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An analysis of the work sampling technique of work measurement in the clerical field

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Boston University
BOSTON UNIVERSITY
COLLEGE OF BUSINESS ADMINISTRATION

THESIS

AN ANALYSIS OF THE WORK SAMPLING TECHNIQUE
OF
WORK MEASUREMENT IN THE CLERICAL FIELD

by

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Bachelor of Arts Degree
Boston College, June 1951

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the requirements for the degree of

MASTER OF BUSINESS ADMINISTRATION, 1958.
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The purpose of this thesis is to determine under what circumstances Work Sampling, or Work Sampling in combination with other techniques, will best accomplish the purposes of work measurement in the clerical field. The method of approach will be to present an analysis of Work Sampling against a background of certain presently employed techniques. This comparative analysis will cover certain aspects of the methods involved in using the various work measurement techniques, the results obtainable, and the possible psychological impact.

The principal reason for work measurement is to arrive at a production or work standard. Management employs production standards as the basis for such functions as rating employees, establishing staffing requirements, planning and scheduling work, estimating completion dates, controlling production, budgeting, and measuring the efficiency of departments and entire companies. These functions are important to management if it is to maintain control of its operations. Since the ultimate results of work measurement are important to management, the techniques of work measurement deserve consideration.

The techniques of work measurement do not necessarily pro-
vide the same information. Information available from certain forms of work measurement may be essential to some job situations, but unimportant to others. Therefore, the selection of the proper work measurement technique is a management problem. There is no point in paying to obtain unnecessary or superfluous information.

In the application of work measurement to the clerical field another factor must often be considered, employee reaction. With some managements this is the prime consideration. This attitude may stem from a desire to avoid treating the office as a factory, and to avoid unionism, or from established company policy which may tend toward "paternalism."

Mostly, techniques of work measurement have been developed in the factory and then, especially in recent years, modified and adapted for use in the office. The latest addition to the available work measurement techniques is Work Sampling, originally known as the "Snap-Shot" Technique and later as "Ratio Delay." Within the past five years or so Work Sampling, too, has been adapted to the clerical field. Work Sampling employs methods and provides information different from "conventional" techniques.

With the introduction of Work Sampling to the clerical field the problem arises of determining where this technique fits in with presently employed techniques. What will Work Sampling do that present techniques will not? What will Work Sampling not do that present techniques will do? What are the possible effects of using Work Sampling under various circumstances?
This thesis is an attempt to fit Work Sampling into its proper place among the techniques available to work measurement personnel in the clerical field. The major information sources for this thesis are the author's experience with the Work Sampling technique as well as private reports and papers made available to the author.
CHAPTER I

DESCRIPTION OF TECHNIQUES

One of the major areas in which the office has been handicapped in systematizing its work, as compared with the factory, has been in the field of establishing work standards and in measuring work output. The reason for this is that office work does not lend itself as easily to work measurement as the much more specialized and formalized routines of the factory. It is more difficult to obtain accurate standards and there are a greater variety of non-routine or non-repetitive jobs in the average clerical worker's day than there are in the factory worker's.* This does not mean that clerical work is unmeasurable but that measurement of clerical work probably will not result in as precise a standard as might be possible in the factory.

Clerical work measurement has been defined as "... a means of comparing actual production against some predetermined level or concept of normal, through which clerical productivity can be measured or controlled." ** There are several reasons for establishing clerical standards programs including:***

* 6, p. 18
** 7, pp. 30–31
*** 7, pp. 31–32
1. Substantial savings in clerical cost can be obtained since experience has shown that most clerical operations are carried on at something like 50% of maximum efficiency.

2. The most inexperienced supervisor can keep himself fully informed as to the effectiveness of the clerks within his unit. He can, with confidence, take action relative to output without fear of charges of discrimination or favoritism.

3. The reasons for existing inefficiencies can be easily discovered since work measurement can indicate the extent of lost time, reoperation, and other excess costs.

4. The supervisor can become acquainted with the details of each activity under his supervision since a detailed analysis is made before standards are set. This is not necessarily true however, if a general standard has been set through past experience.

5. The supervisor is free from demands by higher supervision to reduce the personnel in his unit since he now has a means to prove his need for a certain number of clerks to handle his workload. Conversely, higher supervision has a means of preventing over-staffing.

The advantages of and reasons for a clerical standards program and thus a work measurement program are usually recognized by
management as being desirable. The problem exists, however, of determining "some predetermined level or concept of normal" against which to compare actual performance or productivity. This problem has been and still is the stumbling block preventing the institution of work measurement in many offices.

To solve this problem, several techniques and variations of these techniques have been developed or borrowed from the factory and modified to fit circumstances. The following techniques will be described briefly and in general:

- Historical or past experience
- Self-reporting
- Stop watch
- Observation
- Synthetics

A somewhat more detailed description of the Work Sampling technique will also be given, since this technique is, as yet, not as familiar as the other techniques listed.

**HISTORICAL OR PAST EXPERIENCE**

The historical or past experience technique of work measurement is the oldest and least "scientific" technique in use. It is based upon what management remembers was done in the past. This information is then applied to the present or future. Under this technique, if on past occasions six clerks completed sixty cases of a certain type
in a day, it is assumed that if ninety of the same type case must be
done today that nine clerks will be able to complete the ninety cases.
Usually little is done to determine if the six clerks could have done
seventy cases in the reference day if there had been seventy cases a-
vailable.

Another form of the historical technique is the relating of
similar jobs or jobs with similar characteristics. Thus, if a clerk
has typed a particular ten-page report, eight pages of which contained
only columns of figures, in two hours, a different report containing
five pages, four of which are columns of numbers, should require one
hour to complete.

With further refinements, such as well-kept records and
good supervision, the historical technique of work measurement is wide-
ly used in work situations where it is not felt that detailed work
measurement studies are justified because of certain difficulties or
expense.

A major use of the historical technique is its use as a
point of departure or general check on more refined techniques.

SELF-REPORTING

The self-reporting technique of work measurement has two
basic forms:

. The clerk is asked for his appraisal of the time taken
   or required for a job.
The clerk maintains a record of time spent on various transactions.

Under the first form, the clerk is requested to give an estimate of how long a certain job will take him to do. This technique is similar to the historical or past experience technique. The accuracy of the estimate depends upon the clerk's memory and reliability.

Under the second form, a clerk, or group of clerks, is required to maintain a record of time spent on activities during a period of time. Usually this record is maintained on "time ladders" or similar forms. These "time ladders" are forms on which the working day is divided into periods, usually by minutes. The clerk indicates when he started and stopped various types of transactions and the number of cases he completed during the period. Normally codes are assigned for all possible activities in which the clerk might engage including standard activities such as personal time, idle time, waiting for work, and training.

This technique requires prior preparation to determine the transactions which are included in the clerk's duties, assigning codes to the transactions, determining which clerks are to be included in the study, and in training the clerks to maintain the "time ladders". If the number of clerks involved in the study is large, usually someone must be present to answer questions and to remind the clerks to note their activities.

After the study, the time ladders must be analyzed to deter-
### TIME SURVEY

**Position**

<table>
<thead>
<tr>
<th>Code</th>
<th>Units</th>
<th>Time</th>
<th>Code</th>
<th>Units</th>
<th>Time</th>
<th>Code</th>
<th>Units</th>
<th>Time</th>
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</table>

**SUMMARY**

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</thead>
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<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**CHART I**

**TIME LADDER**
mine unit times. This often involves decisions as to which information to use and which to discard, since often a clerk who has an interruption in his work will forget to note it.

**STOP WATCH**

The stop watch technique of work measurement is the most common "scientific" work measurement technique in use in the factory today. This is not necessarily true of the office, where much of the work measurement would seem to employ the historical or past experience technique.

The stop watch technique requires a detailed description of the method to be measured. This description will usually involve breaking the method into its elements or sometimes into only the transactions involved. If several clerks are employed at the same task usually one or two are selected to be timed. The clerks selected are usually considered to be fully trained and competent clerks. Of course, all clerks could be timed, but the expense involved is most often considered excessive for the small possible increases in accuracy.

The common method is to time a predetermined number of work cycles either by the continuous or the snap-back method. The times are noted on a time study observation sheet and later the individual element or transaction times are calculated. Then, various allowances for personal time, interruptions and waiting for work must be applied to the raw times and lastly the times are levelled for the skill of the clerk. This last requires that each of the clerks in-
volved in the study be rated by the analyst. The various allowances are usually the result of the analyst's judgment or company policy.

Since the stop watch technique of work measurement assumes that the clerk is to be co-operative during the study, and since the technique involves a degree of personal contact between the analyst and the clerk, the analyst's personality is almost as important as his skill if proper standards are to be set.

**OBSERVATION**

The so-called observation technique of work measurement has two facets, study of method employed and what may be termed "clock timing." This technique has been evolved to some extent as a substitute for stop watch timing for use where the stop watch technique is prohibited or is not feasible. The latter is often either true or thought to be true in many clerical operations.

Normally, the observation technique involves the analyst's sitting with a clerk for part of a day, or longer. As with the stop watch technique, the observation technique requires that only fully trained and competent clerks be selected for timing. In this manner, the analyst is able to discover the exact method in use first hand, keep work counts himself, and to time transactions without being obvious that he is doing so, such as occurs with stop watch technique. While the lack of obviousness in timing is not carried to the point of underhandedness, it usually does keep the clerk from becoming self-conscious. Usually the observation technique does not break the work
into such fine segments or elements as the stop watch technique.

When employing the observation technique, the observer glances at a wall clock or wrist watch occasionally to note the time. By noting the elapsed time taken by a clerk to do a bundle of work he can, knowing the number of cases in the bundle, determine the unit time per case. In situations where the unit times are long enough the analyst can measure individual cases. Normally elements cannot be measured, only transactions. Basically, under the observation technique the time taken to do a number of cases is divided by the number of cases to determine the average unit time per case.

The analyst does not stand by the clerk with a watch in his hand constantly making notes, rather he glances at his wrist watch or a wall clock at the beginning and end of every bundle of work. In this manner the clerk usually is not so conscious of being timed.

Under the observation technique, the analyst sitting with the clerk establishes close personal contact with him and is in a position to explain what he is doing and why. Any questions the clerk may have can be answered and the clerk can see exactly what the analyst is doing with the information he obtains. In this manner, the analyst gives his information and is able to "sell" the fairness of the possible standard to the clerk. This last is often an advantage when the standard is finally installed.

Of course, the personal contact of analyst and clerk depends on the personality of the analyst for its advantages; it can be a two-sided picture.
SYNTHETICS

The synthetic or standard data technique of work measurement makes use of standards based on data from time studies from a number of jobs or from micro-motion camera studies.* The standard data is usually stated as the amount of time required for a therblig or basic element in the transaction or operation such as, one typewriter key stroke, or one digit on a calculating machine.

The standard data technique requires a breakdown or synthesis of the operation to be measured. This detailed description includes in a typing operation, for instance, the number of key strokes, uses of the tab key, manipulations of the carriage, media from which typist is working, and the number of carbons. To this must be added make ready times and supplementary times such as unfastening paper clips, folding paper, and placing work in baskets. In addition, all movements such as grasping, reaching, and holding, as well as the distances involved must be carefully detailed. From this detailed analysis the analyst determines the time values for each factor from a set of tables. The time values are multiplied by the frequency and the results added. The total is the standard for the operation.

WORK SAMPLING

The Work Sampling technique of work measurement is based on

* 4, p. 363
### STANDARD DATA WORK SHEET

Division X.Y.Z. | Section | Position | Typist
---|---|---|---

Transaction Title X.X. | Date 6/2/55 | Analyst TR

Operation Title X.X.X.X.

