Predetermined Time Values: A Survey of Chicago Companies' Experiences

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PREDETERMINED TIME VALUES: A SURVEY OF
CHICAGO COMPANIES' EXPERIENCES

by
Frank Robert DiGiovanni

A Thesis Submitted to the Faculty of the Graduate School
of Loyola University in Partial Fulfillment of
the Requirements for the Degree of Master
of Social and Industrial Relations

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1959
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A. **Nature of the problem:**

The American Arbitration Association has investigated the grievances over production standards that required arbitration in 1954. The results of this study indicate that of their sample of 1728 total cases that went to arbitration, one hundred seven (6 per cent) were concerned with incentive plans. Two hundred twenty-three additional cases (13 per cent) were concerned with job evaluation. However, "many of these disputes on the surface seemed to be job evaluation questions while in fact they were disguised requests for individual wage increases or adjustments of incentive rates."¹ This seems to indicate that incentive plans were actually responsible for an aggregate 19 per cent of the cases in their sample that were arbitrated in 1954.

Some labor leaders favor production standards as a means

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of measuring operator efficiency. This obviates the possibility of supervisors discharging indiscriminately on the basis of inefficiency. The president of a large Chicago local of the Electrical Workers expressed it in this manner: "The employer is entitled to a fair-day's work, but the union should see that the worker receives a fair-day's pay, in return. How they [employers] arrive at the standard is the company's prerogative as long as the worker doesn't have to break his back to meet it."²

A recent research study found: "Union officials are . . . unanimous in their insistence that time standards and work loads be determined bilaterally, either through joint union-management participation in the initial setting of standard production rates or through the grievance, negotiation and arbitration of changes in rates set by management."³ Dr. Gomberg (formerly a union spokesmen) feels that unions should participate in rate setting because the time study techniques in use today are unscientific.⁴

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² Information from a phone interview of the author with Mike Frank Darling, President Local 1031, International Brotherhood of Electrical Workers, July 28, 1958.

³ Clifford M. Baumbach, "Incentive Wage Problems in Collective Bargaining", Research Series, 14 (State University of Iowa, Iowa City, 1956), p. 3.

The evidence presented gives the reader an indication of the nature of the problems resulting from the setting of production standards.

B. The three aspects of wage determination:

Contrary to the belief in some circles,* work measurement is not the sole determinant of wages. In a measured-day-work type of operation, for example, work measurement is not the determinant of wages. This type of operation uses work measurement to determine the output for specific operations, in setting production schedules. However, the determined production standard should reflect a "normal working pace", since an accelerated (tight) standard would not be considered fair, and would undoubtedly bring complaints from the workers and their representatives. In practice, wages in this type of operation are determined by a combination of work measurement and job evaluation. Whereas, the incentive type operations have an additional aspect, incentive opportunity.

There are four commonly used methods of work measurement (the first aspect of wage determination). The first method is "measurement by estimates". Under this method, the foreman is responsible for determining the scope of the work as well as estimating the performance time based on

*This idea is common among a large number of management, engineering and union people.
his own personal judgment. The **second** method to arrive at a standard is "measurement by historical records". This method arrives at a standard "by comparing actual man-hours required on any job with a standard index based on average historical time for that type of work."\(^5\)

The refinement of production methods necessitated a refinement in the method of arriving at the production standards. In the early stages of the industrial revolution the designers did not work with very close tolerances. It was considered a "real accomplishment when they [designers] finally manufactured a 57" cylinder, true within the thickness of an old shilling."\(^6\) Subsequently, standards based on estimation or historical records were not compatible with the degree of refinement found in the more advanced type of production runs, since the inefficiencies that existed in the performance record or the mind of the foreman would have been perpetuated throughout the entire operation.

Frederick Winslow Taylor, the father of modern scientific management, is generally credited with introducing the stop watch as a means of refining the standard-setting techniques. This led to the **third** method of work measurement, the

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direct time study method. This method requires the analyst to determine, with a stop watch, the time required to perform a complete operation. This process is repeated for a number of complete cycles; all the observations are averaged out and this figure is reduced to a "normal time" by a rating process.  

"Rating is the process during which the time study man compares the performance . . . of the operator under observation with the observer's own concept of normal performance." 7 The direct time study method has been criticized because this rating factor is strictly in the mind of the observer. Obviously, the rating process is subjective and it may well be that it will cause inconsistencies in the rate setting process. These inconsistencies may adversely affect employee morale.  

The fourth method of work measurement is the standard-data method. This method requires the "breaking down of a job into its basic component parts." The component parts of all jobs are compared and grouped so that the same time is allowed for the same element each time it occurs. 8  

Whereas work measurement is a management technique to attempt to arrive at a fair-day's work, an attempt to determine a fair-day's pay uses the second aspect of wage determination,  

8 Heritage, p. 91.
job evaluation. "The main purpose of job evaluation is to furnish to management and to the employees a systematic and factual basis for the classification of positions and for equitable wage and salary payments on the basis of the kind, importance and difficulty of the jobs." It is the objective of job evaluation, therefore, to arrive at the relative value of the jobs in the organization. This relationship is established by evaluating the job requirements in areas such as education and experience; responsibility; mental and visual application; dexterity and accuracy, physical exertion, and working conditions. 9

In a measured-day-work type of operation it is apparent that work measurement is not considered to be synonymous with wage determination, since the production standard does not determine the wages of the worker. In this type of operation the pace of the work-flow is usually management controlled. The basic function of work measurement in these instances is to determine this pace. The failure of the worker to meet this pace may result in transfer or ultimately in discharge.

Incentive type operations use the third aspect of wage determination, financial incentives. The purpose of these incentives is to offer to the workers the opportunity to in-

crease their earnings by increasing their productivity. This increased productivity is accomplished by performing the operation at an accelerated pace, and in addition, the worker follows the motion pattern which has been worked out so that no time is lost. "This increased effort can only be expended appreciably if no skill is required to perform the operation."10

The importance of a sound system of work measurement in an incentive operation is quite apparent. For example, "loose standards" would result in additional remuneration with little increase in effort. Conversely, "tight standards" would deprive the worker of the additional compensation, to which he is entitled, for the additional effort that he exerted to meet the standard. Where standards have been set inaccurately, by estimation, historical records or direct time study, rate cutting by management may result. Consequently, it is not unusual for the worker to limit his production on a loose-rated job to prevent such management action.

In many cases employing an incentive system, it has been found that workers and their representatives tend to identify their wages with the production standard. This identification seems to exist most often in those instances where job evaluat-

tion has established such a low base rate that the operator is not required to exert much effort to meet it. This low base rate violates the basic principles of a sound incentive system, namely:

The basic wage should reflect the relative worth of the job in the company; work measurement should determine the time required to perform the operation, at a normal pace and incentive opportunity should be offered for increased effort only. Therefore, incentive operations and measured-day-work operations differ in so far as extra effort for additional earnings alone are concerned.

C. History of predetermined time values:

Frederick Taylor was aware of the inherent shortcomings of the direct time study method, for rate setting purposes. He envisioned the possibility of catalogued tables for certain motions based on years of stopwatch data. However, the development of the problem is credited to Taylor's contemporaries, Frank B. and Lillian M. Gilbreth.

The Gilbreths concentrated their efforts in the area of motion study. They developed a set of fundamental motions which they called therbligs (Gilbreth spelled backwards). It wasn't long before it was realized that there were few

11 Information from a personal interview of the author with Edwin Kousch, Director of Industrial Relations, Robert Nieminen, Manager of Manufacturing Services and William Ade, Manager of Industrial Engineering, Kellogg Switchboard and Supply Co., April 1, 1958.

12 Ibid.
differences between the Taylor and Gilbreth approach. These were reconciled, and they were combined in what is now known as methods engineering.\textsuperscript{13}

The Gilbreth approach was not discarded because of this reconciliation. It actually developed into the micromotion school. "Micromotion... is the study of the fundamental elements or subdivisions of an operation by means of a motion-picture camera and a timing device which accurately indicates the time intervals on the motion-pictures film."\textsuperscript{14} This micromotion school has developed fundamental tables of predetermined time values. The advocates of this approach contend that this method minimizes the error of human judgment considerably.

Whether the production standard is applied to a measured-day-work operation or to an incentive operation, predetermined time values must include certain allowances. The first allowance to be considered should be for personal time, fatigue and unavoidable delays. Time must be allowed for the personal needs of the employee. This may be allowed by granting organized rest periods, or it may be allowed by loosening the production standard proportionately.

Fatigue, an abstract term, is assumed to be the cause for

\textsuperscript{13} Karger, \textit{Methods Time Measurement Journal}.
\textsuperscript{14} Bernes, p. 15.
decreased productivity during the "last hours of the day", although no conclusive evidence exists that other factors may not be partially responsible. This allowance may be applied by loosening the standard thereby increasing the total time allowed for the operation. Unavoidable delay allowances to take care of downtime and other causes beyond the operator's control are applied in the same manner. Fatigue and unavoidable delay allowances will vary from operation to operation. However, these allowances can be arrived at by conducting all day time studies. Personal time becomes more subjective, since it attempts to determine the average time required for the personal needs of the worker.15

The predetermined time value plus the allowances for personal time, fatigue and unavoidable delays constitute a worker potential. Three additional allowances are generally made to compensate for the variance in the reaction time of the operator. One expert says, "I believe that any well-informed physician or physiologist will tell you that the body is a chemical engine. Every time you think, every time you see something, every time a muscle moves, an actual chemical reaction takes place. It seems that the chemical portion of these reaction times is constant but that the electrical time may vary depending upon the nerve centers

15Barnes, p. 368-371.
which may be affected."

Another area affecting the worker potential is the nature of the work performed. As the work cycle time decreases the operation becomes "more exhausting and more exacting". A failure, on the part of the operator, to maintain a constant pace may result in decreased production that can not be overcome. Whether or not the operation is wholly or partially a hand operation or a machine operation will also affect the operator's efficiency, since the mechanical contact tends to accelerate the operator's pace. Walter G. Holmes found that, "for difficult and fatiguing hand work, however, the will of the operator is the largest factor in the amount of activity successfully accomplished", and this will tend to decelerate the operator's pace. The social aspect of the work area is still another area affecting potential productivity of the worker. The affects of the interactions of all the individuals in the work group, as well as the physical characteristics of the work environment affect worker motivation.

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Consequently, with these three additional areas affecting worker potential, an additional allowance should be subtracted from the worker potential established by the predetermined time standard, thereby reducing it to a "normal" pace.

In actual practice the observer is required to record the method, motion by motion. Each of the motions has a value on the tables. The time is recorded for each element, and the total of all the elements is the time required to perform the operation. The advocates of predetermined elemental time values boast of a greater consistency, since the rating factor has been eliminated.

In addition, the advocates of predetermined elemental time values claim the number of grievances over production standards decrease, as the result of a more consistent and accurate method of rate setting. In this investigation, the author has attempted to check this claim and to find out if properly applied predetermined time values have resulted in decreased grievances over production standards.

The first formal predetermined system, Motion-Time-Analysis, was developed around 1925, and is still in use today. The second system of predetermined time values was the Work-Factor system. The initial research for this system was con-

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ducted in the early thirties. "Its first application was made at Radio Corporation of America, Camden, New Jersey in 1938."20 General Electric, Western Electric and Minneapolis Honeywell Regulator Companies followed by developing their own private systems of predetermined time values. During this same period Methods-Time-Measurement was introduced, based on research conducted at Westinghouse by the Methods Engineering Council of Pittsburgh.21

General Electric had developed two additional systems by the end of the forties. One of these was called Motion-Time-Standards and the other Dimension-Motion-Time. Nevertheless, up to this time only three independently evolved systems were available, Motion-Time-Analysis, Work-Factor and Methods-Time-Measurement. Basic-Motion-Times were developed from 1949 to 1951 by combining Work-Factor and Methods-Time-Measurement.22

Three different techniques were employed in developing these systems. The first technique was the acceleration-deceleration principle. This technique considers the increase in time required to perform a motion due to the acceleration required to start a motion and the deceleration required to

20 Ibid, p. 119.
21 Ibid, p. 119.
22 Ibid, p. 119.
step a motion. A. B. Segur's **Motion-Time-Analysis** is the foremost system employing this technique. 23

The **second technique** is the **average-motion principle**. This technique compensates for the increase in time required to perform a motion by averaging all similar elemental motions. The systems employing this technique are the captive systems of General Electric, Western Electric and Minneapolis-Honeywell--Regulator Company. **Methods-Time-Measurement** is the only independent system that falls into this classification. 24

The **third technique** is the additive method. This technique advocates the recognition of increased time required for the motion pattern by adding time for the difficulties encountered. The systems sponsoring this method are: **Work-Factor**; **Basic-Motion-Times** and the two captive systems of General Electric Company known as **Motion-Time-System** and **Dimensional-Motion-System**. 25

All of the independent systems of predetermined time values boast of a high degree of accuracy and consistency, irrespective of the particular technique they employ, yet

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23 Clifford Sellie, "Time Study without a Stopwatch", from a series of lectures (Standards Engineering, Chicago, 1958)

24 Ibid.

25 Ibid.
each group approached the problem of increased motion difficulty in a different manner.

D. Method of Approach:

The author attempted to determine overall company experience with, and whether or not fewer grievances did result from the installation of standards based on predetermined time values. The problem was approached by actual field interviews. A copy of the schedule used to conduct these interviews will be found in Appendix I. A list of their clients, in the Chicago Area, using predetermined time values on April 1, 1958 was procured from:

a. Clifford Sellie, Executive Director
   Standards Engineering
   7400 N. Western Avenue
   Chicago, Illinois

b. James Duncan, Managing Partner
   The Work-Factor Company
   206 West Atlantic Avenue
   Haddon Heights, N. J.

Every client (18) on the lists submitted was interviewed by the author.

E. Definitions:

Below is a list of the technical terms that will be used in this thesis, along with the definitions of each.

