Chapter 9

Direct Time Study (Static Example)

9 Introduction

Direct Time Study is the direct observation of a task as it is performed at the job site by a trained time study analyst. It is a method used to determine the time required for a worker to complete a task under specific conditions. It involves direct observation and timing of the task, with adjustments for performance rating and allowances for fatigue and delays. The purpose of direct time study is to establish accurate and fair time standards that can be used for planning, scheduling, and improving productivity.

1. Time study is appropriate for manual work that can be physically observed by an analyst.
2. Time study is appropriate for repetitive tasks that can usually be done in 15 minutes or less.
3. Time study is appropriate for tasks that are repeated in a cyclical pattern over an extended period.
4. Time study is the most versatile and the most widely used work measurement technique. Figure 9.1 shows an example of a time study record.

Your Name: Example A
Time Study Record
Ink, Inc.

1 to 10 = Each Individual Time
11 = Total of all Times
12 = Number of Time Values
13 = Average (11 divided by 12)
14 = Rating Factor (90% = 0.90, 100% = 1.00, 110% = 1.10)
15 = Base Time (13 multiplied by 14)
16 = Frequency (1 = every cycle, 1/10 = once per 10 cycles)
17 = Normal Time (15 multiplied by 16)

Element Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Time	Time	Time	Time	Time	Time	Time	Time	Time	Time	Total	No.	Avg.	Rate	Base	Freq.	Norm.
Put Marker into a Retail Box	6.90	9.85 T	6.75	7.04	7.32	6.04 D	6.81				34.82	5	6.964	.95	6.616	1	6.62
Put Retail Box of 4 Markers into a Master Box	5.52	6.38									11.90	2	5.950	1.15	6.843	1/4	1.71
Push Master Box of 10 Retail bxs onto Conveyor	14.40										14.40	1	14.400	1.00	14.400	1/40	0.36
T = Tighten =	(9.85	-6.964)	=								2.886	1	2.886	.95	2.742	1/7	0.39
D = Discard =											6.04	1	6.040	.95	5.738	1/7	0.82

Operation: Box Markers
Operator:
Equipment: Manual Operation
Date:
Elapsed Time: 70.01 Seconds

Foreign Element Letter Codes and Explanations:
4 Markers per Retail Display Box.
10 Boxes (or 40 Markers) per Master Shipping Box.
T = Tighten Cap and Put Marker in Box.
D = Discard Defective Marker into Trash Can.

Total Normal Time =	9.90
12 % P, F, and D =	1.19
Total Standard Time =	11.09

Standard Time Per: **Marker**

All time values are in Seconds.

Figure 9.1. Example of a Time Study Record

9.1 Steps in Direct Time Study

The general steps involved in performing a time study are as follows:

1. **Select the Task**: Identify the specific task to be studied.
2. **Define the Work Elements**: Break down the task into distinct work elements or steps.
3. **Record Observations**: Use a stopwatch to measure the time taken for each element.
4. **Evaluate Performance**: Assess the worker's pace relative to a standard.
5. **Calculate Normal Time**: Adjust observed times based on performance ratings.
6. **Determine Allowances**: Add allowances for fatigue, personal needs, and delays.
7. **Calculate Standard Time**: Combine normal time and allowances to get the standard time.

9.2 Definitions

Time Study Record (or Worksheet): A data collection form that contains all the necessary information that is required to compute how long it should take to perform a specific task. An example of a Time Study Record form appears in the Ink, Inc. - Example A above.

Column Number: Refers to the number at the top of each column on the Time Study Record form.

Sample Size: The minimum number of observations required to achieve a statistically accurate result. The equations for computing the minimum sample size will be discussed in a future module assignment. To observe enough total cycles, the analyst may conduct Time Studies on several different days to increase the chance of capturing any unusual events that may occur. Each future Time Study should be recorded on a new Time Study Record.

Element Description: A brief description of one small step in the entire job sequence as performed by the employee. This brief element description is shown in the column on the left side of the Time Study Record form.

Element Times (Columns 1 to 10): The actual stopwatch time that corresponds to how long it took the employee to execute one repetition of that element. The time to make the first part is recorded in column 1. The time to make the second part is recorded in column 2. And so on. If more than 10 parts are observed then the time for part number 11 is recorded on the Time Study Record directly below the time for the first part.

Total Time (Column 11): The sum of all the individual times for one element in the entire job sequence.

Number (Column 12): The actual number of observations for that element that were observed by the time study analyst during a single time study and that have not been circled due to unusual work conditions called foreign elements.

Foreign Element: A brief description of any foreign elements is shown at the bottom of the form in the center. A detailed discussion of foreign elements appears later in this module assignment.

Average Time (Column 13 = Column 11 divided by Column 12): The simple arithmetic average of all the recorded times for an element (the mathematical mean).

Rating Factor (Column 14): The evaluation of an employee's actual performance in relationship to the analyst's impression of what the normal, average speed for doing the job should be. The rating factor is recorded on the time study form as the job is being observed. Performance rating has already been discussed in a previous module assignment.