<table>
<thead>
<tr>
<th>Code</th>
<th>Step No.</th>
<th>Description of Step</th>
<th>Time Per Step</th>
<th>Frequency of Step</th>
<th>Time Per Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-01</td>
<td>1</td>
<td>Pick up forms, insert in typewriter, remove, set aside at finish.</td>
<td>.1800</td>
<td>1/1</td>
<td>.1800</td>
</tr>
<tr>
<td>25-01</td>
<td>2</td>
<td>Type top line - &quot;A&quot; #(6 chrs.) tab to date due (5 chrs.) - 16 hrs. @ .0059 + 2 tabs @ .018</td>
<td>.1304</td>
<td>1/1</td>
<td>.1304</td>
</tr>
<tr>
<td>25-01</td>
<td>3</td>
<td>Type &quot;B&quot; (4 chrs.) net amount due (5 chrs.) - 9 hrs. @ .0059 + 1 Man' @ .04</td>
<td>.0931</td>
<td>1/4</td>
<td>.0233</td>
</tr>
<tr>
<td>25-01</td>
<td>4</td>
<td>Type &quot;C&quot; avg. 40 hrs. @ .0059</td>
<td>.2360</td>
<td>1/1</td>
<td>.2360</td>
</tr>
<tr>
<td>25-01</td>
<td>5</td>
<td>Group Constant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>24-01</td>
<td>A</td>
<td>Replace completed tray of accounting cards in files (avg. 50') get next tray 100' @ .005 + .02</td>
<td>.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24-01</td>
<td>B</td>
<td>Replace cards in file, get next group (avg. 750) of cards (estimated)</td>
<td></td>
<td>1/750</td>
<td>.0014</td>
</tr>
<tr>
<td>24-01</td>
<td>C</td>
<td>Take completed forms to table (avg. 30') mark work - count on record. 60' @ .005 + .02</td>
<td>.32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Est</td>
<td>D</td>
<td>Mark count on record (est.)</td>
<td></td>
<td>1/100</td>
<td>.0682</td>
</tr>
</tbody>
</table>

Total Standard Time

Personal Allowance (11.3%)

Total Allowed Time

---

**CHART II**
the statistical theories of probability. The basis of these theories is that if a sufficiently large representative sample of an action or group is taken, what is true of the group will be true of the sample taken to a predeterminable degree. Work Sampling utilizes the well-established principal of drawing inferences and establishing frames of reference from a random sample of the whole. In this case the "whole" is the total activity of the area, persons, or machines observed during the entire period of time over which observations are made. Work Sampling is a practical compromise between the extremes of purely subjective opinion and the "certainty" of continuous observations and detailed study.*#

In other words, Work Sampling does not say, I think the standard is, nor does it say, the standard is, rather it says that I am certain (to a calculable percentage) that the true standard lies between (calculable limits) and that since the limits are equally higher and lower than the result, I shall use the result as the standard. The degree of certainty, or sample reliability, and the limits, or tolerance, of the standard depend on the number of observations or glimpses of the work which are taken.

Another way of looking at Work Sampling is to consider it as a concession to reality between the two extremes of guessing at the standard and of constantly observing each clerk each day. By following the laws of probability it is assumed that by observing the work at

* 2, p. 2
# See GENERAL COMMENTS, p. 78
random intervals a representative sample of the entire work situation will be obtained. This sample may be likened to a miniature print of a large painting, the miniature reproducing the painting on a small scale. Obtaining the sample does not involve the work or detail which the constant observing would require.

The Work Sampling technique is dependent upon two factors for success:

. Randomness of observations
. A sufficiently large sample or number of observations

Randomness means that any given instant of time has an equal likelihood of selection as the time for observation as any other instant, and, thus, that any one time of observation is independent of all other times of observation. *

Randomness of observations has been accomplished, after a fashion, by allowing the analyst to take observations when he wishes or by taking observations at stated intervals such as every fifteen minutes. ** Neither of these methods results in complete randomness. When the analyst takes observations when he wishes he usually will fall into a definite pattern. When observations are taken at regular intervals there is no actual randomness. Both methods introduce bias into the sampling, and so are not usually recommended.

* 2, p. 3
** 3, pp. 171-172; 9
A refined method of obtaining randomness is to take a series of numbers from a Table of Random Numbers either as they are or to subject them to calculations to produce day, hour, minute, and clerk to be observed. In cases where Work Sampling studies are common and IBM equipment is available, master decks of cards with randomized information prepunched are sometimes maintained.

Sample size can be determined by formula and depends upon the accuracy and degree of reliability desired. Sample size can be computed from the following formula where:

\[ N = \frac{\sigma^2 (1-P)}{R^2 P} \]

where:

- \( N \) = Sample size (number of observations)
- \( \sigma \) = Standard deviation
- \( P \) = Sample reliability (1\( \sigma \) = 68\%, 1.3\( \sigma \) = 80\%, 2\( \sigma \) = 95\% and 3\( \sigma \) = 99.7\%)
- \( P \) = Estimated percentage of total time for the transaction requiring the smallest percentage of time
- \( R \) = Precision interval (allowable tolerance)

The formula above requires that an approximation first be made as to the percentage of total time spent by the group to be measured in doing its least time consuming transaction. Sometimes, it is assumed that only transactions requiring a specified percentage of time will be measured, such as five or ten percent, and any transactions requiring a smaller percentage will be grouped under "Other Work."
In addition, a production count during the period of the study is required. Generally this is a group count, although, of course, in more elaborate studies individual work counts can be kept.

As a simple example of the Work Sampling technique, assume five clerks work on two transactions, A and B, and devote this time 60% to A and 40% to B. If over the period of a week 1,000 observations are made of the group, then about 600 will be made of A and about 400 of B. Assuming 2,000 minutes per clerk week and 10,000 minutes spent by the group in a week, the deduction would be that 6,000 minutes per week are spent on transaction A and 4,000 minutes per week are spent on transaction B. If, in addition, it is known that for the same week 3,000 units of A and 8,000 units of B were processed, then unit times could be derived as follows:

\[
\begin{align*}
\text{Minutes Spent} & = \frac{\text{Cases Processed}}{} \\
\text{Transaction A:} & = \frac{6,000}{3,000} = 2.0 \text{ minutes per case} \\
\text{Transaction B:} & = \frac{4,000}{8,000} = 0.5 \text{ minutes per case}
\end{align*}
\]

At the same time, if idle time, personal time, and supervision and training were included as factors in the study they could be calculated as percentages and/or minutes per day.
In the actual study, various possibilities as to method exist. The analyst can note the activities of the clerks on forms, either in longhand or in the form of predetermined codes. A later development is to supply analysts with sheets on which have been printed by IBM machines the day, hour, minute, and clerk to be observed. The analyst merely notes the activity code on the sheet. Later, tabulating cards are key-punched by hand from the sheets and a summary prepared by machine. An even later development is to supply analysts with mark sense IBM cards. Under this method, the analyst lines through the numbers on the card denoting the applicable work code. These mark sense cards require no manual key-punching to provide a machine summary of the study.

If properly set up, the Work Sampling technique of work measurement provides a standard of known or calculable reliability without necessarily requiring a detailed methods analysis.
Sample size for $1.3\sigma$ for values of $P$ from 1% to 40%.

For $T$ of

1. $\pm 5\%$ of $P$
2. $\pm 10\%$ of $P$
3. $\pm 15\%$ of $P$

To determine sample size:

1. Locate the estimated value of "P" along the horizontal axis.
2. Follow the vertical coordinate thus located to the point where it intersects the appropriate tolerance value curve.

The point of intersection is the sample size indicated on the vertical axis.

CHART III
### CHART IV

Example of Mark Sense Observation Card
CHAPTER II

COMPARISON OF TECHNIQUES

Work measurement techniques in their use can be broken basically into three sections:

- Preparation
- Actually conducting study
- Other problems involved

Each technique would, through various possibilities within the technique, offer certain advantages and/or disadvantages. In employing the Work Sampling technique, one of the prime necessities to obtain full advantage, especially in a large study, is that IBM Tabulating equipment be used in the preparation and in the summary of data. One of the latest advantages in the use of this IBM equipment is to maintain a master deck of IBM Tabulating cards containing a series of random numbers. Through these cards of the master deck, given certain basic information concerning the specific study, the IBM machines can turn out either punched cards or sheets on which has been designated the clerk to be observed and the day and the time to observe the clerk. The setting up of these observation cards through the random numbers should assure complete randomness of observation in the study. Without the use of this IBM equipment and
tabulating cards, a sample of any size using the Work Sampling technique can become cumbersome and less economical than the other techniques of work measurement.*

**PREPARATION**

The Work Sampling technique of work measurement requires the following information as the first steps in its preparation:

1. A description of the transactions to be observed.
2. An approximation of the percentage of total time (available to the section being measured) spent on the least time consuming transaction.
3. The number of clerks involved in the study. These usually include only those clerks who are considered to be fully-trained and competent.
4. The number of days allowed or required for the study.
5. The physical layout of the area in which the clerks to be observed are located.

The approximation of the percentage of the total time available to the section spent on the least time consuming transaction is necessary to determine the number of observations to take during the study. This approximation may be derived from a work sampling study of a few hundred observations which is sometimes used to obtain in-
formation for large studies. This procedure, however, involves the problem of work cycles and is more time consuming than other methods which, under most conditions, will give a reasonably reliable approximation.

More frequently, the approximation of percentages is obtained from the local supervision of the section to be measured. These people will normally use variations of the past experience or historical technique to arrive at an answer. The reliability of their estimation, of course, will depend largely on the experience and quality of the supervisors. Another method sometimes used is to assume that only transactions requiring a certain minimum percentage of available time will be measured. The theory behind this method is that transactions requiring less than the minimum percentage are too insignificant to require individual standards. Thus, it may be decided to use five or ten percent as the basis for determining sample size. All work requiring less than the predetermined percentage of time is grouped under the heading, "Other Work."

Another point which must be determined along with the approximation of time spent on any one transaction is the allowable tolerance with which the analyst must work. Thus, if the allowable tolerance is plus or minus ten percent and a certain transaction is shown, as a result of the study, to occupy thirty percent of the section's time, the actual percentage is presumed to be between twenty-seven percent and thirty-three percent.
0.30 x 0.10 = 0.03
0.30 + 0.03 = 0.33
0.30 - 0.03 = 0.27

The effect of the least percentage of time and the allowable tolerance upon sample size is illustrated by the following excerpt from a Reliability Table, assuming 1.3σ (or a sample reliability of 80%).

<table>
<thead>
<tr>
<th>Least Percentage</th>
<th>Allowable Tolerance 10%</th>
<th>Allowable Tolerance 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of Observations Required</td>
<td>Number of Observations Required</td>
</tr>
<tr>
<td>1%</td>
<td>16,730</td>
<td>66,920</td>
</tr>
<tr>
<td>5%</td>
<td>3,210</td>
<td>12,840</td>
</tr>
<tr>
<td>10%</td>
<td>1,520</td>
<td>6,080</td>
</tr>
</tbody>
</table>

Or, assuming 1.65σ (or a sample reliability of 90%).

<table>
<thead>
<tr>
<th>Least Percentage</th>
<th>Allowable Tolerance 10%</th>
<th>Allowable Tolerance 5%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of Observations Required</td>
<td>Number of Observations Required</td>
</tr>
<tr>
<td>1%</td>
<td>26,950</td>
<td>107,810</td>
</tr>
<tr>
<td>5%</td>
<td>5,170</td>
<td>20,690</td>
</tr>
<tr>
<td>10%</td>
<td>2,450</td>
<td>9,800</td>
</tr>
</tbody>
</table>

Since no work standard, especially in the clerical field can

# In this case 1.3σ is 1.3 standard deviations from the mean, and can be thought of as meaning that the probability that the true standard lies within the stated tolerances is four out of five or 80%. 
be exact, management must decide on the allowable tolerance. Only the Work Sampling technique allows for a calculation of a known tolerance. As can be seen from the table, decreasing the tolerance from plus or minus ten percent to plus or minus five percent requires that approximately four times as many observations be taken. Management must decide the need for small tolerances, there is little need to make more observations than necessary, especially since there is a practical limit to the number of observations one observer can take in a day.

