CHAPTER 4

Standard times and operations

There are many techniques used for the measurement of work, depending on the accuracy required for the labor standard, resource availability, the nature of the work, and plant policy. The following are some popular techniques :

Predetermined time standards

Stopwatch timing

Work sampling

Multiple regression analysis

Historical or budgetary standards

As the type of work changes from repetitive high volume to nonrepetitive low volume, the measurement technique changes from the more familiar predetermined time standards and stopwatch to the less familiar multiple regression analysis, work sampling, etc. In addition, the unit of measurement changes from units or parts per hour to crew size per month.

The selected technique which is used here is *Maynard Operation Sequence Technique* (MOST). This technique is one of generic Predetermined Motion Time Systems (PMTS). The MOST technique is applicable for any cycle length and repetitiveness, as long as there are variations in the motion pattern from one cycle to another (Zandin,1990).

The activities for loading, aligning, and unloading different

sizes of sheet-metal components at machines need different process times. The workpieces then should be classified to 3 groups as follows

Group 1 *Small or light objects.* Objects (or components) that are easily grasped, aligned, and manipulated with one hand. The long side should not over 300 mm. and weight should not be over 0.5 kg.

Group 2 *Medium objects.* Objects that are slightly difficult to load, align, and unload. The long side should not over 600 mm. and index values (plate length multiplied by weight) should not be over 1,000.

Group 3 *Large or heavy objects.* Objects that are difficult to handle due to length and/or weight.

Flow diagram in Figure 4.1 is used for specifying the group for each component, and the list on Table 4.1 is an example of specified group for sheet-metal components of product model 40 RR 008.

Table 4.1. Sizes of components for model 40 RR 008.

No	Part Name	Thickness (mm.)	Length (mm.)	Weight (kg.)	Size
1	Baffle Corner 1	1.0	100.0	0.07	S
2	Baffle Corner 2	1.0	112.3	0.09	S
3	Panel RH,LH assy	1.6	1304.9	11.25	L
4.1	Fan Mounting Panel	1.6	1233.4	10.23	L
4.2	Angle Reinforcing	1.6	577.9	0.32	M
4.3	Angle Support	1.6	255.0	0.19	S
4.4	Angle Duct	2.0	679.9	0.48	M
5	Baffle Cont. Tr.	1.0	1190.6	1.02	L

Table 4.1. Sizes of components for model 40 RR 008. (continue)

No	Part Name	Thickness (mm.)	Length (mm.)	Weight (kg.)	Size
6	Panel Acess	1.0	1237.2	6.46	L
7.1	Angle Evap.	1.6	941.1	1.72	L
7.2	Frame Cond. Tr.	1.6	1178.6	2.05	L
8	Angle Corner	3.0	1206.5	2.00	L
9	Plate Motor	3.0	706.9	4.78	L
10	Angle Center Rear	3.0	1206.6	2.54	L
11.1	Plate Panel Sealing	1.6	1139.8	2.20	L
11.2	Retainer Filter	1.6	57.2	0.04	S
12	Gusset	3.0	69.6	0.07	S
13	Fillet	1.6	78.5	0.05	S
14	Angle Center Front	3.0	1174.8	1.94	L
15	Clamp Filter	1.6	119.1	0.14	S

The first step to determines standards is to collect all activities which occur at each work center, and then analyze and compute their times by MOST technique. The second step is to standardize times and operations. The development and application of easier and more effective methods using *method improvement* is then required in this step. Questioning techniques (5W and 2H) may be applied to analyze these subactivities whether they should be eliminated, rearranged and/or simplified or not. These activities will provide as data base used later to calculate standard times and operations. The third step is to construct *Route Sheet* for each type of