Micromotion . . . "is the study of the fundamental elements or subdivisions of an operation by a means of a motion-picture camera and a timing device which accurately indicates
the time intervals on the motion-picture film."^26

**Predetermined elemental time values:** This term applies to the time values for the fundamental elements resulting from micromotion study. These are usually presented in the form of tables and the technician records the appropriate value from them. (This is the most highly refined of the predetermined time methods).

**Predetermined time values:** This term is used to identify either elemental time values or grouped elemental data. This term covers the grouped predetermined time values into tables of standard data. It also covers values that have been recorded by means other than mechanical devices, that cannot calibrate the time values in amounts less than thousandths of a minute.

**Predetermined time standards:** This term is applied to production standards that are based on predetermined time values.

**Micromotion technique:** The term applied to the mechanical devices method of analyzing and recording time values for elements of work based upon tables of fundamental time values.

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^26 Barnes, p. 15.
CHAPTER II

PREDETERMINED TIME STANDARDS

A. Standard data based upon time studies:

Direct time studies necessitate the use of the "leveling" or "rating" process. "Leveling" determines the variation from "normal" of the operator observed, and is applied to the results of the time study (select time) in order to arrive at "normal time". The alternative method of rate setting is to set standards by the indirect or standard-data method. Two experts explain that, "standard times for elements compiled from many studies are the basis for the standard. By determining such standard elemental times from many studies on different operators, variations in work conditions and errors in judging how the operator worked are averaged out. The standard elements, properly combined, will give a true standard, when conditions are standardized within practical limits before the job is begun."1

The ability to set standards prior to production is of paramount importance in companies where short production runs

preval, since the run may be completed before the standards are set by a more detailed process. Furthermore, standard data are believed by one expert to be more consistent than direct time studies, since they "are a composite of many studies. Exactly the same time is allowed in a standard for an element each time the element occurs in a work cycle, and time for variable elements reflects the proportionate difference in time due to a physical difference in the part."\(^2\)

"Standard data developed in the plant where they will be applied," Cyrol says, "are easier to explain to employees, supervisors, and union representatives than the individual study method and once the data are understood and accepted they cease to be a source of trouble. Standard data seem to 'make sense' because the employee has in his work experience unconsciously made such comparison of one production standard to another. Standard data explains the difference readily and acceptably on the basis of differences."\(^3\)

The analyst proceeds to build standard data by surveying the departments, to determine the similarities between the operations. Since standard data is directed to allowing the same time for an element each time it occurs, seeking out


\(^3\)Ibid.
these similarities is actually the process of seeking out the identical elements that occur in different operations.

A glossary of terms is prepared for use with the survey data defining the basic elements in respect to their starting and end points. The next major step is the listing of the variables. That is followed by an investigation of "what dimensions or characteristics cause them to vary."\(^4\)

The advocates of standard data built by stop watch contend that the errors resulting from this method are less than those based on motion pictures. "An operator working under a battery of floodlights and carefully watched by an audience of cameramen, technicians, and engineers, is not likely to perform at a normal and smooth pace," Cyrol holds. The analyst employing the stop watch method (equipped with three watches, so that one watch is running while the analyst is recording the results of the previous reading) is, they feel, capable of timing the fundamental motions accurately.\(^5\)

The followers of the school of "tailor-made" fundamental motion standard data feel that their approach results in more accurate standards, because the basic studies are conducted

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in the same area in which they will be applied. They argue that standard data, built from basic elemental tables, do not take into consideration the individual work characteristics, and furthermore, "tailor-made" data can take into consideration the particular motions that precede as well as follow the particular one being timed. They present laboratory tests to indicate that motions are not isolated and the time required is affected by the elemental combinations that exist in the operation cycle.6

B. Reasons for using Standard Data based on Predetermined Elemental Time Values:

The adversaries of the "tailor-made" school advocate the use of basic tables that "may be resynthesized into standard times for a job, even when the job is entirely different from those previously studied."7 They refute the versatility of "tailor-made" data, on the basis that the elements cannot be isolated into fundamental elements.

The advocates of the elemental time value standard data question the consistency of the "tailor-made" system. The initial program may result in a set of data which will be both adequate and satisfactory for a particular operation. How-

6 Ibid.
ever, no operation is fixed so that the data will be adequate and satisfactory, indefinitely. All data require revisions as additions and deletions, constantly. With the "tailor-made" system these revisions become costly, since the same number of observations must be taken as were taken for the original study. Furthermore, in a dynamic situation like the workplace, the revision may not be consistent with the then existing situation.

Some advocates of the "tailor-made" method feel that these revisions can be compared or even levelled by the elemental method. However, the opposition contends that this would indicate a greater degree of confidence in the elemental tables than in the "tailor-made" method.

The elemental data enthusiasts feel that the tables they use are more accurate as well as more consistent than the "tailor-made" approach. The time values for their tables were obtained by much more refined methods and measuring devices (the motion picture camera and the timing instrument) than the stop watch. In addition, the independent systems attest to billions of hours of application and when any discrepancy is noted further research is conducted, and the required corrections are made.

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8 Simerson, Pacific Coast Garment Manufacturers Production Meeting.
A 1953 survey indicated that 97 per cent of 132 users of predetermined time standards agree that the standards are "accurate enough by the measure that really counts: practical shop application," furthermore, the accuracy of the tables does not seem to be in question as much as the accuracy of the engineer who applies them. 9

Standard data established from predetermined time values is considered by many as less costly than the stop-watch method. However, it has usually been necessary for the company to secure an outside consultant, to initiate the program as well as to make periodic visits to audit the standards and the application of them, to retain accuracy and consistency. 10

Predetermined time standards have been called "work measurement microscopes". 11 Because the analyst is required to make more detailed descriptions of the operations, he questions the necessity of certain of the motions he records. The survey of 1953, mentioned above, showed that 87 per cent of the 132 companies surveyed realized better shop methods with the change over to predetermined elemental time values. 12

9 "Predetermined Time Standards", Factory Management and Maintenance (September, 1953), 134.
10 Ibid.
11 Information from a personal interview of the author with Floyd Simerson, Assistant to the Vice President of Manufacturing Services, Sears Roebuck and Co., June 27, 1958.
12 Factory Management and Maintenance, (September, 1953), 134.
A decided advantage claimed for predetermined elemental time values is that they establish a worker potential, against which production records can be compared to determine overall efficiency, being used like the 98.6°F "norm" on the fever thermometer. Work measurement, like many fields of practical measurement, is not concerned with achieving absolute accuracy, but rather, with "reducing the error resulting from measurement to a point where it can be disregarded."  

Standard data is generally accepted by its advocates as the best means of setting standards, because they believe it provides a comparison with other operations in the total picture. Furthermore, they point out, the operations can be analyzed after the standard has been established, thereby reducing the emotionalism that surrounds the standards set by estimation, historical or direct time study methods. With predetermined elemental times, they feel the problem can be dissected after the fact, and re-analyzed in exactly the same sequence and by the same method. They point out that an arbitrator can actually take the analyses out to the shop  

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13 "Yardstick for Worker Performance," Steel CLX (April 8, 1957), 46.  
14 K C White, "Predetermined Elemental Motion Times", presented at the annual meeting of the American Society of Mechanical Engineers, (December 1, 1950).
and check the method for accuracy and practicality.  

Predetermined elemental time values systems, the followers believe, is the better method of building standard data, primarily because of the advantages derived thereof, in the areas of accuracy, consistency, better shop methods and economy of application.

As mentioned above, each of the eighteen companies interviewed by the author use standard data based on predetermined elemental time values.

Avon Products Incorporated began a program of establishing production schedules based on standard data in October, 1957. These standards replaced production schedules based on the historical method.  

Bell and Howell Company in 1950 instituted an incentive program using the standard data method. These data were based on predetermined elemental time values and they replaced an incentive program based on direct time study.

Borg Erickson Corporation partially replaced incentive  

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17 Information from a personal interview of the author with Fred Gahl, Chief Plant and Industrial Engineer and Henry Steen, Assistant Chief Industrial Engineer, Bell and Howell Company, April 10, 1958.
type standards based on the direct time study and historical method in December, 1956. The new standards were set by standard data based on predetermined elemental time values. However, these were installed in one department (sub-assembly) only. At the time of the interview with the author the standard data method had not been expanded to cover any additional departments.18

Continental Scale Corporation completed the program of building standard data in the month of June, 1957. The initial installation was concerned primarily with establishing production standards on a large backlog of jobs with no existing standards and jobs with standards that needed to be revised because of changed conditions. The production standards based on standard data are of the incentive type and replaced incentive type standards based on the direct time study method.19

Control Company of America installed their standard data program in early 1956 to cover 100 per cent of the company's operations. The only operations not included were those of short run duration. These standards were of the incentive

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18 Information from a personal interview of the author with Harold Piper, Vice President of Manufacturing, Borg-Erickson Corporation, July 14, 1958.

19 Information from a personal interview of the author with William Hutchinson, General Manager, Continental Scale Corporation, June 12, 1958.
type and they replaced incentive type standards based on the direct time study method. 20

Dowst Manufacturing Company installed their program on February 1, 1958. Their standard data program was intended to establish incentive type standards replacing incentive type standards established by the direct time study and historical methods integrated with union negotiation. 21

Duer Tube Bending Company installed their standard data program in August 1957 to set incentive standards. These replaced incentive standards established by direct time study. 22

Fox Valley Manufacturing Division begun operations on January 1, 1958 as a new enterprise. The production standards were of the incentive type, and they have been set by the standard data method from the first day of operation. 23

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20 Information from a personal interview of the author with Carl Noller, Chief Industrial Engineer, Control Company of America, April 16, 1958.

21 Information from a personal interview of the author with Alan Shure, Vice President of Manufacturing and Howard Skolsk, Design Engineer and Chief Industrial Engineer, Dowst Manufacturing Company, July 1, 1958.


23 Information from a personal interview of the author with Edward J. Hill, Vice President of Manufacturing, Fox Valley Manufacturing Division, July 16, 1958.
Franburg, H. A. Company installed the standard date method in May 1956 to establish production schedules for a measured-day-work operation. No standards were used prior to that time. However, production schedule estimates were determined on the basis of percentage of sales dollars.24

Haeger Potteries Incorporated initiated their standard date program in September, 1957 and established their first production schedule in January, 1958. The standard date method was chosen to replace the historical method of establishing production schedules. The historical method had replaced the direct time study method in 1953.25

Helicrafters Incorporated installed the standard date method to establish production schedules in 1955 at which time the direct time study method had been used.26

Henna Engineering Company installed production standards established by the standard date method in the assembly department on July 27, 1956. These standards were of the in-

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26 Information from a personal interview of the author with Joseph Obal, Production Controller, Helicrafters Incorporated, April 10, 1958.
centive type and they replaced the incentive type direct time study standards. 27

**Kellogg Switchboard and Supply Company** replaced direct time study incentive standards with incentive standards established by standard data in May 1956. 28

**Motorola Communications and Electronics Incorporated** replaced production schedules established by the direct time study method with production schedules established by the standard data method in 1947. Incentive standards were used for a period during the war, otherwise, it has been strictly a measured-day-work operation. 29

**Stanley Knight Sode Fountains Incorporated** initiated their standard data program in December, 1956, but did not establish any production schedules until February, 1957. No work measurement prevailed prior to that time, however, production schedules did exist prior to February, 1957

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28 Nieminen, Ade and Rousch, personal interview with author on April 1, 1958.

29 Information from a personal interview of the author with Ted Stewart, Chief Industrial Engineer, Motorola Communications and Electronics Incorporated, July 14, 1958.
Based on the "rule of thumb" method (estimation). 30

**Vulcan Containers Corporation** installed production schedules for a measured-day-work operation on March 22, 1958 in one department only. Production schedules prior to that time were established by estimation. 31

**Warwick Manufacturing Company** began operations in 1953 and established the production schedules for a measured-day-work operation from the beginning by the standard data method. 32

**Webcor Incorporated** installed production schedules established by standard data in 1953. These schedules replaced production schedules established by the direct time study method. 33

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32 Information from a personal interview of the author with John Marchese, Acting Vice President of Manufacturing, John Kajander, Corporative Industrial Relations Director, Burt Flex, Assistant to General Manager, Zion Plant, Richard Gleeson, Industrial Engineering Manager, Zion Plant, Warwick Manufacturing Company, April 24, 1958.

33 Information from a personal interview of the author with Vernon Springer, Chief Industrial Engineer, Webcor Incorporated May 1, 1958.
CHAPTER III

VARIOUS USES OF PREDETERMINED TIME VALUES

A. Wage determination:

Nine of the companies interviewed by the author use pre-determined time standards to establish production schedules for measured-day-work operations.

Avon Products Incorporated established the production standards by applying an allowance factor of 30 per cent. This includes personal, fatigue, unavoidable delay and "normalizing time". Predetermined time standards were installed throughout and the assembly department was allotted an additional 5 per cent "normalizing time".¹

The company conducts efficiency studies periodically and the results indicate that line "A" maintains 87 per cent efficiency based on the allowed time, whereas line "B" maintains 83 per cent efficiency based on the allowed time.