A description of the transaction to be observed is the most important practical consideration in preparing for a Work Sampling study. More than one Work Sampling study has resulted in dismal, irretrievable failure because insufficient attention and planning were given to this point. As an example of the importance of this description, a description such as - "enter figures from form A to index card B and index card C, and enter additional figures on index card D" - is not sufficient for work sampling. Since a requirement in the use of the Work Sampling technique is that the transactions to be measured must be easily recognizable at a glance, each description of a transaction must include observable physical differences involved. The description above to be usable in a work sampling study should state, for instance, the colors of the various index cards, their relative sizes, or some other physical characteristic.

This requirement, that the transaction to be measured must be easily identifiable at a glance and usually from a distance of several feet, presents a problem that is little appreciated in the use
of Work Sampling as a work measurement technique, especially in the clerical field. This condition does not hold true for other work measurement techniques. In using the self-reporting technique, the clerk identifies transactions himself on the "time ladder". When applying the stop watch or observation technique, the analyst can stop timing and ask the clerk what exactly he is doing, if a question should arise. If there are slight differences, such as might be apparent from form numbers or headings, the analyst can become familiar with the very slight variations in a relatively short period. The use of synthetics requires each small variation to be noted, but the analyst has ample opportunity to note these variations if he observes the specimens of the work keenly enough.

In a work sampling study, the analyst cannot stop to ask questions for every observation, especially if he must take one thousand observations during one day, and the time and the clerk to be observed have been predetermined for each observation.

The result of this condition is that if a group of clerks, among other transactions, types three different forms, each of which appears to be approximately the same, the typing of the three forms must be grouped under one transaction. Under the other techniques of work measurement it is possible to measure the typing of each of the three forms separately, as three separate transactions. Thus, if the work mix should change, standards could still be applied, whereas if the work sampling technique has been used originally, a new study
would be required.

Another problem which this matter of identification presents is that if a section does work of the same nature, but on different transactions, such as might occur if a group of typists type various information on various forms, it would mean that in using the Work Sampling technique, if no noticeable physical difference were present in the matter typed, the standard would of necessity be set for all the work as one transaction. This would present problems since the various jobs could not be properly broken down for costing purposes. The other techniques of work measurement would give each transaction or operation at which the typists work a weight whereby a cost breakdown could be derived if this were necessary. As can be seen, this is a drawback of the Work Sampling technique.

One possibility of overcoming the problem of observable physical differences is that of having the clerks set up signs indicating on which transaction they are working at the moment. When these signs can be used, it is possible to measure transactions which do not have observable physical differences; however, there is extra dependence on the clerks. The use of signs is very susceptible to inaccuracies due to forgetfulness on the part of the clerks in setting up the proper signs. The setting up of signs can also be distracting to the clerks. The use of signs has a very limited application and can be used only where the clerks are exceptionally co-operative.*
The number of clerks involved in the work to be measured must be known to insure that each fully-trained, competent clerk is included in the study. In most Work Sampling studies, especially in those studies which make use of IBM Tabulating machines for the preparation of observations, the clerks are assigned code numbers. Under a system based on a master deck of punched cards containing random numbers, the clerk to be observed is preselected for the analyst. If a clerk should not be included in the study, the results may not reflect the facts. This would be the case if, for instance, one clerk did all the more difficult cases. If this clerk should accidentally be excluded from the study, the resulting standard would probably be too "tight." If trainees are included in the study, the resulting standard would probably be too "loose."

Part-time clerks employed in the section to be measured and their hours of arrival and departure must be known ahead of time so that no observations are scheduled for them before or after their working hours. Failure to plan for the part-timers, especially if many are involved, can result in the study's not having the validity planned for it, since a sufficiently large number of observations may be discarded so that the allowable tolerance for the standards is exceeded.

The number of clerks and their exact hours worked must also be known so that the total number of clerk-minutes available during the study can be computed. This figure is necessary in the analysis to convert percentages of observations to the standard which is usually
expressed in minutes.

In using other techniques of work measurement, the number of clerks involved in the section to be studied is of little or no importance to the preparation of the study. In the self-reporting technique "time ladders" can be given to all clerks present on any one day and to part-timers as they arrive and collected as they leave. From these "time ladders" can be obtained the number of minutes of working time available to each clerk, and a total is easily derived. The stop watch and observation techniques usually require that only a few selected clerks be timed. If these selected clerks are not available on a particular day, usually other clerks can be timed as a substitute without affecting the results. The number of hours spent during the study is of little consequence since the observer or timer has available the number of hours as well as the number of minutes, and the number of cases completed, which is all the information needed. He also has the time taken for individual elements or transactions. The preparation involves only selecting fully-trained competent clerks for timing which also is usually the case in using the Work Sampling technique, although in using the Work Sampling technique a wider interpretation of the definition of a fully-trained, competent clerk can be applied. Since synthetics employs standard data, it does not necessarily require that the transaction now exist; it requires no consideration of the number of clerks in its preparation stage.
The number of days allowed or required for the study must be known when using the Work Sampling technique in order to set up the observations. This is especially true if the study is to utilize IBM Tabulating machinery to prepare the observations' sheets. There is a vast difference between making 12,840 observations in two days, and making the same number of observations over 20 working days. The former would be practically impossible to accomplish without using six or seven observers, the latter could be accomplished easily by one observer. In order to set up the times for observations, the period over which the study is to extend must be known. If the study is to extend over five working days, observations are distributed differently than if the study is to extend over ten days. This is true of both the number of observations per day and of the times of the observations.

The effect of the number of days allowed for the study is of little consequence in using other techniques of work measurement. The self-reporting technique, provided the time limit covers a sufficiently large portion of the work cycle, can be varied without undue inaccuracy, at least relative to its normal inaccuracies. If, again, a sufficient number of different transactions can be timed, studies employing the stop watch and the observation techniques can be completed within most time limits.

The time required for a work sampling study can vary within rather wide limits. Usually the time actually required by the study is dependent upon the general work cycle of the section to be measured.
Sufficient time should be taken with the study to cover the complete work cycle or at least a representative portion of the work cycle. From the aspect of the number of observations taken in one day this is dependent upon the number of observers available. It has been found from practical experience that a rule-of-thumb would be that one observer can take approximately one thousand observations per day, if the transactions are relatively easy to recognize, and there are seven to twelve different codes.* If ten observers could be employed, 10,000 observations could be taken in one day. This may result in having more observers than clerks present, which brings up the problem of how many observers can be economically employed and how many observations will be taken per day. This problem must be determined according to the custom of the management applying the technique, and the necessity for completing the study in a short period. The use of the Work Sampling technique becomes less economical as the ratio of observers to clerks becomes larger.

The other techniques of work measurement need only find what transactions exist which must be measured. The stop watch and observation techniques then require that a relatively few examples of each transaction be timed. One or two analysts can usually conduct the studies regardless of the number of clerks employed in the section or the percentage of time spent on any one transaction.

An analysis of the physical layout of the area (in which

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the clerks to be observed are located) is necessary to determine the
number of observers required to conduct the study. In employing the
Work Sampling technique, especially where times to be observed and
clerks to be observed have been predetermined in a study requiring
more than one thousand or so observations per day, the observer may
easily be required to record observations, at times, without much
interval between. If to this is added some transaction with only a
minor observable physical difference from another transaction, it can
be seen that an observer has a relatively small sphere of maneuver-
ability. This generally means that the section to be measured must
first be visited by an analyst who has a knowledge of the observable
physical differences within the transaction to be measured. The an-
alyst must determine the number of clerks the observer can observe
and determine the number of observers needed for the study. Thus,
if the clerks to be observed are scattered, or file cabinets separate
them, more observers will probably be required than if the clerks
work in a compact area.

If the clerks work in a compact area, the number of clerks,
the average number of observations per day, and the obviousness of
the observable physical differences between the transactions to be
measured also have important effects on the number of observers re-
quired to conduct the work measurement study using the Work Sampling
technique. Neglect in planning for any of these factors has re-
sulted in studies which have failed: the study had to be called off
until the problems had been worked out; the observers weren't able
to see properly and either guessed at what to mark down on the card, or the results were so obviously incorrect that they had to be discarded.

If IBM Tabulating equipment is available and if something akin to a master deck of IBM punched cards has already been set up, the actual preparations for the observations to be made, and the summary of observation sheets or mark sense cards recording observations requires but a few hours. If tabulating equipment and a master deck of cards are not available the preparation of observations times on the observation cards can become too time consuming to make a work sampling study economical or feasible unless a system of observing at predetermined intervals is adopted, which is not recommended.

In the preparation of a small-scale work sampling study, such as might be used to determine the approximate percentage of time a small group of clerks spends typing, the preparation would be as described above, but could be abbreviated and simplified. Thus, if management wished to determine if the work content of a group of clerks had changed, the criterion being whether typing is required 40 percent of the time, the allowable tolerance being 20 percent; (i.e., could vary between 32 percent and 48 percent) then the sample size would be small enough to handle without tabulating equipment. The transactions to be observed would be two: typing and non-typing. The percentage used in calculating sample size would be 40 percent with an allowable tolerance of plus or minus 20 percent.
This would result in a sample size of approximately 72 observations with a reliability of $1.3\sigma$ (or 80%).

\[
N = \frac{1.3\sigma^2 (1-P)}{R^2\rho} = \frac{1.69 (1.00 - 0.40)}{(0.20)^2 (0.40)}
\]

\[
= \frac{1.69 (0.6)}{(0.04) (0.4)} = \frac{1.014}{0.016} = 63.4
\]

= 64 plus factor for observations which will fall during lunch period and coffee breaks.

= 64 x 1.125 = 72

True, the results of the study could never be used to set reliable standards, but the 72 observations are easily accomplished at little expense and the reliability is sufficient to indicate whether further action is necessary.

Although the number of work cycles to be timed using the stop watch technique can be calculated statistically,* generally analysts use their judgment in determining this information. The self-reporting and observation techniques also rely upon the analyst's judgment to determine the extent of the timing. Thus, these techniques require little preparation as compared to the Work Sampling technique. These other techniques can vary the number of timings

* 13, pp. 154-163
made as the study progresses. In Work Sampling this is not possible without the probability of losing the randomness of the sampling and hence it could destroy the validity of the results. Generally speaking, once a Work Sampling study has been planned and the preparation completed, the study must carry through as planned unless the study is to be called off and retried. There is very little chance of changing anything once the study is underway.

CONDUCTING THE STUDY

Conducting a work measurement study employing the Work Sampling technique is relatively simple as compared with studies employing other work measurement techniques. Little skill is required of the observers and there is little or no interference with the normal routine of the section being measured nor with individual clerks.

**Work Sampling** After all necessary preparations, as previously described, have been made for the Work Sampling study, the next step is, as in other work measurement studies, to prepare the clerks for the study. This preparation will normally take the form of one or more briefing and instruction sessions. The principal difference in discussing Work Sampling with the clerks is that all clerks, as in the self-reporting method, will probably be included. Usually, with the other techniques only a few clerks are actually timed or observed.
The clerks should be instructed and briefed in what will take place and why, during the Work Sampling study. The success of this instruction and briefing is very important, more so than when employing other work measurement techniques. This importance stems from the fact that it is very probable that the analyst will have no further personal contact with the clerks, hence any knowledge and understanding of what is taking place must be imparted to the clerks during the briefing period.