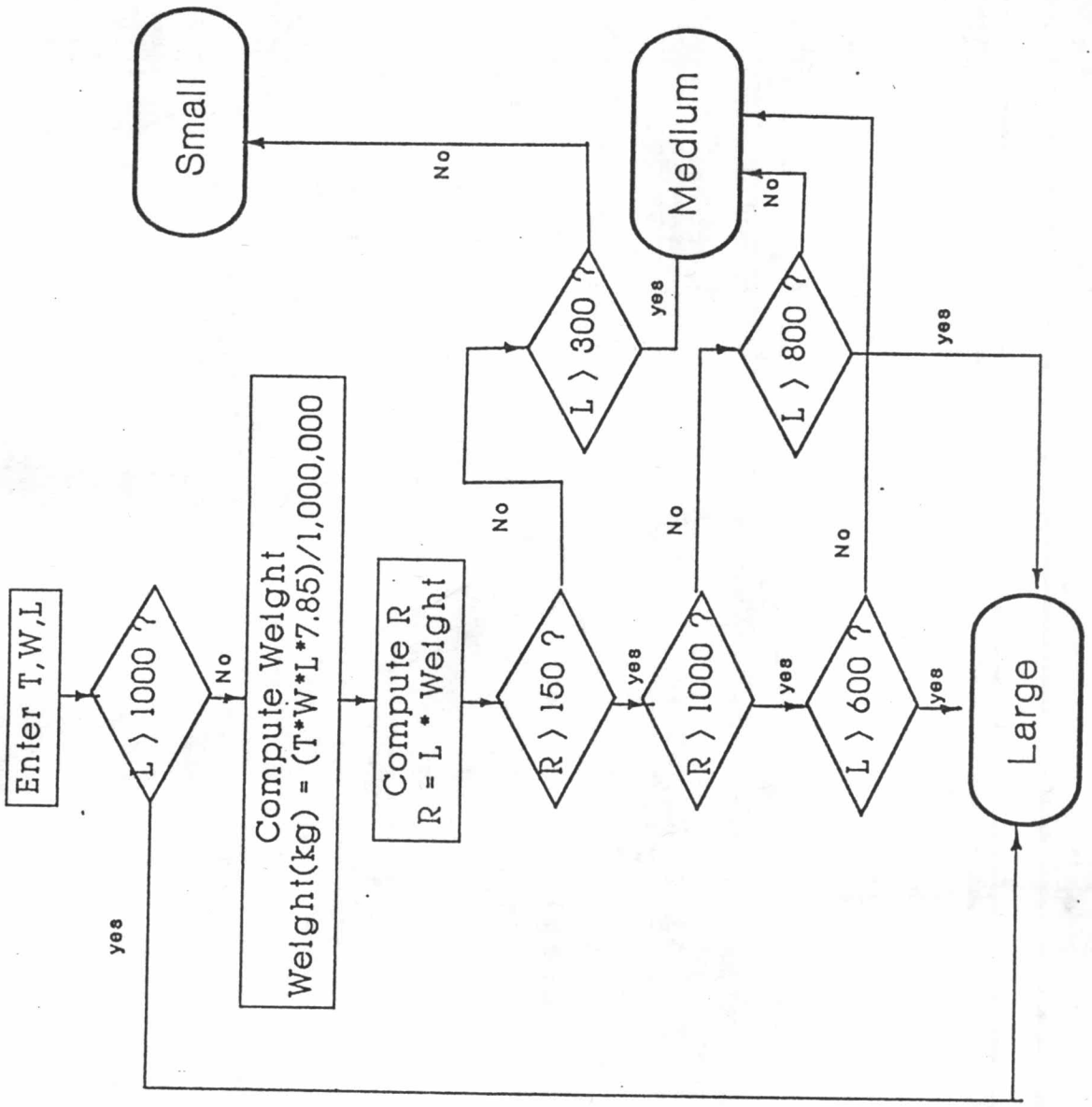


Figure 4.1. Flow diagram for specifying sizes of components.

sheet-metal part. Machine used, tool and equipment, number of setups, manpower and processing time are recorded. The last step is to establish the sheet called "Standard Operation Sequence", "Standard Time Calculation" and "Operation Lead Time".

