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BUREAU OF LABOR STATISTICS

Ewan Clague - Commissioner

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Case Study Data on
Productivity and Factory Performance

RADIO AND TELEVISION MANUFACTURING

(Based on reports submitted
by 16 selected plants)

Prepared for

Mutual Security Agency
Productivity and Technical Assistance Division

by

United States Department of Labor
Bureau of Labor Statistics

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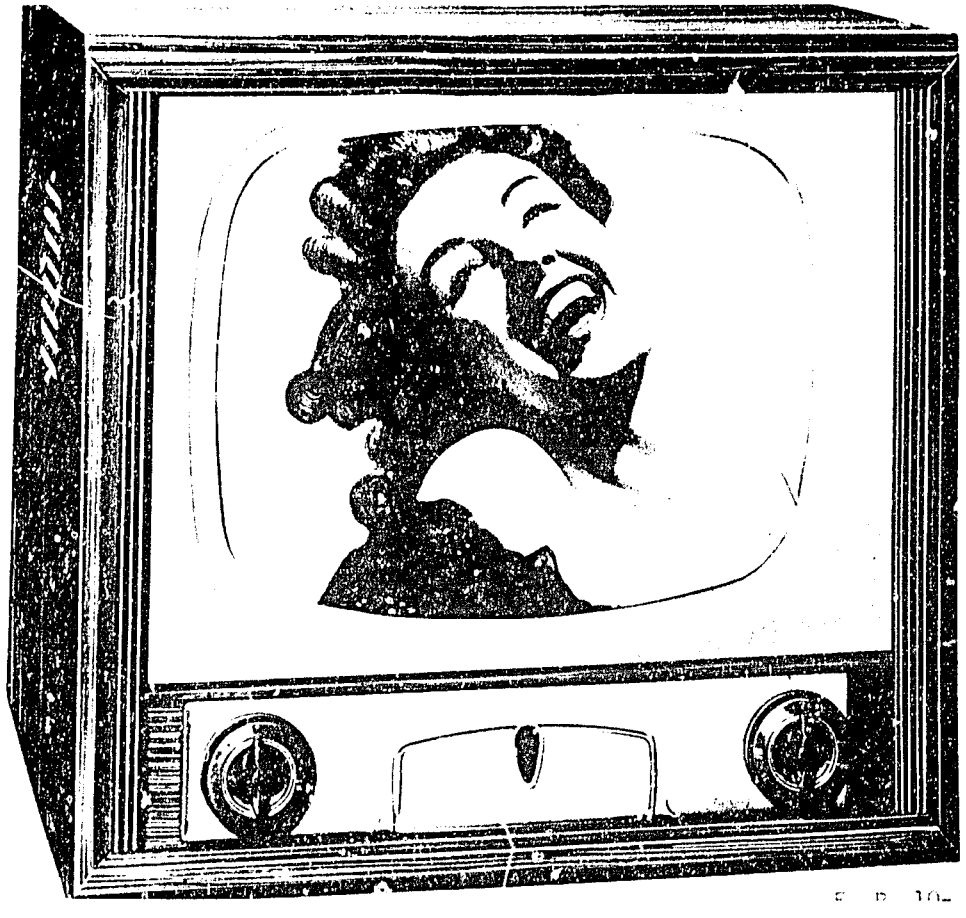

Fig. A A representative table model television set.

Courtesy Olympic Radio and Television, Inc.

Case Study Data on
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RADIO AND TELEVISION MANUFACTURING

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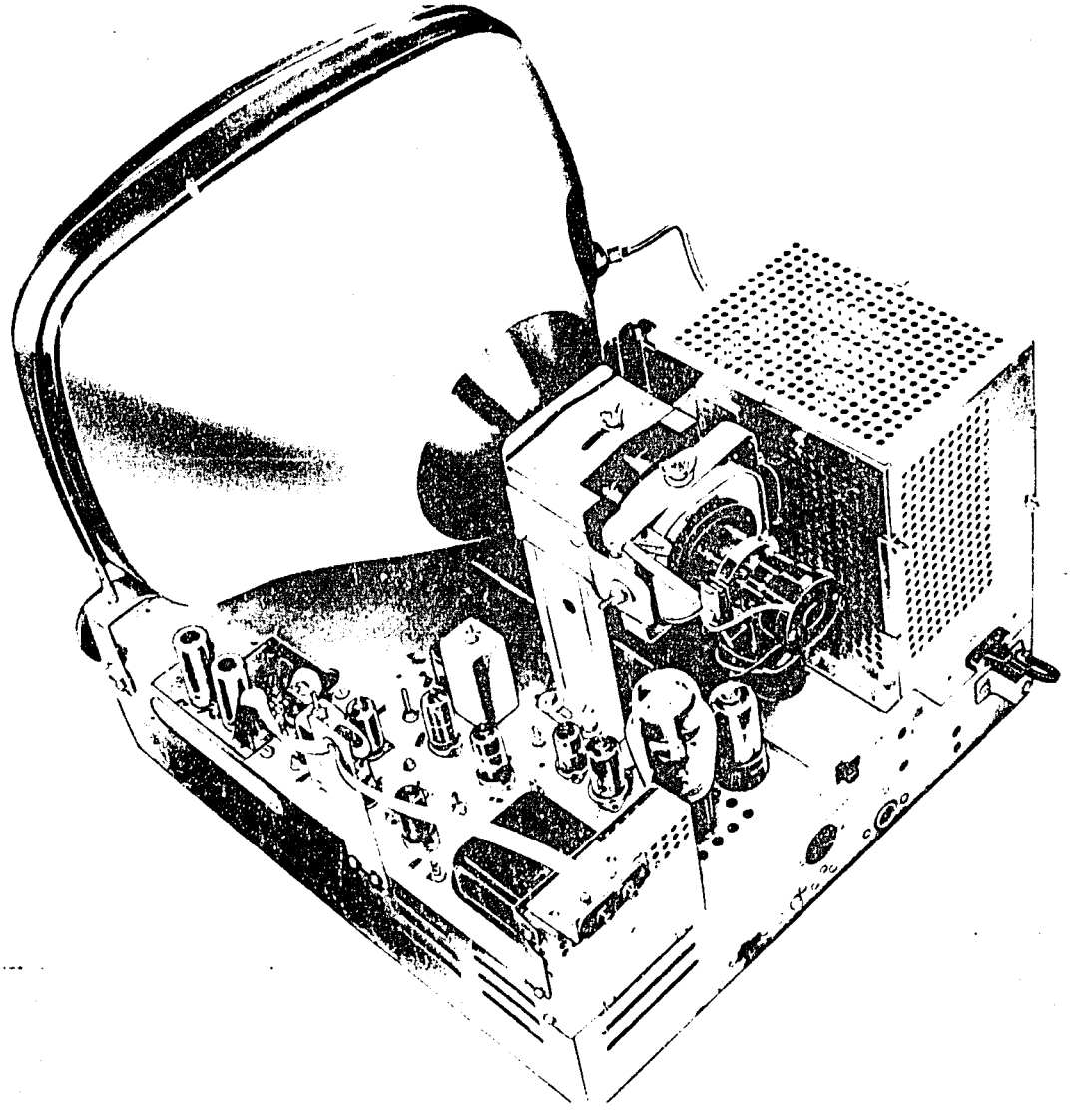

Fig. B A completed chassis of a television set.

Courtesy Olympic Radio and Television, Inc.

Case Study Data on
Productivity and Factory Performance

RADIO AND TELEVISION MANUFACTURING 1/

PART I: GENERAL REPORT

High Lights

Mass production, using line assembly methods, enables a typical American manufacturer to completely assemble, test, and pack a small table model radio in less than one man-hour or a television receiver requiring more than 600 parts in about five man-hours.

A radio or television receiver is primarily the product of the mass-assembly of purchased component parts. These purchased components such as tubes, resistors, capacitors, speakers, and hardware items have been standardized by suppliers to function in a variety of basically similar sets. Many plants are able to produce several models of similar internal design on one main assembly line. The standardization of parts and specialization of jobs permit the use of a large proportion of semi-skilled workers. Standardization of parts and relatively little use of highly trained workers have also enabled many assemblers to enter the industry with small amounts of capital.

Job specialization is promoted by the line assembly method. In many plants more than 100 workers are stationed at intervals along a conveyorized assembly line more than 500 feet long. Each worker performs one or more identical operations on each set. In one plant, for example, the standard time set by six workers for final assembly soldering of one radio is less than a minute. The worker in many cases will have a small instruction sheet or model chassis which shows the operation he is to perform. Because of the repetitiveness of the work, however, such guides are only briefly used in the initial stages of production.

Variations in production processes are generally found in subassembly, coil winding, cabinet making, and occasional metal-working operations. Such operations are performed at work stations which

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1/ Prepared by William M. Graham, Analyst in the Division of Productivity and Technological Developments, Bureau of Labor Statistics, U.S. Department of Labor.

supply, but are not a part of, the main assembly line. Some plants specialize in the production of elaborate "custom-made" sets. These sets are generally produced in such small quantity that typical line assembly methods are impractical.

The production methods of the industry are characterized by a high degree of mechanization. Powered hand tools such as the pneumatic nut-runner with interchangeable heads are increasingly used. Powered materials-handling devices such as electric lift trucks and overhead chain, and roller or belt conveyors are more prevalent, especially since the advent of heavier television sets. Other forms of mechanization are constantly being developed to standardize and simplify the job and reduce the operation time of the worker. Labor costs attributable to the assembly of a set are usually less than 20 per cent of total costs and are often as low as four per cent.

Simplification and specialization of operations, standardization of parts, and mass production by line methods enabled the industry to produce more than 14 million television sets in the last five years.

Arrangement of Report

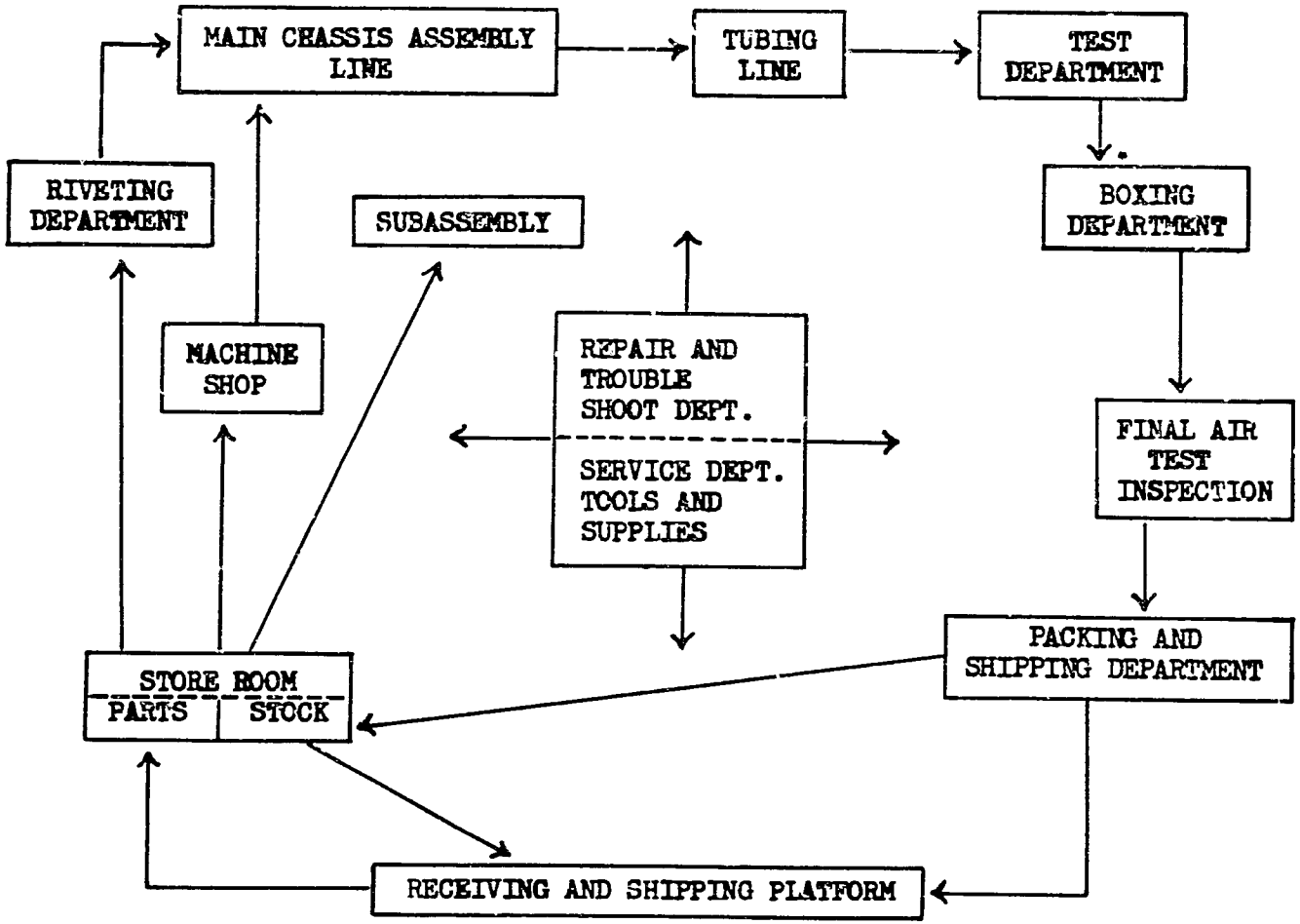
Part I, directed primarily to those having a broad interest in productivity in the radio and television industry, contains a general summary of the characteristics of the industry and of the 16 basic case studies. Detailed descriptions of the reported products are also presented.