H. A. Frunburg Company uses an allowance factor of 35 per cent. Their efficiency studies show the operation 65 per cent

¹Heldermon, personal interview with author, July 16, 1956.
efficient based on this allowed time.\textsuperscript{2}

\textbf{Haeger Potteries Incorporated} applies a 15 per cent allowance factor to the select time; their efficiency studies indicate the operators are 60 per cent efficient on the basis of this allowed time.\textsuperscript{3}

The allowance factor used at \textbf{Hellicrafters Incorporated} is 32 per cent. Foremen review employee performance every three months to determine whether or not the employee is performing at the allowed time. At \textbf{Hellicrafters Incorporated} it is expected that the operators perform at the allowed time.\textsuperscript{4}

\textbf{Motorola Communications and Electronics, Incorporated} uses an allowance factor of 33 per cent. "Line groups" (forty to sixty operators per line) receive an additional 4 per cent. Employees who do not meet the allowed time are separated from the company.\textsuperscript{5}

An allowance factor of 40 per cent is used at \textbf{Stanley Knight Soda Fountains Incorporated}. The work-force progressed from 60 per cent of the allowed time in March, 1957 to

\begin{itemize}
  \item \textsuperscript{2} Franburg, personal interview with author, July 14, 1958.
  \item \textsuperscript{3} Deuchler, personal interview with author, July 16, 1958.
  \item \textsuperscript{4} Obal, personal interview with author, April 10, 1958.
  \item \textsuperscript{5} Stewart, personal interview with author, July 14, 1958.
\end{itemize}
85 per cent of the allowed time in May, 1956. 6

Vulcan Containers Corporation uses a 15 per cent allowance factor, however, the production schedule is set at 85 per cent of this allowed time. At the time of the interview the work-force performed at 82 per cent of this schedule. 7

The Warwick Manufacturing Company uses a varying allowance factor not to exceed 47 per cent. Production schedules are set at the allowed time and the operator is expected to perform at this pace. Provisions have been made to compensate those lines that exceed these schedules with group incentives. However, at the time of the interview over-all efficiency of the work-force ranged between 85 per cent to 96 per cent of the production schedule. This difference in expected efficiency and actual efficiency is attributed to "downtime" caused by management inefficiencies and not to the worker's inability to meet the allowed time. 8

At Webcor Incorporated a 32 per cent allowance factor is used. The company maintains departmental efficiency records which are prepared weekly, whereas individual and group efficiency records are prepared daily. The over all perform-

6 Schneider, personal interview with author, July 16, 1958.
8 Marchese, Kajander, Flex and Gleason, personal interview with author, April 24, 1958.
ence based on the allowed time is approximately 90 per cent. 9

The remaining nine companies interviewed by the author use predetermined time values to establish production standards for incentive operations.

Bell and Howell Company uses an allowance factor of 41 per cent to set their production standards. Detailed production breakdowns are prepared monthly and these reports indicate that the workers perform on an average of 125 per cent of the allowed time. 10

An allowance factor of 25 per cent is applied to the select time at Borg-Erickson Corporation. This is expanded to 35 per cent in special cases, as an inducement to increase production. However, the operator is expected to produce to at least 100 per cent of the production standard. 11

Earnings records are prepared periodically at Continental Scale Company. However, the workers have preconceived concepts of what the standards should be and, consequently, they do not generally enjoy incentive earnings. Women workers are consistently performing at 5 per cent below the standard. Nevertheless, a small percentage of the operators do

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9 Springer, personal interview with author, May 1, 1958.
10 Gahl and Steen, personal interview with author, April 10, 1958.
11 Piper, personal interview with author, July 14, 1958.
perform at or better than the allowed time. The allowance factor used to arrive at this allowed time is 17.6 per cent.\textsuperscript{12}

A thirty per cent allowance factor is used at Control Company of America. Performance reports indicate that exceptional operators produce at select time (the base to which the allowance factor was added). However, time study has been transferred from an engineering function to the function of the plant manager. This allowed time may be altered somewhat to minimize grievances in the plant.\textsuperscript{13}

The Dowst Manufacturing Company uses an allowance factor of 37 per cent. However, no efficiency studies have been conducted since only 40 per cent of the operations are covered by predetermined time standards.\textsuperscript{14}

The Duer Tube Bending Company arrived at a compromise allowance factor of 75 per cent. This factor was the result of comparisons conducted between the predetermined time standards and the stop watch standards that prevailed prior to the installation of predetermined time standards. Under the union agreement they could only introduce the correct standard gradually, consequently, on January 1, 1958, the allowance

\textsuperscript{12}Hutchinson, personal interview with author, June 12, 1958.

\textsuperscript{13}Noller, personal interview with author, April 16, 1958.

\textsuperscript{14}Shure and Skolak, personal interview with author, July 1, 1958.
factor was reduced to 65 per cent. Performance records show that the operators are working at the standard, this includes the revised standards resulting from the reduction in the allowance factor as well.15

The allowance factor used at the Fox Valley Manufacturing Division is 40 per cent. The performance records show they "can't come any where near the production standard."16 Mr. Hill feels the standards cannot be met because, (a) the length of the operation cycles is fairly long; (b) the production runs do not lend themselves to repetitive motion patterns; (c) the supervisory force has not gained confidence in the rate setting process; and (d) the standards engineers had not acquired the knowledge of the industry required to set standards accurately (the company began operations on January 1, 1958).17

The Hanna Engineering Company uses an allowance factor of 43 1/3 per cent. Performance records show that the operators are producing at 100 per cent of the allowed time.18

The allowance factor used at Kellogg Switchboard and

17 Ibid.
Supply Company is 34 per cent. Performance records show that workers produce at or beyond select time. 19

B. Work Simplification and Automation:

Predetermined time values have been advocated by many as a work simplification tool. Work Simplification should not be confused with methods improvement, which is the engineer's analytical approach to the problem of increasing efficiency. Work simplification stresses the human side of methods improvement, and is designed for foremen and employee participation to tap the reservoir of ideas resulting from their practical experience. 20

The role of the industrial engineer in work simplification is one of programming and coordinating the program. Work simplification to be a total success is said to depend on whether or not the participants accept and understand the principles of motion economy and the basic elements of motion. 21

A means by which individuals are "sold" predetermined time values is to use the elemental descriptions as a basis for training the operators. In this manner, the operator and

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19 Nieminen, Ade and Rousch, personal interview with author, April 1, 1958.
line supervisor have an opportunity to gain confidence in the standard as well as the system.

Ten of the eighteen companies interviewed had no formal work simplification program in progress; they rely solely on their engineering departments to improve methods. Six did have formal work simplification programs and each felt that exposure to predetermined time values gave tremendous impetus to the program.

Two surveyed companies had work simplification programs in progress, but they felt that the exposure to predetermined time values had little or no effect on the final outcome. Floyd Simerson, a strong advocate of work simplification, believes that "predetermined time values serve as a very unique tool for applying work simplification fundamentals". He says, "you might think of them as being canned micro-motion study and motion economy."\(^{22}\)

The responses to the question as to whether or not predetermined time values could be applied to automated operations were not favorable. However, the respondents tended to agree with the findings of the survey conducted in 1953, that predetermined elemental time values are desirable tools to be used in such areas as "machine design, plant layout,\(^{22}\)

\(^{22}\)Ibid.
tool selection, product and package design".23

All eighteen companies felt that the use of predetermined time standards does result in a higher degree of mechanization, as a result of the methods improvements that are normally derived from the installation and perpetuation of the program. Predetermined time values, they believe, may have an indirect effect on automation in the future; however, no one felt that the method would be the direct cause of circumventing this technological change. Not one of the companies felt that the system was adaptable to the operations where machines control machines (fully automated operations).

C. Employee training:

A very good example of the application of the micromotion technique to training, is the Chicago Lighthouse for the Blind, which is concerned with training blind individuals to perform certain production line operations, to equip them with such skill that they may compete for jobs with individuals that are not handicapped. The Lighthouse does not produce a staple product, but is actually a job shop type of operation with a variable job mix.24


24Information from a personal interview of the author with Ronald C. Auld, Executive Director, The Chicago Lighthouse for the Blind, October 1, 1958.
Direct time study was instituted with very little success. Six years ago they retained a consulting firm which specializes in predetermined time values, to train one of their staff personnel in the use and application of such a system. Standards have now been set by this system, and the elemental descriptions for these standards are being used successfully as a training tool. It is felt that sighted factory workers develop routine work habits to a degree that he actually performs the motions as if he were blind, consequently, elemental descriptions are an ideal aid in developing these habits in the blind as well.²⁵

The experience in training the blind individuals indicates that the training cycle is longer for individuals with vision. Those individuals, who qualify as being legally blind yet possess a very slight degree of perception, require an even longer training period than those totally blind. It is felt that those individuals that are not totally blind tend to rely on their sight to assist them in developing the motion patterns.²⁶

The survey revealed that not all the users of predetermined time values share this confidence in their value as a training tool. In fact, 50 per cent of the eighteen compen-
ies surveyed employ this technique in training and 50 per cent do not. Some of those that do, make layouts from the elemental descriptions, number them in order of their sequence, and place them in full view of all the operators for reference. In one company a movie has been made of these motions, resulting in a definite decrease in training costs.

D. Facilitates policing of the standards:

In as much as a production standard is based on the sum total of all the individual elements comprising the operation, the operator must perform the operation in the prescribed manner in order to meet the standard. In those companies where efficiency studies are conducted, operators that produced below standard, consistently, were retrained in the proper method, since it was felt that any standard which accurately describes the method can be met and any substandard performance is usually caused by failure of the operator to follow the prescribed method.

Conversely, the "runaway rate" is audited for a possible change in method which may require less time. In as much as all the elements in an operation are recorded the standards can more readily be policed. Under the direct time study

method, a general description of the operation was sufficient. In contrast, the micromotion approach is dependent upon the method, and it is imperative that all elements in the cycle be recorded and followed.

E. Estimating costs of new models:

The training problem was one of two serious problems facing the Chicago Lighthouse for the Blind. The second problem was setting the standard prior to the assembly line operation. The latter problem was especially acute for them, because of the short product runs. Unlike many operations for the handicapped, Chicago Lighthouse procures its production work by competitive bidding. Consequently, they must at least retain the relationship between labor cost and total product cost at the time of the bidding. In the past six years they have been able to set their standards prior to production with a very small margin of error. This feat can be accomplished by the micromotionists as long as the method required to perform the operation can be visualized by the engineer, and the table of values applied to this synthetic method.29

The experience of the Chicago Lighthouse has been repeated by thirteen of the eighteen companies interviewed. Only five companies do not include cost estimation of the new models

29Auld, personal interview with the author, October 1, 1958.
as standard operating procedure on a 100 per cent basis in all departments using predetermined time standards.

Avon Products Incorporated feel that pre-rating is possible but their operation has never been placed in a position where pre-rating was a necessity. 30

Continental Scale Corporation is pre-rating more and more but have not relied upon it on a 100 per cent basis. 31

H. A. Franburg Company uses the historical method for all purposes of cost estimating. 32

Fox Valley Manufacturing Division does not pre-rate because they feel that rates are approximately 25 to 35 per cent too "tight". 33

Kellogg Switchboard and Supply Company had not done pre-rating because the program was not in "full swing". The men interviewed anticipated full scale pre-rating after May 1, 1958 when all stop-watch studies were to be reviewed. 34

30 Heldermon, personal interview with author, July 16, 1958.
31 Hutchinson, personal interview with author, June 12, 1958.
32 Franburg, personal interview with author, July 14, 1958.
33 Hill, personal interview with author, July 16, 1958.
34 Nieminen, Ade and Rousch, personal interview with author, April 1, 1958.
CHAPTER IV

PRODUCTION STANDARDS BASED
UPON PREDETERMINED
TIME STANDARDS

A. Advantages and disadvantages accruing to the union:

Production standards based on predetermined time values stress the method, since the total time allowed for the standard is dependent upon the total of all the motions required to perform the operation. Mr. Fairweather believes that the analysis of the method should be made available to the union and operators as well, so that the analyst does not prescribe an impractical method.¹

The time required to perform the motion is taken from the table, so the analyst is prevented from arriving at a standard time subjectively, since he cannot adjust the time either upwards or downwards at will. If the company offers to the union a copy of the method prescribed by the analyst, Mr. Fairweather feels that the worker and his representative gain the impression that the company is interested in arriving

¹ Fairweather, personal interview with the author, July 21, 1958.
et fair and equitable standards. Furthermore, the union is offered an exact description of the job content. This enables the union to determine whether or not inter-plant inequities exist in jobs with the identical job descriptions, and it can then demand adjustments based upon facts.²

In an incentive shop, Mr. Simerson pointed out, the workers and indirectly the union benefit by production standards based on predetermined time values because once they are correctly installed the workers can work at peak productivity without fear of rate cutting. The only exception to this, he feels, would be those cases where the method being used is not identical with the one used to set the rate, i.e. methods improvements installed by the operator or an error on the part of the analyst in recording the proper method. However, he pointed out, at no time can a rate be cut strictly on the basis of high productivity. This minimizes the pressures of the group on the pace setter to limit his productivity.³

Where there is a union agreement, the union represents the workers in cases resulting over disputes concerning the production standards. Mr. Fairweather has found that emotion-alism usually surrounds the grievances caused by standards set by estimation, historical records or direct time study because

²Ibid.
³Simerson, personal interview with author, June 27, 1958.
there is a subjective aspect which plays an important role in the rate setting process. Because of this subjective aspect, companies are reluctant to permit these cases to go to the final step of the grievance procedure.⁴

In many instances, Mr. Fairweather says, arbitrators are not specialists in setting production standards, and yet they are expected to settle grievances in this area as impartially as possible. The arbitrator is placed at a disadvantage when he is expected to decide a case which of its very nature is based on a subjective process. On the other hand, Mr. Fairweather feels that grievances over standards based on predetermined time values offer the arbitrator the opportunity to settle the case on facts. He may make a tour of the work area, and there he can compare the standard with the method and decide the case on its merits, since with predetermined time standards the standard can be analyzed by anyone, after the standard has been set by the analyst.⁵

Predetermined time standards usually require a short introductory course with key union personnel. Based on his experience, Mr. Simerson feels that predetermined time standards should never be installed unless the work-force understands

⁴ Fairweather, personal interview with the author, July 21, 1958.
⁵ Ibid.
and accepts them. However, Mr. Kingsley's experience shows that it is difficult to sell predetermined time standards to the workers because, "you usually speak above the worker's head". Due to the fact that the workers do not understand predetermined time standards, they fear that they are another rate cutting device.

Because predetermined time standards usually result in methods improvements, Mr. Simerson has found that they create a "fear (in the workers) that you will take all the water from the method so that they can't beat the standard without extra effort." Because predetermined time standards in grievance cases before arbitration, Mr. Fairweather believes. Normally errors in prescribing the method are rectified and only such cases are permitted by the company to reach the last step of the grievance procedure. Consequently, the union is confined to presenting arguments in regard to the distance of the motion pattern used, since the union can't win a case on any other issue.