The instruction of the clerks should include a description of what will occur during the study, what the observers will note on the observation cards or sheets, and what will be done with the data obtained. There should be no aura of mystery surrounding the Work Sampling study, especially since the success of the study is dependent in large degree upon clerk cooperation.

Another item which should be covered in the briefing session is the need for clerks to work at a normal work pace and not to try to stretch work out to avoid having idle time. Since performance rating of individual observations is not feasible, it is most important that the clerks work at a normal work pace. If at all possible, the study should be planned so that it covers a period when work will be heavy enough to insure that the clerks will work at a normal pace, since it appears that people usually adjust their work pace (within limits) according to the amount of work they must do.* Perhaps the most difficult part of the briefing session is to

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convince the clerks that they should not attempt to cover up idle or personal time since the former usually is management's fault, and they are entitled to a certain amount of the latter.*

If any clerk or transaction identification code signs are to be utilized during the study they should be explained to the clerks during the briefing session. The analyst should also be prepared to answer any questions the clerks may ask. The answers should be in non-technical, easily understood terms and should be as complete as deemed necessary to satisfy and not mystify the clerks.

Having made all preparations, it is normally recommended that the observers arrive on the scene prior to the commencement of work since, under normal conditions, the Work Sampling study, especially one which will run continuously for a few days, requires that the observations be started commencing with the start of the work day and ending at the end of the work day. Another reason for arriving early is that, since the observations to be taken are usually indicated by a code for the clerk and since, at first, the observers may not be able to recognize the clerks, it is usually necessary to put some identifying symbol, such as a stand with a number, on each clerk's desk or workplace. This number should be large enough so as to be observable a good distance away.

The methods of observing the clerk may vary; at least the recording of what the clerk is doing at the time of observation may vary. The observer at the time designated for the observation should
glance at the clerk, determine what transaction he is working on, translate the transaction into code, and mark this code on the observation card or sheet.

The observer may or may not be required to walk among the clerks to make his observations. However, experience has shown that it is oftentimes advisable for the observer to walk among the clerks occasionally to keep them in mind that a work measurement study is being conducted.* In fact, not walking among the clerks is a common pitfall in making work sampling studies. In more than one study in which the results have been suspect, later investigation has proven that the observers, considering themselves familiar with the transactions to measure, had remained immobile, more or less standing in one place or maybe moving a few feet in either direction to make their observations. The fallacy behind this immobility is that oftentimes clerks will have work on their desks and still be taking personal time, such as, in a checking operation or an operation requiring some degree of mental activity. Thus, in one study, it was found that clerks had averaged approximately 5 percent personal time. The local management of the area measured, however, stated that this was not reasonable, and brought out the fact that many clerks, having completed their work, had dawdled over their work either glancing at books, or talking quietly with friends without turning their heads to any appreciable extent. The observers, standing at a distance,

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seeing work on the clerk's desk assumed that this was a certain trans-
action. This, however, was not the case. Had the observers moved in
among the clerks, they would have noted that the clerks, customarily,
upon completing their work, and oftentimes with cases left laying on
their desks, carried on their personal conversations until the super-
visor had brought new cases and carried away the completed work.*

In many situations, the clerks will be working on two trans-
actions which are very closely alike as far as observable physical
differences are concerned. The observer who does not walk among the
clerks to some extent is very likely to overlook these subtle differ-
ences and note incorrect transactions on his observation cards or
sheets. This has been the case in studies where the full importance
of this mingling with the clerks has not been fully appreciated.

It is advisable, at least in the early stages of the Work
Sampling study, to have an analyst present who is not observing. The
functions of this analyst are to relieve observers, to answer any
questions which the clerks may have, to investigate any seemingly un-
planned for occurrences, and to ask any necessary questions which may
arise in the minds of the observers. This is particularly true when
a new transaction has been noted and the observers are unsure as to
exactly how they should code the transaction. This might occur in a
situation in which certain transactions are done at certain times of
the week, and two or three new transactions have been noticed on the
second or third day of the study. The code sheet which the observers have may indicate that certain transactions will be indicated by having a yellow index card or a green book on the desk, but it could be that under certain conditions there would be a yellow index card and a green book on a clerk's desk. The additional analyst by checking with the clerk or his supervisor will probably find that the green book is there because the clerk did not bother to put it away when he started another transaction. There could, however, be some other cause and it is recommended to have the extra analyst present to allow the observers to continue making observations on schedule.

Especially in the early stages of the study the clerks may have questions, or they may gather courage later on to ask questions. The clerks oftentimes have an odd feeling when they see men standing around marking on little cards. Such queries as, "I understand that you are checking when friends come to visit me to talk and noting their names" and other such questions or statements must be answered to keep the co-operation of the clerks. In most cases, the observers do not have the time to answer these questions if they are to keep up with their observations.

If an unoccupied analyst is handy to answer these questions it is all the more to the good. Once the observations commence, they must continue as predetermined throughout the study. There is no opportunity for an observer to take a break unless, by chance, he has a long break during observations. Thus, it is an aid to the observers that when an unoccupied analyst is present a shift can take place so
that one person can take a break from the strain of keeping observations; making observations of the complete work day can be a very fatiguing occupation.

It seems to be generally true, from experience, that one person cannot continue observing during the entire day, five days a week and still maintain accuracy, especially when mark sense cards are employed as the means of recording observations. The usual result, when the observers are not relieved at regular intervals is that inaccuracies in the observations will occur. This is especially true in cases where a section may do one transaction to a large extent, and then several clerks are taken off this transaction and assigned to another transaction. The observer becomes more or less hypnotized from the effect of marking down the same transaction continuously for a long period. After awhile he may not even notice that the new transaction is occurring and so will continue to record the earlier transaction instead of the new transaction.* This failure will result in inaccuracies in the final result, which inaccuracies may not be discovered until the incorrect standard has been installed.

It has been found that if the observers move among the clerks while making their observations they are less likely to become hypnotized from marking the same transaction continuously. The physical

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activity appears to counteract the effect of the lack of mental activity or sameness of observations.*

Despite this need of having the analyst move among the clerks on occasion, although this moving about is not necessarily a continuous thing, work sampling still imposes little or no interference with the clerks while they are working since, in the majority of cases, the questions the observers have may be answered by the local supervisor, who, presumably, is not on productive work and, therefore, not engaged in the study.

The actual conduct of the work measurement study is, once the proper preparations have been made, rather a simple affair usually reduced to the observers' being able to recognize the transactions to be measured, and their noting the appropriate codes for the transactions on the observation sheets or mark sense cards. The necessity of observing at exactly the time required and recording the transaction with which the clerk is then involved, not what the clerk is about to do or has just completed, is paramount. Aside from this, there is no real pressure on the observer and no real problems in the actual conduct of the study.

The other work measurement techniques, with the exception of the synthetic technique, involve difficulties in the actual conduct of the study. This is not to say that the Work Sampling technique does not have problems in the actual conduct of the study itself, but rather that the problems it has are basically not technical.

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problems. Merely the misjudgment of what transactions are occurring or the failure to take observations on time are involved.

**Self-reporting** The self-reporting technique requires that a very explicit and detailed set of instructions and code sheets be given to the clerks. In order to insure the validity of the study the clerks must fill out their "time ladders" as carefully and as precisely as possible. This requires that all clerks, and usually all clerks are included in the study under the self-reporting technique since the clerks who are under par or lax can later be dropped from the summary of data, understand what they are to do. The inclusion of all clerks in the study does have the virtue of preventing the clerks from placing the blame on any one, two, three, or four clerks for creating the standards, since all clerks are at least thought to be included in the final data. All clerks, however, must be brought together and instructed. This usually means that the clerks will be given a copy of the code sheet, on which each transaction has been given a code. This, of course, results in much question-asking and is open to misinterpretation. Usually at least one or two analysts must be present, especially in the early part of the study, to answer questions and observe the clerks to insure that the clerks are recording the proper transactions. This is in the nature of a check-up on the clerk. Of course, this check-up will also attempt to uncover any falseness of a deliberate nature in maintaining the "time ladders" by the clerks.
Generally, however, after the discussions with the clerks have been held, there is little in the nature of any difficulties involved in the study except for the question-asking. However, it is usually required that at least one trained analyst is present part-time during the entire self-reporting study to show that management is serious about accuracy.

Stop watch The stop watch technique also requires a briefing session for the clerks in which the purposes of the study, what is expected of the clerks, and what will be done during the study are discussed. Sometimes this briefing session takes the form of a general discussion with all the clerks and then a more detailed discussion of a question and answer nature with the clerks who actually are to be timed. In this manner all clerks know what is going on, yet only those involved in the study receive individual attention.

In using the stop watch technique, the actual making of the time study is both an art and a science. The analyst must have developed the art of being able to inspire confidence, exercise judgement, and create a personable approach to all with whom he comes in contact. Included in the elements in which he must be proficient are the abilities of selecting the clerk to study, analyzing and breaking the job into its elements, performance rating the clerk, and assigning appropriate allowances, as well as working up the results and the preparation of his study.*

* 5, p. 212
Thus, it would seem that under the stop watch technique the analyst, in the actual conduct of the study, is expected to be able to select the clerks to be timed or else, in the event that the clerks whom he had originally selected are not present, then he must be able to select other clerks who will fit in as normal or average clerks, i.e., within the definition of normal or average clerks. Since under the stop watch technique the analyst has very close, personal contact with the clerks being timed, his personality can greatly influence the results of the study.

The analyst must, of course, be proficient in the use of the stop watch, and he must be most observant in noticing variations in the work which the clerk does in order to find variations within the transactions. Oftentimes, the analyst employing the stop watch technique will notice differences between the method used and the supposed method used which he is able to note for future reference. If this occurs, the analyst is in a position to stop the study and to proceed to discuss this matter with the local management to determine why the approved method is not in use. In the majority of situations, if the time study man finds that the method is not proper or management is not aware of the use of a non-approved method, he can postpone the study until later to allow the problem of developing a more efficient system of doing the work to be solved, or to allow the clerks to be trained in the approved method.

The analyst does have the option of using the different methods of time studying, such as the continuous or snap-back method,
and he is also in a position to give the clerk any information he may ask for concerning the purpose of the study and the need for setting standards. He is also in a position personally to do great harm to the study if he does not have the proper personality to get along with the many types of people whom he meets. From this, it would seem that the stop watch technique contains more of a human element than the Work Sampling technique, at least as far as the conduction of the study is concerned.

Of the techniques available in work measurement in the clerical field the stop watch technique probably carries the most "tainted" atmosphere with it. This may result from the traditional feeling of separation or superiority of the office worker over the factory worker. Stop watch timing, of course, has been associated with the factory since the time of Frederick W. Taylor and oftentimes office workers feel that this is a little too much for them to undergo, and that by allowing themselves to be stop watch timed they are demeaning themselves. For this reason the stop watch technique is sometimes not employed in the office.*

Observation The observation technique of work measurement is somewhat akin to the stop watch technique in that usually not all clerks are observed and the analyst does have opportunity to see the actual method being used by the clerks, and to note minor differences between transactions. Also, he is able to note any deviations the

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INTRODUCTION

The purpose of this thesis is to determine under what circumstances Work Sampling, or Work Sampling in combination with other techniques, will best accomplish the purposes of work measurement in the clerical field. The method of approach will be to present an analysis of Work Sampling against a background of certain presently employed techniques. This comparative analysis will cover certain aspects of the methods involved in using the various work measurement techniques, the results obtainable, and the possible psychological impact.

