DON'T DISCLOSE IDENTITIES

From the beginning of these studies, the identities of the persons under study have been kept confidential. We look to you to carry on this trust. Please guard the privacy of the persons involved by substituting fictitious names, or code symbols for real names.

QUALITY OF PRODUCTION
RELAY ASSEMBLY TEST ROOM

6/16/30 to 4/24/31

12 P

UNIVERSITY OF WISCONSIN - MILWAUKEE

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OUTLINE

QUALITY OF PRODUCTION - RELAY GROUP

1. Purpose of study; source of material.

2. Quality of production - percent passing inspection.

3. Classification of defects which cause rejection.

   3.1 Defects of assembly, operators responsible.
   3.2 Defective Parts, operators responsible.
   3.3 Defective parts, operators not responsible.
   3.4 Miscellaneous defects.

4. Share of each girl in group performance.

5. Explanation of attached Sheets 4A to 4D. (Summaries of Source Material)

6. Discussion of attached sheets:

   6.1 Rejections for which operators are responsible.
   6.2 Rejections due to screwdriver action.
   6.3 Rejections due to incorrect assembly.
   6.4 Rejections due to defective parts.

7. A.M. vs. P.M. rejections.

8. Principal causes of rejections.

9. Assembly characteristics of each operator.

   9.1 Operator 1
   9.2 Operator 2
   9.3 Operator 3
   9.4 Operator 4
   9.5 Operator 5

QUALITY OF PRODUCTION - RELAY GROUP

1. Measures of the production of the operators in the Relay test room have heretofore been made chiefly in terms of the quantity of output. It is desirable also to secure a measure of the quality of the work done by these girls, and as a preliminary step in this direction, on June 16, 1930, a new type of record was originated. Sheets listing the twenty-three defects most frequently causing rejection of a relay by the inspector were drawn up and multigraphed, and on the date mentioned the inspector began recording the kind of defect, the hour of assembly, and the operator for each rejection. The study herein described gives a summary of the records of the inspector for forty-three weeks (6-16-30 to 4-24-31) and is intended as a preliminary view of the quality of work done by those operators. Subsequent studies will be made of the relation of various factors to the quality of production.

2. During the forty-three week period studied a total of 9686 relays were returned to the operators for repair. This is an average of 45 rejections per operator per week. The average weekly output per operator was 2280 relays. By division we find that 98.0% of all relays assembled passed inspection, and that 2.0% were rejected.

3. The twenty-three kinds of defects listed on the inspector's record may be grouped under three headings: (1) "Defects of Assembly, Operators Responsible"; (2) "Defective Parts, Operators Responsible"; and (3) "Defective Parts, Operators not Responsible".

3.1 Defects of assembly involve 41% of all defective relays. These defects may be due to carelessness in handling the automatic screwdriver, as screws burred and screws stripped; or they may be due to incorrect assembly of parts, as wrong springs, wrong armature, wrong coil, wrong assembly, insulators missing, insulators assembled wrong, springs missing, terminal missing, and bushing broken (due to irregular pile-up of parts).

3.2 About 37.5% of rejections are due to the inclusion of parts which come to the operators defective. Some of these defects are obvious, and failure to reject them is clearly the fault of the operator. This group of defects (Group 2) constitutes 35% of all rejections and includes wrong or missing contacts, broken insulators, terminals broken or not tinned, adjusting nut missing, armature disc missing or damaged, and damaged coil.

3.3 Other defects can be seen only as a result of close inspection, or are subject to decisions involving judgment. These defects cause 22.5% of all rejections, and while the operators sometimes see and discard such parts, yet they are not fully responsible for failure to do so. This group (Group 3) includes damaged springs, adjusting nut loose, and armature creaked, bent, or damaged.

3.4 A few defects occur so infrequently as not to be classified on the inspector's sheets. These are listed as "Miscellaneous" (Group 4) in this study and constitute 1.5% of all rejections.

