

STUDY OF PROPERTY AND EQUIPMENT DIVISION SHOP—AMES, IOWA

by

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SUMMARY

The results of this study showed the personal activity rating ^{1/} of the property and equipment shop employees to be 77.4 percent. The percent of total time devoted to productive work (excluding supporting work) was 64.6 percent.

A comparison with the same type of activity in one of the nation's leading manufacturers show that the property and equipment shop employees had a higher personal activity rating than the maintenance employees of the manufacturing company.

Analysis of these data indicates that a future personal activity rating of 89.3 percent could be obtained. Achievement of this goal is directly dependent upon the adoption of an aggressive program which results in decreasing the time spent on walking, procurement of tools, and materials, preparation and cleanup, and nonproductive elements.

OBJECTIVES

Three objectives were established for this special study.

1. To determine the personal activity rating of the property and equipment division shop employees.
2. To establish a base point to which future performances can be related.
3. To point out the most profitable areas to be investigated to gain maintenance improvement.

PROCEDURE

This study was designed to measure the personal activity rating of the property and equipment shop personnel through use of the work sampling technique. It does not take into account the actual effectiveness of the work methods being used or the rate at which work is being accomplished.

1/ Personal activity ratings are described in the paragraphs devoted to discussion.

The rating reflects a measure of the time spent by the shop personnel on the job plus additional allowances for essential supplemental work, including necessary walking time.

Personnel covered

This study covered all the personnel in the equipment repair shop, the wood sign shop, the property and equipment warehouse, and the service garage, a total of 54 men. Sampling routes were so designed that the majority of the employees were covered on each trip. The number and employee group of personnel studied are shown in the following tabulation.

<u>No.</u>	<u>Employee group</u>	<u>No.</u>	<u>Employee group</u>
12	Engine mechanics	4	Supervisors
5	Car - bus mechanics	4	General store clerks
3	Machinists (mechanics)	1	Equipment parts clerk
4	Utilities mechanics	4	Store warehouse clerks
2	Miscellaneous laborers	6	Paint shop employees
1	Tool room clerk	4	Carpenter shop employees
1	Office clerk	<u>3</u>	Service garage employees
		54	Total

Method of sampling

All samples, or observations, were taken by Iowa maintenance study personnel. The activity of studied personnel was divided first into three broad categories which are essentially the same as used for production studies and then further into 13 elements. A complete description of the elements used are as follows:

1. Productive work items

(a) Working. A man is applying physical effort or attention to a tool, equipment, or material in the accomplishment of a job.

Example - Drilling a hole	Oiling equipment
Tending a lathe	Using a wrench
Connecting a power tool	Inspecting parts or equipment

2. Supporting work items

(a) Preparation and cleanup. A man is engaged in preparing for or shutting down a job or shift.

Example - Checking work order	Cleaning work space during and
Arranging work space	at completion of the job
	Wiping tools after job

(b) Procure tools. This element represents the procurement and disposal of tools necessary for job performance

Example - Transactions at the tool room window

(c) Procure materials. This element represents the procurement of material necessary for the job.

Example - Transactions at the storeroom.

(d) Walk empty. A man is walking to and from the job emptyhanded.

(e) Walk loaded. A man is walking to and from the job with tools and equipment.

(f) Give and receive instructions. Two or more men are talking about a job or a man may be receiving instructions from the foreman or supervisor.

3. Delays

(a) Waits associated with productive work. This element represents waits associated with operating cycle work items.

Example - Wait until another man completes a task such as drilling a hole or removing an engine head.

(b) Waits associated with related work. This element covers all waits associated with related work.

Example - Wait until man returns with tools or material.
Wait until man cleans spilled oil.

(c) Maintenance - repair shop equipment. This element represents any work done on shop machines or tools.

(d) Start late - quit early. This element represents late starts or early quits at morning, noon, and evening.

(e) Personal. Personal delays include all actions taken by men primarily for their own comfort.