Part II is primarily for the production technician and contains a breakdown of man-hours by operation for each of the reported models. Part II also includes a summary of assembly line, inventory, and inspection practices in use in the surveyed plants. Selected statistics on the radio and television industry in the United States and a glossary of technical terms have been added.

Sequence of Operations

The flow of work in a representative plant is shown on page 3. Purchased parts arrive at the loading platform to be carried to the general storage area on hand trucks, skids, or roller conveyors. Certain parts may be inspected before storage. Components are placed loose or in their original cartons in bins stacked in tiers. Quantities sufficient for one day's production are generally taken to the line at one time on hand trucks.

Some items go to the machine shop for finishing unless the plant stamps such parts as chassis or cans. All chassis go to the riveting department which attaches such parts as tube sockets. The riveting department is usually able to keep the wiring lines for several models supplied at least a day in advance.



Material and product work flow in a radio - television plant, U.S.A.

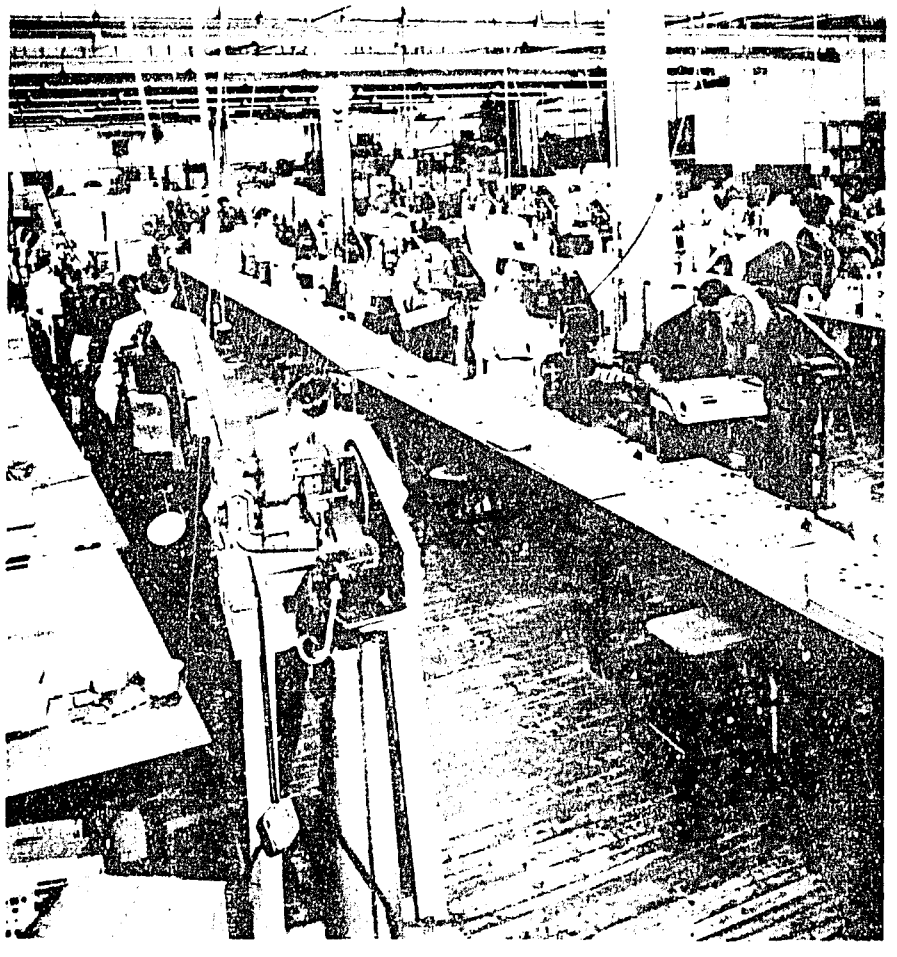


Fig. C Riveting operations on television chassis in a machine shop.

Courtesy Olympic Radio and Television, Inc.

Other components are assembled into units at work stations separated from the main assembly line. In such subassemblies the more intricate wiring operations are usually performed. The units are later attached to the chassis on the main assembly line. Personnel of the subassembly department may be interchanged with those of the main wiring line. The machine shop and the riveting department may also interchange workers.

The main chassis assembly or wiring line is a long straight or U-shaped table. The chassis rests on rails or rollers, generally at a 45-degree angle from the worker, and is pushed manually from one work station to the next. Assembly, wiring, and soldering are broken down into numerous successive groups of operations for each work station along the line. Each worker is assigned a job requiring about the same time cycle (often 30 seconds).

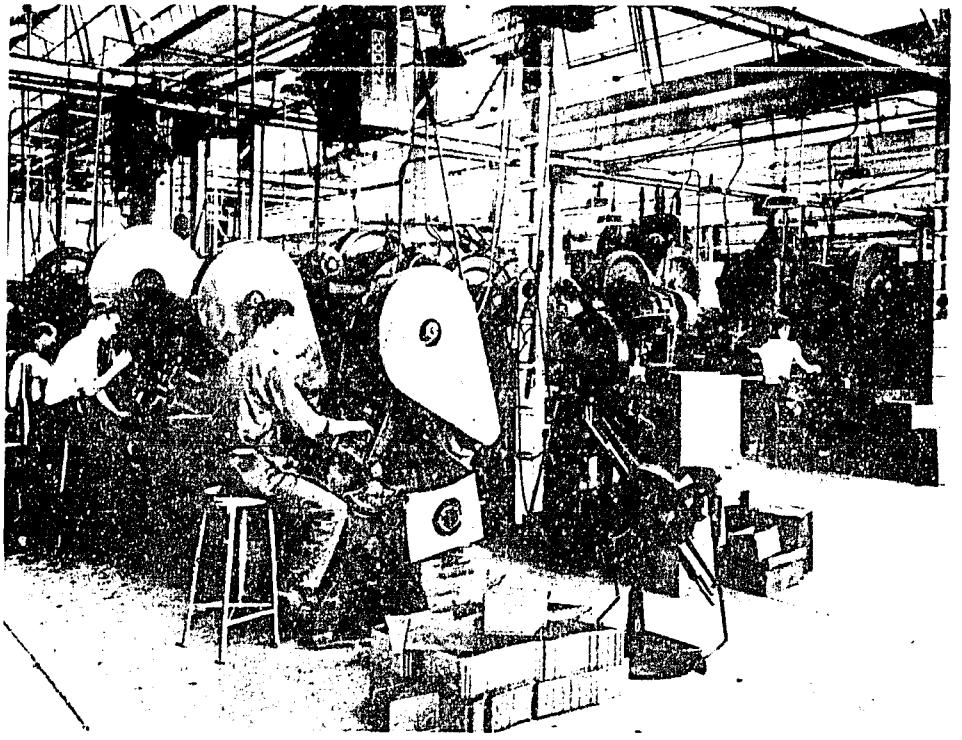


Fig. D Small presses used in a machine shop of a radio plant.

Fig. E Subassembly operations for a radio-television combination set. Note location of parts, bins, and tester. Use of the pneumatic nut-runner is shown.

Tubes are inserted as the completely wired chassis leaves the main assembly line.

The testing department consists of booths on both sides of a conveyor belt. After being electrically tested, the sets are placed on high racks mounted on rollers and having four or five shelves.

The boxing department is at the end of the roller conveyor coming from the testing department. Here cabinets are placed over the completed chassis and are bolted to them by pneumatic nut-runners. The cabinets are given a careful rubdown by a woodworker while an inspector gives each set an "air-test" before packing. Such a test determines whether a set is able to properly receive local radio or television broadcasts.

The majority of sets are taped, labeled, and removed by conveyor to the shipping platform, although some may be sent to the stock room.

Plant and Product Characteristics

The data for each of the 16 representative studies covers a production period of one to eight months during 1949 to 1951. The man-hours required to produce a particular model (table A) were derived from the labor and payroll records of the individual plants. Small differences in required unit man-hours from plant to plant are not completely due to differing production techniques but may arise as a result of different accounting methods used to accumulate labor time.

The most important factor influencing man-hours required per set is the actual design and complexity of the model. A detailed description of the reported radio or television model is presented in table B. The number of soldered connections and the number of required parts serve as excellent guides to the number of operations necessary to complete a given model. The purchase rather than the manufacture of component parts is a major characteristic of the industry, and is evident from the small number of component parts manufactured in the plant. Except for operations such as coil winding and chassis work, all parts such as tubes, resistors, and capacitors are supplied by firms specializing in their manufacture. The different number of parts manufactured in each plant accounts partially for differences in the man-hours required to produce a similar set.

Table A. Actual man-hours per radio or television receiver for sixteen selected plants and related statistics, U.S.A., 1949 - 1951

Plant	Product	Number of man-hours per set			Percent of indirect to total	Number of employees	Production area 1/ (Square feet)
		Total	Direct	Indirect			
A	TV-17"	16.57	13.26	3.31	20.0	2/ 400	42,000
B	TV-12"-FM.	11.29	8.46	2.82	25.0	2/2500	300,000
C	TV-17"	na*	7.51	na	na	2/1200	96,000
D	TV-12"	5.92	4.78	1.15	19.4	3000	100,000
E	TV-12-1/2"-FM. . .	5.17	4.65	0.52	10.1	3000	250,000
F	Radio-4 tubes-AM-SW	2.99	2.33	0.66	22.1	2/ 600	28,000
G	Radio-4 tubes-AM-SW	2.70	1.66	1.04	38.5	400	45,000
H	Radio-4 tubes-AM-SW	1.93	1.45	0.48	24.9	2/2500	300,000
I	Radio-7 tubes-AM-FM	6.64	5.17	1.47	22.1	2/ 600	28,000
J	Radio-7 tubes-AM-FM	3.40	2.55	0.85	25.0	500	52,000
K	Radio-5 tubes-AM	2.15	0.96	1.19	55.3	3000	138,000
L	Radio-5 tubes-AM	1.23	0.88	0.35	28.4	2/ 200	53,000
M	Radio-5 tubes-AM	1.10	0.72	0.38	34.3	280	25,000
N	Radio-4 tubes-AM	1.24	0.89	0.35	28.3	700	43,000
O	Radio-4 tubes-AM	1.02	0.67	0.34	33.6	200	1,200
P	Radio-3 tubes-AM	0.85	0.63	0.22	25.4	500	52,000

* na Not available.
1/ Refers to area devoted primarily to radio and television manufacture.
2/ Production and related workers only.

Table B. Product specifications for sixteen selected radio and television manufacturing plants, U.S.A., 1949 - 1951

Item	Plant and Reported Product			
	A 17" table model TV	B 12" table model TV	C 17" table model TV	D 12" table model TV
Chassis size (inches):		na*	na	
Side to side	19-1/2			17-3/4
Front to back	19-1/4			15-1/4
Cabinet size (inches):				
Side to side	23	22-1/4	20-3/4	20-3/4
Front to back	20-7/8	21-5/16	19-15/16	18-3/16
Height	20-5/8	17-5/16	18-15/16	16-3/4
Number of tubes:				
Less rectifiers	23	19	20	16
Rectifiers	3	3	2	4 (3 selenium)
Number of soldered connections	477	627	315	305
Number of resistors	106	104	75	96
Number of capacitors	88	93	56	90
Total number of hardware items such as nuts, washers, fastners, rivets	397	529	323	295
Total number of all other items to complete (excluding wire, insulation, tubing, tape, solder)	151	398	140	143
Number of TV channels	12	12	12	12
Power supply	AC only	AC only	AC only	AC only
Radio bands	None	FM only	None	None
Speaker size (inches)	6	5-1/4	6	6
Tone control	Yes	None	Yes	None
Retail price (approx.)	$250.00	$300.00	na	$220.00
Products manufactured at plant	TV: 15 models Radio: 1 table model	Television and radio receivers	Primarily television receivers	Radio, television and general electronic equipment
Parts manufactured at plant 1/	Chassis, brackets, sheet metal and plated parts	Chassis, brackets, numerous hardware items; oscillator and antenna coils	None (assembly only)	None (assembly only)

See footnotes at end of table.