Base Time (Column 15 = Column 13 multiplied by Column 14)): The average time for an element multiplied by that element's performance rating factor.

Frequency (Column 16): The frequency is based on the unit of measure for the job. Frequency refers to how often that element should happen, on the average, when compared to the other elements in the Time Study.

Normal Time (Column 17 = Column 15 multiplied by Column 16)): The base time for an element adjusted by the appropriate frequency for that element.

Personal, Fatigue, and Delay (P,F, and D) (Bottom of Time Study Record Form): The additional time required during the course of a normal work day for the employee to attend to their normal personal needs (personal time), and the normal decrease in

productivity due to the passage of time (fatigue time), and the minor interruptions in a person's normal work duties due to a variety of different factors (delay time). The procedure for calculating P,F, and D allowances will be discussed in a future module assignment.

Total Standard Time (Bottom of Time Study Record Form = Sum of Column 17 plus the P,F, and D Allowance): The sum of all the normal times for all the elements plus the appropriate P,F, and D allowances for that job. The total standard time is how long it should take the average trained employee working at a normal pace and with normal effort to perform the task using the standard method.

9.3 Time Study Equipment

1. Stopwatch calibrated in 1/1000 of a minute, or in seconds.
2. Time Study Record forms.
3. Clipboard, pencil, and tape measure.
4. When appropriate, a tachometer or other gauge for determining machine speeds, feed rates, or other critical machine parameters.

9.4 Snapback Time Study

The stopwatch is started at the beginning of the first element in the study. At the end of each individual element, the stopwatch is read and snapped back to zero. The actual elapsed time for that one element is then recorded on the time study form. The most common problem with this technique is snapping the watch either too soon or too late for individual elements. The total time will still be accurate but the average times for the individual elements will be incorrect. At the end of the study, the total elapsed time is read from the watch, and it is recorded at the bottom of the Time Study Record form.

9.5 Continuous Time Study

The stopwatch is zeroed at the beginning of the first cycle and allowed to run continuously throughout the duration of the study. The analyst records the running time on the stopwatch at the end of each respective element. Some analysts prefer to adapt the continuous method by zeroing at the beginning of each work cycle, so that the starting time of any given work cycle is always zero.

9.6 General Time Study Procedure

The general time study procedure is outlined as follows:

1. Pick a job to time study based on any of the following:
    a. Employee request
    b. Supervisor request
    c. Management request
    d. Part of a larger project
    e. Time for a routine audit
    f. Searching for an area of potential improvement

2. Discuss the job with the section supervisor. Have the supervisor suggest a person to observe. Introduce yourself to the employee or have the supervisor introduce you. Explain the reason for the study. Try to get the employee to perform the work as he or she normally would.

3. Verify the employee is following the standard method.

4. Record the generic data about the job (type of equipment, speeds, tools, materials, etc.).

5. If appropriate, draw a simple sketch of the work area on the back of the Time Study Record form.

6. Observe the job and divide it into logical elements.

7. Watch the employee perform the job and record the actual time taken by the employee for each element.

8. Rate each element individually.

9. Continue to collect data on the operation for several complete cycles of the job.

10. Compute the base time to do each element of the job.

11. Compute the normal time for each element based on the frequency of that element in relationship to the appropriate unit of measure for the job.

12. Add the appropriate allowances and compute the total standard time to do the job.

Based on the results of a single Time Study, the time study analyst could do the following:

1. Determine the total number of cycles to observe based on the desired confidence level.
2. Continue timing the job until enough cycles have been observed.
3. Based on the results of all the Time Studies compute the engineered standard time to perform the job.
4. Compute each employee's productivity from each Time Study based on the new engineered standard time.
5. Have the new standard time approved and publish it.
6. Put all supporting Time Study materials in a historical file for future reference.

9.7 How to Collect Time Study Data

Time Studies are usually done at the job site where the operation is currently being performed.

1. Prepare your video recording device (camcorder, smartphone, iPad, etc.) for recording.
2. Observe the employee performing the task enough times to gain familiarity with the work elements involved and what constitutes a normal worker pace.
3. Video the entire process or task.
4. Break down the video into separate and distinct work elements.
5. Record the work element times on the time study worksheet.
7. Long elements can be timed by themselves one at a time.
8. Short elements can be timed in groups (3, 4, or more at a time).
9. Foreign elements should be coded and computed at the end of the study.

9.8 Time Study Equipment

With direct time study, the time study analyst directly observes the worker performing a task and the equipment used by the analyst can range from a stopwatch to video camera to computerized time study techniques.