Example - Put on or remove clothing	Smoke
Coffee break or drink of -	Blow nose - wipe forehead
Eating during working hours	Call of nature

(f) Idle. Idle delays occur when men kill time. Two or more may stop to talk or a man may just stand around.

Example - Talking	Sleeping
Dreaming	Horseplay

Randomness

Three procedures were used to minimize bias and assure that random samples would be taken:

1. The days on which the observations were to be made were selected for study on a random basis.

2. The time of day was selected on a random basis. When the study was completed it was observed that all parts of the day had been studied.

3. Five different sampling routes through the shops were selected on a random basis.

Accuracy

The statistical accuracy of this type of study is dependent on two things:

1. The total number of observations
2. The number of observations in the category to be measured.

The "productive category" is the basis for computing the personal activity rating. The final statistical accuracy of this overall study was ± 1.04 percent as shown by the following computation:

$$E = 2 \sqrt{\frac{P(1-P)}{N}}$$

$$E = 2 \sqrt{\frac{(0.646)(0.354)}{8,434}}$$

$$E = 0.0104 \text{ or } 1.04\%$$

Where E = the absolute accuracy
 P = the percent of observations in the category being considered expressed as a decimal
 N = the total number of observations taken in the study.

In other words, the true percent productive for all shops personnel will be between 65.64 percent and 63.56 percent 95 times out of a hundred. The study showed the percent productive was 64.6 percent.

RESULTS

Computation of personal activity

The personal activity rating was computed by taking the sum of the following:

1. Sampled productive effort (percent of time actually productive)
2. Supplementary allowances for preparation and cleanup, and procurement of tools and materials.
3. An allowance for walking.
4. An over-all allowance for personal needs and fatigue.

The personal activity rating may be expressed as a formula:

$$Y = (100\% + X\%) (A + 7.5\% A + T)$$

Where Y = personal activity rating

X = personal and fatigue allowance = 10%

A = percent of total time devoted to the productive category
 = 64.6% (See Table 190 for time utilization in percent)

7.5% A = supplementary allowance, covering activities not productive themselves, but required in order to accomplish productive work. The analysis of these data indicates that 7.5% of the "A" category realistically represents an acceptable allowance for supplementary activities. This supplementary allowance is then added to the "A" category to make it more representative of the activity of the property and equipment employees. Thus, $7.5\% A = 7.5\% \times 64.6\% = 4.8\%$.

T = Walking allowance = percent of day spent in walking = 1%. This is an estimated figure based on an average walking distance allowed. This average distance was multiplied by a constant of 0.4 minute per 100 feet of movement. This calculation indicated walking to be less than 1.0% per day, but the value of 1.0% per day was used.

Substituting in the formula, the personal activity rating during the study was:

$$Y = (100\% + 10\%) (64.6\% + 4.8\% + 1.0\%) = 77.4\%$$

TABLE 190
TIME UTILIZATION IN PERCENT ^{1/}
(Corrected to include break periods)