Table B. Product specifications for sixteen selected radio and television manufacturing plants, U.S.A., 1949 - 1951 — (Continued)

Item	Plant and Reported Product			
	E	F	G	H
	12-1/2" table model TV	Multiband table radio	Multiband table radio	Multiband table radio
Chassis size (inches):				
Side to side	12-7/8	10-3/4	11-3/4	11-1/2
Front to back	16-7/8	3-13/16	4-3/4	2-7/8
Cabinet size (inches):				
Side to side	15-1/2	12-1/2	14	12-1/8
Front to back	18-1/2	6-1/4	7-7/8	6
Height	17-3/8	7-9/16	9	6-7/8
Number of tubes:				
Less rectifiers	17	4	4	4
Rectifiers	2	1	1	1
Number of soldered connections	155	113	97	86
Number of resistors	40	13	14	11
Number of capacitors	35	16	20	18
Total number of hardware items such as nuts, washers, fastners, rivets	300	110	100	71
Total number of all other items to complete (excluding wire, insulation, tubing, tape, solder)	70	68	52	80
Number of TV channels	12	—	—	—
Power supply	AC only	AC-DC	AC-DC	AC-DC
Radio bands	FM only	AM-SW	AM-SW	AM-SW
Speaker size (inches)	5	6x4 oval	5	4
Tone control	Yes	None	None	None
Retail price (approx.)	$200.00	$55.00	$45.00	na
Products manufactured at plant	na*	Table model and console television, table model and portable radios	Radio, television and general electronic equipment	Television and radio receivers
Parts manufactured at plant 1/	None (assembly only)	None (assembly only)	Oscillator coils, antenna coils, wire preparation	Chassis, brackets, numerous hardware items; oscillator and antenna coils

See footnotes at end of table.

Table B. Product specifications for sixteen selected radio and television manufacturing plants, U.S.A., 1949 - 1951 — (Continued)

Item	Plant and Reported Product			
	I Table radio	J Table radio	K Table radio	L Table radio
Chassis size (inches):				
Side to side	12-7/16	11-1/4	10	12
Front to back	4-7/8	4-1/4	4	4
Cabinet size (inches):				
Side to side	14-7/8	13-7/8	12-1/2	13
Front to back	7	7-5/8	7	7
Height	8-3/4	6-7/16	7-1/2	7-7/8
Number of tubes:				
Less rectifiers	7	7	5	5
Rectifiers	1	1	(1 selenium)	1
Number of soldered connections	192	157	67	57
Number of resistors	34	27	13	8
Number of capacitors	48	32	10	10
Total number of hardware items such as nuts, washers, fasteners, rivets	95	131	48	40
Total number of all other items to complete (excluding wire, insulation, tubing, tape, solder)	81	114	40	25
Number of TV channels	—	—	—	—
Power supply	AC-DC	AC only	AC only	AC-DC
Radio bands	AM-FM	AM-FM	AM	AM
Speaker size (inches)	6	5	5-1/2	5
Tone control	Yes	None	None	None
Retail price (approx.)	$70.00	$60.00	$35.00	$35.00
Products manufactured at plant	Table model and console television, table model and portable radios	AM and AM-FM table model radios	Radio, television, electrical and electronic communications equipment	Radio, television, radio-phonograph sets
Parts manufactured at plant 1/	FM oscillator and FM RF coil windings	High frequency chokes (3), oscillator coil (1), FM 2nd IF coil (1), output transformer (1), AC choke (1), parasitic suppressors (2)	Chassis (1), brackets (3), coils (2), shaft (1) and speaker	None (assembly only)

See footnotes at end of table.

Table B. Product specifications for sixteen selected radio and television manufacturing plants, U.S.A., 1949 - 1951 - - (Continued)

Item	Plant and Reported Product			
	M Table radio	N Table radio	O Table radio	P Table radio
Chassis size (inches):				
Side to side	10	6-11/16	11-1/8	8
Front to back	5	6-15/32	4	3-3/4
Cabinet size (inches):				
Side to side	12	10-3/4	10-1/2	8-1/4
Front to back	6-1/2	5-7/8	5-1/2	3-3/4
Height	7	7	6-1/2	5-1/4
Number of tubes:				
Less rectifiers	5	4	4	3
Rectifiers	1	1	1	1
Number of soldered connections	41	56	43	62
Number of resistors	15	10	7	10
Number of capacitors	10	11	8	10
Total number of hardware items such as nuts, washers, fastners, rivets	68	33	35	46
Total number of all other items to complete (excluding wire, insulation, tubing, tape, solder)	41	63	20	45
Number of TV channels	—	—	—	—
Power supply	AC-DC	AC-DC	AC-DC	AC-DC
Radio bands	AM	AM	AM	AM
Speaker size (inches)	5-1/2	5	5	4
Tone control	None	None	None	None
Retail price (approx.)	$35.00	$20.00	$20.00	$20.00
Products manufactured at plant	Table model and automobile radios	Table model and portable radios, phonographs, radio-phonographs	Table model radios	AM and AM-FM table model radios
Parts manufactured at plant 1/	Coil winding wire processing, (done in separate building)	None (assembly only)	None (assembly only)	High frequency chokes (3), oscillator coil (1), FM 2nd IF coil (1), output transformer (1), AC choke (1), parasitic suppressors (2)

* na Not available.
** Dash indicates data not applicable.
1/ Refers to parts manufactured in plant for use in radio or television sets only.

Productivity Factors Emphasized by Management

The following factors, other than model design, plant size, and degree of integration, were believed by plant officials to have a definite effect on productivity in the industry:

1. Adequate procurement and close control of raw materials and component parts.
2. Coordination of production, design, and methods departments, and willingness to adopt new production methods.
3. Capital investment for additional floor space, conveyor installations, and labor-saving machinery.
4. A well-developed cost control system.
5. Proper production time cycles, specialization of jobs, and standardization of parts.
6. Good labor-management relations.

PART II

Part II contains more detailed information on labor requirements by operation for the plants and models described in Part I. Part II also includes data on the organization and methods of the main assembly line and certain inventory and inspection practices. This information is intended for the technical reader in comparing plants in their experience with those shown here. Selected statistics of the radio and television industry in the United States and a glossary of technical terms have been added.

Part II: DETAILED REPORT AND TECHNICAL DATA

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RADIO AND TELEVISION MANUFACTURING

PART II: DETAILED REPORT AND TECHNICAL DATA

Standard Man-Hour Requirements

Standard operations required to manufacture and assemble a radio or television set are developed by closely controlled time and motion studies at the job. These studies are useful in eliminating unnecessary effort by the worker, developing more efficient production techniques, planning work layout and parts supply, and determining time cycles and work flow. The standard times developed are not optimums or ideal, but reflect the performance (in man-hours expended) of an average worker. Table 1 presents the standard direct man-hours required for each reported model and the actual man-hours required during a normal production period as developed from company records. Reasons for variances between actual man-hours expended and standards are briefly listed below for some plants.

Plant B. The +9.3 per cent variance between actual and standard unit man-hours during the survey period is believed to have been due to conditions such as material shortages, a high percentage of inspection rejects, inexperienced workers, and absenteeism in the plant at that time.

Plant E. The +26.1 per cent unit man-hour variance is attributed to material shortages, defective materials, absenteeism, and uneven work flow during the survey period.

Plants G and H. Variances of +24.0 and +16.7 per cent between actual and standard unit man-hours, respectively, are due to small production runs. The reported models of these plants were manufactured in limited volume. Production for 11 to 14 days is generally necessary to reach line capacity and attain efficient worker performance.

Plant I. The +73.5 per cent variance in unit man-hours is due primarily to shortages of parts during the survey period. Time is lost in removing the chassis from the line and later replacing it for completion when parts are again available.

Plants J and P. The variance of −19.0 and −28.0 per cent fewer actual unit man-hours, respectively, is ascribed to the incentive wage-payment plan in operation.

Plant K. The variance of +48.9 per cent in unit man-hours is the result of determining actual man-hours for this report during a period of low production. Fewer workers than normal are used and each worker performs two to four groups of operations. At such times the conveyor belt is not used; the operator pushes the chassis on to the next work station.

Plant M. The variance of +24.9 per cent in unit man-hours is believed due to material shortages and absenteeism at the time of this study.

Plant N. The variance of +30.3 per cent in unit man-hours is attributed to allowances for worker training or efficiency which amount to about 15 percent each. These allowances were not included when standard times were computed.

Standard Time for Direct Labor Operations

Tables 2 through 17 inclusive show the standard time for each operation of direct labor in the manufacture of each reported model and the number of workers performing the operations. A comparison of the number of parts in each set and the number of parts manufactured in a plant, as shown in Table B, illustrates differences in the design and manufacture of sets of the same size or with the same number of tubes. Such differences, to a large extent, account for variations in the standard man-hours required for radio and television sets of the same type. Therefore, no conclusions may be drawn from plant-to-plant comparisons of the standard man-hours shown in these tables.

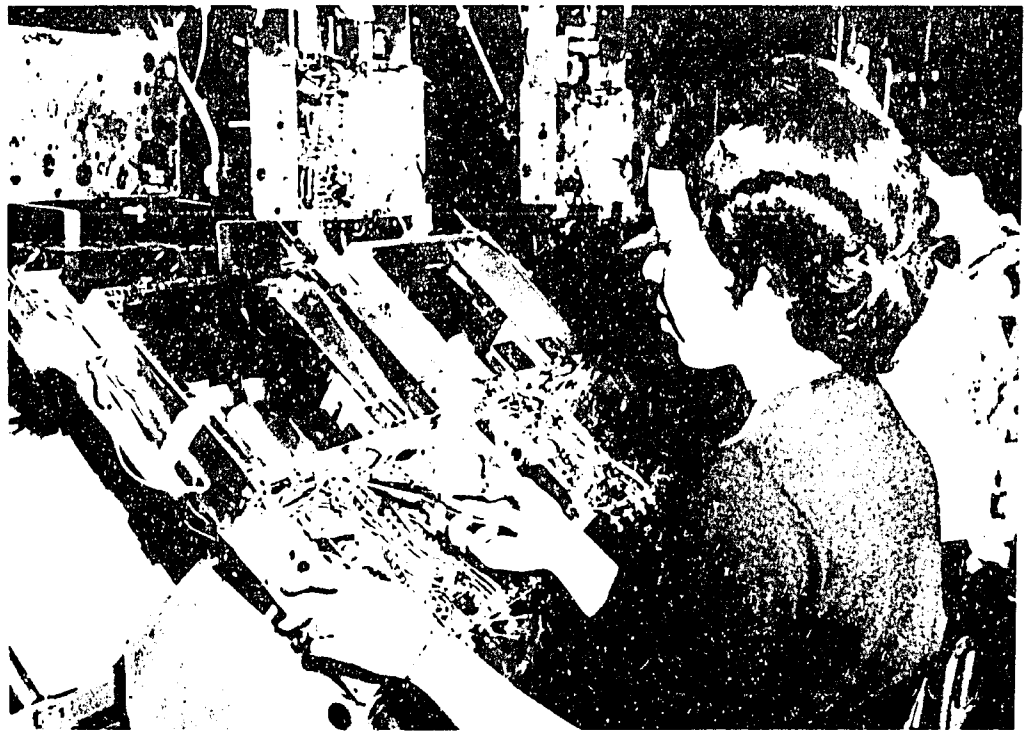

Fig. 1 Wiring operations on the main assembly line.

Table 1. Comparison of standard and actual man-hours required for sixteen selected plants in the manufacture of radio and television receivers, U.S.A., 1951 (selected period)

Plant	Unit man-hours		Percentage variance: actual to standard
	Standard	Actual	
A	13.48	13.26	-1.7
B	7.74	8.46	+9.3
C	na*	7.51	
D	4.78	na	
E	3.69	4.65	+26.1
F	2.74	2.33	-14.9
G	1.34	1.66	+24.0
H	1.24	1.45	+16.7
I	2.98	5.17	+73.5
J	3.15	2.55	-19.0
K	.645	.96	+48.9
L	.869	.88	+1.3
M	.581	.725	+24.9
N	.680	.886	+30.3
O	.766	.67	-12.6
P	.880	.634	-28.0

* na Not available.