The principal reason for work measurement is to arrive at a production or work standard. Management employs production standards as the basis for such functions as rating employees, establishing staffing requirements, planning and scheduling work, estimating completion dates, controlling production, budgeting, and measuring the efficiency of departments and entire companies. These functions are important to management if it is to maintain control of its operations. Since the ultimate results of work measurement are important to management, the techniques of work measurement deserve consideration.

The techniques of work measurement do not necessarily pro-
to see properly and either guessed at what to mark down on the card, or the results were so obviously incorrect that they had to be discarded.

If IBM Tabulating equipment is available and if something akin to a master deck of IBM punched cards has already been set up, the actual preparations for the observations to be made, and the summary of observation sheets or mark sense cards recording observations requires but a few hours. If tabulating equipment and a master deck of cards are not available the preparation of observations times on the observation cards can become too time consuming to make a work sampling study economical or feasible unless a system of observing at predetermined intervals is adopted, which is not recommended.

In the preparation of a small-scale work sampling study, such as might be used to determine the approximate percentage of time a small group of clerks spends typing, the preparation would be as described above, but could be abbreviated and simplified. Thus, if management wished to determine if the work content of a group of clerks had changed, the criterion being whether typing is required 40 percent of the time, the allowable tolerance being 20 percent; (i.e., could vary between 32 percent and 48 percent) then the sample size would be small enough to handle without tabulating equipment. The transactions to be observed would be two: typing and non-typing. The percentage used in calculating sample size would be 40 percent with an allowable tolerance of plus or minus 20 percent.
clerk may have from the approved method of doing the work. Under the observation technique normally the analyst will sit beside a clerk and observe him as he goes through the routine of the day.

The observation technique requires that the analyst be skilled in observing the clerk and also in timing the clerk. Since no stop watch is used it may at times require ingenuity on the part of the analyst to measure the work. If a clerk should do a transaction which requires only thirty seconds, it would be exceedingly difficult to time it using a wrist watch or wall clock. The usual method is to attempt to measure the time required to do several cases and then to divide this time by the number of cases to arrive at a unit time. The analyst using the observation technique is more equipped to measure transactions which occur in large enough volume to require several minutes for a bundle of work.

Here again, the personality of the analyst plays a great part since, unlike the other techniques, he is not standing at a distance, but usually is sitting right with the clerk and in a position to be asked questions by the clerk, as well as by any other clerks who may be sitting near or who wish to join in the general questioning. Oftentimes, the observation technique may not even be used for work measurement, but simply to find out what exactly is involved in the clerk's job.

This technique, of all techniques, will often result in the analyst's gaining a complete knowledge of what is included in a clerk's day, since the usual application of the technique requires
The results obtainable from a work measurement study naturally can be no better than the preparation that goes into the study or than the quality of the conduct of the actual study, since no amount of calculations or afterthought can overcome poor basic data. However, there are certain differences in the results obtainable, and the ease of working with these results.

A late development which has greatly assisted in the feasibility of using the Work Sampling technique is that results of a work measurement study can be summarized by IBM Tabulating equipment. If tabulating equipment is available the data can be summarized on these machines in a matter of a few hours. This tabulation can be very inexpensive from the point of view of salaries and wages especially if the original observations of the study have been made on mark sense cards. If the original study has been made on some other easily-read form, such as observation sheets which are the results of IBM Tabulating machine "runs", the data can be key punched into IBM cards and run through the machines. This procedure, of course, requires a considerably longer time, relatively speaking, than having used mark sense cards originally. However, either utilization of tabulating machines greatly reduces the manual work of summarizing data.
obtained by taking one of the items on which the typist works, counting key strokes, carriage shifts and spacing, and from this setting the standard of that particular item. When using the synthetics technique the analyst may never have contact with the clerks which eliminates the possibility of personality clashes between analyst and clerk.

**OTHER PROBLEMS INVOLVED**

Levelling or performance rating has been defined as "... a technique for equitably determining the time required to perform a task by the normal worker after the observed values of the operation under study have been recorded." The presumption made is that the analyst, after observing a clerk for a period of time, can determine the clerk's deviation from a "normal" work pace. The deviation is usually described as a percentage of "normal." Thus, the "normal" is usually considered one hundred percent and deviations are described, for example, as eighty percent or one hundred and twenty percent, the higher the percentage the better the performance. The basis for performance rating is the judgment of the analyst as to what constitutes "normal" and whether the operator whom he is timing is "normal" or not at each stage in the timing. The analyst's judgment is also the basis for deciding the extent of the deviation from normal. The possibilities of and for performance rating during a time study are the sub-

* 5, p. 240
ject of much controversy.*

In the clerical field the use of performance rating in work measurement studies is even more questionable than in the factory. Most clerical operations, at present, are carried on at something like fifty percent of maximum efficiency.** This appears to be the result, principally, of incomplete utilization of the clerks’ time and of obsolete work procedures.*** Under these conditions it would appear that management has ample room for improvement without employing performance rating in Work Sampling, since improving methods of work would itself account for a considerable increase in efficiency. The office can also make great strides in eliminating interruptions and reducing non-productive time.

In using the Work Sampling technique of work measurement performance rating during observation taking is not feasible. The observer is required to see what the clerk is doing, translate this into a work code, and note the code on an observation sheet or mark sense card all within a period of a few moments. If the observer were also required to performance rate each clerk at the time of each observation, the time required would possibly be excessive. The use of untrained people as observers, rather than analysts, would not be possible if observers were required to rate performance at each observation.

* 1, p. 131; 4, p. 309; 5, p. 241
** 7, p. 30
*** 9
Another problem in performance rating as observations are made is that performance rating, based on subjective human judgment, is subject to error. This error is not calculable mathematically. As a result of this non-calculable, unknown error in the basic data, an unknown bias is introduced into the data.* Hence, the Work Sampling technique loses its advantage of producing standards of known or calculable accuracy when performance rating is introduced when observations are made.

If it is desired to rate performance when employing the stop watch or observation techniques, there is no question of introducing bias from the statistical point of view, but the validity of the factor used has, in the past, been questioned.**

Before commencing a Work Sampling study it is best, however, to performance rate, in a very general way, all the clerks to be studied. This evaluation usually takes the form of determining that clerks will have sufficient work available to assure that they will work at their usual pace and not slow down to compensate for a smaller work load, and that their usual pace is an acceptable pace on which to base a work standard.

* 2, pp. 65-66
** 1, p. 131
CHAPTER III

COMPARISON OF RESULTS OBTAINABLE

The results obtainable from a work measurement study naturally can be no better than the preparation that goes into the study or than the quality of the conduct of the actual study, since no amount of calculations or afterthought can overcome poor basic data. However, there are certain differences in the results obtainable, and the ease of working with these results.

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FORM OF BASIC DATA

The form of the basic data of the Work Sampling study is usually in the form of many mark-sense cards, or in the form of observation sheets which have been prepared by Tabulating machines. This data, if necessary, can be summarized each day to give a running account of how the study is progressing. True, the number of observations for any one day, especially in a one or two week study, does not give particularly close tolerances in the results, but for estimating purposes it is sufficient. Also, each day added to the previous days will give results to a closer tolerance. In this manner, it is possible to check the progress of the study, as well as discover any possible difficulties which may arise.

Using the stopwatch and observation technique, day to day summaries are not particularly valuable. The results concerning the one or two clerks timed during the day will be shown, but these clerks may have been selected improperly and are not representative of the whole population of clerks doing this type of work. By the nature of the self-reporting technique, if any appreciably large number of clerks are employed in the section being measured, it is a physical impossibility to summarize the "time-ladders" daily.

Provided that the Work Sampling technique involves the use of mark-sense cards and IBM equipment, the mark-sense cards can be turned over to the machine installation, and within a relatively short time, at the end of the study, a complete run indicating various breakdowns
of the information obtained can be given. This breakdown of data can take almost any form desired including:

By clerk, by day, by transaction
By day, by clerk, by transaction
By transaction, by day, by clerk
By clerk, by transaction, by day
By transaction, by clerk, by day

Thus, the format of the summary by clerk, by day, by transaction would list the code for each clerk. For each clerk would be listed the days of the study. For each day of the study would be listed the transaction codes and the number of observations recorded for each transaction. The number of observations would be totaled for each day. After the information had been listed, the number of observations recorded for each transaction would be totaled by transaction and the number of observations recorded for the entire study would be totaled. An excerpt from a summary of this type is shown.

<table>
<thead>
<tr>
<th>Clerk</th>
<th>Day</th>
<th>Transaction</th>
<th>No. Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>1</td>
<td>1</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>83 Total</strong></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td><strong>23</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><strong>85 Total</strong></td>
</tr>
</tbody>
</table>

Using summary sheets of this type will indicate if any formal
specialization exists within the group of clerks, and if certain days are devoted exclusively to certain transactions. Any incorrect recordings of transaction codes will stand out and can be eliminated from consideration. The total number of observations recorded can be compared with the number of observations planned to be sure the results will have the reliability planned.

It is advisable to check the number of observations taken each day. With proper randomness of sampling, it will be found that each clerk in each day will have approximately the same number of observations. If there is a wide variation, the randomness of the sample may be suspect.

The basic data of the stopwatch study is usually a time sheet or sheets for each clerk. These sheets will require that manual calculations be made if the continuous method of timing has been used. The snap-back method, if used, will require less arithmetic. The results of the observation technique are somewhat akin to the data of the stopwatch except that generally only transactions and possibly major operations within the transactions have been timed. The data will require subtractions and additions although it is quite possible that the analyst has made these while he was sitting with the clerk waiting for work or during free-time which the clerk may have had.

The basic data of the self-reporting technique includes "a time-ladder" for each clerk for each day of the study. These time-ladders will indicate the codes against the times of the day, and possibly the work counts. It will be necessary for the analyst or his assistant to go
through each time-ladder to calculate the time spent on each transaction each day by each clerk.

**SUMMARIZATION AND DETAILED ANALYSIS**

Work Sampling. In the use of the Work Sampling technique where IBM Tabulating equipment has been used, actual summarization is a machine function and requires little or no time from the analyst. Thus, the analyst is free to carry on his prime function, namely, the analysis of the information which he has obtained. There are two generally employed methods of calculating unit times.

**Method 1**

1. Proportion the number of occurrences for each transaction to the total number of observations taken during the study.

2. Apply the ratios (obtained in (1.) above) for measured work, (i.e. transactions other than supervision, personal time, and idle time) to the total number of clerk minutes actually available during the study. The result is the number of clerk minutes spent on each transaction.

3. Divide the number of clerk minutes spent on each transaction by the number of cases of that transaction completed during the study. The quotients are the unit time for each transaction of measured work.

4. The ratios (obtained in (1) above) for unmeasured work
(i.e. transactions such as supervision, personal time, and idle time) can then be used to evaluate such questions as whether the percentages of time spent on personal activities, idle time, supervision, and training are in line with company policy or the requirements of the particular work situation. If these activities are not in proper proportion further investigation will be necessary to correct the situation.

Example:

Assume that the study has been set up to measure five transactions, A, B, C, Personal, and Idle. A total of 1,000 observations were taken during the study of which 400 were of A, 100 of B, 200 of C, 200 of P, and 100 of I. A total of 20,000 clerk minutes were actually available during the study. The work count shows that 1,000 A, 2,000 B, and 1,000 C transactions were completed during the study.