Employee group	No. in group	Category A	Category B - Supporting work						Category C - Delays						Total
		Productive work	Preparation and clean-up	Get and return tools	Get materials	Walk empty	Walk loaded	Give and receive instructions	Personal	Idle	Wait for productive work	Wait for supporting work	Start late and quit early	Repair shop equipment	
Engine mechanics	12	63.8	1.7	1.3	2.6	5.7	3.5	4.7	7.8	6.6	1.3	0.5	0.5	0.1	100
Car - bus mechanics	5	59.2	2.1	2.0	4.8	7.9	5.5	4.6	6.9	5.3	1.3	0.1	0.4	-	100
Machinists - mechanics	3	69.0	7.3	0.9	0.2	3.8	2.8	5.1	6.6	3.4	0.4	-	0.4	0.4	100
Utilities mechanics	4	65.9	2.6	1.1	0.8	5.2	3.5	6.4	6.0	8.5	-	-	-	-	100
Miscellaneous laborers	2	63.5	3.8	-	0.6	9.8	7.1	0.9	6.6	7.1	0.3	-	-	-	100
Tool room clerk	1	63.2	2.0	0.5	0.5	7.4	2.5	1.0	9.2	12.8	1.0	-	-	-	100
Office clerk	1	64.9	3.5	-	-	5.9	5.9	4.1	9.5	5.9	-	-	-	-	100
Supervisors	4	63.6	0.2	-	0.8	15.5	3.2	-	6.9	9.5	0.3	-	0.2	-	100
General stores clerks	4	60.7	1.6	-	-	9.8	4.2	3.5	7.1	11.2	0.3	0.2	1.3	-	100
Equipment parts clerks	1	72.9	1.0	-	-	6.8	5.4	4.4	6.1	2.4	-	-	1.0	-	100
Stores warehouse clerks	4	57.1	2.4	-	-	8.0	2.1	1.1	7.0	19.6	0.4	-	2.3	-	100
Paint shop employees	6	75.9	3.5	0.1	0.3	4.7	3.5	1.2	7.1	2.9	0.7	0.1	-	0.1	100
Carpenter shop employees	4	68.6	3.1	-	0.6	7.5	4.3	2.8	7.2	4.5	0.8	-	0.5	-	100
Service garage ^{2/}	3	60.3	1.7	0.5	-	6.2	1.7	1.5	7.7	19.0	0.3	-	0.8	-	100
Weighted average		64.6	2.5	0.7	1.3	7.3	3.7	3.1	7.2	8.0	0.7	0.2	0.6	0.1	100

^{1/} A total of 8,434 observations were made.

^{2/} The service garage was open hours during which no sampling was done, thus these figures may not be fully representative of conditions existing at the garage.

Improvement goals

To gain in the productive category, the percent of time spent in the supporting and delay categories must be reduced. These improvements can only be made if supervision has the opportunity of making a closer examination of the time spent in these categories and evaluating and devising programs which will increase the time spent in category "A", productive work. Study personnel made an analysis of this type.

In order to establish a realistic set of values, it was first necessary to determine the difference between the percent of time allowed in the personal activity formula for supplementary allowances as compared with the percent of time actually observed in these categories during the survey.

<u>Element</u>	<u>Observed time</u>	<u>Calculated allowance</u>	<u>Vari- ation</u>
Preparation and cleanup, procure tools and equipment and give and receive instructions	7.6%	4.8%	2.8%
Walk emptyhanded or loaded	11.0%	1.0%	10.0%
Delay	16.9%	0	16.9%

The magnitude of the variation indicates possible potential for improvement. In order to determine realistic goal values, each of the elements shown above is adjusted from its current observed value by an amount equal to one-third the variation indicated. Experience with this type of work in industry has indicated that calculation of goal figures from an initial survey in this manner is realistic and can definitely be attained if a vigorous improvement program is inaugurated. Using the one-third variation principle, the goals for the elements shown above would become:

<u>Element</u>	<u>Observed time</u>	<u>One-third of the variation cited</u>	<u>Goal</u>
Preparation and cleanup, procure tools and equipment, and give and receive instructions	7.6%	-0.9%	6.7%
Walk emptyhanded or loaded	11.0%	-3.3%	7.7%
Delay	16.8%	-5.6%	11.2%
Productive then becomes	64.6%	+9.8%	74.4%
	100.0%	0	100.0%

The goal value for the personal activity rating can now be calculated by substituting the goal values in the regular formula, and adjusting the walk value proportionately to the change in the productive category (see formula below):

$$Y_g = (100\% + 10\%) (A_g + 7.5\% A_g + T_g)$$

$$Y_g = 110\% (74.4\% + 7.5\% \times 74.4\% + \frac{74.4 \times 0.1}{64.6})$$

$$Y_g = 110\% (74.4\% + 5.6\% + 1.2\%)$$

$$Y_g = 89.3\%$$

Computations which have been presented show how this study established an initial rating of 77.4 percent personal activity for the employees of the property and equipment shop of the State Highway Commission. Similar computations show how a realistic goal figure of 89.3 percent personal activity rating could be obtained if an aggressive program was undertaken.