Table 2. Standard time for direct labor operations in the manufacture of 17-inch television receivers in Plant A, U.S.A., 1951 (selected period)

Department and operation	Standard time for direct labor operations		Number of operators
	Unit man-hours	Percentage distribution	
Plant total	13.484	100.00	(1)/
Production (line assembly)	6.262	46.4	137
Wiring or lacing.	.312	2.3	10
Chassis assembly.	2.575	19.1	62
Subassembly . . .	2.575	19.1	39
Cabinet assembly.	.800	5.9	26
Inspection	4.585	34.0	34
TV inspection . .	2.575	19.1	11
Voltage and continuity . .	1.210	9.0	8
Packing	.800	5.9	15
Test	2.420	18.0	47
TV testing . . .	1.210	9.0	42
Tube make-up . .	1.210	9.0	5
Mechanical services.	.217	1.6	21
Press	.217	1.6	21

1/ The total number of operators is not given since some operators perform more than one operation.

Table 3. Standard time for direct labor operations in the manufacture of 12-inch television receivers in Plant B, U.S.A., 1951 (selected period)

Department and operation	Standard time for direct labor operations		Number of operators
	Unit man-hours	Percentage distribution	
Plant total	7.742	100.0	(1)/
Main chassis assembly	2.485	32.1	151
Riveting	.139	1.8	10
Wiring or lacing .	1.427	18.4	87
Soldering	.285	3.7	18
Assembling	.232	2.9	12
Repairing	.081	1.1	5
Relief	.098	1.3	6
Chassis inspection	.223	2.9	13
Subassembly chassis .	2.573	33.2	na *
Riveting	.044	0.6	
Wiring or lacing .	1.263	16.3	
Soldering	.253	3.3	
Inspection, electrical . . .	.239	3.0	
Inspection, visual	.072	0.9	
Wire dressing . .	.053	0.7	
Relief	.046	0.6	
Repairing	.023	0.3	
Assembling	.422	5.4	
Lacing and soldering	.159	2.1	
Analyzing and tracking	.137	1.8	8
Analyzing and tracking	.106	1.4	na
Pre-testing (electrical test just prior to analyzing booth.) .	.031	0.4	na
Parts, fabrication .	1.914	24.7	na
Riveting	.068	0.9	
Coil making . . .	.976	12.6	
Coil making inspection . . .	.041	0.5	
Punch pressing . .	.172	2.2	

See footnotes at end of table.

Table 3. Standard time for direct labor operations in the manufacture of 12-inch television receivers in Plant B, U.S.A., 1951 (selected period) -- continued.

Department and operation	Standard time for direct labor operations		Number of operators
	Unit man-hours	Percentage distribution	
Machine shop . . .	0.021	0.3	
Welding	.074	1.0	
Inspection	.112	1.4	
Wiring	.207	2.7	
Assembling other than coil . . .	.218	2.8	
TV tube handling	.024	0.3	
Installation and packing	.429	5.5	21
Assembling	.151	1.9	10
Packing	.099	1.2	9
Trucking and dolly retrieving . . .	.019	0.3	1
Cabinet inspection	.047	0.6	--**
Testing, final . .	.113	1.5	--
Relief operator .	No standards		1
Final installation, subassembly	.143	1.9	11
Riveting	.015	0.2	1
Assembling	.085	1.1)	
Antenna cable assembling . . .	.035	0.5)	7
Wire processing .	.008	0.1	3
Installation - parts manufacture	.061	0.8	na
Punch pressing . .	.027	0.3	
Welding	.005	0.1	
Wire preparation .	.008	0.1	
Assembling	.021	0.3	

* na Not available.
** No assigned operator.
1/ The total number of operators is not given since some operators perform more than one operation.

Table 4. Actual time for direct labor operations in the manufacture of 17-inch television receivers in Plant C, U.S.A., 1951 (selected period)

Department	Actual time for direct labor operations		Number of operators
	Unit man-hours	Percentage distribution	
Plant total (composite of all departments)	7.505	100.0	(1)/
Riveting	.452	6.0	8
Line	2.716	36.2	56
Subassembly	.842	11.2	24
Test	1.432	19.1	22
Trouble shooting and repairing	.636	8.5	10
Cabinet and box . . .	.910	12.1	26
Packers and assemblers . . .	---*	---	24
Wood finishers .	---	---	2
Inspection	.309	4.1	6
Shipping	.208	2.8	4
Receiving and handling	Indirect		6

* Data not available.

1/ The total number of operators is not given since some operators perform more than one operation.

Table 5. Standard time for direct labor operations in the manufacture of 12-inch television receivers in Plant D, U.S.A., 1950 (selected period)

Operation	Standard time for direct labor operation		Number of operators
	Unit man-hours	Percentage distribution	
Plant total	4.777	100.00	(1)/
Riveting	.065	1.4	25
Wiring and lacing	1.381	28.9)	
Soldering	.424	8.9)	266
Mechanical assembly . . .	.427	8.9)	
Spaghetti on socket . . .	.233	0.5)	
Analyzing and tracking (test).	.707	14.8	77
Jig handling time	.350	0.7	(2)/
Inspection	.530	11.1	49
Installation of chassis into cabinet	1.183	24.8	66
Packers	(3)/	(3)/	16
Finishers	(3)/	(3)/	5
Assemblers (cabinet)	(3)/	(3)/	45
Production supervisors 4/	No standards		13
Factory - clerical . . .	No standards		4
Stockhandlers	No standards		17
Relief operators	No standards		25
Repairmen	No standards		10

1/ The total number of operators is not given because some operators perform more than one function.
2/ No assigned operator.
3/ Man-hours not separately determined for this operation.
4/ Inspection and test supervisors are not included.

Table 6. Standard time for direct labor operations in the manufacture of 12-1/2-inch television receivers in Plant E, U.S.A., 1950 (selected period)

Department and operation	Standard time for direct labor operations		Number of operators
	Unit man-hours	Percentage distribution	
Plant total	3.687	100.0	(1)/
Riveting	.092	2.5	9
Riveting	.092	2.5	8
Stockhandling	No standards		1
Inspecting	No standards		(2)/
Line assembly (main chassis)	1.644	44.7	117
Wiring or lacing	.924	25.2	57
Soldering	.223	6.0	14
Assembling	.257	7.0	17
Inspection	.240	6.5	18
Stockhandling	No standards		2
Repairing	No standards		4
Relief	No standards		5
Subassembly other than IF TV strip	.351	9.5	14
Wiring, lacing, soldering and assembly	.209	5.7	5
Wire cutting, stripping	.075	2.0	3
Inspection	.067	1.8	3
Stockhandling	No standards		3
IF strip subassembly	.753	20.4	57
Riveting	.020	.6	(2)/
Wiring or lacing	.414	11.2	32
Soldering	.113	3.1	9
Assembling	.013	0.3	1
Wire cutting and stripping	.042	1.1	(2)/
Inspection, visual	.103	2.8	7
Coil subassembly	.048	1.3	(2)/
Stockhandling	No standards		1
Relief	No standards		3
Inspection, electrical	No standards		1

Footnotes at end of table.

Table 6. Standard time for direct labor operations in the manufacture of 12-1/2-inch television receivers in Plant E, U.S.A., 1950 (selected period) -- continued

Department and operation	Standard time for direct labor operations		Number of operators
	Unit man-hours	Percentage distribution	
Picture tube to chassis . . .	0.068	1.8	6
Assembling	.067	1.8	4
Stockhandling	No standards		1
Inspection, visual	.001	0.0	1
Tracking	.255	6.9	12
Tracking IF	.083	2.3	4
Tracking RF	.067	1.8	4
Scanning and analyzing . . .	.105	2.8	4
Installation and packing . . .	.441	11.9	32
Riveting	.009	0.2	1
Installation	.188	5.1	12
Installation inspection . .	.025	0.6	1
Packing	.121	3.3	8
Packing inspection	.025	0.7	1
Stockhandlers	No standards		2
Cabinet inspection	.025	0.7	1
Air test	.047	1.3	2
Repair	No standards		4
Raw material inspection . . .	.083	2.3	5
Inspection	.083	2.3	5

1/ Total number of operators not given since some operators perform more than one operation.

2/ No assigned operator.

Table 7. Standard time for direct labor operations in the manufacture of four-tube table radios in Plant F, U.S.A., 1950 (selected period)

Operation	Standard time for direct labor operations		Number of operators
	Unit man-hours	Percentage distribution	
Plant total (composite of all operations)	2.737	100.0	(1)/
Riveting	.047	1.7	0.375
Subassembly	.455	16.6	3.250
Assembly of mechanical parts	.139)	5.1)	
Tubing	.033)	1.2)	1.250
Wiring, soldering	.836	30.6	6.000
Inspection	.279	10.2	2.000
Electrical test	.547	20.0	3.000
Cabinet (boxing)	.267	9.7	2.000
Packing	.133	4.9	1.000
Stockhandlers	No standards		1.500
Relief operators	No standards		1.000
Repairmen (trouble shooters)	No standards		1.000
Line supervisors	No standards		1.000

1/ The total number of operators is not given since some operators perform more than one operation.

Table 8. Standard time for direct labor operations in the manufacture of four-tube table radios in Plant G, U.S.A., 1951 (selected period)

Department and operation	Standard time for direct labor operations		Number of operators
	Unit man-hours	Percentage distribution	
Plant total	1.339	100.0	(1)/
Subassembly	.345	25.8	22.00
Riveting	.042	3.1	3.0
Wiring, lacing, soldering and assembling	.056	4.1	3.0
Range switch subassembly	.036	2.7	(2)/
Twist wire assembly . .	.010	0.7	(2)/
Drive cord assembly . .	.010	0.7	(2)/
Coil making complete . . .	.215	16.1	13.00
S.W. antenna coil . . .	.072	5.4	(2)/
S.W. oscillator coil .	.067	5.0	(2)/
B.S. oscillator coil .	.076	5.7	(2)/
Wire cutting, resister and condenser ends, sleeving	.033	2.5	2.0
Stockhandler and foreman . .	No standards		1.0
Main chassis assembly	.572	42.7	47.0
Wiring or lacing	.295	22.1	21.0
Soldering	.085	6.3	5.0
Assembly	.192	14.3	15.0
Stockhandling	No standards		1.0
Foremen	No standards		1.0
Repairmen	No standards		1.0
Relief operators	No standards		3.0
Installation, phasing, and packing	.359	26.8	28.0
Analysing and tracking . .	.167	12.5	12.0
Installing	.111	8.3	9.5
Packing	.081	6.0	4.0
Stockhandlers	No standards		1.0
Repairmen	No standards		1.0
Foremen	No standards		0.5
Inspection	.064	4.7	4.5
Chassis line inspection . .	.034	2.5	2.5
Air test	.029	2.2	2.0

1/ Total number of operators not given since some operators perform more than one operation.

2/ No assigned operator.

Table 9. Standard time for direct labor operations in the manufacture of four-tube table radios in Plant H, U.S.A., 1950 (selected period)

Department and operation	Standard time for direct labor operations		Number of operators
	Unit man-hours	Percentage distribution	
Plant total	1.242	100.0	(1)/
Riveting	.033	2.7	4.50
Riveting	.028	2.3	3.00
Inspection	.005	0.4	1.00
Stockhandling	No standards		0.50
Subassembly	.320	25.8	10.25
Wiring, lacing and soldering	.027	2.2	1.00
Coil making complete.	.229	18.5	6.00
Checking and balancing coils	063	5.1	3.00
Stockhandling	No standards		0.25
Main chassis assembly .	.655	52.7	21.50
Wiring or lacing . .	.313	25.2	10.00
Soldering	.094	7.6	3.00
Inspection, visual .	.054	4.3	2.00
Assembly, mechanical.	.101	8.1	3.00
Repair operators . .	.031	2.5	1.00
Wire dressing	.031	2.5	1.00
Roving repair operators	.031	2.5	1.00
Stockhandling	No standards		0.50
Installation and packing	.120	9.6	13.00
Installation	.050	4.0	5.00
Packing	.060	4.8	6.00
Repair and relief operator	.010	0.8	1.00
Stockhandling	No standards		1.00
Analyzing, tracking and final test	.114	9.2	5.00
Analyzing and tracking	.077	6.2	3.00
Stockhandling	No standards		1.00
Final, air test . . .	.037	3.0	1.00

1/ The total number of operators is not given since some operators perform more than one operation.

Table 10. Standard time for direct labor operations in the manufacture of seven-tube table radios in Plant I, U.S.A., 1950 (selected period)

Operation	Standard time for direct labor operations		Number of operators
	Unit man-hours	Percentage distribution	
Plant total (composite of all operations)	2.977	100.0	(1)/
Riveting	.070	2.4	.50
Subassembly	.412	13.8	2.75
Assembly of mechanical parts . .	.301	10.1)	1.33
Tubing	.050	1.7)	
Wiring and soldering .	.902	30.3	7.00
Inspection	.301	10.1	2.00
Electric test	.675	22.6	3.50
Trouble shooting .	.150	5.0	(2)/
Air testing	.150	5.0	(2)/
Broadcast and IF .) FM IF . . . . . .)	.225	7.6	(2)/
RF IF	.150	5.0	(2)/
Cabinet (boxing) . . .	.133	4.5	1.00
Packing	.133	4.5	1.00
Stockhandlers	No standards		1.50
Relief operators . . .	No standards		1.00
Repairmen	No standards		1.00
Supervisor	No standards		1.00

1/ The total number of operators is not given since some operators perform more than one operation.