<table>
<thead>
<tr>
<th>Transaction</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>(\frac{400}{1000} = 0.4)</td>
</tr>
<tr>
<td>B</td>
<td>(\frac{100}{1000} = 0.1)</td>
</tr>
<tr>
<td>C</td>
<td>(\frac{200}{1000} = 0.2)</td>
</tr>
<tr>
<td>P</td>
<td>(\frac{200}{1000} = 0.2) or 20%</td>
</tr>
<tr>
<td>I</td>
<td>(\frac{100}{1000} = 0.1) or 10%</td>
</tr>
</tbody>
</table>
2. Transaction
   A \[20,000 \times 0.4 = 8,000\) clerk minutes
   B \[20,000 \times 0.1 = 2,000\) clerk minutes
   C \[20,000 \times 0.2 = 4,000\) clerk minutes

3. Transaction
   A \[8,000 \div 1,000 = 8\) minutes
   B \[2,000 \div 2,000 = 1\) minute
   C \[4,000 \div 1,000 = 4\) minutes

4. The ratios for Personal and Idle time indicate 20% and 10% respectively. This means that 30% of the time of the unit measured is spent unproductively which would indicate that an investigation of the causes for this is necessary.

Method II

1. Proportion the number of clerk minutes actually available during the study to the number of observations taken. The quotient is a factor representing the time value of one observation.

2. Apply the time value for one observation to the number of observations taken for each transaction. The result is the number of clerk minutes spent on each transaction.

3. Same as Method I.

4. Same as Method I.
Example:

Assume the same situation as that in the example under Method I.

1. Total Clerk Minutes = \frac{20,000}{1,000} = 20 \text{ minutes/observation}

2. Transaction
   
   A  \quad 400 \times 20 = 8,000 \text{ clerk minutes}
   
   B  \quad 100 \times 20 = 8,000 \text{ clerk minutes}
   
   C  \quad 200 \times 20 = 8,000 \text{ clerk minutes}

3. Same as Method I.

4. Same as Method I.

If the data has been broken down by clerk, it is possible to compare individual clerks with the averages which are the result of the unit time in the section. True, these results on individual clerks will not be within the same close tolerances as the total for the section; however, if a study has been set up to provide close tolerances for the section then the allowable tolerance of each clerk will not be so great that a definite indication cannot be found of possible trouble areas. If these are found, a close investigation could be made of the individual clerks. It is, of course, possible to take sufficient observations to give very close tolerances for individual clerks, but usually this is not necessary in a Work Sampling study, although it may be done to check actual performance of the particular clerks. It has been found that checking back on the clerks in the summary is often advantageous.
In one particular study,* the unit times were rather large compared to what had been expected. By checking individual clerks in the summary, it was found that personal time ranged from approximately four percent to approximately thirty-five percent. It was also found that the clerks who had the largest percentages of personal time also had the smallest unit times for their transactions, and that the clerks who had the smallest percentages of personal time also had the largest unit times for the transactions measured. This seemed to indicate that observations were improperly made. It was later determined by observation that those clerks who had a large percentage of personal time in the study, had, upon completing their work, turned about and talked or did other things which would be considered non-productive work. Whereas, those clerks who had a small percentage of personal time in the study were spending time holding completed cases in front of them as they daydreamed, or read books under cover. This situation would not necessarily have occurred if the observers in the study had moved about among the clerks and had noticed the books and the obvious daydreaming.

In such a case it is often a question of whether the entire study should be discarded or not. However, the work necessary to check the individual clerks in the summary required approximately an hour or two, and was a very small investment to determine that the results of the study of the section were most unlikely to be used to

* 9
set standards.

Also, by checking back on the individual clerks in the summary it may be possible to discover that one or two clerks are flukes, and that either there were times when they had much more work than the average, or that they have worked on only one transaction. This may be the result of improper planning in that the trainees were not excluded from the study, or that the trainees did all one type case, or that individual specialties had developed within the group and the one clerk does one particular type of case only. This may or may not have an effect on the results of the study and will probably require further investigation or subjective judgment.

Since it is impossible, or almost practically impossible, to measure transactions which do not have noticeable physical differences using the Work Sampling technique, the results of the Work Sampling study may be in very broad classifications of transactions, which in some cases may not be enough for a particular application of work standards. Thus, in a situation in which three transactions do not have physical differences noticeable from a distance of ten to fifteen feet, but which actually involve different unit times, are included in the work of a section, all three will be averaged together in the Work Sampling study to obtain one standard for the three transactions. If management wishes to have these transactions given separate standards some other technique must be devised.

Thus, if a group of clerks checks forms which vary in content and in location of information, but these differences are not
noticeable from any great distance, the result in the Work Sampling study will probably be that all these cases will be placed under one transaction. This may not be desirable if the checking involved six forms each having a different unit time. If management wishes the information for cost purposes, it must average the cost per case if the Work Sampling technique has been used to set the standard, and not the individual costs for the separate types of cases or transactions. This is one draw-back of the Work Sampling technique which, at the present time, cannot be avoided without using special tags and tabs to identify the work. These tags might slow down the work and cost more than will be saved as a result of the study.

One of the definite advantages of Work Sampling, if tabulating equipment is used, is that the entire summarization and detailed analysis of the study can, even for a large study, be accomplished in no more than a few days. This is because size has very little to do with the summarization under these conditions.

**Self-reporting.** Since under the best conditions when the self-reporting technique is used, data are recorded on forms which have times set up by minutes and the clerk has but to draw a line at the start and finish of times spent working on any one transaction and write the code for the transaction, the time for analyzing and summarizing these time-ladders can be considerable, as well as creating undue eyestrain. The analyst must first collect the time-ladders, take each time-ladder and subtract or add the number of minutes spent on each transaction. Since transactions are quite likely to be interrupted by
other transactions, the transaction coded letter A may appear in ten or maybe fifteen different places in the work day. The analyst must count the number of minutes spent on transaction A and note them on a separate sheet, and has to do this for each transaction for each time-ladder for each clerk. It is also customary with this technique to note the average for each clerk each day, and for each part of the day. In this manner, the analyst supposedly is in a position to discard those times which seem exceedingly long or exceedingly short for various reasons.

These variations can occur quite frequently in the self-reporting technique. A clerk who is working on transaction A may be interrupted for a few minutes by friends coming over to talk. He, quite inadvertently, may not note this time on his time-ladder. Thus, there are several minutes added to the time taken for the transaction on which he is working. The analyst attempts to eliminate these times or at least to note them for later discarding if the picture does not seem to require that they be included. To determine this information, sub-summaries are frequently required. This must all be done manually requiring extra time. However, in this manner the analyst is often-times able to discover poor performance, or incorrect recordings which would be difficult to determine unless a day-to-day check is made of the time-ladders. On the following day observations are conducted on the clerk or clerks who have become suspect. Detailed analysis of each clerk for each day is completely possible, although there may be suspicion concerning the basic data with which the analyst must work.
After noting the time spent on each transaction each day by each clerk, which in itself is a great labor, the method usually employed is to array those times and the frequency of occurrence for each transaction. Then, normally, either the extremes would be discarded or kept, but normally they will be discarded. Then the mode or the mean of the observations under consideration will be taken as the unit time. Of course, this may or may not have basis in fact as far as reliable accuracy goes, but in many work situations in the clerical field, it is considered sufficiently accurate for setting standards.

Stop watch  The stop watch technique has the advantage over the self-reporting technique of insuring basic data that has been obtained by the analyst and therefore, depending upon the quality and qualifications of the analyst, will be less open to question than the basic data provided by the self-reporting technique. Normally, the various time readings on the clerk for each transaction will be noted and if there is wide deviation they would be questioned as to the whys and wherefores of these deviations. Since no one person is likely to perform each time at exactly the same pace, deviations naturally are to be expected. Since more than one clerk has been timed, it is possible to compare this information, also, if the clerks have been performance rated the data can at this time be compared generally against the times actually noted. Then it is customary to take the mean, median, or mode of the observations as the unit time. Since the number of observations taken under the stopwatch technique is usually small, at least in relation
to the number taken under the self-reporting technique, the summarization time required will be proportionately smaller.

The analysis under the stopwatch technique will provide much finer distinctions in transactions than the Work Sampling technique. If there is a small difference between transactions, these transactions are measurable with the stopwatch technique since the analyst is observing but one clerk and is standing close enough to the clerk that he is well able to notice small differences which might define transactions. Thus, as fine a distinction between transactions as is required can be noted. With the stopwatch the analyst is also capable of timing transactions which may be so small as not to be timeable using the observation or self-reporting techniques. This may be of importance from several points of view including costing and later changes in the work method.

Observation The observation technique of work measurement will give approximately the same results in summary and detail analysis as the stopwatch technique except that the timings will normally not be carried out to such fine points of distinction. However, especially in work of rather routine nature, where cases come in large bundles and a clerk may work on the same transaction for relatively long periods, it is possible to get unit times down into very small fractions of time. Normally, the basic data of the observation technique are in the form of recordings of elapsed time and the number of cases completed during the time. The calculations involve dividing the time by the number of cases.
Since each clerk timed may have many such periods of time for each transaction, each is calculated separately. Then all time spent on each transaction is combined and divided by the total number of cases of that transaction completed. The analyst then must determine whether the general average, or the median or mode of the separate readings will be used as the unit time.

The analyst, since he was not timing small elements, should have been able to determine the clerks performance to a close percentage, thus enabling him to determine reasonable standards.

**Synthetics** The synthetics or standard data technique of work measurement can give information concerning very small differences in the work since normally synthetics starts with the smallest measurable elements and builds them up into a transaction. This is an almost complete difference from the Work Sampling technique. The Work Sampling technique starts looking at the entire picture and comes down to individual unit time, the synthetics technique starts with the smallest measurable element and works outward to the unit time per transaction. The actual analysis in synthetics must be done before the times are brought into the picture. It is necessary that a minute analysis of the transaction be made in order to apply the elemental times. Since very little has been done in the use of synthetics as applied to those transactions which require a thought process, and since it is not oftentimes economical to develop elemental times for transactions which are not done in large numbers or are not more or less on a mass production basis, synthetics is a limited field.
The results of the Work Sampling technique can be calculated as to accuracy and reliability*. Thus, presuming that the study has been properly set up and the observations made without unintentional bias having been introduced, the results of the study fall within known tolerances or limits. The results of all work measurement techniques are subject to certain inaccuracies, and the reliability will fluctuate within certain limits. However, the Work Sampling technique is the only work measurement technique which commonly makes use of formulae to determine the degree of accuracy of the tolerance which must be expected, and of the unit times developed. True, this could be calculated for the stopwatch study*, however, this method of calculating the possible statistical error in the stopwatch is new and rarely used.

Assuming a Work Sampling study was set up on the basis that the least time-consuming transaction of the section would require ten percent of the time with allowable tolerances of plus or minus ten percent. If the study should show a transaction requiring five percent of the total time of the section, it is possible to calculate the tolerance within which the true percentage of this transaction would range. It is already known (from the planning stages of the study) that transactions requiring ten percent or more of the total time will have tolerances of ten percent or less (the tolerance percentage decreasing as

*2 pp. 81 - 100
*8 pp. 154 - 163
the transaction percentage increases), the problem remains of determining the tolerance percentage for the unexpected five percent transaction. Generally, discovering a five percent transaction indicates that the original estimates of transaction percentages was faulty.

The formula is as follows:

\[ R = \text{The precision interval (Allowable tolerance)} \]

\[ \sigma = \text{The sample reliability} \]

\[ P = \text{The percentage of total time required for the transaction which actually is found as the result of the study.} \]

\[ N = \text{The sample size (number of observations)} \]

\[ R^2 = \sigma^2 \left( \frac{1 - P}{PN} \right) \]

Example:

Assuming, as above, that:

\[ \sigma = 1.3 \]

\[ P = 5\% \]

\[ N = 2000 \text{ observations} \]

Then:

\[ R^2 = \frac{(1.3)^2 (1 - 0.05)}{(0.05)(2000)} = \frac{1.69 (0.95)}{100} \]

\[ = 0.016055 \]

\[ R = \sqrt{0.016055} = 0.1267 \]

\[ R^* = 12.7\% \]
Thus, the true percentage of the five percent transaction is somewhere between 4.37 and 5.62 percent.

\[
0.05 \times 0.127 = 0.00625 \\
0.05 \times 0.0062 = 0.0056 = 5.62% \\
0.05 \times 0.0062 = 0.0437 = 4.37%
\]

In actual practice no other work measurement technique offers this possibility of determining the accuracy and reliability of the results. This ability to state the accuracy and know the accuracy and reliability of the results plus the fact that the study has included all clerks working on the transactions over a period of time is a very good selling point for the Work Sampling technique when the standards have been derived.