AUXILIARY STUDY OF EQUIPMENT PARTS ROOM

Purpose

The purpose of studying the equipment parts room was to:

1. Determine if the mechanics were spending excessive time waiting at the parts window for parts.
2. Determine if enough clerical help was provided to receive, store and distribute equipment parts.
3. Determine if the demand for parts is evenly distributed throughout the day.

Conclusion

1. Time spent waiting at parts window. The total waiting time by all the mechanics at the parts window for one week amounted to only 68 minutes, or about 14 minutes per day. Of this 14 minutes, about 5 minutes were spent for reasons other than to get supplies or parts.

2. Workload of equipment parts clerk. The parts clerk actually spends about an hour per day servicing mechanics who come for parts, giving technical advice, engaging in personal conversation, etc. This time does not include receiving parts, storing them, or writing store requisitions. The clerk does productive work 73 percent of the time, does related or supplementary work 17 percent of the time and is nonproductive 10 percent of the time.

Since there is such a small amount of waiting time for the mechanics and since the clerk's workload appeared reasonable, one clerk is sufficient to handle the parts room.

3. Daily distribution of workload. The clerk's work is such that it can be planned and evenly distributed throughout the workday. The clerk cannot control the scheduling of servicing mechanics at the parts window; however, this amounts to only one hour a day and it is distributed over the whole day. The peakload happens during the first two hours of the day when six to seven mechanics per hour are served. After 2:00 p.m., the load drops to two to three mechanics per hour.

Discussion

Three different studies were made of the parts room operation. A production study was conducted in which one of the study personnel followed the parts clerk for one whole day timing with a stopwatch and recording the complete operation, including all delays, and a record of all personal time taken. From this production study, it was determined that it took on the average 1.84 minutes to service a mechanic at the parts window.

A work sampling study was conducted for a period of two weeks. It showed how the clerk spent his time during the day.

A third study was conducted for a period of one week. A record was kept of each trip the mechanics made to the parts window. This record also indicated the time of day that each trip was made and indicated when a mechanic had to wait to be served because someone else was already at the window.

The conclusions of this report are based on the following calculations.

TABLE 191
TOTAL NUMBER OF MECHANICS SERVED AT THE
PARTS WINDOW FOR A PERIOD OF FIVE DAYS

Time of day	Number of mechanics going to parts window		Total for five days
	For parts	Not for parts	
7:45-8:45	27	12	39
8:45-9:45	22	9	31
9:45-10:45	14	7	21
10:45-11:45	10	7	17
11:45-12:45	LUNCH		
12:45-1:45	16	11	27
1:45-2:45	10	5	15
2:45-3:45	8	4	12
3:45-4:45	4	6	10
Total	111	61	172

TABLE 192

TIME REQUIRED TO SERVICE THE MECHANICS
THAT WENT TO THE PARTS WINDOW

<u>Reason for trip</u>	<u>Hours per week</u>	<u>Hours per day</u>
For parts - $\frac{(1.84 \times 111)}{60}$	3.4	0.68
Not for parts - $\frac{(1.84 \times 61)}{60}$	1.9	0.38
	5.3	1.06

Total time to service mechanics = 5.3 hr/week or 1.06 hr/day.

The tabulation that follows shows how extensively use is made of the equipment parts room and the variation in use from person to person. For example, some mechanics did not use the parts room on a particular day, yet others used it as many as six times.

<u>No. of trips to parts room</u>	<u>Distribution of 26 mechanics</u>
0	9
1	5
2	3
3	4
4	4
5	0
6	<u>1</u>
	26

PERSONAL OBSERVATIONS AND OPINIONS

Most of the mechanics enjoy their work of repairing and reconditioning equipment and would prefer not having to search for parts and follow up on ordered parts. Once a mechanic has begun to repair a piece of equipment, he would prefer to complete it and start on another instead of disassembling several pieces and not being able to complete them because of lack of parts. Also, he would prefer to reach at arm's length to get frequently used inexpensive parts instead of making several trips to write requisitions, locate the stores clerk, and wait for the order to be filled.