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8 Simerson, personal interview with author, June 27, 1958.
B. **Advantages and disadvantages accruing to the foreman:**

"I go further to insist that a foreman should have been an 'expert time study man'," says one expert. "Then he knows when the conditions fit the standard time. Thus equipped, he tends to look for causes when complaints come up. The smarter ones will know before hand and try to correct the causes. Those they must live with will be allowed for in advance. Either way, the causes of complaints are greatly reduced."10 Through such training, the foreman can understand the standard and, consequently, he can adequately perform his job. However, in the event a disagreement over the standards results and the foreman is compelled to accept them, he may not exert all his efforts to motivate the workers into accepting a standard he does not approve.

"It is the foreman to whom the men come with their questions," Phil Carrol has found. "They ask the foreman what happened to their premium. They ask why they did not make as much as they expected to. They wonder why the standard time is less than the actual time taken during the time study. They say to the foreman that the standards are

too tight.\footnote{11}{Phil Carrol, Jr., \textit{Time Study Fundamentals for Foremen}, (New York, 1944), p. 17.} The foremen can adequately answer these questions, Mr. Fairweather believes, by actually reviewing the analyses sheets with the operator under the same conditions that prevailed at the time the study was taken, if predetermined time standards are used.\footnote{12}{Fairweather, personal interview with author, July 21, 1958.} On the other hand, Mr. Simerson pointed out, if neither the worker nor the foreman have been thoroughly indoctrinated in the manner in which predetermined time standards are set, confusion may result.\footnote{13}{Simerson, personal interview with author, June 27, 1958.}

The foreman is expected to use the standard as a yardstick to measure worker performance. He is expected to use this yardstick to praise, instruct or reprimand the worker. No foremen can adequately evaluate worker performance with standards he neither understands nor believes.

Standards based upon predetermined time values can, in addition, be used by the foreman to evaluate himself. At \textit{Bell and Howell Company} an incentive plan has been devised for the supervisors to receive additional remuneration as part of the evaluation process. Three of the areas weighted heavily in this process are standards, schedules and methods improvement. It is felt by Messrs. Gahl and Steen that pre-
determined time standards have played a major role in this area of supervisory evaluation.14

Because the standard is based on the sum total of the motions comprising the standard, the foreman participates in the rate setting process in a consultative capacity by reviewing and approving the method set by the analyst. All men interviewed insist in some degree of review by the foremen, since they feel that in this manner he actually plays a greater role in rate setting than he would using either the time study or historical method.

C. Advantages or disadvantages accruing to management:

Production standards interest management because of the relationship of labor costs to the total cost picture. A survey conducted in 1952 indicated that the deterioration of work standards was widespread, and "the company where no substantial looseness in standards has crept in is the exception rather than the rule."15 Obviously, had the methods of these standards been recorded accurately, the respondents of this survey point out, the degree of looseness may have been more readily recognized.

Each of the representatives interviewed in the eight-

14 Gahl and Steen, personal interview with author, April 10, 1953.

een companies felt that loose standards had prevailed in their operations, a factor in their decision to install predetermined time standards. Ten of these companies have developed comparisons and they are firm in their belief that labor costs have decreased with the installation of production standards based on predetermined time values.

Bell and Howell Company's work-force produces more for sixty minutes work with the installation of predetermined time standards, and, in addition, costs were reduced in other areas as well, because of them.16

Borg-Erickson Corporation has experienced a decrease in costs because of predetermined time standards amounting to 8 per cent.17

Control Company of America has realized a reduction in costs amounting to 30 per cent with increases in productivity amounting to 25 per cent.18

Production standards require more units per hour at Dowst Manufacturing Company because of predetermined time standards.19

16 Gahl and Steen, personal interview with author, April 10, 1958.
17 Piper, personal interview with author, July 14, 1958.
18 Noller, personal interview with author, April 16, 1958.
19 Shure and Skolesk, personal interview with author July 1, 1958.
Deur Tube Bending Company has realized a ten per cent reduction in labor costs since January 1, 1958 (when the allowance factor was reduced by 10 per cent). 20

Heeger Pottery Incorporated realized increased productivity to the extent of a saving of two cents (\$0.02) on each sales dollar. 21

At Henna Engineering Company productivity has increased four or five times for the same rate of pay in the departments where predetermined time standards were installed. 22

Savings of 17 per cent on direct labor costs have been realized at Kellogg Switchboard and Supply Company, in those areas where predetermined time standards have been installed. 23

Motorola Communications and Electronics Incorporated has realized savings of 20 per cent of the direct labor costs for a period of ten years, because of predetermined time standards. 24

The ratio of total labor dollars to total production has

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22 Burgess and Clerk, personal interview with author, June 23, 1958.

23 Nieminen, Ade and Rousch, personal interview with author, April 1, 1958.

24 Stewart, personal interview with author, July 14, 1958.
indicated a savings of 16 per cent and it is still increasing at Stanley Knight Soda Fountains Incorporated. 25

Representatives of five of the companies feel they have realized reduced costs due to the installation of predetermined time standards but have not developed any comparisons to validate these assumptions.

Two companies, Fox Valley Manufacturing Division and Warwick Manufacturing Company, have used predetermined time standards from their inception and consequently comparisons are not possible.

The H. A. Franburg Company is the only company surveyed that has not experienced any benefits of reduced labor costs because of predetermined time standards. However, they feel reduced costs may be realized after August 1, 1958, when they intend to install predetermined time standards in the largest department in the company. 26

25 Schneider, personal interview with author, June 23, 1958.
26 Franburg, personal interview with author, July 14, 1958.
CHAPTER V

LABOR'S ATTITUDE TOWARD
PRODUCTION STANDARDS

A. Union's criticism of production standards:

The main criticisms by unions of production standards in general, are that they mean "speed-up" and "rate cutting". "After a period of time [workers]," reported one union, "found themselves working faster and harder but getting little, if any, increased pay, for as soon as they stepped up their production their rates were cut. Once this became apparent to a large number of them, they then realized that only organization into strong industrial unions could put an end to the objectionable practices."¹

Unions charge that "speed-up" with the direct time study method is achieved by manipulation of the stop-watch studies through the rating process. "The very nature of rating," says the AFL-CIO, "opens it to abuse, by manipulating this rating factor, it is easy for the time study man to end up with practically any result he chooses. In fact, as many unionists

know, the rating factor is often used to enable the time study man to end up with a standard determined before the time study is taken. In other words, time study is often used to 'prove' to the workers that a workload or standard set by the company is fair."\(^2\)

Despite the fact that Frank Darling advocates standards set by the company, arrived by any method, so long as that method doesn't place undue strain on the workers, unions do not generally accept standards that are set unilaterally by management. The attitude of unions in the area of standards, as voiced by the AFL-CIO, seems to be that, "union judgment is on a par with management's"\(^4\) Furthermore, the Federation feels that the worker on the job "is as accurate a judge as anyone" of the adequacy of the production standards.\(^5\)

Dr. Gomberg, a former union spokesman, agrees with the advocates of grouped elemental data that a greater degree of consistency results with the type of standard data. Furthermore, it "reduces to writing an implied bargain between

\(^3\) Darling, phone interview with author, July 28, 1958.
\(^4\) Collective Bargaining Report, p. 53.
\(^5\) Ibid.
them [workers] and the management." The workers are made aware of the productivity expected from them and they adjust themselves accordingly. Furthermore, the engineer's curve is kept in balance and his "predictions come out correctly even if it is for the wrong reasons."7

Dr. Gomberg is more critical of the predetermined elemental time value advocates. His first objection to this method of building standard data is that this group has not made available to the public the basic data for compilation of the tables. Second, he feels that since different approaches to develop these tables have been pursued, no consistency exists among the advocates themselves. Third, the combination of the elemental motions in tables of standard data requires a certain degree of judgment by the engineers. Consequently, the subjective factor of the historical, estimation or direct time study methods has been replaced by a different form of judgment and not eliminated as they would want everyone to believe.8

B. Joint-determination of production standards:

The opposition of unions to time study has led to the demand that rates be negotiated or co-determined. In the men's

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6 Gomberg, p. 158.
7 Gomberg, p. 159.
8 Gomberg, p. 163.
clothing industry of the Chicago Market, "the initial agreement (1911) opened the way for the union to participate in setting piece rates and in specifying quality."³⁹

The standard date method of setting rates has existed in the New York Garment Industry, for over forty years. In 1916 the Dress Manufacturers' Association and the International Ladies Garment Workers Union retained the Thompson Lichtner Company, Engineers to establish fair production standards. The Thompson Lichtner Company established "unit times for all operations and these by proper combinations, were tabulated so that they could be used to determine the time to make a blouse of any desired style and of any material."⁴⁰

Both of these systems of union participation have met with great success. The method employed in the men's clothing industry of Chicago substitutes the subjective aspects of rate setting with an agreement through negotiation. By this means the rate setting process accepts the union's judgment as being on even par with that of management's. On the other hand, the method employed in the New York Dress Industry is based on a more impartial and "scientific" approach.

⁴⁰ Spencer Miller, Jr., "Labor's Attitude Toward Time and Motion Study", Mechanical Engineer (April, 1938), p. 289-294.
C. Union participation through grievance procedure:

With predetermined time standards the union, the workers and the foremen participate in the setting of the production standard, by approving the method. For further assurance that the company is not employing another "gimmick", the union may demand that their trained personnel periodically audit the standard data. By this means the union is assured that the data has been compiled in accordance with the basic tenets of the systems.

Secondly, the operator is in a position to determine whether or not the standard is based on a method that is practical. An impractical method will become obvious and the operator can call the attention of the steward to the impracticality. In this manner the union is determining the standard jointly with management.

This type of participation is most widely used in the nine unionized companies among those surveyed for this investigation. The objections to the methods are filed through the grievance procedure. The nine companies that were non-union have a formal rate protest procedure available to the workers through which they can register their complaints.

Another form of union participation in the rate setting process is the use of union time-study stewards. These stewards are not permitted to set standards, they are re-
stricted to checking the standards in question. In the event the differences over the standards are not resolved, the cases are heard in one company by a board of "five time-study stewards and the company's top time study men." The case study conducted by the American Management Association indicates that not a single case has gone beyond this step in the rate-protest machinery.\textsuperscript{11}

Dr. Gomberg, feels that unions should be suspicious of this type of union participation. Usually the engineers have been indoctrinated by management, consequently, their analyses of the rate in dispute will be no better than those of the time-study engineer. Furthermore, if the company pays the salaries to these union stewards they may feel they are "employees of those managements who hired them".\textsuperscript{12}

D. Effect of predetermined time standards or schedules on total grievances in the eighteen companies surveyed.

Three of the companies surveyed could not make litigimate comparisons in this area.

No comparison can be made at the \textit{Fox Valley Manufacturing Division} since the operation has used predetermined time standards from its inception. However, Mr. Hill, Vice President of

\textsuperscript{11} Edmund P. Dylensky and M. R. Wilson, "Union Management Cooperation in Developing Standards", American Management Association Production Series, CXLVI, (New York, 1943).

\textsuperscript{12} Gomberg, p. 174.
Manufacturing, has been maintaining close contact with the operators and has adjusted the allowance factor upwards. This adjustment was necessary because the workers and Mr. Hill felt the standards could never be met.  

At the Vulcen Containers Corporation the program had not been in effect long enough for workers to adequately evaluate the standards and voice their opinion in the proper manner.

At the Warwick Manufacturing Company predetermined time standards have been used from the first day the operation commenced. Consequently, no comparisons are possible. However, during the three year period prior to the date of interview only five grievances had been filed.

Four of the companies surveyed have experienced no change in the total number of grievances filed.

At Duer Tube Bending Company grievances have remained the same since the standards were "levelled" with the existing standards so that the workers were not affected by the change. On January 1, 1958, all standards were tightened by 10 per

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15 Meehan, Flex and Gleeson, personal interview with author, April 24, 1958.
cent, but this did not cause any increase in grievances.\textsuperscript{16}

The H. A. Franburg Company has not experienced any change in the number of grievances because they "have not really pushed the installation of predetermined time standards."\textsuperscript{17}

Haeger Pottery Incorporated did not have any grievances over production standards before the installation of predetermined time standards and they have not had any since their installation.\textsuperscript{18}

At Stanley Knight Soda Fountains Incorporated the grievances remained unchanged because predetermined time standards were still in the trial stage as far as the union and the workers were concerned.\textsuperscript{19}

Eight of the companies have experienced a decrease in the number of grievances over standards with the installation of predetermined time standards.

Avon Products Incorporated was subjected to more grievances before the installation of predetermined time standards. They feel that when they used the historical method, they reprimanded workers for not producing enough, with no basis to substantiate their claims. Therefore, they feel they may have

\begin{footnotes}
\item[16] Smith, personal interview with author, May 28, 1958.
\item[17] Franburg, personal interview with author, July 14, 1958.
\item[18] Deuchler, personal interview with author, July 16, 1958.
\item[19] Schneider, personal interview with author, June 23, 1958.
\end{footnotes}
been reprimanding exceptional workers as well as the marginal workers. However, since they installed predetermined time standards, they prepare daily records that are compared to the standards and in this manner they feel they do not reprimand workers unjustly. 20

Due to the consistency between jobs as well as an increase in take home pay of the workers, grievances at Bell and Howell Company have decreased to 10 per cent of the total grievances before the installation of predetermined time standards. At most there are only "three or four grievances a year filed over production standards." 21

Predetermined time standards at Borg-Brickson Corporation resulted in improved methods that were less fatiguing to the workers and this resulted in a decrease in grievances filed over standards. 22

The decrease in grievances at Continental Scale Corporation is due to the fact that rates prior to the installation of predetermined time standards were adjusted (after installation) by individual bargaining. It is felt that this policy was directly responsible for most of the grievances filed.

20 Heldermon, personal interview with author, July 15, 1958.
21 Gahl and Steen, personal interview with author, April 10, 1958.
22 Piper, personal interview with author, July 14, 1958.
The Dowst Manufacturing Company has experienced a decrease in grievances over standards. However, it is felt that a certain percentage of this decrease may have been due to "depressed economic conditions in general."  

