WORK SAMPLING

IENG 301

FUNDAMENTALS OF WORK STUDY AND ERGONOMICS

Work Sampling

- Work Sampling is a fact finding tool. In many cases, needed information about men or machines can be obtained in less time and at lower cost by this method than by other means.

Work Sampling has three main uses:

1. Activity and Delay Sampling
   - To measure the activities and delays of workers or machines (e.g. to measure the percentage of the day that a person is working or not working).
2. Performance Sampling
   - To measure working time and nonworking time of a person on a manual task, and to establish a ***performance index*** or performance level for the person during his or her working time.
3. Work Measurement
   - To establish a time standard for an operation.

Work Sampling

- Work Sampling is based upon the laws of probability. A sample taken at random from a large group tends to have the same pattern of distribution as the large group or universe. If the sample is large enough, the characteristics of the sample will differ but little from the characteristics of the group.
  - Sample: is the term used for this small number
  - Population or Universe: is the term used for large group
  - Sampling: Obtaining and analyzing only a part of the universe

Example 1

- Working: 36 observations
- Idle: 4 observations
- Total: 40 observations

Percentage of;

- Idle time = (4/40 x 100) = 10%
- Working time = (36/40 x 100) = 90%

On an 8hr working day;

- 480 x 0.10 = 48 mins → the operator was idle
- 480 x 0.90 = 432 mins → the operator was working

The Normal Distribution Curve

- It is typical of the kind of frequency distribution which is of importance in Work Sampling because it represents graphically the probability of the occurrence of certain chance phenomena.

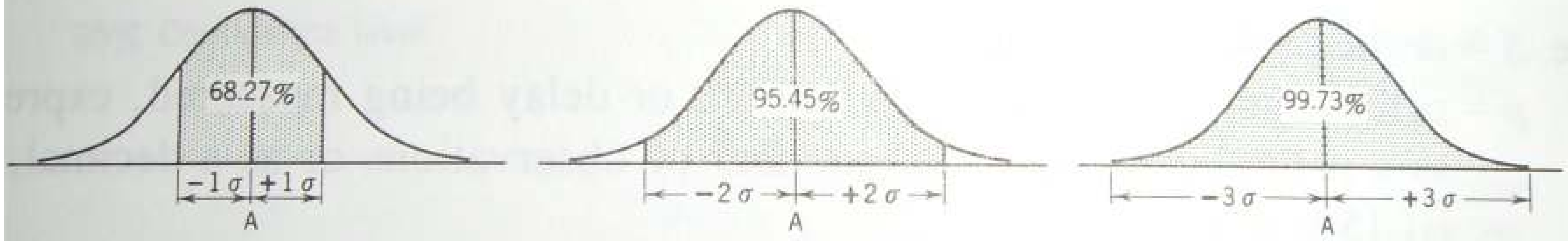


Figure 244 Areas under the normal curves.

The Normal Distribution Curve

- The formula for determining the sample size for a confidence level of 68% or 1 sigma is:

$$Sp = \sqrt{\frac{p(1-p)}{N}}$$

Where;

S: Desired relative accuracy
p: Percentage expressed as a decimal
N: Number of random observations (Sample Size)

The Normal Distribution Curve

- Fortunately, in Work Sampling study the analyst can determine in advance the number of observations needed for a given degree of accuracy.

- For many kinds of measurement an accuracy of ±5% is considered satisfactory. This is sometimes referred to as the standard error of the percentage.

Confidence Level

- The formula for determining the ***number of observations required*** is:

$$Sp = \textcircled{2}\sqrt{\frac{p(1-p)}{N}}$$

implies 2 confidence interval (CI) or 95% CI

Example 2

- Suppose that a total of 100 observations were made, and in this preliminary study 25 observations showed the machines to be idle. (S = ±5% = ±0.05)