4. The following table is based on the relation of each girl's performance to group performance. The share each girl had in the

total group output for the forty-three weeks of this study is here shown, together with her share in the rejections of the group:

TABLE 1

Percent of Group Performance for each Operator

		Defects				
		Operators Responsible				
Operator	Production	Screw-driver	Incorrect Assembly	Defective Parts	Total	Total Defects
1	20.4	18.9	25.1	20.4	21.7	20.6
2	22.4	31.5	25.1	30.0	28.6	26.7
3	19.2	16.2	21.8	18.2	19.1	19.3
4	19.5	20.8	8.5	11.4	12.1	12.8
5	18.5	12.6	19.7	20.0	18.5	18.4
Group	100.0	100.0	100.0	100.0	100.0	100.0

The rejections of Operators 1, 3, and 5 bear about the same relation to group rejections as does their production, while Operator 2 has a disproportionately large share of rejections, and Operator 4 a very small share. Operator 2 is the fastest and the least accurate assembler of the group. Her greatest difficulty is with the automatic screwdriver, but she is high in other defects as well. Operator 4, though having the smallest share in all other classes of defects, ranks second to Operator 2 in screwdriver defects. Operators 5 and 3, the slowest assemblers in the group, are both leisurely in their use of the automatic, and show proportionately less defects due to that cause.

5. The attached Sheet 4A shows a summary of defects classified as described above. Such defects in each group as involve a very small percentage of rejections are grouped under "Other." Totals are shown for each operator for the forty-three week period, by A.M., P.M., and day. Sheet 4B shows the same divisions, but the figures are here given as percentages of the operator's total for the period involved. Sheet 4C gives the totals for each group of defects as outlined in paragraph 3, Page 1, and 4D gives the percentages for this division.

6.1 As shown on Sheet 4D, operators may be regarded as responsible for 76% of their defective relays. Some of the operators are responsible for a larger percentage of their own defects than this, some for a smaller. The responsibility is as follows: (See Sheets 4C and 4D.)

TABLE 2

Operator	No. of her rejections for which she is responsible.	Percent of her total rejections
1	1402	80.6%
2	1361	76.3%
3	2107	75.7%
4	1406	74.3%
5	802	71.7%
Group	8078	76%

As shown in Sheets 4A and 4C, Operator 4 has had only 1245 rejected relays during this period out of a total of 9088 for the five operators, and the above table shows that she is responsible for a smaller percentage of her rejections than are any of the other operators.

TOTAL DEFECTIVE RELAYS
FORTY-THREE WEEKS
6-16-50 TO 4-24-51

	Operators Responsible													
	Assembly (1)							Parts (2)			Operators Not Responsible (3)			
			Ins.					Contacts						
Oper.	Screws Burred	Screws Stripped	Ins. Miss.	Assm. Wrong	Springs Wrong	Bushings Broken	Other	Wrong or Missing	Ins. Broken	Other	Springs Damaged	Other	(4) Miss.	Total
A.M.														
1	85	68	116	64	52	67	27	194	134	96	185	27	13	1126
2	151	104	89	85	55	125	30	270	285	56	330	58	19	1651
3	55	70	68	57	65	90	19	251	90	46	245	24	7	1087
4	84	84	33	19	25	25	22	106	74	43	166	26	16	721
5	38	54	87	27	75	52	11	257	103	35	194	57	5	1008
Total	393	380	393	260	264	355	109	1078	684	276	1110	191	60	5593
P.M.														
1	59	56	101	70	54	70	22	124	108	37	112	30	16	859
2	120	89	94	54	30	54	31	177	191	43	199	44	36	1162
3	38	65	81	85	51	44	22	140	62	27	164	38	11	802
4	59	64	25	12 72	18	32	9	86	51	26	112	19	14	524
5	31	34	102	41	44	45	12	171	89	25	153	29	7	783
Total	307	308	381	262	197	245	96	697	501	158	730	154	84	4130
TOTAL														
1	142	124	217	134	106	137	49	318	242	133	297	57	29	1985
2	251	193	183	137	85	177	61	447	474	99	519	102	55	2783
3	93	135	149	142	114	134	41	391	152	73	409	56	18	1889
4	143	148	58	31	41	57	31	191	125	69	278	45	30	1245
5	69	108	189	68	117	97	23	428	192	60	387	86	12	1786
Total	700	708	774	522	463	600	205	1775	1185	434	1890	346	144	9688