At Hanne Engineering Company, no records have been kept to substantiate their claims of a decrease in grievances over standards with the installation of predetermined time standards. However, the company feels it has experienced a decrease primarily "because they [workers] have a better understanding of the rate and how it is set." Furthermore, "they [workers] recognize it is less subjective and more scientific." 

The original installation of predetermined time standards at Motorola Communications and Electronics Incorporated resulted in a sit-down strike. An investigation by the industrial engineering department indicated that the rates were 15 per cent too tight. This problem was corrected; grievances over standards have decreased 99 per cent over the number

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23 Hutchinson, personal interview with author, June 12, 1958.
24 Shure and Skolsk, personal interview with author, July 1, 1958.
filed before predetermined time standards were installed. 26

Since predetermined time standards have been installed at **Webcor Incorporated** they have experienced **only one major grievance.** 27 "Based on their experience with predetermined time standards in a smaller electronics installation, the union recommended to management that they be adapted to the production runs at Webcor," Mr. Sellie claims. The reason the union recommended their acceptance to management was because they felt that predetermined time standards were more consistent and resulted in "less headaches" than the direct time study method. 28

The three remaining companies surveyed for this investigation experienced an increase in grievances over production standards with the installation of predetermined time standards.

Grievances at the **Control Company of America** increased so much with the installation of predetermined time standards, that time study is no longer a function of industrial engineering. It has been made a responsibility of the plant manager.

26 Stewart, personal interview with author, July 14, 1958.
28 Information from a personal interview of the author with Clifford Sellie, Executive Director, Standards Engineering, April 1, 1958.
where rates are adjusted by individual bargaining.28

Hallicrafters Incorporated experienced a "tremendous amount of labor turnover" with the installation of predetermined time standards. This increase in labor turnover was required, according to a company spokesman, in order "to stabilize the work force." On the other hand, "all grievances are settled by the foreman with the help of the industrial engineer, whenever needed to re-analyze the job."29

Kellogg Switchboard and Supply Company negotiated a three year contract with the union in order to install predetermined time standards throughout. The reasons for the long term contract is as follows:

a. One year to plan the program of installing predetermined time standards in conjunction with a job evaluation program;
b. One year to install the combined programs;
c. One year for the workers to "cool down before negotiation time because it is anticipated that the

28Noller, personal interview with author, April 16, 1958.
29Obal, personal interview with author, April 10, 1958.
installation will result in a tremendous increase in labor turnover."

30 Nieminen, Ade and Rousch, personal interview with author, April 1, 1958. The spokesman for Hellicrafters Incorporated is the only other individual interviewed that substantiates the anticipated labor turnover feared at Kellogg Switchboard and Supply Company.
CHAPTER VI

CONCLUSION

Tailor-made standard data is now accepted by many as a more consistent method of establishing production standards than either the older direct-time study or estimation methods. However, predetermined elemental time values are not generally accepted because: the basic data has not been made public; inconsistencies still exist among the various systems and judgment is not eliminated completely.

Standard data can be used to set production standards, but certain allowances still must be applied in order to make the standard practical.

The results of this investigation do not substantiate the claims that predetermined time standards are necessarily a good work simplification tool, although some of the companies surveyed did reap certain benefits in this area. On the other hand, methods engineering may result in a high degree of mechanization but as yet not one of the companies surveyed experienced automation to any degree with the installation of predetermined time standards.

Predetermined time standards have been used as a train-
ing tool successfully by some of the companies surveyed. The
companies that do use them for that purpose feel that they
are a valuable tool. Their value here is augmented by the
fact that the analyses used for training can be used success-
fully for the purpose of policing the standards, after
installation.

Predetermined time standards can be advocated as a
means of pre--rating and estimating the costs of new models,
since most of the companies surveyed for this investigation
use them for this purpose with a high degree of consistency
to the existing standards.

Predetermined time standards are especially advantageous
to the worker and union because when the standards are
correctly set the worker can work at peak productivity with-
out fear of rate cutting, providing the proper and adequate
allowance factors have been applied. Furthermore, this
necessarily implies that the workers accept the standard and
they are sufficiently motivated to work to meet or beat it.

Predetermined time standards should never be used as a
substitute for good supervision. Incentive standards from
time to time are set specifically because it is felt that in-
centives are a means of obtaining peak productivity. This
is not so! Incentive standards should only be established to
offer the exceptional workers additional compensation for
output above and beyond the prescribed "norm".

Predetermined time standards can be used as a measuring device by the supervisor. They can be used as a yardstick in measuring the workers and in this manner the supervisor can adequately evaluate himself in determining whether or not he is performing his functions properly. That is to say, the efficiency of the work group under this system is looked on as a direct reflection of proper supervision.

Predetermined time standards have resulted in decreased costs to management. However, care must be exercised so that predetermined time standards are not used solely as a speed-up or rate cutting device. Usually, reduced costs are a result of methods improvements by the engineers brought about by the necessity of recording each motion in the operation cycle.

This investigation does not substantiate the claims of the micromotionists that grievances will decrease with the installation of predetermined time standards. Of the eighteen companies surveyed, eight companies did experience a decrease in grievances but this is not sufficient proof to substantiate the claims that grievances will decrease necessarily with the installation of predetermined time standards.

In conclusion, predetermined time standards can be advocated as a tool of efficient management. However, they should not be substituted for sound and prudent managerial
activity. They are a means of assisting managers in carrying out their responsibilities. However, failure of the workers to meet the standards set is not to be considered the fault of the workers: rather it should be considered an indication that management has failed at some point to consider the other areas that affect productivity, namely psychological and sociological aspects of the work area.
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A. BOOKS


B. ARTICLES


Baumbach, Clifford M. "Incentive Wage Problems in Collective Bargaining and in Arbitration," Research Series, XIV (State University of Iowa, Iowa City, 1956).


II. SECONDARY SOURCES


D'Archangelo and Majesty. "How effective are our Industrial Tools?" Advanced Management, (February 1952).


APPENDIX I

INTERVIEW SCHEDULE

1. Approximately when did you institute production standards based upon predetermined time values?

2. Were your previous standards of the "piece work" or the "time work" type?

3. What type of work measurement was employed to establish the "old standards"?

4. Have you attempted to correlate the production standards based upon predetermined time values to production? If so, what relationship exists at present, and how long did it take to attain this relationship?

5. What uses are made of predetermined time values?
   (a) What role do they play in wage determination?
   (b) Has your Work Simplification Program gained impetus because the predetermined time practitioner naturally becomes methods conscious?
   (c) Does automation become more realistic because methods and equipment can be designed on a "scientific basis"?
   (d) Is employee training affected because methods can be precisely and accurately described?

6. Which of the following means are employed to permit the employees or their representatives to participate in the setting of the production standards:
   (a) Union steward as a member of the time study committee?
   (b) Union verification of the standard before it is installed?
(c) Challenging the unsatisfactory production standards through a formal grievance procedure?

7. Have the employees or their representatives accepted production standards based on predetermined time values?

8. If they have, how long have they accepted them? What reasons did they give for not accepting them when they were first installed? What reasons do they give for accepting them now?

9. Do you find that grievances over production standards have increased or decreased since you are using predetermined time values? Why?

10. What has been the affects of predetermined time values upon costs?

   (a) Actual costs?

   (b) Estimating costs of "new models"?
APPENDIX II

LIST OF INDIVIDUALS INTERVIEWED

Auld, Ronald C.  
Executive Director

Boyer, Emmet  
Chief Industrial Engineer

Burgess, Ted  
Vice President of Manufacturing

Clark, Robert L.  
Works Manager

Darling, Mike Frank  
President

Kingsley, Merlin  
Business Agent

Deuchler, Erwin  
Comptroller

Fairweather, Owen  
Partner

Franburg, Stanley  
President

Chicago Lighthouse for the Blind  
1850 W. Roosevelt Road  
Chicago, Illinois

Vulcan Containers Corporation  
Congress Expressway and Mannheim Road  
Bellwood, Illinois

Henne Engineering Company  
1765 N. Elston Avenue  
Chicago, Illinois

Local 1031  
International Brotherhood of Electrical Workers Union  
5247 W. Madison Street  
Chicago, Illinois

Heegar Potteries Incorporated  
7 Maiden Lane  
Dundee, Illinois

Seyforth, Shaw, Fairweather, & Geraldson, Attorneys at Law  
231 S. La Salle  
Chicago, Illinois

Hi. A. Franburg Company  
3320 W. Cerrol Street  
Chicago, Illinois
Gehl, Fred  
Chief Plant and Industrial Engineer

Steen, Henry  
Chief Industrial Engineer

Helderman, Albert  
Work-Factor Coordinator

Hill, Edward J.  
Vice President of Manufacturing

Hutchinson, William  
General Manager

Marchese, John  
Acting Vice President of Manufacturing

Kejander, John  
Corporate Industrial Relations Director

Flax, Burt  
Assistant to General Manager (Zion Plant)

Gleson, Richard  
Industrial Engineering Manager (Zion Plant)

Nieminen, Robert  
Manager of Manufacturing Services

Ada, William  
Manager of Industrial Engineering

Rousch, Edwin  
Director of Industrial Relations

Bell and Howell Company  
7100 McCormick  
Lincolnwood, Illinois

Avon Products Incorporated  
6901 Golf Road  
Morton Grove, Illinois

Fox Valley Manufacturing Division  
667 N. State Street  
Elgin, Illinois

Continental Scale Corporation  
5701 S. Claremont  
Chicago, Illinois

Warwick Manufacturing Company  
7300 N. Lehigh Avenue  
Niles, Illinois

Kellogg Switchboard and Supply Company  
6650 S. Cicero Avenue  
Chicago, Illinois
Noller, Carl  
Chief Industrial Engineer  
  
Obel, Joseph  
Production Controller  
  
Piper, Harold  
Vice President of  
  Manufacturing  
  
Schneider, Robert  
Vice President of  
  Manufacturing  
  
Shure, Alan  
Vice President of  
  Manufacturing  
  
Skolak, Howard  
Design Engineer & Chief  
  Industrial Engineer  
  
Simerson, Floyd  
Assistant to Vice President  
  of Manufacturing Division  
  
Smith, Joseph  
General Manager  
  
Springer, Vernon  
Chief Industrial Engineer  
  
Stewart, Ted  
Chief Industrial Engineer 

Control Company of America  
9558 W. Soreng  
Schiller Park, Illinois  
  
Helicopters Company,  
Incorporated  
4401 W. 5th Avenue  
Chicago, Illinois  
  
Borg-Erickson Corporation  
1133 N. Kilbourn Avenue  
Chicago, Illinois  
  
Stenley Knight Soda Fountains  
3400 N. Pulaski Road  
Chicago, Illinois  
  
Dowst Manufacturing Company  
600 N. Pulaski Road  
Chicago, Illinois  
  
Seers Roebuck & Company  
925 S. Homan  
Chicago, Illinois  
  
Duer Tube Bending Company  
2810 Madison Avenue  
Bellwood, Illinois  
  
Webcor Incorporated  
5610 Bloomingdale Avenue  
Chicago, Illinois  
  
Motorola Communications and  
Electronics Incorporated  
4501 W. Augusta  
Chicago, Illinois
Appendix III

Information About

The Work-Factor® System

Of Labor Measurement

THE WORK-FACTOR COMPANY

MANAGEMENT CONSULTANTS

206 WEST ATLANTIC AVENUE
HADDON HEIGHTS, NEW JERSEY
WORK-FACTOR is one of the pioneer systems for establishing timestudies by use of motion time standards.

Work-Factor timestudies are based upon the application of pre-determined times to each individual motion involved in an operation, rather than upon the conventional stopwatch and speed rating technique.

The system is applicable to all factory and office operations which are performed manually, and to the manual portions of those operations which involve machine time.

Establishing the time for a specific operation involves the following simple steps:

1. List all motions necessary to do the job.
2. Determine the time for each listed motion from the WORK-FACTOR Moving Time Table.
3. Total the time and make the proper allowances for fatigue, delay and incentive.

The WORK-FACTOR Moving Time Table contains a series of time values which were originally determined through years of controlled research involving thousands of operations and workers. The Table can be reproduced on a single wallet size card as shown on the next page.

In order to select the correct time from the card it is only necessary to know:

1. The body member making the motion
2. The distance moved
3. The weight carried
4. The manual control required (Stopping at a definite location, steering to a target, etc.)

(Continued next page)
The WORK-FACTOR system for establishing timestandards from pre-determined motion times offers many unique advantages.

The technique eliminates the inaccuracies of timing and the variations of judgment which lead to rate inconsistency in conventional timestudy. The engineer does not have to judge or guess the performance level of the operator when the Work-Factor timestudy is made. He doesn’t have to take into consideration whether or not the operator was a slow worker or a fast worker. All that he is interested in is the motions which must be made. As a result:

Management is assured that rates are both accurate and fair.

Labor is assured that all rates are established for the same level of performance and that one employee will not have to work harder to make his standard than will any other.

Many other advantages result from the application of Work-Factor, among them:

The elimination of the stop watch -- which promotes better labor relations. It makes timestudy possible in plants where policy opposes the use of the watch.

**Increased accuracy** -- which insures management that rates are as accurate, or more accurate, than any of their competitors.

**Motion Economy** -- which results in lower costs. Since it is necessary to evaluate every motion it is easy to detect unnecessary movements and to devise the most economical work place setups. The record indicates that most companies where Work-Factor is used have been able to reduce costs from 10% to 20% as a result of motion economies.

( Continued next page )
Pick up a building brick
and move to work area

Reach 24” to brick
Grasp brick with fingers
Move brick 30” to position

Total Time

86
23
142

0.0251 Minutes

Move garment to sewing machine

Reach 18” to garment
Grasp garment
Move 18” to machine

Total Time

76
16
98

0.0190 Minutes

(1) Note: Time values are given in Work-Factor Units. Each unit is equivalent to .0001 minutes. These times require the addition of allowances for fatigue delay and incentive.