The self-reporting technique will be as accurate as the clerks themselves will wish to make it. Thus, if clerks have been inaccurate in recording their activities, or the times required for these activities the results will be completely inaccurate. True, constant observation of the clerks and obtaining their cooperation will result in a closer accuracy than might otherwise be expected, however, it is almost inevitable that many small distractions from the work will never be included in the "time-ladder."

The synthetic or standard data technique of work measurement will be as accurate as the analysis of elements going into a certain transaction. This requires a very fine description of the method employed, and the inclusion of any surrounding conditions which may change the degree of the element.
The observation technique offers the possibility of determining the picture of what one clerk is doing at any time, however, the accuracy and reliability, while often considered sufficient for clerical procedures early in a work measurement program, leaves much to be desired.

**CHANGES IN STANDARDS**

In the event that the work mix of a section changes after the work measurement study has been conducted the Work Sampling technique will offer certain problems, since transactions to be measured must have observable physical differences. In this case more transactions must be averaged under one work standard because observers could not distinguish between the transactions. This average standard is satisfactory until there is a radical change in the work mix. When this change in work mix happens a new work measurement study must be conducted to set a new average standard for the transactions involved. An example of this situation follows.

Assume that a section works on two transactions, A and B. At the time of the Work Sampling study twenty percent of the work of the section is transaction A, eighty percent is transaction B, and five thousand cases are received daily. Actually, transaction A requires three minutes per case and transaction B requires one minute per case. There are no observable physical differences between transactions A and B so an average standard of 1.4 minutes would be set since both transactions would be one transaction during the study.

If the work mix should change so that transaction A is eighty
percent of the work and transaction B is twenty percent of the work, the previous standard of 1.4 minutes per case would no longer be valid since the new average standard must be 2.6 minutes per case.

Using the Work Sampling technique the average standard only is known, and a constant check on work mix is necessary so that a new study can be made with each change.

The Work Sampling technique does not measure the elements of a transaction, only the entire transaction. If the method of doing the work is changed and some steps are eliminated or added, a new study must be made.

These disadvantages are not necessarily serious since a re-study generally is not as difficult nor as expensive as the original study.* Much of the planning can be eliminated, the observers are familiar with the work to be observed, and in many cases the original observation mark sense cards can be re-used.

In the self-reporting technique, the clerks themselves are aware of the distinctions between transactions and thus can record transactions as finely as desired. In this manner a separate work standard can be established for each transaction. Hence, a change in the work mix does not require a re-study. This technique does not measure element times so any change in the method of performing a transaction will probably require a re-study. This re-study need concern

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itself only with the transaction which has changed, hence will require little time.

The stop watch technique allows the analyst to distinguish between transactions regardless of the minuteness of the differences between them. This results in individual standards for each transaction so that a change in work mix presents no problems. This technique can be used to measure many elemental times and can therefore, in many cases, allow an adjustment in standards without a re-study when the method of doing the work is changed.

Like the stop watch technique the observation technique allows the analyst to establish a standard for each transaction. Unlike the stop watch technique it rarely allows the analyst to measure elemental times, and hence generally requires a re-study to adjust standards if a method change occurs.

The synthetics technique, being based on element times, allows for adjustments in the standard when methods changes occur.

**GENERAL COMMENTS**

Although the Work Sampling technique will give standards of known reliability within known tolerances, and its data are relatively easily and quickly summarized, its real advantage is that it gives an overall picture of a section.* The other work measurement techniques give segments of the overall picture, from which the overall situation

* p. 31
may be surmised, but Work Sampling eliminates the suppositions. By showing that percentages of the time are spent in various non-productive activities (or, more often, inactivity) the Work Sampling technique informs management where it must improve.
CHAPTER IV

POSSIBLE IMPACT

Formal work measurement programs, and more especially programs employing the Work Sampling technique, have become well established in the clerical field only within recent years. As a result, the effects of Work Sampling as a work measurement technique cannot be fully evaluated. There are, however, sufficient implications and indications to determine certain aspects of the possible impact of Work Sampling when used as a work measurement technique.

Work Sampling as a work measurement technique would seem to have an impact on three groups.

- Clerks
- Work measurement personnel
- Management

The impact of the use of Work Sampling will be different for each group, although the effect on one group could react on one or both of the other groups. For instance, if the clerks are happier, the work of the analyst is easier, and management will probably have fewer personnel problems with which to contend.

In a series of forty-three work measurement studies in which the Work Sampling technique was employed the reactions of the
clerks were carefully noted by the analysts. After the studies had been completed the analysts, clerks, and section supervisors involved were interviewed to determine what, if any, reactions they had to the use of the Work Sampling technique. Approximately thirty of the studies were conducted in sections which had previously been work measured by either the self-reporting, the observation, or, in a few cases, the stop watch technique. Several of the sections had previously been measured by two or all three of these techniques. The current portion of this paper will set forth the general results of these observations and interviews as well as the possible implications of these results.

**CLERKS**

It appears that a prime necessity of using the Work Sampling technique in work measurement studies is that a complete, full, understandable explanation of what is to take place and the reasons for its taking place must be given to the clerks involved. In using the stop watch and, especially, in using the observation techniques the analyst is afforded ample opportunity to answer questions during the study. He can easily overcome a poor initial general explanation given to all the clerks. While timing one clerk he can explain the technique, how it is used, and why. This clerk, later is able to en-

# These studies were developed and directed by the author and form part of the source material for this paper.
lighten other clerks in the section and, if all goes well, all clerks eventually will understand what is being done.

In using the Work Sampling technique no clerk is given individual attention so all information must be given in the explanations before the study begins. Many of the problems clerks believe Work Sampling produces are the result of poor or erroneous explanations which gave the clerks wrong impressions. If the explanation is faulty, many clerks, when part of a group, do not realize that the explanation leaves room for questions, or are either disinterested or even afraid to ask questions of the analyst at the time. The faulty or poor explanation may leave the clerk with the feeling that something underhanded is going on, or that he is being engulfed by some inhuman, "scientific" method of spying on him. There is little chance of re-explaining away these impressions since there is little likelihood of later personal contact between observer and clerk.

The majority of clerks seem to prefer that at least some of the observers be known to them. It was found that utilizing such people as the section supervisor's secretary, assistant section supervisors, and former fellow clerks who were assigned to other sections or to staff work at the time of the study as observers aided the general conduct of the study as well as gained the appreciation of the clerks. The utilization of observers known to the clerks enabled the clerks to ask questions during luncheon and official work breaks. The clerks were more likely to believe their friends than the analyst who explained the study beforehand. The utilization of these persons
gave them a better understanding of work measurement and Work Sampling
which in turn was transmitted to the clerks.

The use of Work Sampling tended to prevent the clerks from
becoming nervous or upset as might have been the case if the observa-
tion technique or stop watch technique had been used. The feeling of
being "clocked" was not so noticeable and the feeling that everything
must be done faster than usual was not present as with the timing
techniques. The feelings of nervousness and tensions were almost com-
pletely eliminated when known persons acted as observers. The Work
Sampling technique gave the clerks a feeling of normalcy during the
study, a feeling which only the self-reporting technique approached.
This feeling of normalcy seemed to take effect one or two hours after
the study had started. The clerks' curiosity had usually subsided by
that time. The use of known persons improved the feeling of normalcy
even beyond that given by the self-reporting technique. These factors,
the feeling of normalcy and avoiding nervousness and tension, were espe-
cially noticed among the older clerks, and especially those who had
had experience with the stop watch technique in the past. These con-
ditions resulted in the clerks' conducting themselves as they would
in a normal day, neither slowing down nor speeding up, but rather
spending the usual amounts of time on personal time and other non-
productive work.

The use of the Work Sampling technique also eliminated the
feeling of being timed for which many clerks had a dislike. In many
cases clerks had associated stop watches and timing with factory
machine operations, and considered that the use of the stopwatch techni-
ique and, to a lesser degree, the observation technique treated them as machines. This reaction can have a bad effect on morale. When the Work Sampling technique was used for work measurement the clerks did not even consider the thought of being likened to machines.

Many of the clerks who had been selected for timing in prior studies employing the stopwatch or observation techniques had had misgivings about being selected. The clerks felt that being singled out for timing put them in an awkward position. Many who realized that they could do their work faster than many others experienced worry about being held out by other clerks as the pace-setter. This had happened to clerks who were considered "average" workers in sections which also included much slower or lazier clerks. The standards had been set on the basis of the "average" clerks. The slower or lazier clerks either had to speed up or received call-downs from their supervisors. This had sometimes led to the group's turning against the pace-setters. Even in cases where this did not occur, and was unlikely to occur, many clerks still felt uneasy about being selected for timing. Some of the clerks felt that when they were selected for timing they were on exhibition for all to see, especially their supervisors. These clerks did not care to have a record kept of the time they spent working and not working.

Another group of clerks felt left out if they were not selected for timing. These clerks seemed to feel that there might be some honor or distinction to being selected for timing and, thinking
that they were as good as the clerks being timed, felt that they were being neglected or left out. When the Work Sampling technique was employed both the clerks who did not want to be timed and the clerks who did want to be timed felt better. Since all clerks were included no one felt left out; no one felt that all eyes were on him, and no one feared being regarded as a pace-setter.

Although exceptionally difficult cases may, in actuality, occur only rarely, most clerks remember them and place emphasis on them out of all proportion to reality. Regardless of whether their importance in the work was actual or imagined, most of the clerks felt that a time study of a few hours or a day on a few clerks might easily miss these cases. The reasoning was that if the time study missed these difficult cases the standard would not be realistic. When Work Sampling was employed as the work measurement technique, especially if the study lasted a week or longer, most of the clerks were satisfied that the difficult cases had been included in the work measured.

Indications are that, if the Work Sampling technique and work measurement are properly explained to clerks, many of the potential personnel problems associated with work measurement programs can be eliminated. The use of Work Sampling as a technique of work measurement offers great possibilities for wide clerk acceptance. Since many companies hesitate about installing formal work measurement programs because of a fear of upsetting the clerical personnel, the clerk acceptance possibilities of the Work Sampling technique
may well provide the necessary means of overcoming many of the objections to installing work measurement programs in much of the clerical field.

**WORK MEASUREMENT PERSONNEL**

The taking of observations to gather the data in the Work Sampling study does not require the services of trained analysts. In many studies supervisors, secretaries, and clerks from sections other than the section being work-measured have acted as observers.* One of the principal advantages of this utilization of non-analysts is that trained analysts can spend more of their time on methods improvement and in establishing work standards in areas where other work measurement techniques are deemed more suitable. Another advantage is that standards can be established in more sections of a company more quickly.

The Work Sampling technique requires only that the observer knows the transactions being measured and the codes for these transactions. Observers can be trained in a few hours, the actual time depending upon the number of transactions and the degree of difference between them. True, these observers may know little about the theories behind work sampling, and will be trained only to take observations, but this is sufficient in most cases. In fact, these robot-like observers will probably introduce less bias into the sample.*

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Experience seems to indicate that observers have a limit of perhaps two hours or so before they should be relieved for from fifteen to thirty minutes rest.* The endurance of the observers depends upon the density of observations, the physical layout, and the ease of distinguishing transactions. After a time fatigue sets in and the observations tend not to be recorded on time, to be noted incorrectly, or non-existent work codes tend to be recorded. Since spare observers should be on hand to trace down any information which the observers may require, the need for shifting observers does not impose any extra personnel requirements.