9.8.1 Stopwatch Time Study

A traditional time study consists of a stopwatch and a time study worksheet on which to record observed time values. Alternatives to the stopwatch include a wristwatch, stopwatch features on a wristwatch or iPad, or a wall clock. The time study worksheet and stopwatch are typically held on a clipboard. Mechanical stopwatches are graduated in any of three time measurement scales: (1) decimal minutes, (2) decimal hours, or (3)

TMUs (or time measurement units such that 1 TMU = 0.00001 hour = 0.036 seconds. Conversely, 1 second = 27.8 TMUs). Different scales are used because organizations have adopted different units to convey their time standards. An example of a mechanical stopwatch is shown in Figure 9.2. Digital stopwatches have largely replaced mechanical stopwatches because: (1) they provide a digital display of time, (2) are easier to read than reading tick marks on graduated scales, (3) reading errors are less frequent, and (4) some digital stopwatches can be switched back and forth between different time scales. An example of a digital stopwatch is shown in Figure 9.3.

Figure 9.2. A mechanical stopwatch.

Figure 9.3. A digital stopwatch

9.8.2 Video Recorded Time Study

Video recording devices, such as a camcorder, an iPad, or smartphone, have become very popular among time study analysts because they can obtain the entire visual and audio elements of the task performed by the worker. The time study analyst can then break down the video and conduct a time study, advancing the video forward or reverse, as needed. Videos typically have a clock feature running when the video is being played. Recorded videos allow many advantages over traditional stopwatch studies, such as having a video record of the task that led to the computation of the standard time, discovery of possible improvements in the task, observation of cycle-to-cycle variations, and perhaps a more objective assessment of worker performance ratings.

9.8.3 Computerized Time Study

An optimal computerized work measurement system sets time standards for a task in advance, such as predetermined motion time systems (PMTS) or standard data systems (SDS). The two principal goals of a computerized time study are:

1. The system should have the capability of setting a time standard for a task as well as a description of the methods used in the performance of the task.

2. The computerized work measurement system should include a database of empirical time standards as well as a means for maintaining those time standards.

9.9 Factors that Influence the Accuracy of the Standard Time

It is important to document the standard method as precisely and thoroughly as possible for the following reasons:

1. To distinguish if the worker has made methods changes that might justify the need for retiming the task and determining a new time standard.
2. To provide work instructions for future batches.
3. As a reference document (i.e., SOP) to settle disputes between management and the worker.
4. To provide data to the standard data system that might be used in the future.

Factors that influence the accuracy of the standard time include:

1. The efficiency of the employee being observed in relation to the analyst's ability to correctly rate that level of performance.
2. The conditions under which the study is made:
    a. How the equipment is doing
    b. Raw material quality
    c. Fatigue of the employee
3. The way the job is divided into elements.
4. The number of cycles observed.
5. The Student t distribution is used in the calculation of the number of work cycles rather than the normal distribution because the sample size in direct time study is usually smaller than 30.

9.10 Irregular Elements

An **irregular element** is an element performed with a frequency of less than once per cycle. Examples of irregular work elements include periodic changing of tools (i.e., changing a knife blade) and replacing tote pans or pallet loads of parts when containers become full.

9.11 Foreign Elements

A **foreign element** is an unusual element that occurs during a normal work element. When observed, foreign elements are noted with a code letter beside or above or below the time value, and the code letter is explained elsewhere on the time study form.

9.11.1 Examples of some common foreign elements:

F = A fumble which lengthens the normal work cycle.
P = A personal movement, such as scratching the ear.
M = A minor adjustment to the machine or equipment.
R = A repair or rework.
S = Replenishing supplies.
... = Any other unusual work element.

The above are only examples. The time study analyst may select any letter to represent any foreign element.

9.12 Computing Foreign Elements

1. Note the unusual element on the time study form.
2. Compute the average time for the other cycles of that element with the unusual element omitted.
3. If appropriate, deduct the average element time from the foreign element time to yield the additional time required for the foreign element. This would be appropriate if the foreign element occurred during a regular work cycle and the foreign element time also included a regular work cycle time. However, if the foreign element time does **not** include the time for a normal work element, then use the time as originally observed.
4. Multiply by the rating factor to yield the base time for the foreign element.
5. Determine the frequency of occurrence for the foreign element and adjust by that frequency to yield the normal time per cycle.

9.13 Reasons for Omitting an Element

You **must** have a reason to omit an element as a foreign element. Some common reasons for omitting a foreign element are as follows:

1. The element is paid for in another part of the standard (such as personal time).
2. The foreign element does not belong in the standard (such as machine down time).

3. The time is outside the normal range of times for the element (too high or too low) and the analyst could not determine why at the time of the study (analyst error).

Circle element times that are to be omitted from inclusion in the standard time, or that are to be treated uniquely in the calculation of the standard time.

Do **not** circle an element just because it is unusually large or small in comparison to other times.

Example 1. Time Study Record Examples A, B, and C

Brief Overview of the Business Operation at Ink, Inc.

Ink, Inc. makes Felt Tip Marking Pens. The company manufactures Markers one at a time in a continuous manufacturing process.

Four individual Markers are put into one Retail Display Box because the Retail Stores sell the Markers four at a time inside one Retail Box.