PERCENTAGE OF TOTAL DEFECTS IN EACH CLASSIFICATION
FORTY-THREE WEEKS
6-16-30 TO 4-24-31

	Operators Responsible										Operators not Responsible(3)			
	Assembly (1)							Parts (2)						
Oper.	Screws Burred	Screws Stripped	Insul. Missing	Insul. Assm.Wrong	Springs Wrong	Bush. Broken	Other	Contacts Wrong or Missing	Ins. Broken	Other	Springs Dam-aged	Other	(4) Misc.	Total
A.M.														
1	7.4	6.0	10.3	5.7	4.6	6.0	2.4	17.2	11.9	8.5	16.4	2.4	1.2	100.0
2	8.1	6.4	5.5	5.1	5.4	7.6	1.8	16.6	17.5	3.5	19.7	3.6	1.2	100.0
3	5.1	6.5	6.3	5.2	5.8	8.3	1.7	23.1	8.3	4.4	22.8	2.2	.6	100.0
4	12.9	11.7	4.6	2.6	3.2	3.1	3.1	14.7	10.3	6.0	25.0	3.6	2.2	100.0
5	3.2	5.4	8.7	3.7	7.2	5.2	1.0	25.7	10.3	3.5	19.4	5.7	.4	100.0
Total	7.1	6.2	7.1	4.7	4.8	6.4	1.9	19.4	12.3	5.0	20.0	3.4	1.1	100.0
P.M.														
1	6.9	6.5	11.8	8.1	6.3	8.1	2.6	14.4	12.6	4.3	13.0	3.5	1.9	100.0
2	10.5	7.7	8.1	4.7	2.6	4.6	2.7	15.2	16.4	3.7	17.1	3.8	3.1	100.0
3	4.7	8.1	7.6	10.6	6.4	5.5	2.7	17.5	7.7	3.4	20.4	4.0	1.4	100.0
4	11.3	12.2	4.4	2.3	3.4	6.1	1.7	16.2	9.7	5.0	21.4	3.6	2.7	100.0
5	4.0	6.9	13.0	5.2	5.6	5.8	1.5	21.9	11.3	3.2	17.0	3.7	.9	100.0
Total	7.4	7.9	9.2	6.3	4.8	5.9	2.3	16.9	12.4	3.8	17.4	3.7	2.0	100.0
TOTAL														
1	7.2	6.2	10.9	6.7	5.3	6.9	2.5	16.0	12.2	6.7	15.0	2.9	1.5	100.0
2	9.0	6.9	6.6	4.9	3.1	6.4	2.2	16.1	17.0	3.5	18.6	3.7	2.0	100.0
3	4.9	7.1	6.8	7.5	5.0	7.1	2.2	20.7	8.0	4.0	21.7	3.0	1.0	100.0
4	11.6	11.9	4.5	2.5	3.3	4.4	2.5	15.3	10.1	5.4	22.3	3.6	2.4	100.0
5	3.9	6.0	10.6	4.4	6.5	5.4	1.3	24.0	10.8	3.5	18.3	4.8	.7	100.0
Total	7.2	7.3	8.0	5.4	4.8	6.2	2.1	18.5	12.2	4.5	18.9	3.6	1.5	100.0

6.2 Sheet 4D further reveals that defectives caused by carelessness in handling the screwdriver are as follows:

TABLE 3

Operator	No. of Rejections due to Screwdriver	Percent of her total Rejections
4	293	25.5%
2	444	15.9%
1	264	15.4%
3	228	12.8%
5	177	9.5%
Group	1406	14.8%

It will be observed that almost one-fourth of all Operator 4's rejections are due to faulty use of automatic screwdriver.

6.3 The defects due to careless selection and placement of parts in assembly are as follows:

TABLE 4

Operator	No. of Rejections due to Incorrect Assembly	Percent of her total Rejections
1	645	32.5
2	540	29.6
3	504	28.2
5	445	25.2
4	314	17.2
Group	2448	25.5

6.4 Rejections due to the use of imperfect parts show the following relative standings:

TABLE 5

Operator	No. of Rejections due to use of defective parts (Operators Responsible	Percent of her total Rejections
5	690	38.1
2	1000	36.6
1	995	34.9
3	618	32.7
4	305	31.0
Group	3608	35.5

7. Because of the difference in the number of hours worked mornings and afternoons, any comparison of the quality of work for these two divisions of the day must be based on average hourly defects, rather than total A.M. and total P.M. defects. Table 6 gives the average number of defects per hour for each operator and for the group, for the divisions given in Sheet 4C. The figures were found by dividing the A.M. figures in Sheet 4C by 915.75, the number of A.M. hours worked during the 45 weeks; and by dividing the P.M. figures in Sheet 4C by 617.33, the number of P.M. hours worked during the 45 weeks.