For a more detailed demonstration of Work-Factor see W-F Bulletin No. 104 "Application of WORK-FACTOR Timestandards".
HISTORY & DEVELOPMENT OF

Work-Factor Timestandards

WORK-FACTOR originated in 1934, because of a need for improved labor relations in a large manufacturing corporation in Philadelphia. A group of engineers assigned themselves the task of developing a system which would avoid the element of human judgment in conventional stopwatch timestudy.

The basic time values, and the means of modifying the values for different classes of motions, were developed through thousands of observations in shop and laboratory. These involved the use of special stopwatches, micro-motion analysis of films, stroboscopic camera measurements, and the use of a specially constructed photo-electric time machine. Four years were required to develop the data to the point where it could be tested by actual application in the shops.

An additional year was spent in checking, correcting, and simplifying the system before it was placed in general use in 1939. Since that time, the system has been thoroughly proved through successful measurement of millions of man-hours of work in a wide variety of industries, union and non-union.

The first major factory application of Work-Factor was in an organization whose plants offered a unique proving ground, because of the variety of products made in both large and small quantities. Broadcast transmitters, army and navy radar installations, underwater sound detectors, and the electron microscope, are examples of large equipments built in small quantities. Combined with the supporting machine shops, and plating and painting plants, production of these items involved some of the most difficult types of fabrication, electrical and mechanical assembly, as well as heavy erection work. Also, in these plants, were produced electrical and mechanical parts, phonograph records, radios for car and home, and automatic record changers. Quantities in the press shops, moulding shops, and cabinet factory, frequently exceeded millions annually.

After a three year period of careful application in these products, Work-Factor had been tested on nearly every conceivable type of work -- large and small, mass production and short order. By 1942, the system was thoroughly tested and applicable to industry in general.

Other than general lectures before S.A.M. Chapters, and other groups, the first public information on the system was presented in an article titled "Motion Time Standards," prepared in 1944, and published in Factory Management and Maintenance, May 1945.

( Continued next page )
tion -- which results in more accurate cost estimates, more rapid computation of quotations to customers with sure knowledge that profit margins are protected; also better layout, tooling, and work assignments.

Opportunity to adjust rates for methods changes without restudy of entire operation -- which eases the load on the timestudy engineer and also eliminates any question about the specific results of a method change.

Increased output from each timestudy engineer (Especially when used in connection with Standard Data) -- which results in greater shop coverage and a lower overhead cost per rate established.

A sound basis for machine loading and production control -- which insures more accurate scheduling and reduced overhead through less lost time and better use of facilities.

Accurate assembly line balances -- which insure an even flow and equal assignment of work to each operator. This type of extreme accuracy can not be obtained by conventional techniques.

An ideal technique for establishing Timestudy Standard Data -- which results in more rapid application of rates. Work Factor can be used to establish data involving variations in time which can not be timed with the watch. Standard Data can be constructed more rapidly than by any other means.
The WORK-FACTOR system is based on the fact that the time required to perform a single manual motion, for a specific purpose, can be permanently measured and classified for use in establishing timestudies. The Work-Factor Moving Time Table, therefore, has been set up to cover all types of manual motions performed in any form of operation.

First of all, the system recognizes a difference in the speed with which the various body members move when performing work. The fingers move the fastest, the arm second fastest, the trunk the slowest, etc.

The element of DISTANCE is present in every movement. Obviously, the longer the distance the greater is the time.

A movement which involves no difficulty other than distance is called a BASIC motion. Such a motion requires no precision. Tossing or waving movements, or dropping the hand to the side of the body are representative examples of the Basic motion.

As soon as an element of precision or difficulty is added to a movement it ceases to be Basic. Work-Factor recognizes the following elements of difficulty, all of which tend to make movements slower:

**W** - WEIGHT OR RESISTANCE represents the additional difficulty present in a manual motion due to the retarding effect of weight, or the force required to overcome friction within the limits specified in the Moving Time Table. (For example: Carry a carton weighing 5 lbs. is equivalent to one Work-Factor).

**S** - STEER OR DIRECTIONAL CONTROL represents the manual control required to perform a motion when that motion is through a limited clearance or towards a small target area. (For example: Align a plug over a hole with a 1/16" clearance).

(Continued next page)
control required to perform a motion when it is necessary to exercise caution to prevent damage or injury or to maintain control. (For example: Carry a filled glass of water).

U - CHANGE OF DIRECTION represents the manual control required to move in a specified path other than in a straight line. (For example: Move around an obstruction to assemble a part).

D - DEFINITE STOP is the manual control required to terminate a motion at the will of the operator and not by being arrested by some physical obstruction. (For example: Move arm to grasp pencil on desk).

The presence of any one of the above difficulties constitutes a one Work-Factor motion and the corresponding time value is found on the Moving Time Table under the column headed "1 WF".

The presence of any two of the above variables results in a two Work-Factor motion with a time value under the column titled "2 WF".

The occurrence of other difficulties constitutes three and four Work-Factors which are found on the table in the same manner.

When preparing a timestudy each motion is described by first writing the abbreviation for the body member used. (F for finger, A for arm, T for trunk, etc.) This is followed by the distance moved in inches and finally the symbols for the Work-Factors involved. For example:

A 20 S D

Arm motion - 20” - Directional control (Steering) and a Definite Stop; (2 Work-Factors).

F 1

Finger motion - 1” - Basic; (No Work-Factors).

A 10 W D

Arm motion - 10” - Weight and Definite Stop; (2 Work-Factors)

Time values shown on the Moving Time Table are given in Work-Factor Units. Each Unit is equivalent to .0001 minutes. Thus, 16 units are .0016 minutes, 78 units are .0078 minutes, and so on.

Work-Factor Units are in terms of "Select Time" and contain no allowance for fatigue, personal time or unavoidable delays. Employees meeting the Work-Factor time, after appropriate allowances for fatigue, etc., are working at a premium level with better than average skill and effort.
The first draw on the housing for an automobile radio.

**SEQUENCE OF MOTION (1)**

1. Reach for blank
2. Grasp blank - 2 hands
3. Carry blank & place on die
4. Release & clear fingers (R.H.)
   Place fingers (L.H.) on blank
   Push blank against pins
   Withdraw hand & wait
5. Reach for trip lever
6. Grasp lever
7. Pull lever to trip press
8. Reach for oil rag (R.H)
9. Grasp Rag
10. Carry rag & dip in oil
11. Raise from oil pan
12. Shake & squeeze rag
13. Carry rag to stack of blanks

**MOTION ANALYSIS**

- A20D
- F1W
- A40WSD
- F3W
- Simo
- with 5,6.
- A40D
- F1
- A10WW
- A30D
- F1
- A12UD
- A6
- A4
- A18

(1) Numbers preceding motion descriptions refer to elements listed on the complete timestudy shown on a following page. The underlined motions
15. Release blank (L.H.) A1W
16. Withdraw L.H. (Strike to dislodge blank R.H.) A16
17. Approach blank (L.H.) A3D

18. Grasp blank (L.H.) F1W
19. Turn blank over 2A14W
20. Move hand to blank center A13D
21. Press down to hold blank A1W
22. Apply oil (R.H.) A40U
23. Toss rag near pan A15

24. Reach for trip lever (R.H.) A20D
25. Grasp handle F1
26. Wait for machine
27. Push lever to stop press A15WW
(Move to piece on punch L.H.)

28. Catch piece on palm (L.H.) React.
29. Carry piece to chute A40WPD
30. Toss to chute A5W

31. Turn to work table 120°
<table>
<thead>
<tr>
<th>No.</th>
<th>Elemental Description</th>
<th>Motion Analysis</th>
<th>Elem. Time</th>
<th>Cumulative Time</th>
<th>Motion Analysis</th>
<th>Elem. Time</th>
<th>Elemental Description</th>
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<td>1</td>
<td>Reach For Blank</td>
<td>A20D</td>
<td>0080</td>
<td>0080</td>
<td>A20D</td>
<td>0080</td>
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<td>2</td>
<td>Grasp Blank</td>
<td>FIW</td>
<td>0023</td>
<td>0103</td>
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<td>0023</td>
<td>Grasp Blank</td>
</tr>
<tr>
<td>3</td>
<td>Carry Blank To Die</td>
<td>A40W5D</td>
<td>0159</td>
<td>0262</td>
<td>0262</td>
<td>0159</td>
<td>Carry Blank To Die</td>
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<tr>
<td>4</td>
<td>Release &amp; Clear Fingers</td>
<td>F3W</td>
<td>0028</td>
<td>0290</td>
<td>0290</td>
<td>0028</td>
<td>Release &amp; Clear Fingers</td>
</tr>
<tr>
<td>5</td>
<td>Place Fingers On Blank</td>
<td>F3D</td>
<td>0028</td>
<td>0318</td>
<td>0399</td>
<td>0109</td>
<td>Reach For Trip Lever</td>
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<td>Push Blank Against Pin</td>
<td>A2P</td>
<td>0019</td>
<td>0347</td>
<td>0415</td>
<td>0016</td>
<td>Grasp Lever (No W Regd.)</td>
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<tr>
<td>7</td>
<td>Withdraw Hand (Arm) &amp; Wait</td>
<td></td>
<td>0146</td>
<td>0443</td>
<td>0443</td>
<td>0078</td>
<td>Pull Lever To Trip Press (10lbs)</td>
</tr>
<tr>
<td>8</td>
<td>Move Hand To Hold Blank(Small)</td>
<td>A30D</td>
<td>0096</td>
<td>0589</td>
<td>0589</td>
<td>0096</td>
<td>Reach For Oil Rag (Turn 90°-Sim)</td>
</tr>
<tr>
<td>9</td>
<td>Push Down To Hold Blank</td>
<td>A1W</td>
<td>0026</td>
<td>0415</td>
<td>0406</td>
<td>0017</td>
<td>F2</td>
</tr>
<tr>
<td>10</td>
<td>Hold Blank at Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Carry Rag &amp; Die In Oil Pan</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Raise From Oil Pan</td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Shake (Source Sim)</td>
</tr>
<tr>
<td>13</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Carry Rag To Stack Of Blanks</td>
</tr>
<tr>
<td>14</td>
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<td></td>
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<td>Apply Oil (Circular Motion)</td>
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<td>Release Blank</td>
<td>A1W</td>
<td>0026</td>
<td>0939</td>
<td>0955</td>
<td>0042</td>
<td>Raise Rag From Blank</td>
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<tr>
<td>16</td>
<td>Withdraw Hand From Blank</td>
<td>A10</td>
<td>0085</td>
<td>0991</td>
<td>0997</td>
<td>0042</td>
<td>Strike To Dislodge Blank</td>
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<tr>
<td>17</td>
<td>Arm from Blank</td>
<td>A3D</td>
<td>0032</td>
<td>1023</td>
<td>1048</td>
<td>0051</td>
<td>Withdraw Rag To Side</td>
</tr>
<tr>
<td>18</td>
<td>Grasp Blank</td>
<td>FIW</td>
<td>0023</td>
<td>1046</td>
<td></td>
<td></td>
<td>Hold Rag</td>
</tr>
<tr>
<td>19</td>
<td>Turn Blank Over (Release Sim)</td>
<td>2 A14W</td>
<td>0138</td>
<td>1184</td>
<td></td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>20</td>
<td>Move Hand To Blank Center</td>
<td>A13D</td>
<td>0067</td>
<td>1251</td>
<td></td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>21</td>
<td>Press Down To Hold Blank</td>
<td>A1W</td>
<td>0026</td>
<td>1277</td>
<td>1277</td>
<td>0055</td>
<td>Carry Rag To Blank</td>
</tr>
<tr>
<td>22</td>
<td>Hold Blank At Center</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Apply Oil (Circular Motion)</td>
</tr>
<tr>
<td>23</td>
<td>Release Blank</td>
<td>A1W</td>
<td>0026</td>
<td>1412</td>
<td>1437</td>
<td>0051</td>
<td>Toss Rag Near Pan</td>
</tr>
<tr>
<td>24</td>
<td>Hand Idle (Turn 90° Sim)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Reach For Trip Lever (Turn Sim)</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Grasp Handle (No W Regd.)</td>
</tr>
<tr>
<td>26</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Wait (0042-1800-1923-0042-0196)</td>
</tr>
<tr>
<td>27</td>
<td>Move Hand To Pinch On Pinch</td>
<td>A20D</td>
<td>0080</td>
<td>1873</td>
<td>1873</td>
<td>0092</td>
<td>A15WW</td>
</tr>
<tr>
<td>28</td>
<td>Catch Piece On Palm</td>
<td>React</td>
<td>0020</td>
<td>1893</td>
<td>1896</td>
<td>0023</td>
<td>Release Handle</td>
</tr>
<tr>
<td>29</td>
<td>Carry Blank To Chute (Balance)</td>
<td>A40WPD</td>
<td>0189</td>
<td>2082</td>
<td></td>
<td></td>
<td>Hand Idle</td>
</tr>
<tr>
<td>30</td>
<td>Toss To Chute Or Stack</td>
<td>A5W</td>
<td>0043</td>
<td>2095</td>
<td></td>
<td></td>
<td>&quot;</td>
</tr>
<tr>
<td>31</td>
<td>Turn To Worktable</td>
<td>120°</td>
<td>0100</td>
<td>2195</td>
<td>2195</td>
<td>0100</td>
<td>120° Turn To Workable</td>
</tr>
</tbody>
</table>
The preceding example shows how Detailed Work-Factor would be used in analyzing a short cycle mass production job where great timestudy accuracy is important.

If the job were of a short quantity nature, it would not be essential to be so precise and Simplified Work-Factor would be used. The simplified technique permits the grouping of motions and Work-Factors for speed of application with a slight loss in accuracy. (For a further discussion of Simplified Analysis, see W-F Bulletin No. 105 "Flexibility of Work-Factor Time Standards").