It seems that inventory controls could be designed to permit automobile tuneup mechanics to keep a supply of parts, such as condensers, spark plugs, distributor points, etc., in a locked cabinet mounted on wheels to permit its being moved to the work areas.

Personal conversations increase when the mechanics are forced to come into contact with other employees while traveling to get parts and while waiting for the parts at the store window.

As hard as the employees work in the paint and sign shop, they would much prefer the feeling that they accomplished more with the same effort.

RECOMMENDATIONS

The recommendations which follow represent those operations or areas of work where, in the opinion of the study crew leader, it should be possible to:

1. Increase the personal activity rating
2. Reduce the number of employees
3. Increase the morale and incentive to work

Automotive and equipment shop

1. Provide self-service bins at the mechanics' work areas for small inexpensive parts, such as common nuts, bolts, screws, and other frequently used parts.
2. Provide locked bins mounted on wheels at the tuneup mechanics' work areas for more expensive and frequently used items, such as condensers, spark plugs, and distributor points, etc.
3. Make sure the mechanics use time and labor saving tools, such as power tools, semiautomatic equipment and speed wrenches.
4. Improve the availability of parts by the following actions:
 - (a) Stock a greater number and variety of parts
 - (b) Reorder parts earlier so that the parts room will not be out of stock while the order is being filled.
 - (c) Persuade local parts dealers to stock parts that would be desirable to have but uneconomical to stock by the property and equipment stores because of limited space, infrequent use, or high cost.
 - (d) Improve the practice of delivering parts to the mechanics at their work areas.
5. Relieve mechanics of work that could be done just as well by another employee such as sweeping the work areas and transporting parts and equipment.

Paint and sign shop

If the making of signs is to be continued as a regular program, then definite plans should be made toward designing or purchasing higher productive equipment. Almost all the work now done is manual.

It was determined from the study that the employees in this group spent more time working than any other group; therefore, most improvements will have to come from a change in methods, not a greater utilization of delay and idle times.

If the procurement of new equipment is accomplished, the following improvement will increase productivity while reducing the number of men required:

1. Construct a paint booth so racks with several wood barricade boards, or other types, could be pushed in and painted at one time with a spray gun. Presently, the painter gets the boards one at a time, lays them

down and paints one side with a roller, carefully turns each over and paints the other side and edges, then puts them aside.

2. Eliminate, if possible, the paper dividers used to separate the triangular shaped "No Passing" signs when they are packed for shipment. If this could be accomplished, it would reduce the crew by at least one man. To accomplish this, first, send a few small sample shipments to determine if the signs really do stick together. If they do, try drying them by sending them down a conveyor under heat lamps or putting them in an oven. This would also provide additional space by reducing the drying time and reducing the number of drying racks presently required.

3. Four, maybe five or more, rolls of scotchlite material from which the "No Passing" signs are made could be unrolled together so four or more signs could be cut at one time instead of one.

4. Redesign the silk screen stencil to include a power unit or some type of control linkage which would permit one man to stencil the letters on the signs instead of two men.

Stores - property and equipment shops

1. Reduce the store warehouse crew from four men to three men. The results of the study showed that the area was over-manned by one full-time man.

2. Continue to use one man in the parts room. This clerk's workload can be reduced by changing work methods. One example would be to use a light hand truck or cart to transport several items instead of carrying two or three at a time by hand over a long distance. A more organized method of stocking and labeling of parts would be desirable.

3. Use snapout carbon packs whenever forms need to be duplicated. Individual handling of single carbon sheets is very time consuming.

4. Streamline and update methods of processing stores records. Eliminate forms that are no longer useful and combine forms that give the same information. Use a small diazo type machine to duplicate printed material which is now rewritten by hand.

Some of the above recommendations could be put into effect using the present personnel but others will need the attention of someone, such as a methods engineer, who can provide expert assistance.

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