Activity analysis

The following are the lists of activities

Activities for shearing operation

Operation	TMU
For small and medium plate	
Get 1 plate from pile (on hand truck) to m/c	60
Align plate on m/c against stop	50
Push clutch pedal with foot	40
Get + Place cut-plate to table	60
Get + Place cut-plate from floor to cut-pile (on pallet)	60
Measure cut-plate length using steel-tape 2 m.	190
For large plate	
Op.-1 Get + Slide 1 plate from pile (on table) to op.-2 & 3	120
Op.-2 & 3 Align plate on m/c against stop	70
Op.-3 Push clutch pedal with foot	40
Op.-2 & 3 Get + Place cut-plate to table	100
Get + Place cut-plate from floor to cut-pile (on pallet)	80
For all sizes	
Measure cut-plate length using steel-tape 2 m.	190
Write date,m/c no.,manpower,setup and processing time using pen and return to pocket	610

Activities for punching and notching operation

Operation	SIZE		
	S	M	L
Grasp + Align plate from hand truck to m/c against stop	40	-	-
Get + align plate from hand truck to m/c against stop	-	60	80
Push clutch pedal with foot	40	40	40
Overturn plate	30	40	40
Turn plate 180 deg. (horizontal)	30	60	80
Align plate to m/c against stop(s)	20	40	60
Get + Place punched-plate (or notched-plate) to pile	-	60	80
Move punched-plate (or notched-plate) lay aside m/c	30	-	-
Write date,m/c no.,manpower,setup and processing time using pen and return to pocket	610	610	610

Activities for bending operation

Operation	SIZE		
	S	M	L
Grasp + Align plate from hand truck to m/c against stop	40	-	-
Get + Align plate from hand truck to m/c against stops	-	60	80
Push clutch pedal with foot	40	40	40
Turn plate 90 deg. (horizontal)	30	40	60

Activities for bending operation (continue)

Operation	SIZE		
	S	M	L
Push clutch pedal with foot	40	40	40
Turn plate 90 deg. (horizontal)	30	40	60
Turn plate 180 deg. (horizontal)	30	60	80
Move plate up and down	50	70	90
Get + Place bended-plate to pile (on hand truck)	40	60	80
Align (small) plate against stop	20	-	-
Align (medium or large) plate against stops	-	40	40
Write date,m/c no.,manpower,setup and processing time using pen and return to pocket	610	610	610

Standard operation

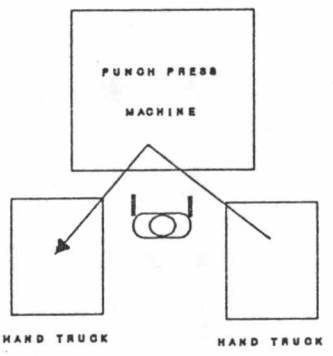
After an investigation of the most economical ways of performing an operation, it is essential that a permanent record be made of it. This record may be called "*standards operation*" or "*standard practice*". In addition to serving as a permanent record of the operation, the standard operation is often used as instruction sheet for the operator. Figure 4.2 is an example of a standard operational method sheet for a punching operation. The sheet gives information on how the production of a workpiece will be achieved and what equipment will be used, but operation time values are not included due to their time variation.

For this study, only a few standard operational method sheet are prepared and are used as a sample. Information as shown in Figure 4.2 had been approved by foreman and his workers.

Standard Operation sheet

Operation :	Punch holes in plate using "Strippit" punch holders.
Machine :	Manual punch press machine (P-2,P-3,P-5,P-6,P-7)
Previous Operation :	Shearing (or Notching, Nipping)
Next Operation :	Bending

Workplace layout



List of tools, jigs and fixture

1. Punch holder
   4BN 3, 8BN 1 1/4, 8BN 1 3/4, 8BN 2 1/4, 8 BN 3
   12 BN 1 1/4, 12 BN 2 1/4, 12BN 5
   18 BN 3/4, 18 BN 2 1/4
   200 B 128
2. Punch and die
3. Stopper
4. Guide
5. Wrench no. 17
6. Allen key 3 mm and 6 mm.
7. Fixed wrench for 66 mm. bolt head
8. Steel rod 8 mm. dia.

Job elements

1. Read details from drawing file. Ensure what tools and jigs must be used.
2. Assemble a set of punch and die. Uses uni-punch (a completed set of punch and die) if available.
3. Install the die set to punch press machine.
4. Produce 1 plate, inspect the position of punched holes. If the hole(s) out of position, operator must adjust either the die set or machine.
   After the adjustment, operator must produce a new one and inspect.
   The producton can be run after the run test is satisfied.
5. Operator should randomly inspect the output throughout the production.
6. After workpiece is punched, it must be stacked on hand truck.