The preceding metal stamping job would be analyzed by Simplified Work-Factor as follows:

<table>
<thead>
<tr>
<th>Part Name</th>
<th>Sheet No.</th>
<th>COMPANY</th>
<th>Section No.</th>
<th>Part No.</th>
<th>Sub.</th>
<th>Oper. No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>OLDSMOBILE HOUSING</td>
<td>1</td>
<td>SYLVANIA ELECT. PROD.</td>
<td>1</td>
<td>54637</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**Operation Name & Description**
1st Draw - Place blank on die, trip press, oil blank, stop press, remove & stack

**WORK-FACTOR SIMPLIFIED ANALYSIS**

<table>
<thead>
<tr>
<th>No.</th>
<th>ELEMENTAL DESCRIPTION</th>
<th>ANALYSIS</th>
<th>Select Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Turn from chute to stack of blanks</td>
<td>180° Turn</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>Pick-up next blank to die (simple - 2 hands - 4.04 lbs.)</td>
<td>40&quot;</td>
<td>230</td>
</tr>
<tr>
<td>3</td>
<td>Place blank in position on die (2 hands)</td>
<td>Asy-Simp.</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>Pull lever to trip press (Grasp 20) (RH)</td>
<td>40&quot;-1.10&quot;-2</td>
<td>220</td>
</tr>
<tr>
<td>5</td>
<td>Oil next blank and stop machine during machine cycle</td>
<td>Mach. Time</td>
<td>1380</td>
</tr>
<tr>
<td>6</td>
<td>Catch finished piece as it drops off punch (LH)</td>
<td>React.</td>
<td>20</td>
</tr>
<tr>
<td>7</td>
<td>Carry finished piece to chute (LH)</td>
<td>40&quot; - 3</td>
<td>150</td>
</tr>
<tr>
<td>8</td>
<td>Toss finished piece into chute (LH)</td>
<td>5&quot; - 1</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>2230</td>
<td></td>
</tr>
</tbody>
</table>

It should be noted that whereas the detailed study required the use of 43 elemental time values, the simplified analysis requires only 10 values, most of them of greater magnitude. While some accuracy is lost through the use of simplified data, it is adequate for the class of work for which it is recommended. A study requiring one hour for detailed analysis, may require only 15 minutes if simplified can be used. The relative accuracy can be seen by comparing the total values as follows:

**Oldsmobile Punch Press**

<table>
<thead>
<tr>
<th>Time Units</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Detailed Analysis</td>
<td>2195</td>
</tr>
<tr>
<td>Simplified Analysis</td>
<td>2230</td>
</tr>
<tr>
<td>Difference</td>
<td>35</td>
</tr>
</tbody>
</table>

\[
\frac{35}{2195} = 1.6\% \text{ overall variation or approximately } 4\% \text{ on the manual portion of the cycle.}
\]

As a rule the Simplified analysis results in greater time allowances than the Detailed but not in excess of 5% for overall cycles.
The Work-Factor system is extremely flexible and can be adapted for application to almost all types of production. The original technique was primarily intended for mass production. In order to insure practical application for small quantities certain simplifications are made.

To fit the measurement technique to the requirements of various type shops and operations the following Work-Factor techniques are used:

1. **Detailed Work-Factor** - For short cycle or mass production. 
   Employs detailed values and exact measurements of distances moved, weights carried, size and shape of objects handled. It is extremely accurate.

2. **Simplified Elements** - For medium quantity production.
   Employs simplified tables of elements, approximate distances and weights, generalized classification of objects handled. Nearly as accurate as detailed but much more rapid to apply.

3. **Simplified Elements Grouped** - For short order shops.
   Employs simplified tables of elements and tables of these elements grouped into commonly used combinations. Also average distances, weights, and object characteristics. Less exact than Simplified Elements but well suited for short order quantities and for preliminary estimates.

4. **Standard Data** - For any kind of production.
   The Work-Factor system of standards lends itself to the use of detailed or simplified values in the compilation of standard data. The choice of values is dependent on the class of work to be measured and the accuracy required of the data. By the use of standard data, values can also be established for non-standard or non-repetitive cycles such as maintenance, stock handling, etc.

The chart on the following page shows how the above techniques are applied:
# COMPARISON OF FOUR WORK-FACTOR TECHNIQUES

## Operation: Pick-up bolt and assemble into hole in panel

<table>
<thead>
<tr>
<th>Detailed Analysis (Mass production)</th>
<th>Simplified Elements (Medium Quantities)</th>
<th>Simplified Grouped (Short order Quantities)</th>
<th>Standard Data (Any Type of Work or Quantity)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Motion Description</strong></td>
<td><strong>Anal.</strong></td>
<td><strong>Time Units</strong></td>
<td><strong>Motion Description</strong></td>
</tr>
<tr>
<td>9&quot; to mach. (3/8&quot; dia. long)</td>
<td>A0B</td>
<td>58</td>
<td>Reach to mach. screw (10&quot;)</td>
</tr>
<tr>
<td>mach. screw grasp</td>
<td>F1</td>
<td>16</td>
<td>Grasp Screw (3/8&quot; dia. x 2&quot; long)</td>
</tr>
<tr>
<td>y screw 11&quot; in panel</td>
<td>A10DS</td>
<td>81</td>
<td>Carry screw to hole in panel (10&quot;)</td>
</tr>
<tr>
<td>ida in panel</td>
<td>A1S</td>
<td>13</td>
<td>Assemble screw in 3/8&quot; dia. hole in panel</td>
</tr>
<tr>
<td>light screw</td>
<td>A1S</td>
<td>26</td>
<td>Assemble screw in 3/8&quot; dia. hole in panel</td>
</tr>
<tr>
<td>V screw</td>
<td>A2</td>
<td>20</td>
<td>Assemble screw in 3/8&quot; dia. hole in panel</td>
</tr>
<tr>
<td>F1</td>
<td>8</td>
<td></td>
<td>Assemble screw in 3/8&quot; dia. hole in panel</td>
</tr>
<tr>
<td><strong>Total units</strong></td>
<td></td>
<td>246</td>
<td><strong>Total units</strong></td>
</tr>
<tr>
<td>time in minutes</td>
<td></td>
<td>.0246</td>
<td>time in minutes</td>
</tr>
<tr>
<td>no. of time values required</td>
<td></td>
<td>9</td>
<td>no. of time values required</td>
</tr>
</tbody>
</table>
| Note: Approximate reach and carry distances of 10" have been used instead of 9" and 11". The simplified medium grasp value (Gr-M) and the simplified assembly value (Asy-El) have been used instead of a detailed analysis. Values not as specific, but quite accurate. | Note: Average reach and carry values have been combined with simplified grasp values and tabularized for quick use. Assembly value is same as that used in the simplified element analysis at left. | Note: Only one value required. This combines all motions of reach, grasp, carry and assembly. This value can be as accurate as desired, depending on the range of screw sizes covered in "Class No. 1 screw" and the range of distances included in the "Ave. Move. Dist." which in turn depends on size and type of panel. 

---

**Note:**

- These detailed values reflect exact 9" and 11" moving distances. Also detailed analysis of the grasp and assembly of the screw based on exact screw size and hole size. This provides nearly perfect accuracy as can be obtained.

- These values are approximate and may not be as specific as the detailed analysis, but they are quite accurate for quick reference.
"Standard Element" is the term applied to the basic divisions of manual work. All manual work consists of one or more standard elements which are themselves composed of one or more motions. The Work-Factor standard elements are:

1. Transportation (Reach or Move)
2. Grasp
3. Pre-position
4. Assemble
5. Use (or machine time)
6. Disassemble
7. Mental process (Visual inspection, etc.)
8. Release

When properly described and analyzed with Work-Factor, a standard element is a complete unit of work. Therefore, when that same element occurs in an operation other than the one for which it was originally established, it is usable without further analysis. Standard elements are like the bricks used in building a wall. Once properly moulded, each brick becomes an independent unit which can be used at any time so long as it is applied to the proper wall.

When a large number of Work-Factor standard elements have been analyzed and properly classified, the engineer, or company has a store of fundamental time values which can be used and reused with no effort other than to identify those needed for the particular job being studied. Standard element values are usually filed in a "Standard Element Book." Obviously, the larger the store of standard elements, the more likelihood that the proper ones will be available when needed.

There are two ways to accumulate a store of standard elements.

1. Simply classify and tabulate them as detailed studies are made for routine timestudy purposes. Dependent on the number of detailed studies made, the file of element values will grow rapidly or slowly.

2. Establish a special program for calculating important standard elements in order to get a substantial file quickly.

Inasmuch as the Work-Factor Company has performed extensive research and made many studies in a large number of companies, it has naturally acquired a rather substantial file of standard elements. (Continued next page)
WORK-FACTOR STANDARD ELEMENT

Name of Element: Grasp internal tooth lock-washer (random - blind)

Element Numbers

| GR-9 | ASY-59 |

Sketch

WORK-FACTOR ANALYSIS

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>16</td>
<td>F1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>08</td>
<td>2F1 5%</td>
<td>Regrasp 65%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td>48</td>
<td>2F1 50%</td>
<td>Separate 50%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>64</td>
<td>16</td>
<td>50%</td>
<td>Simo.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DESCRIPTION AND EXPLANATION OF MOTIONS

Grasp washer from pile in bin. Element begins with hand at end of transport motion, ready to begin grasp. Element ends with one part in fingers under manual control.

Box Cover is spread wide enough to permit easy placement over bottom.

4, 6, 7 These elements occur because folded box cover type does not open perfectly, so that edges of cover and edges of bottom catch during the assembly.

Allowance for recurring difficulty with edges.

ELEMENT NUMBER BREAKDOWN

1 2 3 4 5 6 7 8 9 10

THE WORK-FACTOR CO. Management Consultants, 166 Madison Ave, N.Y. City
Standard Data is essential for the practical operation of any timestudy department. It not only insures greater consistency but also makes rate setting speedier and more economical. It makes it practical to establish rates for small quantity jobs.

Standard Data is not an exclusive feature of Work-Factor except that it has been demonstrated that Work-Factor permits more rapid and accurate construction of data.

The Work-Factor system of pre-rating is unique in its simplicity. At one of the larger machine shops in the East, producing small and large runs, the timestudy department is set up to establish from ten to forty rates per man per day depending on the complexity.

A careful system of pre-rating from standard data frequently makes possible the establishment not only of extremely accurate cost estimates, but also actual production rates in advance of production. When such a system has become well organized it is often practical to issue actual rates in advance of production, checking only the occasional job (as few as 5%) which has tools or fixtures different than specified on the process. This high degree of accuracy requires good coordination between tool designers, process and timestudy, and a program of standardized jigs and fixtures.

Example of Standard Data:

The following is a portion of an actual set of Standard Data which was developed by Detailed Work-Factor Analysis.

<table>
<thead>
<tr>
<th>Diameter in Inches</th>
<th>Constant Time</th>
<th>Weight of Reel or Bobbin in Pounds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Up to 250</td>
</tr>
<tr>
<td>0 - 12.5</td>
<td></td>
<td>143</td>
</tr>
<tr>
<td>12.6 - 17.5</td>
<td></td>
<td>110</td>
</tr>
<tr>
<td>17.6 - 22.5</td>
<td>20</td>
<td>92</td>
</tr>
<tr>
<td>22.6 - 27.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27.6 - 32.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32.6 - 37.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>37.6 - 42.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>42.6 - 47.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>47.6 - 52.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>52.6 - 57.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Select time = 20 + (units/ft) x (feet rolled)
Example: 20" Reel weighing 500 pounds rolled a distance of 30 feet -
20 + 106 x 30 = 20 + 2120 = 2140 units
SINGLE & DOUBLE RIVETING WORK FACTOR PRERATE SHEET (Cont'd)

<table>
<thead>
<tr>
<th>CLASS OF LARGE PART</th>
<th>SMALL PT. FIRST</th>
<th>EACH ADD'L. PT.</th>
<th>EACH ADD'L. PT.</th>
<th>LGE. PT. FIRST</th>
<th>LGE. PT. FIRST</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
</tr>
<tr>
<td>II</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
</tr>
<tr>
<td>III</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
</tr>
<tr>
<td>IV</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
</tr>
<tr>
<td>V</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
<td>IA</td>
</tr>
</tbody>
</table>

ADDITIONAL ALLOWANCES: See data for explanation
1. FLANGED PARTS 1" TO 3" - .010 1ST TIME .015 ADD'L.
2. BLIND POSITIONING - .005
3. RESTRICTIONS - REFER TO LINE WIRING DATA
4. ROTATE LARGE PART - 90° OR 180°, .010
5. ALIGN 2ND HOLE IN ADDED PART - .005
6. OBTAIN PARTS FROM CARTON - UNWRAP - STACK IN TRUCK (SEE DATA)

PARTS CLASSIFICATIONS
CLASS IA - TERMINAL LUGS, STRIPS, WASHERS
CLASS III - NORMAL SIZE PANELS, BASES
CLASS II - SMALL SPRINGS, ETC., TENDENCY TO CLING TOGETHER
CLASS IV - LARGE Bases 8 PANELS
CLASS V - EXTRA LARGE PANELS

MOTOROLA INC.

TOTAL SELECT TIME .459 MIN.

MACHINE NAME Tube: ular Riveter
T. E. ERR1S, T. F. DATE 3/10/47

PERSONAL ALLOWANCE %

TOTAL STANDARD TIME MIN. APPROVED BY T. S.

HANDLING TIME MOVING DISTANCE

SMALL PARTS

UPPER LINE - P.I. & OFFICE PARTS
LOWER LINE - P.IU & POSITION ADD'L. PARTS
CLASS II & III ADD -.005 WHEN PARTS REQUIRE PREPOSITIONING

TOTAL SELECT TIME .459 MIN.

STD. TIME PER PIECE X 1.67 H.P.

PERSONAL ALLOWANCE %

TOTAL STANDARD TIME MIN. APPROVED BY T. S.
The following is the Work-Factor analysis which supports the Class IV, 20" handling time which is circled on the Riveting Pre-Rate Sheet.

Every time value which appears on the Pre-Rate Sheet is supported by an equally detailed and accurate Work-Factor analysis.