Ten Retail Display Boxes are put inside one cardboard Shipping Carton. The Retail Stores order an entire Shipping Carton (Master Box) of Markers each time they place an order. The cardboard Master Box protects the Boxed Markers while in transit to the Retail Store. When the Retail Store receives the Master Box, they open the Master Box, transfer the ten Retail Display Boxes onto their Retail Display Rack, and then they discard then break down and recycle the Master Box.

Brief Explanation of the Information on the Time Study Record Examples

The above generic capacity information is recorded at the bottom center of the Time Study Record. The final operation on these Markers is called **Box Markers** and it is done by the operator. This is a manual boxing operation, and no production equipment is required. The Time Study Record for One Marker is shown in Figure 9.4.

Your Name: Example A
Time Study Record
Ink, Inc.

1 to 10 = Each Individual Time
11 = Total of all Times
12 = Number of Time Values
13 = Average (11 divided by 12)
14 = Rating Factor (90% = 0.90, 100% = 1.00, 110% = 1.10)
15 = Base Time (13 multiplied by 14)
16 = Frequency (1 = every cycle, 1/10 = once per 10 cycles)
17 = Normal Time (15 multiplied by 16)

Element Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Time	Time	Time	Time	Time	Time	Time	Time	Time	Time	Total	No.	Avg.	Rate	Base	Freq.	Norm.
Put Marker into a Retail Box	6.90	9.85 T	6.75	7.04	7.32	6.04 D	6.81				34.82	5	6.964	.95	6.616	1	6.62
Put Retail Box of 4 Markers into a Master Box	5.52	6.38									11.90	2	5.950	1.15	6.843	1/4	1.71
Push Master Box of 10 Retail bxs onto Conveyor	14.40										14.40	1	14.400	1.00	14.400	1/40	0.36
T = Tighten =	(9.85	-6.964)	=								2.886	1	2.886	.95	2.742	1/7	0.39
D = Discard =											6.04	1	6.040	.95	5.738	1/7	0.82

Operation: Box Markers
Operator:
Equipment: Manual Operation
Date:
Elapsed Time: 70.01 Seconds

Foreign Element Letter Codes and Explanations:
4 Markers per Retail Display Box.
10 Boxes (or 40 Markers) per Master Shipping Box.
T = Tighten Cap and Put Marker in Box.
D = Discard Defective Marker into Trash Can.

Total Normal Time =	9.90
12 % P, F, and D =	1.19
Total Standard Time =	11.09

Standard Time Per: **Marker**

All time values are in Seconds.

Figure 9.4. Time Study Record of Ink, Inc. – Example A: per Marker

The first step was to create logical elements for the Time Study data. The brief **Element Descriptions** that appear in the left column on the Time Study Record are more fully explained as follows:

Put Marker into a Retail Box: The operator picks up one Marker at a time from the Incoming Conveyor and puts it into a Retail Display Box. The Retail Display Box will hold four Markers. Each individual element time represents the time required to pick up one Marker from the Incoming Conveyor and put it inside a Box.

Put full Box of 4 Markers into a Carton: After a Retail Display Box has been filled with four Markers, the operator closes the top lid of the Box and places the full Box of Four Markers into a cardboard Master Box. The cardboard Master Box will hold a total of 10 Retail Display Boxes, which is equal to 40 Markers (4 Markers per Box multiplied by 10 Boxes).

Push Full Carton of 10 Boxes onto Conveyor: After a cardboard Master Box has

been filled with Ten Retail Display Boxes, the operator closes the top of the Carton, tapes the top of the Carton shut, and then pushes the full Carton onto the Outgoing Conveyor that leads to the Shipping Warehouse. The operator then transfers the next empty cardboard Master Box onto his workstation.

Foreign Elements: If anything unusual occurred, then a Code Letter is written on the Time Study Record below the time value in the same block, and a brief description of that foreign element was added to the bottom center of the Time Study Record. Following is a more detailed description of the two foreign elements that have been circled on the Time Study Record:

T = Tighten Cap and Put Marker in Box: The operator noticed that the cap was loose on top of the Marker and, therefore, the operator took the time to properly tighten the cap onto the Marker before she put the Marker into the box. There was nothing else wrong with this Marker and the operator was able to salvage the unit and create a first-quality Marker that could be sold to a future customer.

D = Discard Defective Marker into Trash Can: The operator noticed that the barrel on the Marker was cracked, and that the Marker could not be salvaged. Therefore, instead of putting the bad Marker into a Box the operator put the bad Marker into a trash can. This prevented the bad Marker from being sold to a future customer.

First Element: Put Marker into a Retail Box

Explanation of the Data in Columns 11, 12, 13, 14, 15, 16, and 17

Put Marker into a Retail Box: There were seven individual time values but two of those time values were circled and were treated as foreign elements. This left five good time values for the first element.

Column 11: The Total Column is the sum of the five good time values for the first element as follows: 34.82 = 6.90 + 6.75 + 7.04 + 7.32 + 6.81

Column 12: The No. Column indicates the number of good time values for the first element that were used to calculate the total that is shown in Column 11. Five time values were used so the number in Column 12 is Five (5).

Column 13: The Avg. Column is the average of the five good times values for the first element shown to three decimal places as follows: 6.964 = (34.82) divided by (5).