- Therefore; the percentage of idle time = 25% (i.e. 25/100)

$$0.05p = 2\sqrt{\frac{p(1-p)}{N}}$$

$$0.0025p^2 = 4\left[\frac{p(1-p)}{N}\right] = \frac{4p(1-p)}{N}$$

$$N = \frac{4p(1-p)}{0.0025p^2} = \frac{4(1-p)}{0.0025p} = \frac{1600(1-p)}{p}$$

$$N = \frac{1600(1-0.25)}{0.25} = 4800 \text{ observations}$$

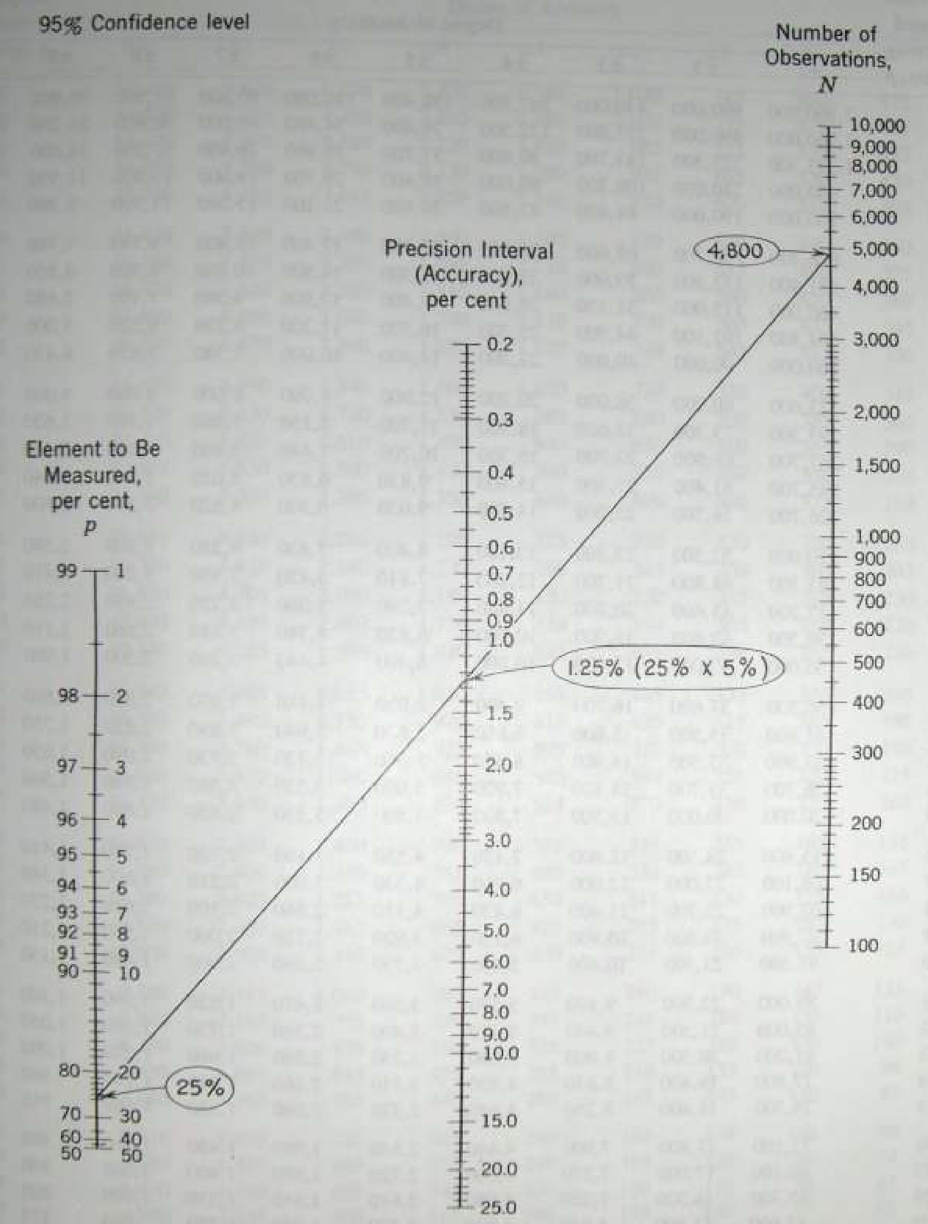


Figure 245 Alignment chart for determining the number of observations needed for a given degree of accuracy and value of p, 95% confidence level. (Courtesy Johns-Manville Corporation.)

Accuracy of Work Sampling Measurment

- **Note:** We can, by using the same formula to calculate the Accuracy (S) given the Number of observations (N).