Figure 4.2. Sample of standard practice.

Another operation sheet which gives steps of operations and how long it will take to perform each operation is called "*standard operation sequence*". They are used for operation control at workstations, and also applied to standard time calculations. Each separated operation sheet is required for each component and each activitiesin these sheets is related to the activity time values on the previous section. An example of a standard operation sequence sheet is shown in Figure 4.3. More standard operation sequence sheets are placed in Appendix A.

Standard time calculation

At each fabrication section work center, operators do the following three main operations : setup machine and equipment, manipulate materials on machine, and material handling. Setup activities are required whenever the final workpiece in a batch is completed. A workpiece may require more than one setup at a workstation because of the limitation of machine capability. For CNC or NC machines, however, setup actions are different from manual machines and times used are far less than those of manual machines. For material handling, in general,there are five steps performed at the workstation: preparatory handling of materials at the workstation, moving materials into the workstation, manufacture materials within the workstation, removing materials from the workstation, and transferring materials to next station. If the job shop produces workpieces by variable lot size the setup and material handling time per piece will be dependent on unit quantity per lot.

STANDARD OPERATION SEQUENCES

Part Name	Part No.
Base pan	51 MSA 520304
Model	No. of setups required
51 MSA 009	2
No. per model	No. of workers required
1	3
Operation	Machine
Bending	B-3,B-1

No	Method	No	TMU	Total TMU
	Bend at side 1,2,3 and 4 (use press brake m/c no. B-3)			
1	Get+Align plate from hand truck to machine against stop	1,18	80	160
2	Push clutch pedal with foot	2,6,10, 14,19,23	40	240
3	Move plate up and down	3,7,11, 15,20,24	90	540
4	Turn plate 90 deg. (horizontal)	4,8,12, 16,21	50	250
5	Align plate to machine against stop	5,9,13, 17,22	40	200
6-9	Repeat op. no. 2 to 5 for op. no. 6 to 9			
10-13	Repeat op. no. 2 to 5 for op. no. 10 to 13			
14-17	Repeat op. no. 2 to 5 for op. no. 14 to 17			
	Bend at side [3,4] and [1,4] (use m/c no. B-1)			
18-22	Repeat op. no. 2 to 5 for op. no. 18 to 22			
23-24	Repeat op. no. 2 and 3 for op. no. 23 and 24			
		TMU		**1150**
		MINUTE		**0.690**

Figure 4.3. Standard operation sequence.

Standard time of any operations at the fabrication section is the sum of setup time and processing time. Both are composed of *Base time* and *allowance time* as shown by figure 4.4. Setup time means the time used for preparing workpieces, machine, tools and equipment before a job start and after completing the job. Processing time is the required time for manipulating one lot of workpieces.