Column 14: The Rate value was added when the Time Study data was collected.

In the Time Study analyst's opinion, the operator was working at approximately 95% (0.95) of the speed that a normal, average trained operator should be working when doing this first element.

Column 15: The Base value is the Average Time in Column 13 multiplied by the Performance Rating Factor in Column 14 and shown to three decimal places as follows: 6.616 = (6.964) multiplied by (.95)

Column 16: The Freq. Column represents the frequency for that element based on the **Unit of Measure** for this study.

On the bottom right of the Time Study Record it shows the **Standard Time Per: Marker.**

This means that the Time Study will be summarized so the Total Standard Time represents the Total Standard Time it takes to make One Marker.

All the time values must be prorated into the time on a per Marker basis.

Since the first element is the correct time for One Marker, the frequency for the first element is One (1).

Column 17: The Norm. Column represents the Normal Time for the Element based on the appropriate **Unit of Measure.**

The Normal Time is Column 15 multiplied by Column 16 and rounded to two decimal places as follows: 6.62 = (6.616) multiplied by (1) and rounded to two decimal places

Second Element: Put Full Retail Box of 4 Markers into a Master Box

Explanation of the Data in Columns 11, 12, 13, 14, 15, 16, and 17

Put Full Retail Box of 4 Markers into a Master Box: This element was observed twice by the Time Study analyst, so there are two time values recorded beside this element.

Column 11: The Total Column is the sum of the two time values for the second element as follows: 11.90 = 5.52 + 6.38

Column 12: The No. Column indicates the number of time values for the second element that were used to calculate the total that is shown in Column 11. Two time values were used so the number in Column 12 is Two (2).

Column 13: The Avg. Column is the average of the times values for the second element shown to three decimal places as follows: 5.950 = (11.90) divided by (2)

Column 14: The Rate value was added when the Time Study data was collected. In the Time Study analyst's opinion, the operator was working at approximately 115% (1.15) of the speed that a normal, average trained operator should be working when doing this second element.

Column 15: The Base value is the Average Time in Column 13 multiplied by the Performance Rating Factor in Column 14 and shown to three decimal places as follows: 6.843 = (5.950) multiplied by (1.15)

Column 16: The Freq. Column represents the frequency for that element based on the **Unit of Measure** for this study.

On the bottom right of the Time Study Record it shows the **Standard Time Per: Marker.**

This means that the Time Study will be summarized so the Total Standard Time represents the Total Time it takes to make One Marker.

All the time values must be prorated into the time on a per Marker basis.

Since the second element is the correct time for a Retail Box of Four Markers, the frequency for the second element is one-fourth (1/4).

This frequency indicates that this work element occurs one time for every four markers.

Column 17: The Norm. Column represents the Normal Time for the Element based on the appropriate **Unit of Measure.** The Normal Time is Column 15 multiplied by Column 16 and rounded to two decimal places as follows: 1.71 = (6.483) multiplied by (1/4) and rounded to two decimal places

Third Element: Push Full Master Box of 10 Retail Boxes onto Conveyor

Explanation of the Data in Columns 11, 12, 13, 14, 15, 16, and 17

Push Full Master Box of 10 Retail Boxes onto Conveyor: This element was only observed once by the Time Study analysis so there is only one time value recorded beside this element.

Column 11: The Total Column is the sum of the only time value for the third element as follows: 14.40 = 14.40

Column 12: The No. Column indicates the number of time values for the third element that were used to calculate the total that is shown in Column 11. One time value was used so the number in Column 12 is One (1).

Column 13: The Avg. Column is the average of the times values for the third element shown to three decimal places as follows: 14.400 = (14.40) divided by (1)

Column 14: The Rate value was added when the Time Study data was collected. In the Time Study analyst's opinion, the operator was working at approximately 100% (1.00) of the speed that a normal, average trained operator should be working when doing this third element.

Column 15: The Base value is the Average Time in Column 13 multiplied by the Performance Rating Factor in Column 14 and shown to three decimal places as follows: 14.400 = (14.400) multiplied by (1.00)

Column 16: The Freq. Column represents the frequency for that element based on the **Unit of Measure** for this study.

On the bottom right of the Time Study Record it shows the **Standard Time Per: Marker.**

This means that the Time Study will be summarized so the Total Standard Time represents the Total Time it takes to make One Marker.

All the time values must be prorated into the time on a per Marker basis.

Since the third element is the correct time for a Master Box of 40 Markers, the frequency for the third element is one-fortieth (1/40).

This frequency indicates that this element occurs one time for every 40 markers.

Column 17: The Norm. Column represents the Normal Time for the Element based on the appropriate **Unit of Measure.** The Normal Time is Column 15 multiplied by Column 16 and rounded to two decimal places as follows: 0.36 = (14.400) multiplied by (1/40)

Foreign Element: T = Tighten Cap and Put Marker in Box
Explanation of the Data in Columns 11, 12, 13, 14, 15, 16, and 17

T = Tighten Cap and Put Marker in Box: This element was only observed once by the Time Study analyst, so there is only one time value recorded beside this element. This element was a foreign element that occurred during the first work element, so the time value has been circled on the Time Study Record

Column 11: The Total Column is the net time value for this foreign element. The foreign element includes the extra time to Tighten the Cap in addition to the usual time of putting the Marker in the Retail Box.