- Absolute Error; (i.e. Sp) can be used to determine N. (see table 59 on page 422 and table 60, figure 246 and figure 247)

- Use of Random Number Tables to schedule the observations of work sampling. (see table 61 on page 424 and table 62 on page 428)

Continuous Performance Sampling

- In most organizations, the number of standard minutes earned can be compared with the number of minutes actually worked and a performance index can be determined for each worker and for the department. This plan of labor control is widely used and is very effective in many situations.

- However, much work does not lend itself to direct measurement. The cycles may be long and varied, methods may not be standardized, and it is often difficult to obtain a count of the units of work completed. In such situations it is possible to obtain some control of labor by the use of work sampling.

Continuous Performance Sampling

- Continuous performance sampling can be carried on, and this can provide management with information concerning the work force such as:
  1. Percentage of time working
  2. Percentage of time out of department
  3. Percentage of time idle
  4. Average performance index while working
  5. Labor effectiveness factor (Item1xItem 4)

Procedure For Making A Work Sampling Study

1. Define the problem (state objectives + describe each element in detail).
2. Obtain the approval of the supervisor of the department and make sure operators and other people understand the purposes of the study.
3. Determine the desired accuracy.
4. Make a preliminary estimate of the percentage of occurrence of the activity or delay to be measured.

Procedure For Making A Work Sampling Study

5. Design the study
    - Determine the number of observations to be measured
    - Determine the number of observers
    - Determine the number of days or shifts needed to be studied
    - Make a detailed plan for taking the observations, such as the time and the route to be followed by the observer.
    - Design the observation form.

6. Make observations according to the plan. Analyze and summarize the data.

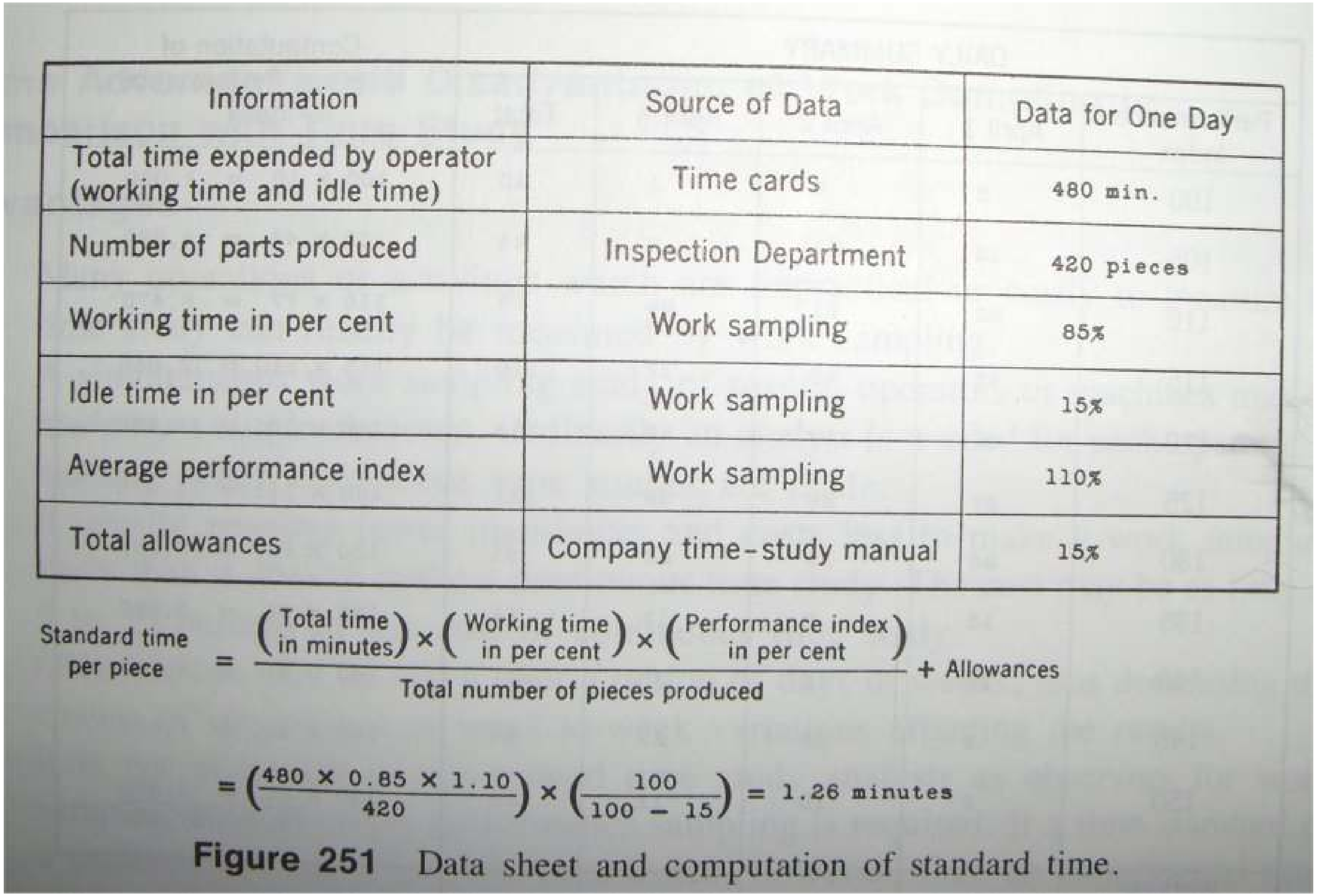
7. Check accuracy or precision of the data at the end of the study.

