	Value of 1/ products shipped (thousands)
1899	$ 19,821	1927	$127,802
1904	26,560	1929	144,966
1909	45,057	1931	75,050
1914	45,378	1933	46,173
1919	80,367	1935	85,700
1921	72,054	1937	115,096
1923	118,979	1939	124,582
1925	129,698	1947	474,759
		1949	515,862

1/ Value of products shipped are the received or receivable net selling values, f.o.b. plant, after discounts and allowance, and excluding freight charges and excise taxes.

Source: Census of Manufactures, 1899 to 1947, Bureau of the Census, United States Department of Commerce, Washington, D.C., and unpublished information supplied by Bureau of the Census.

of 12 to 13 inches and over-all length of 48 to 54 inches; the inside of the reflector finished in white porcelain enamel and the outside gray porcelain enamel. The shipping weight is from 25 to 30 pounds. The factory sales price for these fixtures ranges from $25.00 to $30.00. Each plant lists many models differing by variations in body style, number of lamps, length of lamps and auxiliary equipment. Variations in the model for which data was reported by the plants surveyed are noted in the body of the report.

Machinery and Equipment

Various types of machinery and equipment are required to manufacture a fluorescent lighting fixture. The type of equipment used in a

Table 13. Value of products shipped by the lighting fixture industry, by type of equipment, U.S.A., 1947

Type of lighting equipment	Value 1/ of product (thousands)	Percent of total
Lighting Fixtures, Total	$471,148	100
Fluorescent lighting equipment	122,990	26
Incandescent lighting equipment, except searchlights, vehicular, hand portable, etc.	137,367	29
Searchlights, floodlights and spotlights	10,556	2
Vehicular lighting equipment	115,053	24
Hand portable equipment, such as flashlights, miner's lights, etc.	26,260	6
Nonelectric lighting equipment, such as kerosene and gasoline lanterns	10,310	2
Electric lighting equipment not elsewhere classified including street and highway lighting, marine, aviation, and railway	26,196	6
Lighting fixtures, not specified by type .	22,416	5

1/ Value of products includes the received or receivable net selling values, F.O.B. plant, after discounts and allowances, and excluding freight charges and excise taxes.

Source: Census of Manufactures, 1947, Bureau of the Census, U.S. Department of Commerce, Washington, D. C.

Table 14. Domestic shipments of industrial fluorescent lighting units by size and type by 29 leading manufacturers, U.S.A., 1950

Types of lighting units	Sizes					Total
	40-W Single pin and bi-pin	85-W	72"	96"	All Others	
Porcelain enamel, 1 lamp	609	-	-	-	8	617
Porcelain enamel, 2 lamp	366,891	94,906	548	39,361	1,158	522,864
Porcelain enamel, 3 lamp	110,057	-	7	371	-	110,435
Synthetic enamel on steel, 1 lamp . .	7,618	-	-	123	25,236	33,067
Synthetic enamel on steel, 2 lamp . .	337,031	28,263	102	14,377	6,318	386,091
Synthetic enamel on steel, 3 lamp . .	26,212	19	-	79	1,615	27,925
Aluminum, 1,2,3 lamp	17,790	-	224	431	211	18,656
All other	2,236	712	5	634	4,001	7,588
Total	888,404	123,900	886	55,376	38,637	1,107,243

Source: Statistical Bulletin, Industrial and Commercial Lighting Equipment Section, National Electrical Manufacturers Association, New York City.

large factory (350-400 production workers) and that used in a small factory (25-30 workers) are shown below.

The large factory uses the following machinery:

Machine	Type	Maximum rating
25 presses	punch, draw wide bed	300 ton
10 press brakes	maximum size 12 feet	200 ton
5 power shears	maximum size 12 feet	10-gauge mild steel
11 welders	spot and press	Up to 200 K.V.A.
2 toppers	(not available)	(not available)
2 dull presses	multiple	(not available)

Miscellaneous machine tools including two lathes, shaper, surface grinder, contour machine, milling machine, hand screw machine and rolling machine are also used.

The small factory uses the following machinery:

3 punch presses	1 power shear
3 click presses	1 4-foot all purpose press
1 press brake (6-foot)	1 8-foot all purpose press
2 spot welders	

Materials handling varies from plant to plant. The small firms move materials by two and four-wheel hand trucks. The larger plants are more mechanized and use power lift trucks for moving materials from station to station, and have mechanized assembly lines including chain belt conveyors, monorails and waist-high rollers to speed up the assembling process. Figure 7 illustrates the use of the overhead monorail conveyor in the finishing process.

MANIFORMS

DATE ENTERED	SHIPMENT PROMISED	DATE SHIPPED

NO.

CUSTOMER NO.	PREPAID	SHIP TO
SOLD TO	P.P.	
	EXP.	
	FRT.	
		MARK
SALESMAN		

1-SHOP COPY (PRODUCTION)

2-OFFICE COPY

3-SHIPPING COPY

4-RECORD COPY

5-CUSTOMER COPY

6-SALESMAN'S COPY

7-TERRITORIAL

8-CONSIGNEE COPY

Fig. 8 Customer's requisition manifold, showing copies to different departments.

OD 706-A

PRODUCTION ORDER

Prod. Order No. _____ Part No. _____

Schedule Date _____ Dwg. No. _____

Quantity _____ Part Name _____

For _____

Material _____

No. of Sheets _____ No. Pcs. Out _____

Dept.	Oper. No.	Operation	Mach. No.	Die or Tool No.	Set up Time	Std. Hrs Per 100

Fig. 9 Production order form.

WITHDRAWALS FROM STOCKROOM NO.