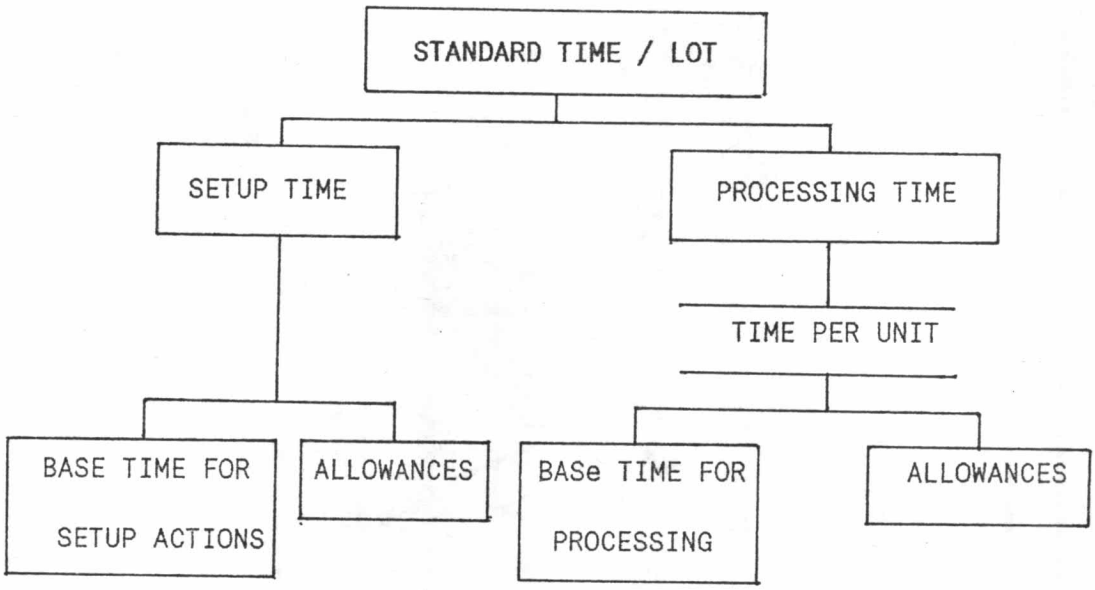


Figure 4.4. The structure of standard time.

The following is an example of standard time calculation sheets (Figure 4.5). The sheets show the time calculation of "mounting motor" of model 51 MSA 009.

To validates the run times which were obtained from the standard time calculation sheet, technique of *work sampling* is then be used to detect time when real production sequence is running correspondingly to the sequence appeared in standard operation sequence sheet. This study is randomly check for 12 observations for the same batch of

STANDARD TIME CALCULATION

BENDING OPERATION

Part Name	Drwg. No.	Page
Mounting motor	51 MSA 520 306	4 of 4
Model	**Material**	**Date effective**
51 MSA 009	1.6 EG	
No. per model	**Unit Weight**	**Size**
1	1.0 kg.	Medium
Quantity		
N		

	TMU	Fr	Min	Total (min)
Setup time		5	10	50.00
Run time				
Grasp+Align plate from hand truck to m/c against stop	-			
Get+Align plate from hand truck to m/c against stop	60	5	0.036	0.180
Push clutch pedal with foot	40	6	0.024	0.144
Move plate up and down	50	6	0.030	0.180
Align plate to m/c against stop(s)	40	1	0.024	0.024
Turn plate 90 deg. (horizontal)	40			
Turn plate 180 deg. (horizontal)	60	1	0.036	0.036
				0.564

No. of plates x run time = 0.564 N mins.

Total leveled minutes = 50 + 0.564 N mins.

Plus 30 % P.F.& D. allowances

$$= 1.3\ (50 + 0.564\ N)\ \text{mins.}$$

Figure 4.5. Sample of standard time calculation sheet.

each sub-operation as shown in Figure 4.6. For this example, first sub-operation is the sub-activity 1 to 3, second sub-operation is sub-activity 4 to 10, sub-activity 11 to 13 for third sub-operation, and so on. See also standard operation sequence sheet of "mounting motor" under the "bending operation". When the calculation of each component is completed, the *operation lead time* of the component can be computed by summing all operation times (Figure 4.7).

Part Name *Mounting motor*

Part No *51 MSA 520306* Model *51 MSA 009*

Operation *Bending*

	Cycle time in sub-operation (seconds)				
No	1st	2nd	3rd	4th	5th
1	*6.1*	*14.2*	*4.8*	*4.7*	*4.5*
2	*7.3*	*10.1*	*5.6*	*4.9*	*5.3*
3	*4.5*	*14.3*	*6.0*	*4.5*	*5.1*
4	*5.2*	*13.4*	*5.2*	*4.0*	*4.7*
5	*4.8*	*10.4*	*4.9*	*5.3*	*4.3*
6	*4.1*	*12.5*	*5.4*	*5.1*	*5.7*
7	*5.0*	*9.7*	*7.0*	*4.9*	*5.2*
8	*5.6*	*12.1*	*5.3*	*5.5*	*5.5*
9	*7.6*	*13.3*	*6.1*	*4.7*	*6.7*
10	*6.0*	*12.4*	*4.5*	*5.6*	*4.8*
11	*7.3*	*11.5*	*5.0*	*5.1*	*4.6*
12	*4.5*	*10.2*	*5.3*	*5.3*	*5.2*
Mean	*5.67*	*12.00*	*5.42*	*4.97*	*5.13*
Total	*33.19 sec. (0.533 mins.)*				

Figure 4.6. Sample data from work sampling.