The need for having extra observers on call or present to act as reliefs does not pose a problem since observers are easily trained and hence observer material should be plentiful. In several of the forty-three studies persons already familiar with the work being measured were trained in as little as thirty minutes, although persons not familiar with the work required up to eighteen hours in a few cases.

Analysts are required to make the preliminary analysis and preparation for the Work Sampling study as well as to analyze the data, but tabulating machinery and non-analyst observers can eliminate all routine work and the taking of observations. If the Work Sampling technique should be used on a large scale, a relatively small number

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of analysts could institute standards on a company wide basis in a relatively short period of time.

The collection of data for the observation and stop watch techniques require that the analyst observing the work be skilled and well trained if the study is to be a success. In addition, the analyst must, in many cases, possess the abilities of a diplomat.

In many areas, local management is fearful of arousing clerks in any way whatsoever. This attitude may stem from the present shortage of clerical help, local management's lack of managerial ability, or company personnel policies. When employing the observation and stop watch techniques in a section whose management has this attitude, the analyst must always be on guard against antagonizing any clerk. A chance remark in an unguarded moment or a remark that was misunderstood by an unfriendly clerk has stopped several work measurement studies or at least caused long delays while good relations were restored. When such a situation develops the analyst usually suffers in the eyes of management. He is held accountable for causing any furor, and may be barred from the area by local or company management with bad effects on his professional status in the company. Many analysts feel that the Work Sampling technique helps greatly in avoiding such problems.* In some situations Work Sampling has been employed where management feared personnel trouble. The analysts experienced no trouble in areas from which previous analysts

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had been barred.*

Some local managements feel that a work measurement study will interfere with their clerks and cause a drop in production during the study. Since the Work Sampling technique does not require any interference with the normal routines of the clerks it has allowed analysts to overcome this objection. Once local management has been convinced that a Work Sampling study will not interfere with the work, wide areas have been opened to work measurement.** The analyst may well find that "selling" a proposed study is easier when Work Sampling is to be employed.

"Selling" the standards resulting from a Work Sampling study can be easier than selling standards resulting from other techniques. Once the management understands the Work Sampling technique, the standard is usually accepted as is.*** The basic problem is to explain Work Sampling properly. Once it is explained, all standards developed through Work Sampling for the same management are almost automatically sure of acceptance. This has been found to be true, in many cases, because there are no judgment factors involved. With no judgment factors involved, the results represent facts which, if the planning and preparation of the study have been done properly, cannot be denied. The results are known to have a certain validity
and to fall within certain tolerances. These factors tend to make life easier for the analyst.

Indications are that the Work Sampling technique will, where employed, release analysts for less routine work. The use of the Work Sampling technique can aid the analyst to avoid situations created by personality conflicts and suspicious managements. The "selling" of a standard resulting from a Work Sampling study promises to be easier, which will release the analyst from long periods of preparation for "selling" and from the frustrations of not "selling" his standards.

MANAGEMENT

When tabulating machines are utilized to set up the observations required for, and to summarize the data developed in, a Work Sampling study, and low level observers are employed, management may well achieve the objective of installing standards over a wide area at less cost than is possible using other work measurement techniques. This factor may lead to an increasing interest in work measurement programs in the clerical field.

Since it can be used to measure only transactions with obvious observable physical differences, and only these differences need be known, the Work Sampling technique does not require as complete a methods description as other techniques of work measurement which differentiate between transactions regardless of the obvious-
ness of the differences between them.* This characteristic of the Work Sampling technique can save analyst time and allow standards to be established at less expense.

Of course, a detailed method description should be written whenever final work standards are set, but Work Sampling does offer a relatively rapid and inexpensive means of establishing interim standards. There are circumstances under which these interim standards are desirable even though the work methods and procedures in use could be improved. In these situations a detailed method description is not necessary and maximum advantage can be obtained from Work Sampling.

These studies can also serve to define the problems requiring later attention. Thus management has in the Work Sampling technique a tool for setting interim standards which at the same time indicates the areas of first importance for methods and supervisory improvement. The result of having this tool may well prod some managements into pushing a formalized procedures improvement and work measurement program.

The fact that the standards resulting from a Work Sampling study depend less upon human judgment than other techniques of work measurement leaves management less open to criticism. With less likelihood of personnel troubles, management in the clerical field has one barrier to a work measurement program removed.

* 2, p. 37
It may develop that exposure to the Work Sampling technique may arouse interest in quality control programs and work control programs.\* Once supervisors understand the theory behind Work Sampling and have seen concrete results of its accuracy, quality control programs based on statistical sampling seem to be easier to "sell". In fact, in more than one instance section supervision has instituted its own quality control program after being exposed to the Work Sampling technique.** Some supervisors have applied the principles of Work Sampling for supervision purposes.*** By observing clerks randomly and recording these observations there is no need to rely on impressions in deciding upon who are good workers and who are not. This arousal of interest may offer possibilities for improving supervision.

The Work Sampling technique has been used successfully in measuring the work of jobs previously thought to be unmeasurable such as maintenance work.**** Indications are that success can also be expected in some jobs requiring thought processes and in other non-routine work.***** If this can be extended into wide usage, management will gain a better control over its work. This is especially true of the clerical field where much of the work has been difficult to measure because of its non-routine or thought-process nature.

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As with any new possibility, management must exercise care with the Work Sampling technique.* After a few work measurement studies employing the Work Sampling technique have been successful, many analysts may look upon it as a panacea. With this attitude they may launch into Work Sampling studies without proper preparation or may make observations in a slipshod manner. After a few Work Sampling studies have failed the analysts may decide that the technique is no good after all and thereafter ignore the technique.

The Work Sampling technique of work measurement is not a panacea but it may well offer many long range possibilities to management.

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CHAPTER V

SUMMARY AND CONCLUSIONS

Work Sampling is a work measurement technique based upon the statistical laws of probability. The basis of these theories is that if a sufficiently large random sampling of an action or group is taken, what is true of the sample will be true of the group to a determinable degree. By estimating the least element (or the least element which it is desired to measure) the number of observations in the sample can be calculated. If the study indicates a least element other than that anticipated, the reliability and tolerance of this element can be calculated. By applying Work Sampling to work measurement, standards of known reliability, lying between known tolerances can be obtained. This is the only work measurement technique which supplies such information so easily accomplished.

Proper preparation for the Work Sampling study is most necessary because the success of the Work Sampling study is dependent upon the proper sample size and the randomness of the same. These factors must be determined in addition to the factors which are associated with the preparation of any work measurement study.

The utilization of tabulating machines, and especially tabulating machines capable of "reading" mark sense tabulating cards, is a
prime factor in making large scale Work Sampling studies feasible. Without these machines the preparation and summary of the data obtained in the study would be excessively time consuming and expensive.

Once the Work Sampling study has been prepared and started, it cannot be altered in any way without jeopardizing the results. Thus, once planned, the technique becomes inflexible.

The Work Sampling technique can be used to measure only those transactions with observable physical differences. The only possible way to measure transactions without these differences is to rely upon the clerks being measured to display signs indicating on what transaction they are working. This method requires a high degree of clerk co-operation to be successful.

Those transactions which do not possess observable differences must be grouped under one transaction for measurement purposes. The result of this is that, should the work mix change, a re-study is required to establish a new general or average standard for the transactions involved.

It is not feasible to performance rate for individual observations when using the Work Sampling technique, since this would introduce an unknown bias into the sampling and destroy the reliability of the results. This is not too important since, at present, the efficiency of most clerical operations can be vastly improved by improving procedures and methods.

The Work Sampling technique practically eliminates personal contact between observers and clerks, and, hence, the possibility of
personality conflicts. At the same time, this elimination of personal contact requires that a clear, understandable explanation of the study and its purposes be given to the clerks before the study begins in order to insure their co-operation.

Although, in theory, the observations of the Work Sampling technique can be taken from a fixed point, in practice it has been demonstrated that the observers must move among the clerks to insure accuracy. Moving among the clerks also aids in keeping the observers alert.

Taking observations over prolonged periods results in inaccurate recordings of observations. To overcome this it has been demonstrated that observers should be relieved every one to three hours. This does not present manpower problems since most persons with normal eyesight can be trained as observers in from one-half to eighteen hours, depending upon previous experience and the extent of information it is felt necessary for them to acquire.

The utilization of non-analyst personnel as observers has produced some advantageous side effects. When personnel familiar to the clerks are utilized, any traces of antagonism or non-co-operation are removed. Many non-analyst observers gain a better understanding of work measurement and, hence, usually cease any resistance to the work measurement program. If supervisors are employed, they, in many cases, become more conscious of what is going on in their sections, and some develop interest in other applications of the probability theories, such as quality control. One of the principal effects of
utilizing non-analyst observers is that analysts are released from routine duties to concentrate on procedures and methods improvement.

The Work Sampling technique has been used successfully in situations previously thought to be unmeasurable, or at least impractical to measure. These include some thought-process requiring positions as well as many maintenance positions.

Indications are that the Work Sampling technique has overcome many objections which clerks have had toward other work measurement techniques. Work Sampling does not single out individual clerks as "pace-setters", nor does it give people the feeling of being "clocked".

Work Sampling does not interfere with the clerk's work, and so has overcome an objection sometimes put forth by local supervision against other work measurement techniques.

The greatest advantages of Work Sampling as a work measurement technique appear to be; that it gives an overall picture of a section indicating where methods and procedures, as well as supervision, improvements are required, and its objectivity. The avoidance of subjective factors in the setting of work standards appeals to both clerks and management.

The greatest disadvantages of Work Sampling as a work measurement technique appear to be; that it requires observable physical differences in order to establish work standards, and that it loses some of its simplicity and ease of use since work standards require a written
detailed methods analysis which Work Sampling does not require in order to function.

FUTURE OUTLOOK

Work Sampling is not a panacea; it is not the perfect work measurement technique. Other work measurement techniques have not become obsolete with the development of Work Sampling as a work measurement technique. Synthetics remains the preferable technique for evaluating non-existent transactions and the effects of contemplated methods changes. The stop watch and observation techniques provide finer breakdowns of standards than Work Sampling, and do not require that transactions have observable physical differences to be measurable.

The Work Sampling technique offers excellent possibilities for establishing interim work standards quickly and inexpensively. Combined with the Work Sampling technique's attribute of indicating where improvements should be made, interim standards appear to be an excellent starting point for a work measurement program. The Work Sampling study would allow interim standards to be set as well as indicate where methods, procedures, and supervision improvements should be made. The interim standards would give many of the advantages of regular work standards, and a program of improvement could be established, giving priority to those areas indicated as requiring immediate attention. After the methods and procedures and supervision have been improved regular work standards can be established. Later, Work Sampling studies could be made to determine that the work situations
have not altered. This type of approach would serve to eliminate the "dike plugging" hit-or-miss programs often used today. Such a program would probably not be feasible before the development of Work Sampling as a work measurement technique.

Wide employment of the Work Sampling technique and non-analyst observers should allow analysts to spend more time on methods improvement. Having areas requiring improvement indicated by the Work Sampling studies should further increase the methods work time available. In this manner an increase in general efficiency should come about.

The Work Sampling technique offers possibilities of wide clerk and supervisor acceptance. This could well lead to wide spread use of Work Sampling as a means of determining local trouble spots, and merit rating clerks.

There are already indications that the Work Sampling technique is becoming increasingly popular to measure previously "unmeasurable" positions. Future refinements and experimentation may prove that Work Sampling can be used to measure many thought-process involving positions. This would be a major contribution to work measurement in the clerical field.
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