DATE

FOR JOB NO. PURCHASER

QUANTITY	PART NUMBER AND DESCRIPTION	UNIT PRICE	TOTAL VALUE	REMARKS

STOCKROOM CLERK

PERSON RECEIVING MATERIAL

Fig. 10 Material requisition form.

JOB NUMBER	START DATE	DUE DATE	PART NUMBER
			SPF-14--A
QUANTITY			DRAWING NUMBER
			SPF-14

COST PER OPERATION PER PART — PER UNIT

PART NUMBER	PART NAME	PCS PER UNIT
SPF-14-A	SLIDE HOOK FOR M-3232-34	2--A

MATERIAL EGGCRATES PER
2-3/4" x 34" 18 GA STEEL 7-PCS PER BLANK 5-1/2"PC.

OPR. NO.	OPERATION DESCRIPTION	DEPT. NO	SER NO.	MACHINE NUMBER	QUANTITY FINISHED
1	SHEAR	1			
2	P.P. BLANK	13			
3	CUTOFF FOR SLIDE HOOK	13			
4	P.P. FORM RIGHTS & LEFTS	13			
5	P.P. FORM RIGHTS & LEFTS	13			
6	P.P. FORM RIGHTS	13			
7	P.P. FORM LEFTS	13			
	SLITLINE UNITS				
	M-6006-M-6007				

OPR'S NO.	DATE	TIME	QUANTITY
		IN / OUT	
		IN / OUT	
		IN / OUT	
		IN / OUT	
		IN / OUT	
		IN / OUT	
		IN / OUT	
		IN / OUT	

Fig. 11a Typical information on a production order card.

JOB NUMBER	DATE PROD. ORDER ENTERED	PART NUMBER
QUANTITY		DRAWING NUMBER
COST PER OPERATION PER PART		PER UNIT
PART NUMBER	PART NAME	PCS' PER UNIT
MATERIAL		

OPR. NO.	OPERATION DESCRIPTION	DEPT NO	BIN No.	MACHINE NUMBER	QUANTITY FINISHED

OPR'S NO.	DATE	TIME	QUANTITY
		IN OUT	
		IN OUT	
		IN OUT	
		IN OUT	
		IN OUT	
		IN OUT	
		IN OUT	
		IN OUT	
		IN OUT	
		IN OUT	

O CIRCLE OPERATION PERFORMED

ROUTE CARD

Fig. 11b Production route card.

JOB NUMBER	DATE PROD. ORDER ENTERED	PART NUMBER
QUANTITY		DRAWING NUMBER
COST PER OPERATION PER PART		PER UNIT
PART NUMBER	PART NAME	PCS' PER UNIT
MATERIAL		

OPR. NO.	OPERATION DESCRIPTION	DEPT NO	BIN No.	MACHINE NUMBER	QUANTITY FINISHED

QUANTITY COMPLETED

MATERIAL WITHDRAWN FROM STOCK

QUANTITY REQUIRED	DESCRIPTION OF MATERIAL	QUANTITY ISSUED	UNIT PRICE	EXTENSION

DELIVERED TO | DATE | EXTENDED BY | DATE | POSTED BY | RECEIVED BY

Fig. 11c Material requisition card.

Job Order # _____

Description _____

_____

Date of Order _____ Date Completed _____

Estimated Cost _____ Actual Cost _____

Estimated Quantity _____ Actual Quantity _____

		COST			
DATE	REFERENCE	MATERIAL	LABOR	BURDEN	TOTAL

Fig. 12 Production summary form.

WEEKLY PAYROLL HOURS APPLIED BY JOB ORDERS

Name _____ Clock No. _____

	JOB ORDER NUMBER												
													TOTAL
Hours Monday													
Hours Tuesday													
Hours Wednesday													
Hours Thursday													
Hours Friday													
Hours Saturday													
Total Hours													
Rate													
Amount													

Fig. 13 Payroll summary form.

DESCRIPTION | UNIT | MAX. | MIN.

DATE	ORDER NUMBER	QUANTITY			UNIT PRICE	DOLLAR VALUE		
		IN	OUT	BAL.		DEBIT	CREDIT	BALANCE

DESCRIPTION | UNIT | MAX. | MIN.

Fig. 14 Inventory control card.

Glossary of Terms

BALLAST	An inductance or choke coil which supplies varying voltage, to the fluorescent lamp.
CHANNEL	The metal box located at the top of the fluorescent fixture to which the reflector is attached. It houses the sockets, ballasts, wiring, and assures rigid alignment of all parts.
DIRECT LABOR	All the operations directly involved in the manufacture of a fluorescent fixture classified as direct labor cost.
FORMING	A shaping operation used in bending the reflector and channel into its final form.
INDIRECT LABOR	The supplemental operations necessary in the manufacture of a fluorescent fixture such as shipping, maintenance, repair, stock-keeping, material handling, supervision, etc., classified as indirect labor cost.
LAMPHOLDER	An insulated receptacle which supports the fluorescent lamp and makes connections from the operating circuit to the contact pins on the end of the lamp.
LOUVER	A slatted metal piece resembling a lattice which is used on a fluorescent lighting fixture to aid in the diffusion of light. The eggcrate style of louver is a common form used on fluorescent fixtures.
PIERCING	A punching operation used in making holes and openings in the sheet metal parts of the fluorescent fixture.
RLM LABEL	The symbol of compliance with rigid specifications set up by the RLM Standards Institute which is an organization whose purpose is to promote and encourage high standards of quality in the design, construction, composition, finish, performance and service of lighting equipment.
SHEARING	A cutting operation used in squaring off the sheet steel in the machining of the metal parts of the fluorescent fixture.
SOCKET SADDLE	A metal strip in the channel to which the base of the starter socket is attached.
STARTER	A specially designed switch used in the fluorescent lighting wiring circuit to establish the electronic discharge through the gas inside the tubing of the fluorescent lamp.