Operation Lead Time Calculation

Part Name
Mounting motor

Drwg. No.
51 MSA 520 306

Model
51 MSA 009

Material
1.6 EG

No. per model
1

Unit Weight
1.0 kg.

Quantity
N

(1) (2)

Seq. No.	Operation	Machine	No. of setup	Setup (min)	Run/plate (min)	Run time for n plates (min)	Tot. time (min)
1	SHEAR	S-2	4	6.5		0.44 A + 0.08 AB + 0.12 ABC	(1)+(2)
2	NOTCH	N-1 or N-2	4	8	0.672	0.672 N	(1)+(2)
3	PUNCH	Manual punch press m/c	4	20	0.456	0.456 N	(1)+(2)
4	BEND	B-3	4	40	0.474	0.474 N	(1)+(2)
5	BEND	B-1	1	10	0.090	0.090 N	(1)+(2)
						Total time =	?

Multiply 1.3 for P.F.& D.

? x 1.3 = [redacted] min.

Operation lead time = [redacted] min.

Figure 4.7. Sample of operation lead time calculation sheet.

Allowances in the standard time

In the establishment of production standards, it is necessary to apply certain allowances to the labor content. The duration of the time study is usually relatively short, and even the accumulation of a number of studies will not fully show all delays and factors that affect the operator's production.

Allowances in labor standards are provided to cover time taken for personal needs, unavoideable delays, and a slowdown of output because of fatigue. Since these are usually beyond the control of the operator, they must be accounted for in the final time standard.

Personal time

This includes time for personal needs during the day. These can be allowed as percentages of standard time or as definite periods of time for the day. The amount of time needed by the operator for personal reasons will depended upon the working conditions, the class of work performed, facility layout, etc.

Fatigue

Fatigue, which may be defined as a lessening in the capacity for work, is most difficult to meaure and, consequently, controversial. The amount of fatigue experienced varies significantly, not only from one person to the next, but also for the same person from one day to the next. The human machine is a very complex mechanism with many interreactions involving the body functions, age of the worker, emotional stress, plus many external factors such as humidity, duration of exertion, and many other complex interrelationships.

Figure 4.8 is an example of personal and fatigue allowances

1. *CONSTANT ALLOWANCES:*

	Men	Women
Personal Needs Allowance	5	7
Basic Fatigue Allowance	4	4
	9	11

2. *VARIABLE ADDITIONS TO BASIC FATIGUE ALLOWANCE*

A. Standing Allowance	2	4
B. Abnormal Position Allowance		
Slightly awkward	0	1
Awkward (bending)	2	3
Very awkward (lying, stretching up)	7	7
C. Weightlifting or Use of Force *(lifting, pulling or pushing)*		
Weight lifted or force exerted (in kg)		
2.5	0	1
5	1	2
7.5	2	3
10	3	4
12.5	4	6
15	6	9
17.5	8	12
20	10	15
22.5	12	18
25	14	–
30	19	–
40	33	–
50	58	–
D. Light Conditions[2]		
Slightly below recommended value	0	0
Well below	2	2
Quite inadequate	5	5

	Men	Women
E. Air Conditions *(excluding climatic factors)*		
Well ventilated, or fresh air	0	0
Badly ventilated, but no toxic or injurious fumes	5	5
Work close to furnaces[3], etc.	5–15 per cent.	
F. Visual Strain		
Fairly fine work	0	0
Fine or exacting	2	2
Very fine or very exacting	5	5
G. Aural Strain		
Continuous	0	0
Intermittent, loud	2	2
Intermittent, very loud / High-pitched, loud	5	5
H. Mental Strain		
Fairly complex process	1	1
Complex or wide span of attention	4	4
Very complex	8	8
I. Monotony: Mental		
Low	0	0
Medium	1	1
High	4	4
J. Monotony: Physical		
Rather tedious	0	0
Tedious	2	1
Very tedious	5	2

Figure 4.6. Example of personal and fatigue allowance.

under different work conditions.