TABLE 6

	Operators Responsible						
	Assembly						
	Screwdriver	Incorrect Assembly			Opers.Resp.	Opers. not	
Opers.	Action	Assembly	Total	Parts	Total	Respons.	Total
A.M.							
1	.105	.307	.412	.464	.906	.232	1.232
2	.237	.416	.653	.666	1.319	.414	1.774
3	.137	.265	.402	.426	.828	.294	1.12
4	.196	.121	.317	.244	.561	.21	.771
5	.161	.265	.426	.432	.858	.273	1.098
Total	.846	1.314	2.16	2.232	4.392	1.433	5.825
P.M.							
1	.126	.314	.7	.436	1.136	.25	1.361
2	.329	.436	.765	.666	1.431	.394	1.825
3	.167	.436	.596	.371	.944	.317	1.261
4	.199	.182	.381	.262	.643	.212	.85
5	.129	.365	.495	.468	.963	.302	1.265
Total	1.050	1.313	2.363	2.197	5.136	1.475	6.61

Table 6 reveals a definite tendency for rejections due to defective assembly processes to increase in the afternoon. However the

rejections due to failure to detect and discard defective parts (see both the fourth and sixth columns) show no real difference. The figures for each operator are consistent with the group totals, indicating that attention to work processes decreases during the day, but that visual observation remains the same.

8. The following tables indicate the relative importance of the five kinds of defects which caused 72% of all relay rejections. Table 7 shows the share of each operator in the group total:

TABLE 7

	Operators					
	1	2	3	4	5	Group
Springs Damaged	16.2	28.4	22.3	15.2	17.9	100.0
Contacts Wrong or Missing	17.9	25.2	22.0	10.8	24.1	100.0
Screws Burred or Stripped	18.9	51.5	16.2	20.8	12.6	100.0
Insulators Broken	20.4	40.0	12.8	10.6	16.2	100.0
Insulators Missing	26.0	23.6	16.7	7.3	24.4	100.0
Production	20.4	22.4	19.2	19.8	18.5	100.0

Table 8 shows the share of each operator's rejections which was due to each of the five kinds of defects:

TABLE 8

	Operators					
	1	2	3	4	5	Group
Springs Damaged	15.0	18.6	21.7	22.5	18.3	18.9
Contacts Wrong or Missing	16.0	16.1	20.7	15.3	24.0	18.3
Screws Burred or Stripped	13.4	15.9	12.0	23.3	9.9	14.5
Insulators Broken	12.2	17.0	8.0	10.1	10.8	12.2
Insulators Missing	10.9	6.6	6.8	4.3	10.6	8.0
Other Defects	32.5	25.8	30.8	24.3	26.4	28.1
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0

9. These tables show that the individuals have the greatest trouble with the following defects:

Oper.	Defect	% of Group Rejections for this cause	% of her own Rejections for any cause
1	Insulators Missing	38.0	10.9
2	(Screws Burred or Stripped	31.5	15.9
	(Insulators Broken	40.0	17.0
3	(Springs Damaged	22.3	21.7
	(Contact Wrong or Missing	22.0	20.7
4	(Springs Damaged	15.2	22.3
	(Screws Burred or Stripped	20.8	23.5
5	(Contacts Wrong or Missing	24.1	24.0
	(Insulators Missing	24.4	10.6

9.1 Operator 1 has an exorbitant share of only the "Insulators Missing" rejections. This defect is due to absent-mindedness in assembly processes. Sheet 4D shows that 32.3% of this girl's defects are due to incorrect assembly, while the group as a whole has 26.8% of its defects from this cause. In other types of defects this operator is always near or below the group average.

9.2 Operator 2 leads the group in every sort of defect, but she is most out of line in rejections due to failure to watch for defective insulators, and to hasty and careless use of the screwdriver.

9.3 The defect known as "Springs Damaged" is regarded as one for which operators are not fully responsible, yet this defect may be cut down by careful observation of springs. Wrong or Missing

Contacts, too, is a result of failure to watch the springs. Operator 3, then, can charge 42.4% of her defects to failure to observe the springs she uses.

9.4 The fact that a large share of Operator 4's rejections is due to damaged springs is due to the very small number of her total rejections, as her percentage of the total rejections for the group from this cause is much smaller than her percentage of the group output. She is, however, responsible for a much larger share of the screw-driver defects than is characteristic of her, and this accounts for 23.5% of her rejections.

9.5 Operator 5 is responsible for more "Insulators Missing" rejections than anyone else, and the portion of her defects due to associated errors (Incorrect Assembly - see Sheet 4D) is a little higher than the group average. Her percentage of defective parts, too, to which group "Contacts Wrong or Missing" belongs, is above the percentage for the group (see Sheet 4D). Her share in the screw-driver defects is very small indeed.

LO-[illegible]