8. Prepare the report and state conclusions. Make recommendations if such are called for.

Determining Time Standards by Work Sampling

$$\text{Standard Time per piece} = \frac{\begin{pmatrix}\text{Total time}\\ \text{in minutes}\end{pmatrix} \times \begin{pmatrix}\text{Working time}\\ \text{in \%}\end{pmatrix} \times \begin{pmatrix}\text{Performance Index}\\ \text{in \%}\end{pmatrix}}{\text{Total number of pieces produced}} + \text{Allowances}$$

Example 3



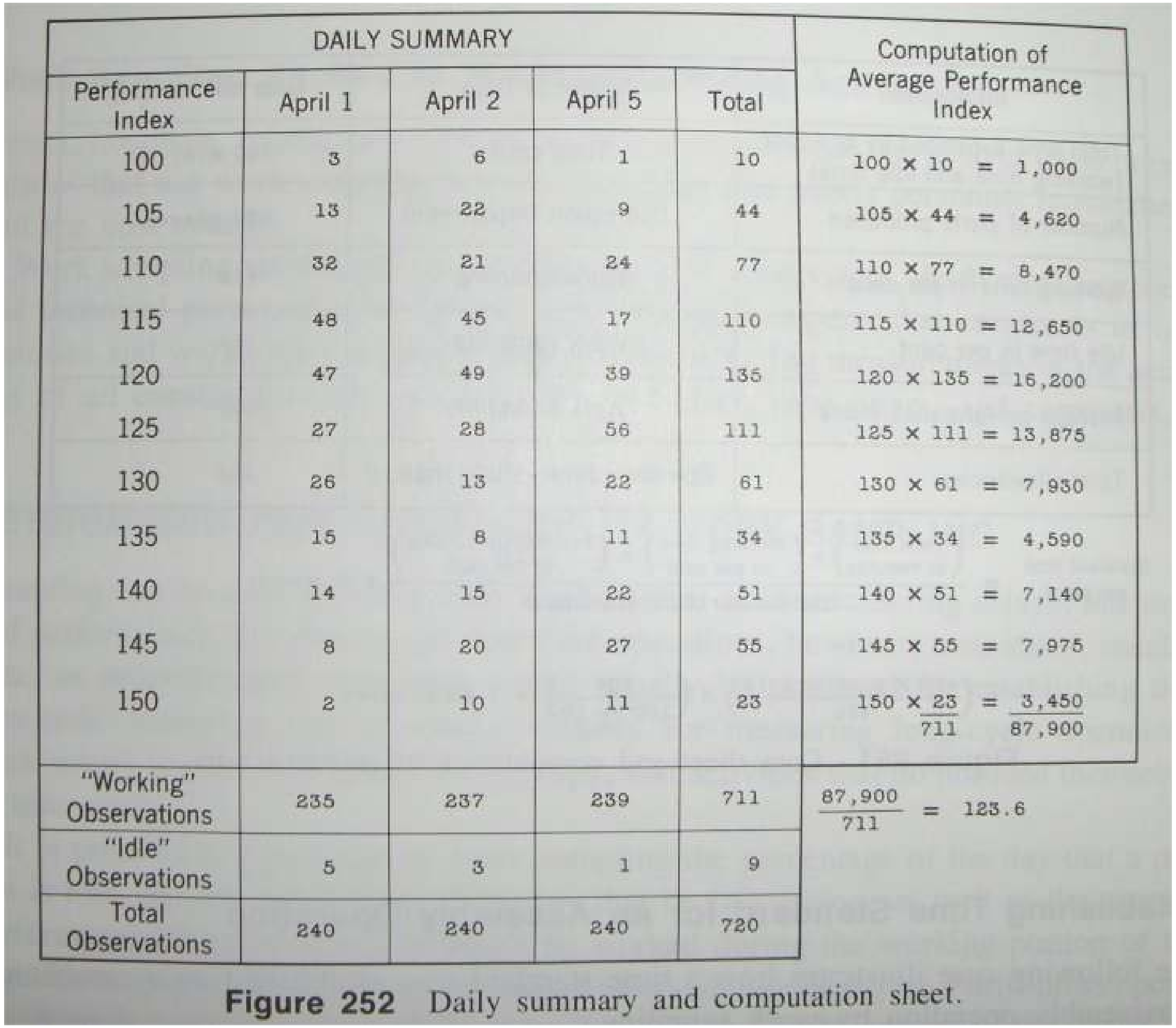
Information	Source of Data	Data for One Day
Total time expended by operator (working time and idle time)	Time cards	480 min.
Number of parts produced	Inspection Department	420 pieces
Working time in per cent	Work sampling	85%
Idle time in per cent	Work sampling	15%
Average performance index	Work sampling	110%
Total allowances	Company time-study manual	15%