Delays

Miscellaneous unavoidable delays will be varied during the day that occur at random intervals, depending upon how well production is organized. The delays including short waits for materials, supervision, minor machine delays, defective materials, equipments, and numerous other similar occurrences.

Such delays can be determined through work sampling, by long time studies, historical production records, and so on.

Tucker and Lennon (1982) stated that when *Person*, *Fatigue*, and *Delay* allowances are composed of percentages and minutes, the formula to combine these into one overall figure is arrived at as follows :

T = Total length of shift in minutes

m = Shift allowance in minutes

a = PF&D applied to base time (as decimal)

A = Combined allowance (as percentage).

Then,

$$A = \frac{T - \{(T - m) / (1.0 + a)\}}{(T - m) / (1.0 + a)}$$

The formula can be simplified to

$$A = (aT + m) / (T - m)$$

The following are the estimated reasonable allowances which are analyzed from technique of *work sampling* and applied to *base time* for a shift in the fabrication section :

	minutes/shift
Personal, Fatigue, Delay	
1.0 Personal	
Trip to restroom and to drinking fountain	10
2.0 Fatigue	
Rest after strenuous work and gradual tiring during the shift	20
3.0 Unavoidable delay	
Less than 5 minutes per occurence	30
Sub-total 1, 2, and 3	60
Shift allowance	
Start up	15
Area clean up	15
Work break, 10 minutes each	20
Sub-total	50

Grand total = 60 + 50 = 110 minutes

Base time = 480 - 110 = 370 minutes

When PF&D allowance is allowed to the base time, the resulting standard time for a shift is equal to 480 - 50 = 430 minutes. The ratio between standard time and base time for the shift is (430/370) = 1.162.

The PF&D allowance is 16.2 % and shift allowance is (50/370) or 13.5 %.

Total allowance is then the sum of PF&D and shift allowance

Total allowance = 16.2 + 13.5 = 29.7 %

The total allowance can also be computed by using formula as mentioned above :

$$A = (aT + m) / (T - m)$$

$$= (0.162 \times 480 + 50) / (480 - 50)$$

$$= 29.7 \%$$

The answer is identical to the previous obtained without using formula.

It is possible to obtain a complete picture of the standard time for a straightforeward manual job or operation. The standard time for a job will be the sum of the standard times for all the elements of which it is made up, due regard being paid to the frequencies with which the element recur, plus the contingency allowance (International Labour Office,1970). The standard time may be represented graphically as follows :

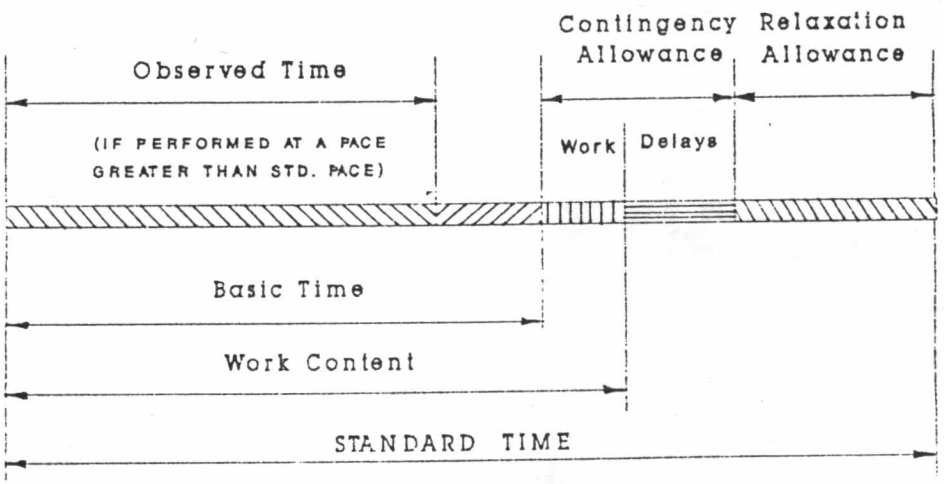


Figure 4.9.The standard time for a simple manual job.