Therefore, the average time for putting the Marker in the Retail Box must be subtracted from the observed time to yield the extra time for just Tightening the Cap as follows:

The extra time to perform the 'Tighten' foreign element can be rounded to three decimal places, or 2.886, in the following calculation: 2.886 = (9.85) minus (6.96)

Column 12: The No. Column indicates the number of times this foreign element was observed to calculate the total that is shown in Column 11. One time value was used so the number in Column 12 is One (1).

Column 13: The Avg. Column is the average of the times values for the foreign element shown to three decimal places as follows: 2.886 = (2.886) divided by (1)

Column 14: The Rate value was added when the Time Study data was collected. In the Time Study analyst's opinion, the operator was working at approximately 95% (.95) on the first element, so this is also the rating that will be used for this foreign element.

Column 15: The Base value is the Average Time in Column 13 multiplied by the Performance Rating Factor in Column 14 and shown to three decimal places as follows: 2.742 = (2.886) multiplied by (.95)

Column 16: The Freq. Column represents the frequency for the foreign element based on the **Unit of Measure** for this study. This foreign element occurred one time per seven Markers in the first work element, so the Frequency is 1/7.

On the bottom right of the Time Study Record it shows the **Standard Time Per: Marker.**

This means that the Time Study will be summarized so the Total Standard Time represents the Total Time it takes to make One Marker.

All the time values must be prorated into the time on a per Marker basis.
There were seven markers in the study with the following results:

1. Five Markers were good Markers, and they required no corrective action.
2. One Marker had a loose Cap and it had to be Tightened. Tightening the Cap made this Marker a good Marker.
3. One Marker was defective, and it was Discarded into a Trash Can.

There was one Marker that required the cap to be tightened and put back into the population of good Markers. Since this foreign element (Tighten cap) occurred one time per seven Markers, the frequency for this foreign element is one-seventh (1/7).

(**Frequency Note:** This estimate of 1/7 is based on the actual data in this one Time Study. This estimate will not be revised on this Time Study. However, this estimate will be different for future Time Studies because those studies will use the data collected on those studies. The final Summary of all the Time Studies will include a weighted average from all the time studies to compute a final weighted average frequency for this foreign element.)

Column 17: The Norm. Column represents the Normal Time for this foreign element based on the appropriate **Unit of Measure.** The Normal Time is Column 15 multiplied by Column 16 and rounded to two decimal places as follows: 0.39 = (2.742) multiplied by (1/7) and rounded to two decimal places.

Foreign Element: D = Discard Defective Marker into Trash Can
Explanation of the Data in Columns 11, 12, 13, 14, 15, 16, and 17

D = Discard Defective Marker into Trash Can: This element was only observed once by the Time Study analyst, so there is only one time value recorded beside this element. This element was a foreign element that occurred during the first work element, so the time value has been circled on the Time Study Record

Column 11: The Total Column is the net time value for this foreign element.
The foreign element does **not** include the usual time of Putting the Marker in the Box.
The time for this element only includes the time to put the Marker into a Trash Can.

Therefore, the average time for putting the Marker in the Box is **not** subtracted from the observed time. Hence, 6.04 = 6.04

Column 12: The No. Column indicates the number of times this foreign element was observed to calculate the total that is shown in Column 11. One time value was used so the number in Column 12 is One (1).

Column 13: The Avg. Column is the simple arithmetic average of the times values for the foreign element shown to three decimal places as follows: 6.040 = (6.04) divided by (1)

Column 14: The Rate value was added when the Time Study data was collected. In the Time Study analyst's opinion, the operator was working at approximately 95% (.95) on the first element, so this is also the rating that will be used for this foreign element.

Column 15: The Base value is the Average Time in Column 13 multiplied by the Performance Rating Factor in Column 14 and shown to three decimal places as follows: 5.738 = (6.040) multiplied by (.95)

Column 16: The Freq. Column represents the frequency for the foreign element based on the **Unit of Measure** for this study. This foreign element occurred one time per seven Markers in the first work element, so the Frequency is 1/7.

On the bottom right of the Time Study Record it shows the **Standard Time Per: Marker.**

This means that the Time Study will be summarized so the Total Standard Time represents the Total Time it takes to make One Marker.

All the time values must be prorated into the time on a per Marker basis.

There were seven markers in the study with the following results:

1. Five Markers were good Markers, and they required no corrective action.
2. One Marker had a loose Cap and it had to be Tightened. Tightening the Cap made this Marker a good Marker.
3. One Marker was defective, and it was Discarded into a Trash Can.

There was one defective Marker that was discarded into the trash can. Since this foreign element (Discard Marker) occurred one time per seven Markers, the frequency

for this foreign element is one-seventh (1/7).