2/ No assigned operator.

Table 11. Standard time for direct labor operations in the manufacture of seven-tube table radios in Plant J, U.S.A., 1951 (selected period) 1/

Department and operation	Standard time for direct labor operations	
	Unit man-hours	Percentage distribution
Plant total	3.1500	100.0
Press	.0848	2.7
Tuning shaft bracket	.0014	0.0
Chassis base	.0301	1.0
RF Tuner base	.0036	0.1
Loop bracket	.0042	0.1
Dial back	.0113	0.4
Dial plate mounting bracket	.0098	0.3
Dial light bracket	.0017	0.1
Decorative rail	.0226	0.7
Inspection	.0001	0.0
Plate	.0079	0.2
Chassis base	.0056	0.2
RF Tuner base	.0005	0.0
Loop bracket	.0002	0.0
Dial back	.0005	0.0
Dial plate mounting bracket	.0005	0.0
Dial light bracket	.0001	0.0
Decorative rail	.0005	0.0
Rivet	.0702	2.2
RF tuner base	.0053	0.2
Dial back	.0108	0.3
Chassis wiring	.0541	1.7
Paint	.0429	1.4
Cabinet	.0340	1.1
Dial back	.0039	0.1
Decorative rail	.0050	0.2
Coils	.4604	14.6
High frequency choke	.0167	0.5
Parasitic suppressor	.0180	0.6
Parasitic suppressor	.0194	0.6

See footnotes at end of table.

Table 11. Standard time for direct labor operations in the manufacture of seven-tube table radios in Plant J, U.S.A., 1951 (selected period) -- (continued) 1/

Department and operation	Standard time for direct labor operations	
	Unit man-hours	Percentage distribution
Detector transformer	0.1146	3.6
Hi-frequency choke	.0153	0.5
Hi-frequency choke	.0308	1.0
Oscillator coil	.0264	0.8
2nd I.F. coil (FM)	.0390	1.2
Output transformer	.0697	2.2
A.C. choke	.0675	2.2
Inspection	.0430	1.4
Wire cutting	.0500	1.6
Chassis wiring	0500	1.6
Cabinet assembly	.0523	1.7
Cabinet	.0523	1.7
Line assembly	1.3140	41.7
Chassis wiring	1.3140	41.7
Balance and test	.6113	19.4
Chassis wiring	.6113	19.4
Pack	.1670	5.3
Radio complete	.1670	5.3
Other inspection	.2892	9.2

1/ The number of operators for this plant is shown in table 18.

Table 12. Standard time for direct labor operations in the manufactu of five-tube table radios in Plant K, U.S.A., 1950 (selected period)

Operation	Standard time for direct labor operations		Number of operators
	Unit man-hours	Percentage distribution	
Plant total (composite of all operations)	0.645	100.0	(1)/
Riveting	.027	4.2	10
Wiring	.310	48.1)	590
Soldering	.064	10.0)	
Mechanical assembly . .	.107	16.6	15
Electric testing . . .	.034	5.3	11
Packing	.034	5.3	5
Inspection	.068	10.5	27
Coil winders	(2)/	(2)/	6
Aligners	(2)/	(2)/	10
Stockhandlers	No standards		8
Relief operators . . .	No standards		16
Repairmen	No standards		6
Trouble shooters . . .	No standards		24

1/ The total number of operators is not given because some operators perform more than one function.

2/ Separate man-hour figures for these operations are not available.

Table 13. Standard time for direct labor operations in the manufacture of five-tube table radios in Plant L, U.S.A., 1950 (selected period)

Department and operation	Standard time for direct labor operations		Number of operators
	Unit man-hours	Percentage distribution	
Plant total	0.869	100.0	(1)/
Materials inspection	.037	4.3	2.0
Inspection, electrical and visual	.037	4.3	2.0
Subassembly (combined)	.151	17.4	10.0
Wiring, lacing, soldering, and assembly	.103	11.9	6.0
Wire cut and strip	.031	3.6	2.0
Inspection	.017	1.9	1.0
Stockhandling	No standards		1.0
Riveting department	.016	1.9	2.0
Riveting	.016	1.9	2.0
Main chassis assembly line	.479	55.1	35.0
Wiring or lacing	.249	28.6	15.0
Soldering	.054	1.2	5.0
Assembly	.089	10.2	6.0
Inspection	.087	10.1	6.0
Stockhandling	No standards		1.0
Relief operators	No standards		2.0
Tracking	.583	6.7	2.0
Analyzing and tracking	.583	6.7	2.0
Installation and packing	.1265	14.6	10.0
Installing	.0473	5.5	3.5
Packing	.0233	2.7	1.5
Cabinet inspection	.0167	1.9)	2.0
Installation inspection	.0167	1.9)	
Air test	.0225	2.6	2.0
Stockhandling	No standards		1.0

1/ The total number of operators is not given since some operators perform more than one operation.

Table 14. Standard time for direct labor operations in the manufacture of five-tube table radios in Plant M, U.S.A., 1950 (selected period)

Department and operation	Standard time for direct labor operations		Number of operators
	Unit man-hours	Percentage distribution	
Plant total	0.581	100.0	(1)/
Line chassis assembly . .	.267	46.1	18.5
Wiring or lacing . . .	.127	22.0	7.0
Soldering	.054	9.3	3.0
Mechanical assembly . .	.086	14.8	5.0
Inspection	No standards		2.0
Stockhandling	No standards		0.5
Relief operators . . .	No standards		1.0
Analyzing and tracking. .	.041	7.1	3.0
Analyzing and tracking	.041	7.1	3.0
Subassembly	.133	22.8	9.0
Riveting	.030	5.1	2.0
Wiring, lacing, and soldering	.091	15.6	6.0
Assembly	.012	2.1	1.0
Final assembly	.099	17.0	8.0
Packing	.029	4.9	2.0
Air test and final test	.031	5.4	8.0
Installation	.039	6.7	3.0
Stockhandling	No standards		1.0
Subassembly	.041	7.0	3.0
Coil making	.029	5.1	2.0
Wire processing	.011	1.9	1.0

1/ The total number of operators is not given since some operators perform more than one operation.

Table 15. Standard time for direct labor operations in the manufacture of four-tube table radios in Plant N, U.S.A., 1950 (selected period)

Department and operation	Standard time for direct labor operations		Number of operators
	Unit man-hours	Percentage distribution	
Plant total	0.680	100.0	(1)/
Riveting, subassembly . . .	.074	10.9	8.1
Riveting	.025	3.6	2.7
Assembling	.050	7.3	5.4
Chassis assembly	.345	50.8	37.5
Assembling and soldering	.276	40.6	30.0
Inspection	.041	6.1	4.5
Group leaders	.028	4.1	3.0
Testing	.101	14.9	11.0
Testing	.092	13.5	10.0
Group leaders	.009	1.4	1.0
Line assembly and packing	.159	23.4	17.3
Assembling	.083	12.1	9.0
Packing	.037	5.4	4.0
Testing	.028	4.1	3.0
Group leaders	.012	1.8	1.3

1/ The total number of operators is not given since some operators perform more than one operation.

Table 16. Standard time for direct labor operations in the manufacture of four-tube table radios in Plant O, U.S.A., 1949 (selected period)

Department and operation	Standard time for direct labor operations		Number of operators
	Unit man-hours	Percentage distribution	
Plant total	0.766	100.0	(1)/
Riveting	.027	3.5	2.0
Riveting	.027	3.5	2.0
Subassembly	.103	13.5	8.0
Wiring, lacing and soldering	.045	5.9	3.5
Wire cut and strip	.031	4.0	2.0
Assembling	.011	1.4	0.5
Inspection, visual	.017	2.2	1.0
Stockhandlers	No standards		1.0
Main assembly chassis line	.396	51.7	33.0
Wiring or lacing	.188	24.6	12.0
Soldering	.057	7.4	6.0
Assembling	.088	11.5	7.0
Stockhandlers	No standards		1.0
Inspection, visual	.063	8.2	4.0
Repairmen	No standards		1.0
Relief operators	No standards		2.0
Tracking	.053	7.6	2.0
Analyzing and tracking	.058	7.6	2.0
Installation and packing	.144	18.8	12.0
Installation	.070	9.1	4.0
Packing	.018	2.4	1.0
Cabinet inspection	.017	2.2)	2.0
Installation inspection	.017	2.2)	
Air test	.023	2.9	2.0
Repairmen	No standards		2.0
Stockhandlers	No standards		1.0
Raw material inspection	.037	4.9	2.0
Inspection	.037	4.9	2.0

1/ The total number of operators is not given since some operators perform more than one operation.

Table 17. Standard time for direct labor operations in the manufacture of three-tube table radios in Plant P, U.S.A., 1951 (selected period) 1/

Department and operation	Standard time for direct labor operations	
	Unit man-hours	Percentage distribution
Plant total	0.880	100.0
Press	.050	5.7
Transformer	.001	0.1
IF coil mounting bracket	.003	0.3
Chassis base	.018	2.0
Cabinet	.023	2.6
Cabinet back	.005	0.5
Inspection	.0002	0.0
Plate	.007	0.8
Transformer case	.0002	0.0
Chassis base	.007	0.8
Paint	.030	3.4
Cabinet painting	.030	3.4
Coils	.272	30.9
IF transformer	.055	6.3
Antenna coil	.063	7.1
Oscillator coil	.057	6.5
Output transformer	.064	7.3
Inspection	.032	3.7
Wire cutting	.009	1.0
Chassis wiring	.009	1.0
Cabinet assembly	.015	1.7
Cabinet	.015	1.7
Line assembly	.277	31.5
Chassis wiring	.277	31.5
Balancing and testing	.055	6.3
Chassis wiring	.055	6.3
Packing	.093	10.6
Radio complete	.078	8.9
Inspection	.015	1.7
Other inspection	.072	8.1

1/ The number of operators for this plant is shown in table 18.

Table 18. Staffing pattern: In radio manufacturing plants J and P, U.S.A., 1951 (selected period)

Department and occupation	Number of operators		Department and occupation	Number of operators	
	Plant J	Plant P		Plant J	Plant P
Paint	17	17	Riveting	12	0
Inspectors, visual	2	2	Riveters	10	
Repairmen	4	4	Set-up man . . .	1	
Spray painters . .	4	4	Group leader . .	1	
Mixer	1	1			
Degreaser	1	1	Line assembly . .	87	44
Material handlers and packers . . .	4	4	Inspectors . . .	19	10
Striper	1	1	Electrical . .	7	4
			Visual	11	4
Cabinet assembly . . .	21	21	Other	1	2
Inspectors, visual	2	2			
Assemblers	17	17	Wirer or lacers	20	10
Material handler . .	1	1	Solderers . . .	11	4
Group leader	1	1	Relief operators	1	1
			Repairmen (electrical)	5	3
Coil	84	84			
Inspectors, visual	16	16	Packers	2	2
Stockhandlers . . .	1	1	Machine operators	15	8
Assemblers	53	53	Stockchasers . .	2	2
Coil winders	12	12	Subassemblers	8	2
Machine set-up . .	1	1	Group leaders	4	2
Wax impregnator operator	1	1			