<table>
<thead>
<tr>
<th>Description</th>
<th>Motion Analysis</th>
<th>Work-Factor Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Move riveted part to bench.</td>
<td>A20WWD</td>
<td>124</td>
</tr>
<tr>
<td>Align along side other parts</td>
<td>A1SWW</td>
<td>40</td>
</tr>
<tr>
<td>Slide to position</td>
<td>A1WW</td>
<td>34</td>
</tr>
<tr>
<td>Release</td>
<td>F1W</td>
<td>23</td>
</tr>
<tr>
<td>Reach for next part</td>
<td>A40D</td>
<td>109</td>
</tr>
<tr>
<td>Grasp next part</td>
<td>Simplified B-3</td>
<td>80</td>
</tr>
<tr>
<td>Move next part to machine</td>
<td>A20WWD</td>
<td>124</td>
</tr>
<tr>
<td><strong>Total Units</strong></td>
<td></td>
<td>534</td>
</tr>
<tr>
<td><strong>Total Select Time</strong></td>
<td></td>
<td>.0534 minutes</td>
</tr>
<tr>
<td><em>Three place value which appears on Pre-Rate Sheet</em></td>
<td></td>
<td>.053 minutes</td>
</tr>
</tbody>
</table>
The research performed by The Work-Factor Company has included the isolation of times required to perform certain mental operations. For some time these values have been applied to a limited extent. It is believed Work-Factor is a pioneer in this field as well as other aspects of standard element times. Results with mental times so far are good but extensive research still continues.

Mental Processes include the following:

1. Reception time (Inspection, etc.)
2. Decision time
3. Signal time

Depending on the number and strength of stimuli, the number of possible conclusions and other factors, the time required to perform mental processes will vary.

Operations common in industry which involve mental process time are:

1. Inspection
2. Reading gauges
3. Throwing switches at a given signal
4. Sorting
5. Planning

In many cases the mental processes can be performed simultaneously with the manual part of the cycle. In such cases no measurement of the mental time is necessary. However, when the manual motions cannot be made without deliberate direction from the mind, and this direction cannot be done during the motion time, then mental process time must be measured.

The following simple example shows Work-Factor Mental Process time values for inspecting a white surface 2" x 4" to determine whether or not a uniformly placed black dot appears in the center of the area.

The accompanying table gives inspection time values as the size of the dot varies from .01" diameter to 3/4" diameter.

(Continued next page.)
<table>
<thead>
<tr>
<th>Diameter of Dot</th>
<th>Pure Inspection Time</th>
<th>Time including Reception time which overlaps inspection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Units</td>
<td>Units</td>
</tr>
<tr>
<td>3/4&quot;</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>1/2&quot;</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>3/8&quot;</td>
<td>14</td>
<td>24</td>
</tr>
<tr>
<td>1/4&quot;</td>
<td>16</td>
<td>26</td>
</tr>
<tr>
<td>1/8&quot;</td>
<td>17</td>
<td>27</td>
</tr>
<tr>
<td>.05&quot;</td>
<td>18</td>
<td>28</td>
</tr>
<tr>
<td>.03&quot;</td>
<td>19</td>
<td>29</td>
</tr>
<tr>
<td>.02&quot;</td>
<td>24</td>
<td>34</td>
</tr>
<tr>
<td>.01&quot;</td>
<td>58</td>
<td>68</td>
</tr>
</tbody>
</table>

Assuming inspection for a .02" diameter black spot in the center of a 2" x 4" white card, the above values would be used in the analysis as follows:

<table>
<thead>
<tr>
<th>Description</th>
<th>Analysis</th>
<th>Work-Factor Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Right hand withdraws inspected card 2&quot; from group held in left hand. (Right hand then carries card to table and places it on one of two piles - one pile containing cards with dots, the other containing blank cards.)</td>
<td>2/5 A5</td>
<td>12</td>
</tr>
<tr>
<td>2. Eyes focus on next card as soon as RH has withdrawn previous one.</td>
<td>Focus</td>
<td>20</td>
</tr>
<tr>
<td>3. Inspect for .02&quot; diameter dot in center of card.</td>
<td>Insp.</td>
<td>34</td>
</tr>
<tr>
<td>4. Make decision as to whether card goes in pile with dots or pile with no dots.</td>
<td>Dec.</td>
<td>10</td>
</tr>
<tr>
<td>5. Signal to RH to remove card from deck. (RH has already grasped card after placing previous card on table).</td>
<td>Sig.</td>
<td>11</td>
</tr>
</tbody>
</table>

Total Select Time 87

It should be noted that the only manual part of this cycle which affects time is Item No. 1, the time required by the card to travel 2" as the right hand withdraws it. Elements Nos. 2, 3, 4, and 5 are all mental times.

The placing of the finished card on one of the two piles and returning the right hand for the next card and grasping is done simultaneously and faster than the mental processes.
Unions have a difference of opinion as to whether incentives are desirable from the worker's standpoint. It is well known that many labor organizations prefer to have their members work under a system of straight day-work, without direct incentives. Nearly all unions, however, realize the necessity of measuring labor's output so that management has a standard on which to base its prices, and with which to compare their operation with that of competition. These unions also recognize the benefit of a production standard to determine a fair rate of output for the protection of the worker.

The lack of respect for timestudy on the part of many union officers usually stems from one or more unfortunate experiences with inaccurately applied labor standards. It is true that some managements and unions have, by mutual consent, discarded incentive systems because of the inconsistencies of standards established by conventional timestudy and because of the constant bartering or haggling in attempting to agree on a fair level of performance.

Some grievances over standards will always be present where any method of timestudy measurement, however accurate, is used. Even if timestudy errors were completely eliminated, the cases of inferior or disgruntled employees would still be present.

In plants where Work-Factor is applied, the union representatives can be shown that the standard values, when correctly applied, will result in a consistently accurate and equitable rate.

In these plants, the shop steward (and perhaps the employee) reviews the details of the operation with the timestudy engineer to make sure everything has been included and errors in arithmetic have not been made. Rate grievances are usually settled without progressing beyond the shop steward - foreman - timestudy engineer level.

Except for the substantial benefits derived from accuracy, consistency, fairness, and elimination of human judgment, Work-Factor has no magic formula for handling union problems. Each case is different and requires different treatment. The men behind Work-Factor, however, have a wealth of experience in dealing with labor unions. Plants in which Work-Factor has been applied are experiencing sound employee and union relations.
Work-Factor is a system of elemental time values which have been isolated and tabulated through an exhaustive study of very nearly all types of manual work. Therefore, its range is extremely wide. To date there has been no work problem encountered which was not adequately evaluated by Work-Factor analysis—either detailed or simplified—or by means of Standard Data compiled from Work-Factor.

There are some types of manufacture wherein the product is built in quantities of only 1, 2, or 3, etc. Work of this nature does not lend itself easily to any form of timesudy unless standard data has been compiled. It is, therefore, not justifiable to state that Work-Factor is practical for all labor measurement since there are some situations inadequately covered by any timesudy system because of short duration, one time occurrence, etc. A fair statement concerning Work-Factor is that it is highly applicable to any form of work which can be practically measured. In high production it apparently affords greater accuracy than any system so far devised. In short order work the simplified Work-Factor analysis seems to provide the necessary speed in rate setting, along with accuracy as great as any technique.

The following list will provide a good cross section of the variety of operations which have been measured successfully by Work-Factor:

- Non-repetitive or non-standard
  - Hand trucking of material
  - Manual handling of cartons of material
  - Sweeping and janitor work
  - Sanitization of wash rooms
    - (cleaning toilets, basins, etc.)
  - Maintenance of lighting fixtures
  - Loading materials into stock bins

- Metal Working (Including setting up machines and operating)
  - Punch presses
  - Milling machines
  - Radial drill presses
  - Sensitive drill presses
  - Tapping machines
  - Profiling machines

- Metal Working (Continued)
  - Centerless grinding machines
  - Vertical broaching machines
  - Deep hole drilling machines
  - Engraving machines
  - Hand and automatic screw machine
  - Other related machine shop operations
  - Snagging and burring
  - Spinning

- Metal Joining
  - Spot welding
  - Arc welding
  - Flame welding
  - Soldering
  - Riveting

(Continued on next page)
Barrel plating
Automatic plating
Anodizing
Wiring and racking for plating
Paint spraying - wood and metal surfaces

Moulding
Compression moulding of plastics
Injection moulding of plastics
Moulding of hard and soft rubber
Crayon extrusion
Pressing of phonograph records

Wood Working
Sticker operations
Tennon machine operations
Veneer gluing
Band sawing
Automatic nailing
Rubbing, sanding, and polishing
Other miscellaneous wood shop operations

Special Purpose Equipment and Operations
Machine labeling
Wardwell braiding
Radio frequency soldering
Extruding
Box folding
Spring winding
Wire drawing - coarse and fine
Wire covering - paper, fiber, plastic
Paper slitting
Forming and stitching of cartons
Packing and packaging
Spooling of ribbon and tape
Cotton and rayon spinning

Inspection and Testing
Gauging of metal parts
Inspection of finishes
Inspection of printed material
Calibration and adjustment of mechanical instruments
Inspection of metal, plastic, and paper products
Testing of electrical circuits
Calibration and alignment of electronic devices

Mimeographing
Check writing
Key punching
Posting
Sorting paperwork

Manufacturing and Assembly of Products (In many cases these include fabrication, sub-assembly, assembly, packaging, etc.)
Radar equipment
Sonar equipment
Proximity fuse
Paper boxes
Altimeters
Broadcast and television transmitters
Drawing boards
Toys and games (wood, metal and paper)
Jig saw puzzles
Finger paints
Shoes
Gauges and measuring instruments
Automobile radio receivers
Television and radio receivers
Magnet wire
Copper rod
Pulleys and wheels
Automatic record changers
Automobile heaters
Phonograph records
Automotive electrical accessories
Mercury switches and circuit breakers
Household refrigerators
Coils - ignition, radio, etc.
Transformers - large and small
Greeting card
Crayons
Cabinets - wood and steel
Pianos
Corrugated boxes
Tanning and leather processing
Garment manufacturing (uniforms)
Imprinting of forms and Insurance Policies
Fire extinguishers
Drug packaging
Kitchen ranges
Time recorders
Electronic Tubes
Plastic lens
Ink
Movie projectors
PREDETERMINED TIME VALUES: A SURVEY OF
CHICAGO COMPANIES' EXPERIENCES

by
Frank Robert DiGiovanni

Summery of a Thesis submitted to the Faculty of the Graduate
School of Loyola University in Partial Fulfillment
of the Requirements for the Degree of Master
of Social and Industrial Relations

June
1959
The predetermined-elemental-time-values method of work measurement requires the use of basic tables whose values are synthesized into grouped elements. The advocates of this method of building standard data argue that: (a) consistency will be retained with the building of subsequent data; (b) revisions of the data are less costly; (c) these data are more versatile because the elements can be isolated; (d) the data are more accurate because of the method used in preparing the elemental tables; and (e) the tables used to build the data attest to billions of hours of application.

The author sought information on actual company experience with predetermined time values and also whether or not fewer grievances had resulted from the installation of standards based on predetermined time values. The problem was approached by actual field interviews. A list of companies, in the Chicago Area, using predetermined time values on April 1, 1958 was procured and representatives of each of the eighteen companies was interviewed.

Wage Determination:

Nine of the company representatives interviewed use predetermined time values to establish production schedules for measured-day-work operations; the remaining nine use them to establish production standards for incentive operations. An allowance factor for personal time, fatigue, unavoidable delay
and normalizing applied to these ranging from a low of 15 per cent in one company to 75 per cent in another.

**Work Simplification and Automation:**

Predetermined time values were considered by six of the men interviewed as having played an important role in the work simplification program; two felt that they had little effect on work simplification; the remaining ten have no formal work simplification program in progress.

Representatives of each of the eighteen companies felt that the use of predetermined-time-standards play an important role in bringing about a higher degree of mechanization. However, not one of the men believed that predetermined-time-values would directly result in bringing about automation.

**Employee training:**

The representative of the Chicago Lighthouse for the Blind felt that predetermined-time-values are valuable training tools. There blind individuals are trained in a sheltered work shop in order to equip them with the degrees of skill required to compete for production type jobs with individuals with full vision. Representatives of nine of the companies interviewed shared this confidence in predetermined-time-standards as a training method. A few have gone so far as to prepare layouts and movies using the elemental analysis.
Estimating costs of new models:

The Chicago Lighthouse for the Blind is a job shop with short production runs. Since the installation of predetermined-time-values six years ago, standards have been set in advance on a synthetic method. Thirteen of the company men interviewed include pre-rating of the new models as part of their standard operating procedures. Of the remaining five companies: (a) one does not pre-rate because their operation does not require it; (b) two will be pre-rating more and more; and (c) two companies do none more do they intend to pre-rate in the future.

Advantages and disadvantages:

Ten of the men interviewed have developed comparisons between the costs with production standards based on predetermined-time-values and the standards that existed previously. The figures show that five of the companies interviewed feel that labor costs have been reduced but they have not developed any comparisons to validate their assumptions.

Two of the companies surveyed have used predetermined-time-standards from their inception and consequently before and after comparisons are not possible.

Only one company surveyed did not experience any reduced labor costs after the installation of predetermined-time-values.
Effect on the number of grievances:

Three of the companies surveyed did not have sufficient information to make comparisons, while four have experienced no change in the total number of grievances filed. Since the installation of predetermined-time-standards eight of the companies have had a decrease and one experienced an increase in grievances. One company had had a very high labor turnover rate until the work force was stabilized with the installation of predetermined-time-values. The remaining company fears labor turnover until the work force becomes stabilized after that they plan to install the program on an overall basis.
The thesis submitted by Frank Robert DiGiovanni has been read and approved by three members of the faculty of the Institute of Social and Industrial Relations.

The final copies have been examined by the director of the thesis and the signature which appears below verifies the fact that any necessary changes have been incorporated and that the thesis is now given final approval with reference to content, form, and mechanical accuracy.

The thesis is therefore accepted in partial fulfillment of the requirements for the Degree of Master of Social and Industrial Relations.

May 20, 1959

Date

Signature of Advisor