(**Frequency Note:** This estimate of 1/7 is based on the actual data in this one Time Study. This estimate will not be revised on this Time Study. However, this estimate will be different for future Time Studies because those studies will use the data collected on those studies. The final Summary of all the Time Studies will include a weighted average from all the time studies to compute a final weighted average frequency for this foreign element.)

Column 17: The Norm. Column represents the Normal Time for this foreign element based on the appropriate **Unit of Measure.** The Normal Time is Column 15 multiplied by Column 16 and rounded to two decimal places as follows: 0.82 = (5.738) multiplied by (1/7) and rounded to two decimal places

Explanation of the Three Totals on the Bottom Right Side of Example A

Example A in Figure 9.4 is reproduced here and computes the Standard Time per Marker = 11.09 Seconds.

Your Name: Example A
Time Study Record
Ink, Inc.

1 to 10 = Each Individual Time	14 = Rating Factor (90% = 0.90, 100% = 1.00, 110% = 1.10)
11 = Total of all Times	15 = Base Time (13 multiplied by 14)
12 = Number of Time Values	16 = Frequency (1 = every cycle, 1/10 = once per 10 cycles)
13 = Average (11 divided by 12)	17 = Normal Time (15 multiplied by 16)

Element Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Time	Time	Time	Time	Time	Time	Time	Time	Time	Time	Total	No.	Avg.	Rate	Base	Freq.	Norm.
Put Marker into a Retail Box	6.90	9.85 T	6.75	7.04	7.32	6.04 D	6.81				34.82	5	6.964	.95	6.616	1	6.62
Put Retail Box of 4 Markers into a Master Box	5.52	6.38									11.90	2	5.950	1.15	6.843	1/4	1.71
Push Master Box of 10 Retail bxs onto Conveyor	14.40										14.40	1	14.400	1.00	14.400	1/40	0.36
T = Tighten =	(9.85	-6.964)	=								2.886	1	2.886	.95	2.742	1/7	0.39
D = Discard =											6.04	1	6.040	.95	5.738	1/7	0.82

Operation: Box Markers
Operator:
Equipment: Manual Operation
Date:
Elapsed Time: 70.01 Seconds

Foreign Element Letter Codes and Explanations:
4 Markers per Retail Display Box.
10 Boxes (or 40 Markers) per Master Shipping Box.
T = Tighten Cap and Put Marker in Box.
D = Discard Defective Marker into Trash Can.

Total Normal Time =	9.90
12 % P, F, and D =	1.19
Total Standard Time =	11.09

Standard Time Per: **Marker**

All time values are in Seconds.

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Figure 9.4. Time Study Record of Ink, Inc. – Example A: per Marker

Total Normal Time: This is the sum of all the time values in Column 17 as follows: 9.90 = (6.62) + (1.71) + (0.36) + (0.39) + (0.82)

12% P, F, and D: In most cases a Time Study is for a short duration of time at the actual workstation where the employee does his or her normal job. The Time Study will, therefore, while it includes the Normal Time it takes to do the employee's job, each employee also needs additional time for Personal, Fatigue, and Delay activities.

The P, F, and D Allowance is usually expressed as a percentage. However, when used in the equations, it is expressed as a decimal value.

The P, F, and D values for manufacturing operations can vary from 10% to 20%.

In this Example the percentage is set at 12% (0.12). This percentage may be different in different examples. The P, F, and D Time is the Total Normal Time multiplied by the P, F, and D decimal value. Therefore, the value on this line is determined as follows: 1.19 = (9.90) multiplied by (0.12).
Total Standard Time: This is the sum of the Total Normal Time plus the P, F, and D Allowance as follows: 11.09 = (9.90) + (1.19)

This is the **Standard Time per Marker.**

In other words, it would take the average trained employee approximately 11.09 seconds to do the operation **Box Markers** when the time is computed on a **Per Marker** basis**.**

Explanation of Example B and Example C

Example B in Figure 9.5 computes the Standard Time per Box of 4 Markers = 44.34 Seconds.

Your Name: Example B
Time Study Record
Ink, Inc.

1 to 10 = Each Individual Time	14 = Rating Factor (90% = 0.90, 100% = 1.00, 110% = 1.10)
11 = Total of all Times	15 = Base Time (13 multiplied by 14)
12 = Number of Time Values	16 = Frequency (1 = every cycle, 1/10 = once per 10 cycles)
13 = Average (11 divided by 12)	17 = Normal Time (15 multiplied by 16)

Element Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Time	Time	Time	Time	Time	Time	Time	Time	Time	Time	Total	No.	Avg.	Rate	Base	Freq.	Norm.
Put Marker into a Retail Box	6.90	9.85 T	6.75	7.04	7.32	6.04 D	6.81				34.82	5	6.964	.95	6.616	4	26.46
Put Retail Box of 4 Markers into a Master Box	5.52	6.38									11.90	2	5.950	1.15	6.843	1	6.84
Push Master Box of 10 Retail bxs onto Conveyor	14.40										14.40	1	14.400	1.00	14.400	1/10	1.44
T = Tighten =	(9.85	-6.964)	=								2.886	1	2.886	.95	2.742	4/7	1.57
D = Discard =											6.04	1	6.040	.95	5.738	4/7	3.28