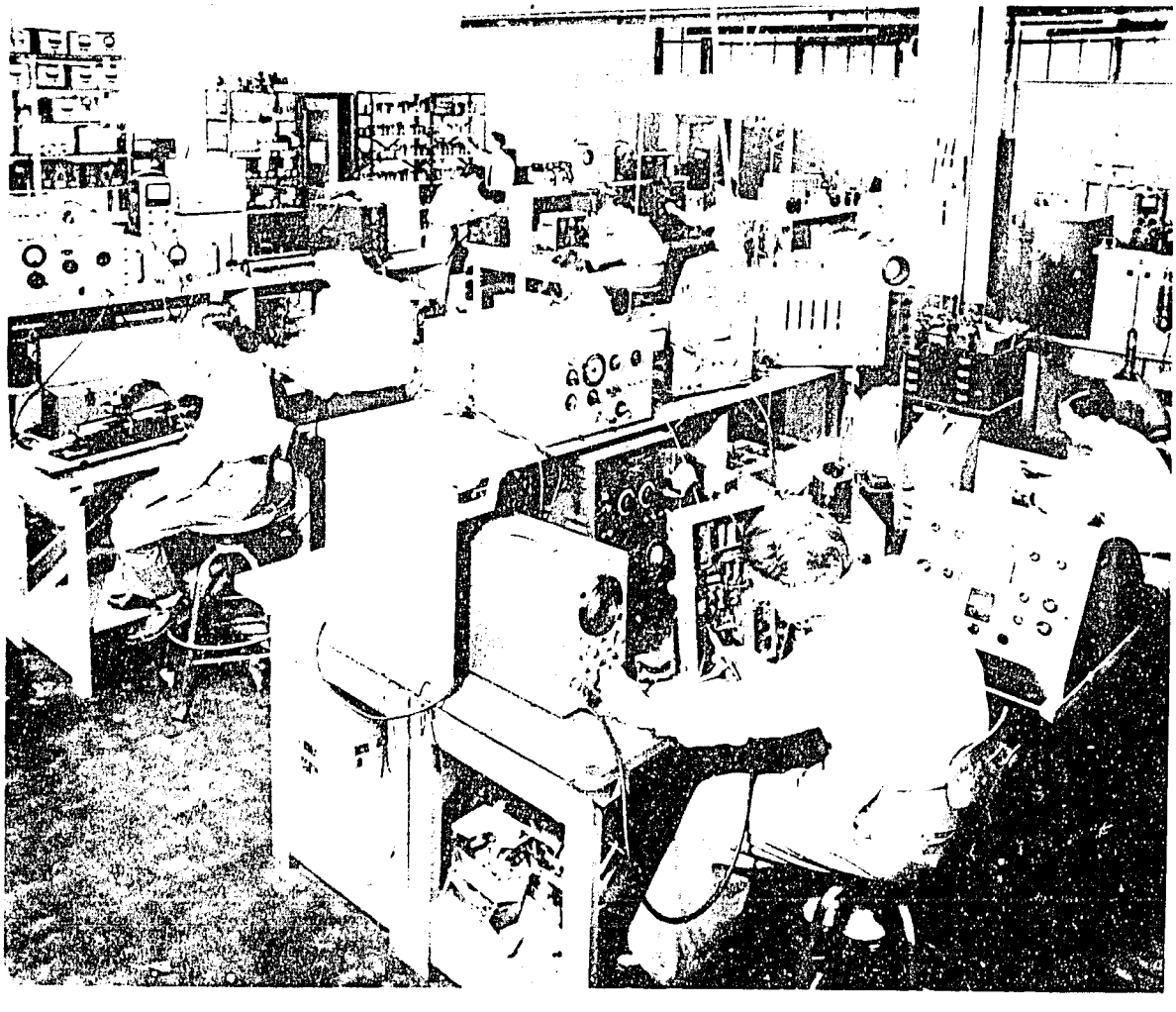

Fig. 2 Section of a plant's research and development laboratory.

Courtesy Olympic Radio and Television, Inc.

Organization of Main Chassis Assembly Line

The main line, called the wiring line, chassis line, or assembly line, differs from plant to plant in number, kind, and layout of work stations. The division of functions is the result of the scale of operations, the number and complexity of models, and work layout of the plants. It is important that the main line in all plants be carefully balanced and controlled since a major proportion of labor time is expended here. Characteristics of the organization of the main line in reporting plants are presented in Table 19.

Fig. 3 The main assembly line in a television plant.

Table 19. Description of the main assembly line for sixteen selected radio and television manufacturing plants. U.S.A., 1949 - 1951

Item	A	B	C	D	E	F	G	H
Number of lines	1	1	1/ 3	2	1 - 4	1	2	1
Difference between lines:								
Identical and parallel			X		X			
Significantly different				X			X	
Length of line(s) in feet	550	384	276	200 & 640	308	70	120 & 240	120
Number of work stations	111	112	66	50 & 160	2/ 75	17	3/10 - 60	17
Work stations on one (O) or both (B) sides of line	B	B	O	B	B	O	O	O
Average number of workers								
Per inspector	5	10	8	6	6	4	20	10
Per relief operator	11	20	4/30	12	15	16	15	20
Number of subassemblies made off the line	19	16	8	4	8	7	1	2
Shape of line: Straight (S), U-shaped (U), or Winding (W)	5/S	6/S	U	W	6/S	S	7/S	U
Inspection on line:								
Visual	X	X	X	X	X	X	X	X
Mechanical	X	X	X		X		X	
Electrical	X	X	X		X	X	X	
Work positioning:								
Flat on work bench	X							
Slanted at 45 to 60 degree angle from horizontal		X	X	X	X	X	X	X
Positioning equipment	na*							
Wooden chassis jib		X		X	X		X	X
Casters or ball bearings				X	X	X		
Steel rails or channels			X	X		X		
Automatic conveyors		X					X	X

Table 19. Description of the main assembly line for sixteen selected radio and television manufacturing plants, U.S.A., 1949 - 1951 -- (Continued)

Item	A	B	C	D	E	F	G	H
Average light intensity in foot candles	40	35 - 40	na	60 - 80	35	40	30	35 - 40
Approximate number of days required for "line capacity attainment"	60	na	5	8/5 - 10	15	5	10	14

* na Not available.

** X's indicate performance or usage.

1/ Approximately 200 sets are produced per day per line; at the time of the survey this plant was operating only one line.

2/ Twenty-five additional work stations in the tubing line serve all four wiring lines.

3/ Varies directly with volume of production.

4/ This average does not include subassembly operators. Subassembly operators, more highly skilled than other operators, produce and stack their work about one week in advance of the remaining lines. In this way the subassembly operator may be used as a relief in any vacant position on the line.

5/ Straight line supplemented by feeder lines. Single line split after wiring test. Chassis flow to different model type lines.

6/ Plants B and E use straight line assembly with workers stationed on both sides of the line. In one case the successive work stations are in zigzag order across the line, and the chassis is passed from operator to operator in this fashion. In the other case the work stations run successively along one side, then the other side; with this method the chassis is run through the line twice by a mechanical conveyor. When the operations on one side are completed, the chassis is returned by the conveyor to the head of the line and rerun in the same direction but on the other side of the line.

7/ One is a straight flat top table 120 feet long. The other is a conveyorized line which is oval-shaped and measures 120 feet on each side.

8/ For an entirely new model with new help; fewer days required for experienced help.

(Table continued on next page.)

Table 19. Description of the main assembly line for sixteen selected radio and television manufacturing plants, U.S.A., 1949 - 1951 -- (Continued)

Item	I	J	K	L	M	N	O	P
Number of lines	1	1	1	1	1	1	1	1
Length of line in feet	9/ 160	300	70	180	100	280	228	130
Number of work stations	18	78	19	27	30	66	25	48
Work stations on one (O) or both (B) sides of line	O	O	O	B	O	O	B	O
Average number of workers:								
Per inspector	4	10	9	6	15 - 16	15	6	10
Per relief operator	17	20	9	15	20	10	15	20
Number of subassemblies made off the line	5	2	0	6	7	2	5	1
Shape of line:								
Straight (S), U-shaped (U)	S	U	S	S	S	S	S	S
Inspection on line:								
Visual	X	X		X	X	X	X	X
Mechanical		X		X	X	X	X	X
Electrical	X	X	X	X			X	X
Work positioning:		na						na
Flat on work bench			X			X		
Slanted at 45 to 60 degree angle from horizontal	X			X	X		X	
Positioning equipment:								
Wooden chassis jib			X	X	X	X	X	
Casters or ball bearings	X		X				X	
Steel rails or channels	X	X			X			X
Automatic conveyors			X			X		
Average light intensity in foot candles	40	40	na	35	50	na	35	40
Approximate number of days required for "line capacity attainment"	5	30	10	10	10 - 15	10	10	30

9/ Only about 3/4 of this line actually is in use.

Production Control, Inventory, and Inspection Practices

Production control, inventory, and inspection practices differ widely from plant to plant depending upon the size of the plant, the number of parts and products manufactured, the number of parts purchased, and the requirements of the parent company. All plants, however, attempt to secure delivery of necessary component parts well in advance of production, particularly those items which are in short supply in the market.

After a sales forecast is made and the design of the new model approved, production is initiated by top management by means of a production authorization sent to all departments in the plant.

PRODUCTION AUTHORIZATION

MODEL NO.
Factory
Sales

DESCRIPTION: CABINET AND CONTENTS:

AUTHORIZED PREVIOUSLY	REQUESTED AUTHORIZATION	TOTAL AUTHORIZED TO DATE

SALES ESTIMATES:

	Units	Value
Jan.		
Feb.		
Mar.		
Apr.		
May		
June		
July		
Aug.		
Sept.		
Oct.		
Nov.		
Dec.		
TOTAL		

PLAN FOR PRODUCTION:
Start: Date
Completion: Date

SIGNED:
Sales
Cost
Mfg.
Acctg.
V.P. in Chg.

COMMITMENTS:
Sales Value $
COST:
Cabinet
Speaker
Tubes
Record Chgr.
Chassis Etc.
TOTAL
Labor-Burden & Overhead
TOTAL COMMITMENT:

REMARKS:

Date:
Form No. E-36

COPIES TO:
Sales
Service
Purchasing
Engineering
Manufacturing
Accounting - Cost
Packaging

No.

Fig. 4 Production authorization.

Production begins only after sufficient purchased parts are on hand for one to two weeks' production. The purchase requisition of one company (fig. 5) contains the date (cycle code number) when not less than the first two weeks' requirements of purchased parts for the final assembly line are in stock. The number of weeks' production for which subassembly parts lead the final assembly cycle date appears in the "L" (lead) box. An entry in the "D" box authorizes daily delivery of the part.

PURCHASE REQUISITION-

PURCHASE ORDER NO. FORM 137

VENDOR | DELIVERY REQUIRED | QUANTITY ORDERED | REMARKS

VOID

DOMESTIC RADIO TUBES, SPEAKERS RECORD CHANGERS & CABINETS

TAX EXEMPT - REG. NO. 344

TAX FREE - EXPORT

NON-TAX. TRANS. TUBES

TELE. TUBES

TAXABLE COM. PARTS & SERVICE

WRITTEN BY | SIGNED BY | DATE CONFIRMED | TO

UNIT | PRICE | AMOUNT | REBALE | CHG. TO ACCT. NO | CONSUM.

PART NUMBER	DESCRIPTION	UNIT	RELEASE NO.	CYCLE	PREPACK	L	P	D	ACCT. NO.	MO.	DAY	YR.
80088	SPRING	EA	729 731 732	45		69			133	09	09	1

AVAILABLE	1ST 2 WKS-REQUIRED	2ND 2 WKS-REQUIRED	3RD 2 WKS-REQUIRED	4TH 2 WKS-REQUIRED	5TH 2 WKS-REQUIRED	TOTAL REQUISITION
40000	30000CR	10000CR	30000CR	20000CR	40000CR	90000CR

Fig. 5 Purchase requisition.

A detailed description of the operations required to manufacture or assemble each part of a model is developed by most plants. Standard times of similar operations are used to determine the time required to complete the part or unit. Such process layout sheets (fig. 6) are then divided into combinations or sequences to meet the requirements of the production schedule. For example, the sheets may be divided into 20 operations for 20 workers, or 16 for 16 workers. It is important to remember that the time cycle of each operation must be as equal as possible to insure a smooth flow of work.

Information necessary for the operations determined from the process layout sheet is filled in on an operation layout sheet (fig. 6). One form is filled out for each worker, and a new set must be made if the number of workers changes.

PROCESS LAYOUT

PROCESSED BY _____ MODEL _____ PART NO. _____

DATE _____ DESCRIPTION _____ DESCRIPTION _____

SIMILAR TO _____ USED ON _____ SHEET NO. _____ OF _____

TOOL NO AND DESCRIPTION	PARTS USED	SEQ	DETAILS OF OPERATIONS

OPERATION LAYOUT

ISSUED BY _____ DATE _____ MODEL _____ RATE OF PROD PER 8 HR DAY, 100% EFF. _____

SOLDERERS _____ SOLDERING CONNECTIONS PER OPER _____ SOLDERING CONNECTIONS TOTAL _____

WIRERS _____ WIRING CONNECTIONS PER OPER _____ WIRING CONNECTIONS TOTAL _____

ASSEMBLERS _____ COMB SOLDERER AND WIRER _____ GROUND CONNECTIONS TOTAL _____

OPER NO	TYPE OF WORK	UNIT TIME	SEQUENCE NO.	PART REF NO	VALUE OR COLOR	PART NO	LENGTH OR BODY SIZE	CUT OR STRIP OF I.F

DAILY PRODUCTION AND SHIPPING REPORT

PAGE _____ OF _____

CHECKED BY _____ AT THE END OF _____

PREPARED BY _____ LAST RELEASE CONSIDERED _____

CHASSIS	MODEL	AUTH. TOTAL	CHASSIS OFF LINE TODAY	ACCUM NET CHASSIS OFF LINE TO DATE	PASSED TEST TODAY	PACKED		ACCUM. NET PACKED TO DATE	SHIPPED		ACCUM. NET SHIPPED TO DATE	BALANCE ON HAND	IN TRANSIT TO ZRC FROM WINCO	RETURNED TO STOCK FROM SERVICE DEPT.	QUALITY CONTROL SERVICE TODAY
						TODAY	THIS MONTH		TODAY	THIS MONTH					

Fig. 6 Process layout, operation layout, and daily production forms.