$$\text{Standard time per piece} = \frac{\begin{pmatrix}\text{Total time}\\ \text{in minutes}\end{pmatrix} \times \begin{pmatrix}\text{Working time}\\ \text{in per cent}\end{pmatrix} \times \begin{pmatrix}\text{Performance index}\\ \text{in per cent}\end{pmatrix}}{\text{Total number of pieces produced}} + \text{Allowances}$$

$$= \left(\frac{480 \times 0.85 \times 1.10}{420}\right) \times \left(\frac{100}{100 - 15}\right) = 1.26 \text{ minutes}$$

Figure 251 Data sheet and computation of standard time.

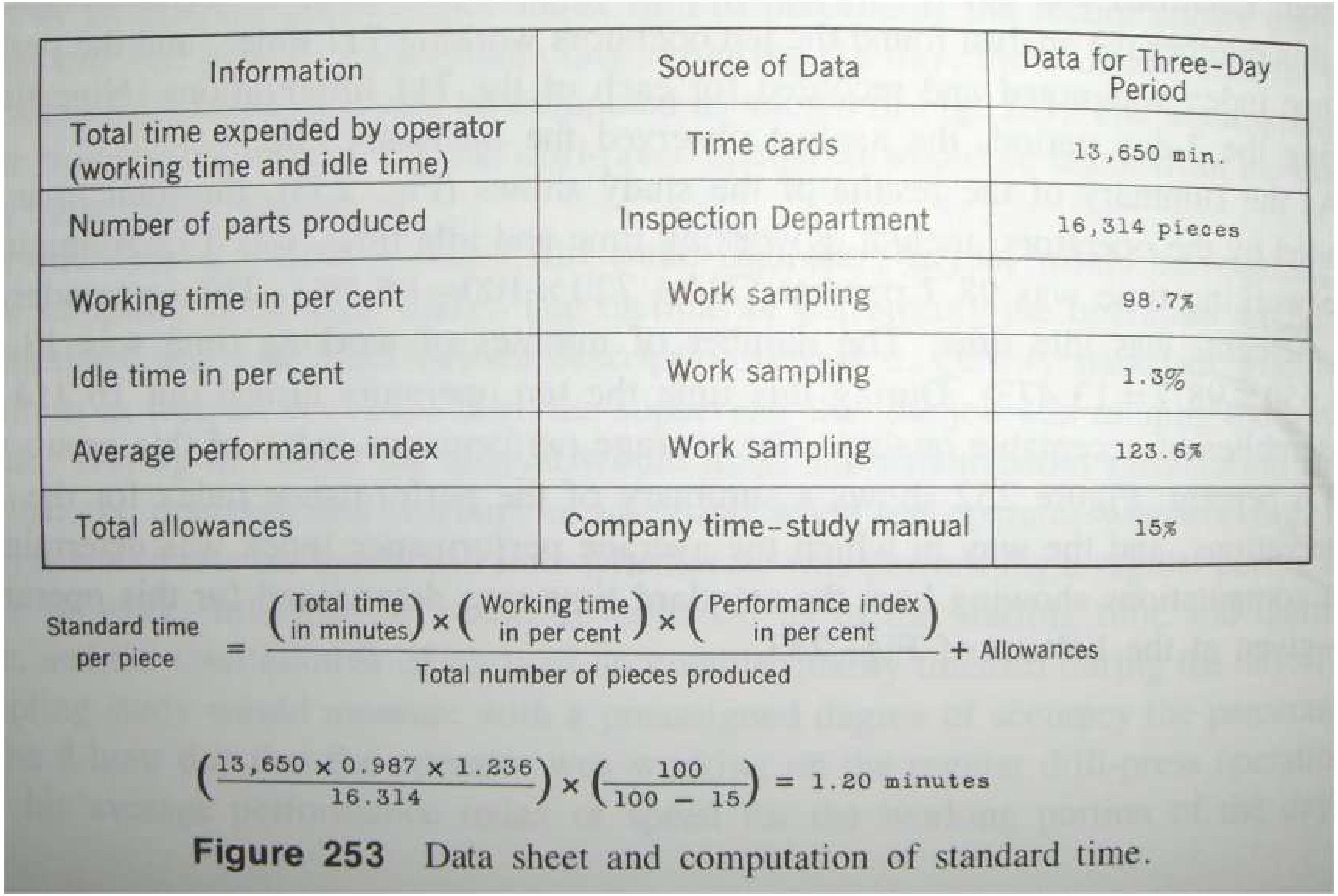
Example 4



DAILY SUMMARY					Computation of Average Performance Index
Performance Index	April 1	April 2	April 5	Total	
100	3	6	1	10	100 × 10 = 1,000
105	13	22	9	44	105 × 44 = 4,620
110	32	21	24	77	110 × 77 = 8,470
115	48	45	17	110	115 × 110 = 12,650
120	47	49	39	135	120 × 135 = 16,200
125	27	28	56	111	125 × 111 = 13,875
130	26	13	22	61	130 × 61 = 7,930
135	15	8	11	34	135 × 34 = 4,590
140	14	15	22	51	140 × 51 = 7,140
145	8	20	27	55	145 × 55 = 7,975
150	2	10	11	23	150 × $\underline{23}$ = $\underline{3,450}$ 711 87,900
"Working" Observations	235	237	239	711	$\frac{87,900}{711}$ = 123.6
"Idle" Observations	5	3	1	9	
Total Observations	240	240	240	720	

Figure 252 Daily summary and computation sheet.

Example 4



Information	Source of Data	Data for Three-Day Period
Total time expended by operator (working time and idle time)	Time cards	13,650 min.
Number of parts produced	Inspection Department	16,314 pieces
Working time in per cent	Work sampling	98.7%
Idle time in per cent	Work sampling	1.3%
Average performance index	Work sampling	123.6%
Total allowances	Company time-study manual	15%

$$\text{Standard time per piece} = \frac{\begin{pmatrix}\text{Total time}\\ \text{in minutes}\end{pmatrix} \times \begin{pmatrix}\text{Working time}\\ \text{in per cent}\end{pmatrix} \times \begin{pmatrix}\text{Performance index}\\ \text{in per cent}\end{pmatrix}}{\text{Total number of pieces produced}} + \text{Allowances}$$

$$\left(\frac{13{,}650 \times 0.987 \times 1.236}{16.314}\right) \times \left(\frac{100}{100 - 15}\right) = 1.20 \text{ minutes}$$

Figure 253 Data sheet and computation of standard time.