Operation: Box Markers	Foreign Element Letter Codes and Explanations:	Total Normal Time =	39.59
Operator:	4 Markers per Retail Display Box.	12 % P, F, and D =	4.75
Equipment: Manual Operation	10 Boxes (or 40 Markers) per Master Shipping Box.	Total Standard Time =	44.34
Date:	T = Tighten Cap and Put Marker in Box.		
Elapsed Time: 70.01 Seconds	D = Discard Defective Marker into Trash Can.	Standard Time Per: **Box of 4**	
	All time values are in Seconds.	Copyright © 2025 by Robert S. Keyser, PhD	

Figure 9.5. Time Study Record of Ink, Inc. – Example B: per Retail Box of 4 Markers

Example C in Figure 9.6 computes the Standard Time per Carton of 40 Markers = 443.44 Seconds.

Your Name: Example C
Time Study Record
Ink, Inc.

1 to 10 = Each Individual Time	14 = Rating Factor (90% = 0.90, 100% = 1.00, 110% = 1.10)
11 = Total of all Times	15 = Base Time (13 multiplied by 14)
12 = Number of Time Values	16 = Frequency (1 = every cycle, 1/10 = once per 10 cycles)
13 = Average (11 divided by 12)	17 = Normal Time (15 multiplied by 16)

Element Description	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	Time	Time	Time	Time	Time	Time	Time	Time	Time	Time	Total	No.	Avg.	Rate	Base	Freq.	Norm.
Put Marker into a Retail Box	6.90	9.85 T	6.75	7.04	7.32	6.04 D	6.81				34.82	5	6.964	.95	6.616	40	264.64
Put Retail Box of 4 Markers into a Master Box	5.52	6.38									11.90	2	5.950	1.15	6.843	10	68.43
Push Master Box of 10 Retail bxs onto Conveyor	14.40										14.40	1	14.400	1.00	14.400	1	14.40
T = Tighten =	(9.85	-6.964)	=								2.886	1	2.886	.95	2.742	40/7	15.67
D = Discard =											6.04	1	6.040	.95	5.738	40/7	32.79

Operation: Box Markers
Operator:
Equipment: Manual Operation
Date:
Elapsed Time: 70.01 Seconds

Foreign Element Letter Codes and Explanations:
4 Markers per Retail Display Box.
10 Boxes (or 40 Markers) per Master Shipping Box.
T = Tighten Cap and Put Marker in Box.
D = Discard Defective Marker into Trash Can.

Total Normal Time =	395.93
12 % P, F, and D =	47.51
Total Standard Time =	443.44

Standard Time Per: **Master Box of 40**

All time values are in Seconds.

Figure 9.6. Time Study Record of Ink, Inc. – Example C: per Master Box of 40 Markers

In all three Examples the original Time Study Record data is the same. All the numbers in the three examples are the same from Column 1 through Column 15. The three examples are unique because of the values in Columns 16 and 17, and the Totals at the bottom of the form. By changing the frequency value in Column 16, the answer in Column 17 is changed and this changes the total at the bottom of the page.

Table 9.1 shows the difference in the Column 16 frequency values for each of the three Examples.

Table 9.1. Results for Ink, Inc. Examples A-C.

	Per Marker	Per Retail Box of 4	Per Master Box of 40
Element Description	**Example A, Column 16**	**Example B, Column 16**	**Example C, Column 16**
Marker into Retail Box	1	4	40
Retail Box into Master Box	1/4	1	10
Master Box onto Conveyor	1/40	1/10	1
T = Tighten	1/7	4/7	40/7
D = Discard	1/7	4/7	40/7

Before you summarize a Time Study Record form you should first determine how the company is going to use the data that you provide.

1. If the company quotes its prices to its customers on a Per Marker basis, then Example A would be correct.
2. If the company quotes its prices to its customers for a Retail Box of 4 Markers, then Example B would be correct.
3. If the company quotes it prices to its customers for a Master Box of 40 Markers, then Example C would be correct.

9.15 Summary

Direct time studies play a crucial role in setting accurate time standards by providing empirical data on task durations. While they offer high accuracy and detailed insights, they also involve subjectivity, are time-consuming to perform, and are resource intensive. Compared with other work measurement techniques, direct time studies are particularly beneficial for tasks requiring detailed analysis and precision, despite their inherent challenges. Understanding these advantages and disadvantages helps in selecting the most appropriate method for establishing time standards in various production environments.

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References

[1] Atkins, R.W. *Work Measurement and Ergonomics*, Grandpappy, Inc., 2019.

[2] Groover, M.P. *Work Systems and the Methods, Measurement, and Management of Work*, Upper Saddle River, NJ: Pearson Prentice Hall, 2007.