DAILY CHASSIS AND MODEL PRODUCTION COUNTS

FOR _____
DAY MONTH DATE YEAR

MODELS PACKED- TODAY				CHASSIS OFF LINE- TODAY			
CHASSIS NO.	OFF LINE TODAY	CHASSIS NO.	OFF LINE TODAY	MODEL NO.	PACKED TODAY	MODEL NO.	PACKED TODAY

Fig. 7 Typical form showing daily production.

Every plant keeps a cumulative record of daily production (figs. 6 and 7). Such a record usually shows the number of chassis of each model which are on the line, the number completed, and the number which passed the electrical test. All plants also keep a record of the number of sets packed, shipped, and still on hand. Plants do not generally produce for stock or inventory unless it is necessary to maintain an even or balanced work flow on the line. Some items with stable demand, however, are sometimes kept on hand.

Inventory records are one of the most important control devices of a radio and television plant. Shortage of parts is one of the reasons most frequently cited by plant managers as the cause of excessive production time. Regular times are usually set aside to count and check parts kept in stock. One form of inventory control record is the IBM card shown in fig. 8.

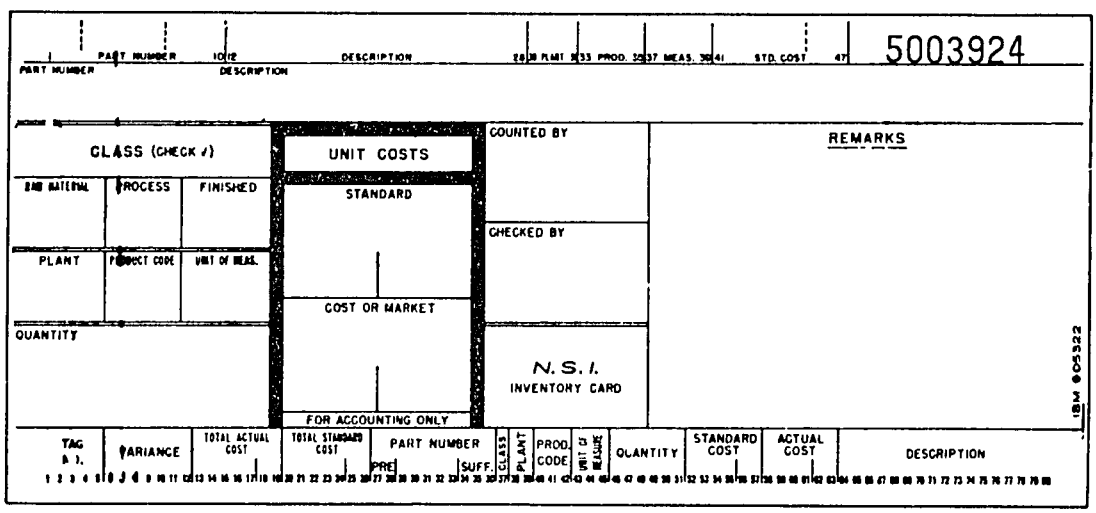

Fig. 8 IBM Inventory control card.

All plants do electrical testing of some parts. The methods and number inspected, however, vary from plant to plant for such items as transformers, speakers, tubes, condensers, coils, and resistors. The majority of plants test only a sample of purchased parts, varying from one to ten per cent of a box or carton to 100 per cent for coils. In many cases the previous record of the supplier determines the inspection practice. If the supplier is new or has a previous high rejection rate, inspection may be 100 per cent of the lot.

Half the surveyed plants use statistical quality control charts to determine what percentage of parts to inspect and what defective rate justifies the rejection of an entire lot.

SPOT CHECK REPORT

FROM: _____

TO: PLANT MANAGER _____ DATE: _____

MODEL _____ TESTED BY: _____

CHECKED BY: _____

SENSITIVITY

FREQUENCY									
LIMITS									
AS RECEIVED									
RE-ALIGNED									

REMARKS: _____

Fig. 9 Sample form used for spot checking.

Inspection of the completed chassis is often made as the set leaves the main assembly line. Such an inspection, while brief, checks manually and electrically the strength and accuracy of connections and the complete circuit. After tubes are inserted, the set is given a more complete inspection in testing booths to determine whether the frequency, phasing, voltage, and resistance of the set are correct. Figs. 10, 11, and 12 illustrate the inspection of television chassis.

Final inspection takes place just before the set is boxed, and consists of an "air-test" which checks the ability of the set to receive local radio or television broadcasts. This air-test is often given under conditions which closely resemble those of a typical home.

Some of the inventory and inspection practices of the surveyed plants are shown in table 20.

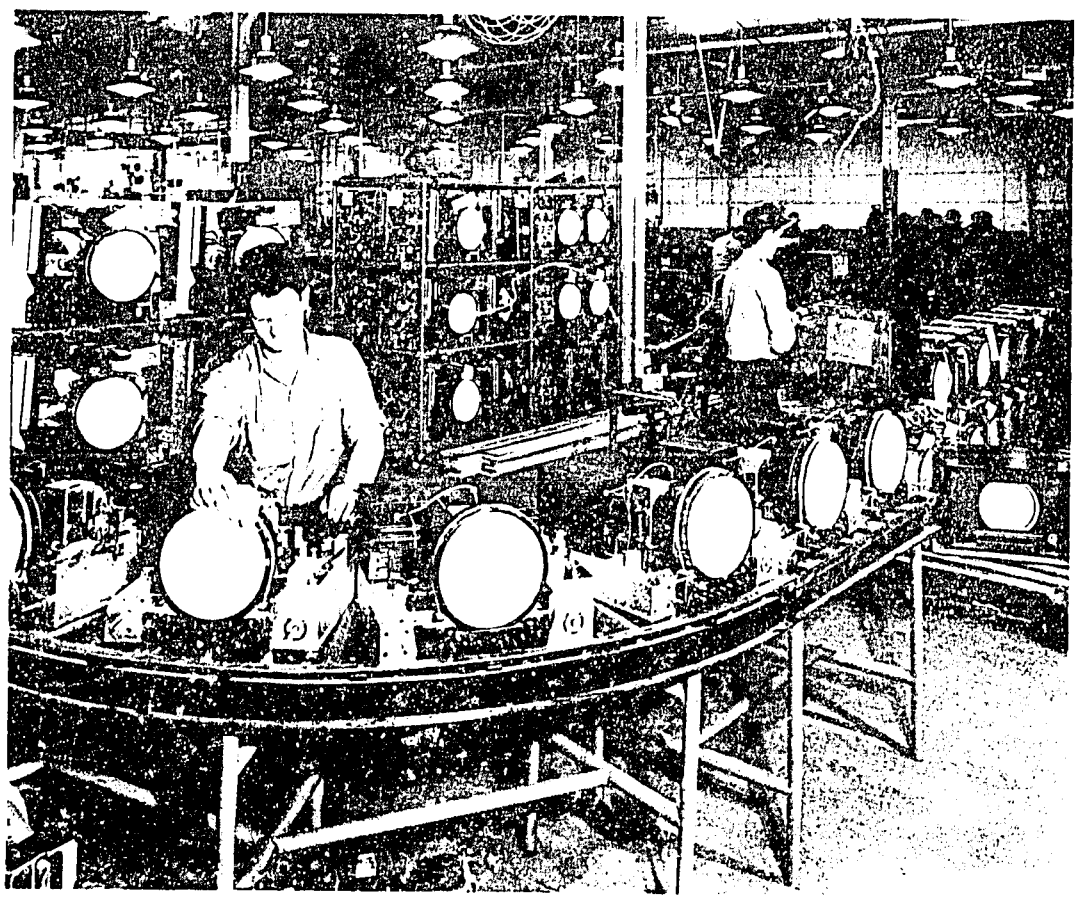

Fig. 10 Assembly and inspection operations in a television plant.

Table 20. Inventory and inspection practices in the manufacture of radio and television receivers in sixteen selected plants, U.S.A., 1949 - 1951 (selected periods)

Items	A	B	C	D	E	F	G	H
Number of days production for which a complete parts inventory is usually maintained	60 - 90	10	1	(1)/	20 - 40	(1)/	(1)/	10
Number of days production of finished sets usually kept in stock . .	30	2	2	na*	2	3 - 5	(2)/	5
Percent of sets which do not pass final inspection	15	12 - 14	3/ 1 or 2	na	10	3	less than 5	15
Percent of vacuum tubes inspected before installation	0	1	0	0	0	0	5	0
Percent of cathode ray tubes inspected before installation	0	1	0	2	0	--**	--	--
Other parts given electrical inspection before installation:								
All electrical parts		X***		X				
Speakers	X						X	
Coils	X			X	X	X	X	
Condensers and resistors			X		X	X		X
Gang condensers							X	
Transformers					X			X

See footnotes at end of table.

Table 20. Inventory and inspection practices in the manufacture of radio and television receivers in sixteen selected plants, U.S.A., 1949 - 1951 (selected periods) -- continued

Item	I	J	K	L	M	N	O	P
Number of days production for which a complete parts inventory is usually maintained	(1)/	60	15	23	20	20	21	60-90
Number of days production of finished sets usually kept in stock	3-5	30	4	2-7	2-3	1	2-3	30
Percent of sets which do not pass final inspection	3	8	3	10	5	3-4	10	4
Percent of vacuum tubes inspected before installation	0	0	2	0	50	0	0	0
Other parts given electrical inspection before installation:								
All electrical parts								
Speakers		X			X	X		X
Coils	X	X		X		X	X	X
Condensers and resistors . . .	X			X		X	X	
Gang condensers				X			X	
Transformers		X	X	X		X	X	X

* na Not available.
** Dashes indicate data not applicable.
*** X's indicate performance or usage.
1/ Supplies are purchased for a complete lot before production is begun.
2/ This type built to stock once yearly. Diminishing inventory throughout remainder of the season.
3/ This is at boxing; 15 to 20 per cent fail at end of main assembly line.

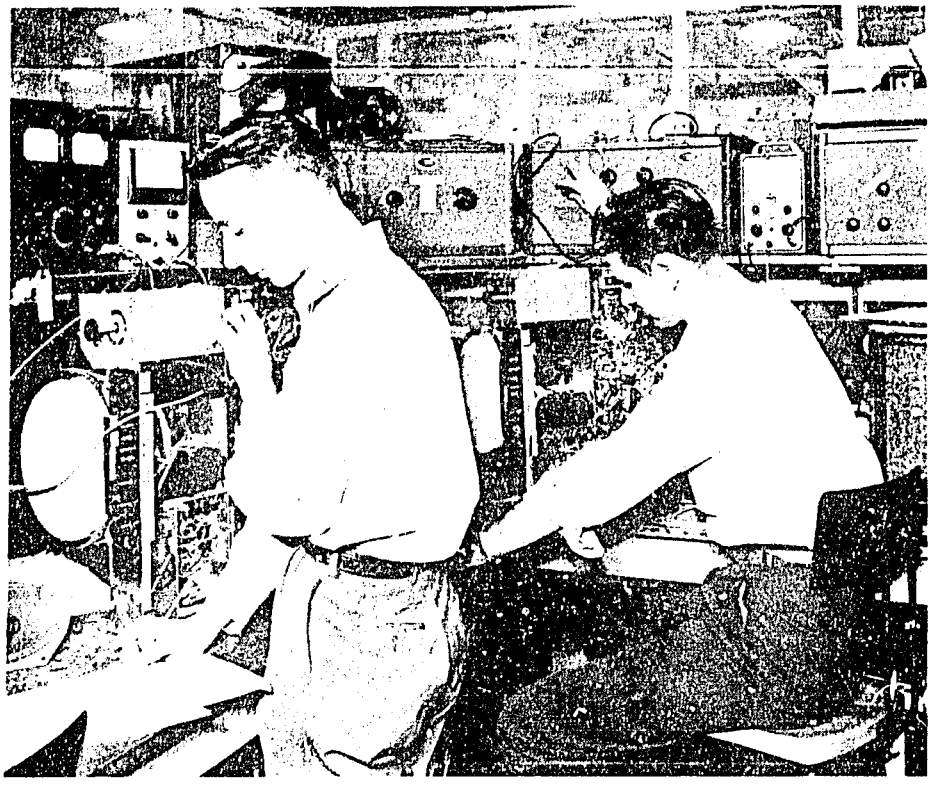

Fig. 11 Inspection and analysis of a television set.

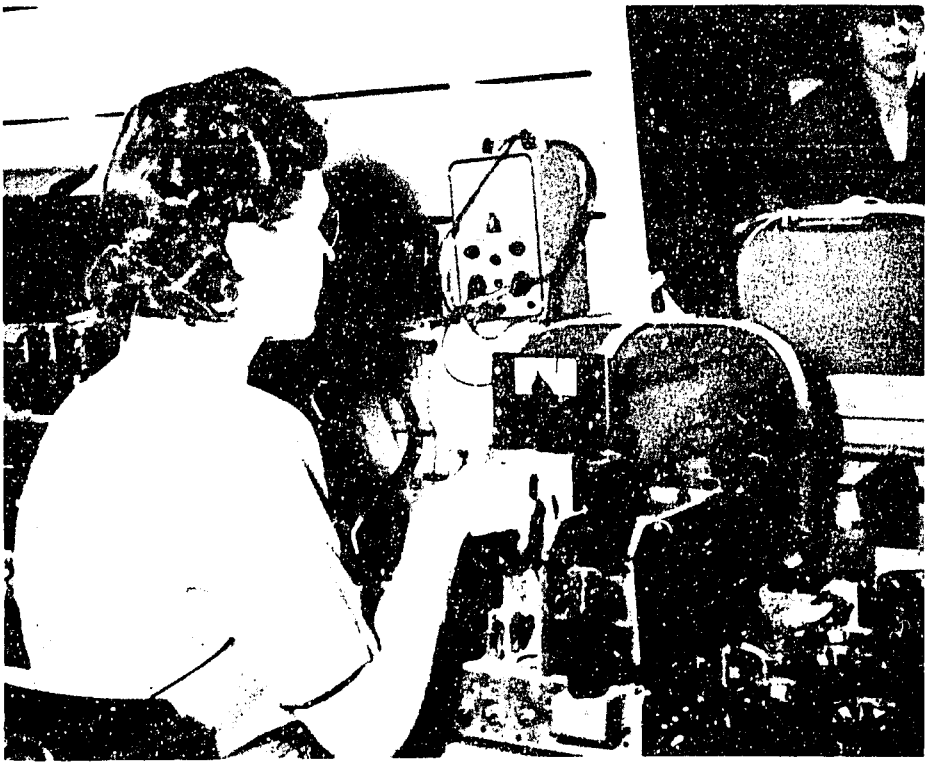

Fig. 12 Examination of test patterns with the aid of a mirror.

The Radio and Television Industry in the United States

Tables 21, 22, 23, and 24 have been prepared to give a comprehensive picture of the size, growth, and current composition of the radio and television industry in the United States. Variations in coverage and arrangement are due to differences in the source of the tables.

Table 21. Radio and television receiver production, for sale and interplant transfer, U.S.A., 1939 and 1947

(Money figures in thousands of dollars)

Product	1939		1947	
	Quantity	Value f.o.b. plant	Quantity	Value f.o.b. plant 1/
Household radio receivers, television sets, and radio-phonographs 2/	na*	$163,898	na	$727,694
Home radio receivers:				
Socket powered	6,891,000	95,760	11,107,000	184,688
Battery powered . . . . . .)	1,365,000	16,087	588,000	12,058
Portable radio receivers . . .)			2,902,000	60,672
Automobile radios (broadcast receivers only) . .	1,583,000	27,444	3,472,000	102,560
Television sets 3/	4,000	806	4/ 153,000	50,038
Receiving set chassis, for sale separately	na	6,608	110,000	5,716
Radio-phonograph combinations, except television sets (including sets with recorders)	475,000	17,193	3,507,000	311,982

* na Not available.

1/ These values represent total shipments and interplant transfers.

2/ Phonographs and record players, including some record players for installation in combination sets, are excluded from this table.

3/ Includes television sets with audio limited to television band, television only sets, television-radio sets, and combination phonograph-television-radio sets.

4/ This figure indicates total shipments and interplant transfers; all other figures are total production for sale and interplant transfer.

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

Table 22. Selected statistics for the radio and television industry, U.S.A., 1939 and 1947 1/

Item	1939	1947
Number of establishments . . .	305	857
All employees:		
Number (average for year). .	na*	178,595
Salaries and wages, total. .	na	$462,207,000
Salaries and wages average annual	na	$ 2,588
Production and related workers:		
Number (average for year). .	45,484	142,478
Wages, total	$47,568,000	$324,300,000
Wages, average annual . . .	$ 1,046	$ 2,276
Value added by manufacturer. .	$125,429,000	$773,233,000
Purchased electric energy. . .	na	$ 5,068,000
Expenditures for plant and equipment:		
New plant and equipment . .	na	$43,714,000
Construction	na	$ 20,406,000
Machinery and equipment. .	na	$ 23,308,000
Used plant and equipment . .	na	$ 6,971,000

* na Not available.

1/ The American standard industrial classification of this industry includes radios, radio and television equipment (except radio tubes), radar and related detection apparatus, and phonographs (except records), public-address, and music distribution apparatus. The figures of this table apply to a relatively wide industrial grouping while the body of this report presents data from assemblers of home radio and television receivers only. In this respect it is noteworthy that the 1939, 1947, and 1950 membership of the Radio-Television Manufacturers Association was 104, 347, and 314 firms for each of these years, respectively. Membership represents 85 to 90 percent of all radio-television assemblers and their suppliers in the United States.

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

Table 23. Composition of the electronics manufacturing industry, U.S.A., 1950

Type of product	Number of units 1/	Retail value
Radio receivers	14,000,000	$ 650,000,000
Table model	6,770,000	147,586,000
Console	1,210,000	162,140,000
Portable	1,960,000	78,400,000
Automobile	4,060,000	261,874,000
Television receivers	7,000,000	2,149,000,000
Table model	3,570,000	na*
TV only consoles	2,730,000	na
Combination with FM and/or AM	140,000	na
Combination with phonographs . .	560,000	na
Phonographs (combinations)	5,570,000	(2)/
TV antennas and accessories . . .	na	
Tubes	380,000,000	615,600,000

*na Not available.

1/ Number of units are production figures except for television breakdown which are sales figures.

2/ Not available as separate figures; otherwise included.

Source: Tele-Tech (Caldwell-Clements Inc.), New York, N.Y. (The source and method of classification of this table are not the same as for Tables 21 and 22. Therefore, no measure of individual growth should be drawn directly from a comparison of production statistics.

Table 24. Size and growth of the radio and television receiver manufacturing industry, U.S.A., 1922 - 1950 1/

(All figures in thousands)

Year	Total civilian sets manufactured 2/		Homes with sets	Total sets in U.S.A.
	Number	Retail value 3/		
1922	100	$ 5,000	260	400
1923	550	30,000	1,000	1,100
1924	1,500	100,000	2,500	3,000
1925	2,000	165,000	3,500	4,000
1926	1,750	200,000	5,000	5,700
1927	1,350	168,000	6,500	7,000
1928	3,281	400,000	7,500	8,500
1929	4,428	600,000	9,000	10,500
1930	3,827	300,000	12,049	13,000
1931	3,420	225,000	14,000	15,000
1932	3,000	140,000	16,810	18,000
1933	3,806	180,500	20,402	22,000
1934	4,084	214,500	21,456	26,000
1935	6,027	330,192	22,869	30,500
1936	8,248	450,000	24,600	33,000
1937	8,065	450,000	26,667	37,600
1938	6,000	210,000	28,000	40,800
1939	10,500	354,000	28,700	45,300
1940	11,800	450,000	29,200	51,000
1941	13,000	460,000	29,700	56,000
1942	4,400	154,000	30,800	59,340
1943	(4)/	(4)/	32,000	58,000
1944	(4)/	(4)/	33,000	57,000
1945	500	20,000	34,000	56,000
1946	14,000	700,000	35,000	60,000
	(10)	(5,000)	na*	(10)
1947	17,000	800,000	37,000	66,000
	(250)	(100,000)	na.	(260)
1948	16,000	700,000	40,000	74,000
	(1,000)	(350,000)	na	(1,260)
1949	10,000	500,000	42,000	81,000
	(3,000)	(950,000)	na	5/ (4,130)
1950	14,000	650,000	45,000	90,000
	(7,000)	(2,149,000)	na	(11,000)

* na Not available.

1/ Television data are shown separately and indicated by inclusion in parentheses.

2/ Radio figures are production data; television data, shown separately in parentheses, are annual sales.

3/ Figures for value of sets include value of tubes in receivers.

4/ WPB ordered (April 1942) all civilian radio set production stopped and factories converted to war production. Reconversion to civilian-radio production began August 1945.

5/ Estimate derived from annual sales figures and other sources.

Source: Tele-Tech (Caldwell-Clements, Inc.), New York, N.Y.

Glossary of Terms

AM	Amplitude modulation: a method of modulation (superimposing of microphonic variations of current on a carrier current) involving variation of the amplitude of a carrier wave.
Aligning,) Analysing,) Phasing,) Tracking)	Generally synonomous terms for those production operations concerned with the scientific observation and adjustment of previously installed parts of a set to their proper relation for optimum coordinate performance.
Audio	A circuit carrying a low frequency of alternating current which can produce audible sounds with the aid of a loud speaker.
Ballast Tube	American name for barretter, a device for maintaining a current in a circuit at constant strength in spite of any variations of voltage, within certain limits, across the circuit. One form of it is a small glass tube filled with hydrogen through which passes a fine wire made of an alloy, the resistance of which rapidly increases with the increase of temperature.
Boxing	That phase of the production process dealing with the installation of mechanically and electrically complete chassis into a finished cabinet.
Capacitor or Condenser	An electrical apparatus consisting of two or more conducting plates of metal separated by an insulating substance. They may be of fixed capacity (rigid) or variable capacity (rotating).
Chassis	The metal frame on which are mounted the parts of a receiving set; also the assemblage of mounted parts.
Choke	A coil of wire which has a large inductive reactance as compared with its resistance. There are high-frequency chokes which are wound upon insulating formers with no iron core and low-frequency chokes wound on iron cores.

Custom manufacture	Fabrication of small quantities of a product usually of specialized design. Quality design and workmanship are emphasized. Assembly line techniques are either modified or not used.
Direct labor	Factory labor involved in the actual production of the models reported and included in company accounting procedures as a direct labor cost.
FM	Frequency modulation.
IF	Intermediate frequency.
Indirect labor	General factory and departmental overhead labor costs applied to the reported model in company accounting procedure.
Gang condenser	An assemblage of two or more variable condensers mechanically coupled to the same control mechanism.
Lacing	An intricate wiring operation involving a number of strands in close proximity and securely fixed.
Line capacity attainment	American trade jargon referring to the initial accomplishment of reaching an anticipated rate of normal or full production on a new or re-organized assembly.
Man-hour requirements	The time needed to produce a specified product measured in the number of hours per worker (Cf. unit man-hours).
Pneumatic nut-runner	An air-operated hand tool into which bits may be inserted for tightening nuts, screws, and other similar items. It is usually adjustable so that nuts or screws are tightened to the same torque each time the device is used.
Release	A management device by which a predetermined quantity of production is manufactured according to a carefully detailed plan which becomes fixed at the release date or the day actual production is begun.

Rectifier	A device for converting alternating current into unidirectional current by the inversion or suppression of alternate half-waves.
Resistor	An apparatus of fixed resistance which, when connected to a circuit, increases the resistance of the circuit.
RF	Radio frequency.
Scanning	In television, the repeated traversing of the surface of the picture by a beam of light or electrons for the purpose of reproducing the image and exploration of minute portions of the picture. This may be a mechanical or electronic method.
S.I.C.	Standard Industrial Classification.
Semi-skilled worker	One who follows a manual occupation characterized by manipulative ability of a high order but limited to a well-defined work routine. Major reliance is placed upon having the important decisions made by others rather than upon the worker's judgement.
Spaghetti	Trade jargon for a casing to cover bare wire; sometimes used to refer to an elaborate assemblage of wires located about a central location such as a socket.
Standard time	The time established by a time study (any detailed analysis of work time), required for an average worker to perform a specified operation or group of operations without undue fatigue.
SW	Short wave.
Total factory labor	The sum of direct and indirect productive labor excluding such costs as general administration, office, engineering, and sales.
Transformer	An electrical appliance for altering the intensity of the available electromotive force. Either an iron-core transformer or an air-core transformer is used, the former for low frequency circuits and the latter for high frequency circuits.

Unit man-hours	The man-hour requirement for a single unit of a specified product.
Wire preparation or processing	Cutting wire into appropriate lengths for leads and stripping off a fraction of the insulation at the tips of the leads. This is usually done on an automatic machine designed for this purpose.