

Chapter 6

: Techniques of Micromotion Study Operations Analysis

Introduction

- Macromotion study is called **the broad view** because it includes all the required operations to produce a product.
- Micromotion study interests in smallest detail of individual operations.
- Forms of jobs:
 1. Individuals working alone with simple hand tools and fixtures.
 2. Individuals working at a machine (operator/machine)
 3. Individuals working many machines (multimachine cells)
 4. Groups of people work together (gangs, cells)

Introduction (contd.)

- The techniques of micromotion study charts discussed in this chapter are:
 1. Operations analysis chart
 2. Operator/machine chart
 3. Multimachine chart
 4. Gang chart
 5. Left-hand/right-hand chart
 6. SIMO chart

.)Introduction (contd

- These techniques have several common factors:
 1. Each activity is broken into elements. An activity is one unit of production. For example, if one operator were to operate three machines, there would be four activities: one operator and three machines.
 2. Time is measured linearly. A scale is drawn down the side of activity. The elements with time values are listed sequentially and divided by horizontal lines
 3. All operations analysis techniques can use the same form. Only the number of activities varies.
 4. ○ All these charting techniques are visual. The length of the operation is shown by a scale on the chart. Present method can be held next to the proposed method

Operations Analysis Chart

- See Figure 6-1
- Is used to describe a single activity, usually one operator using only tools and equipment that are totally operator-controlled.
- The single activity is broken up into elements.
- An element of work is one unit of work that cannot be divided realistically.
- These elements are timed. The method of timing will be studied later.

Example: A packout operator on an assembly line is required to pack the following parts for swing set into a carton: Two legs, one bar, and two seats. See fig 6-1.

FRED MEYERS & ASSOCIATES		MULTI ACTIVITY CHART	
OPERATION NO. 25		PART NO. 1772	
DATE: 9-15-XX		TIME: 2:30	
BY I.E.: Mary Tuttle		OPERATION DESCRIPTION: Swing Set Packout Station #5	
ACTIVITY	TIME IN MINUTES	ACTIVITY	
.150 Pack two legs from cart at left	.05	NONE	This side is not used with operations charting except before & after studies.
.065 Get & pack bar from over conveyor	.10		
.125 Get & pack two seats from box at right	.15		
.060 Idle	.20		
	.25		
	.30		
	.35		
	.40		
	.45		
	.50		
	.55		
	.60		
	.65		
	.70		
	.75		
	.80		
	.85		
	.90		
	.95		
	1.00		
	1.05		
	1.10		
TOTAL UTILIZATION	.340	TOTAL UTILIZATION	
% UTILIZATION	85%	% UTILIZATION	
TIME STUDY CYCLE	COST:		TOTAL NORMAL TIME
	HOURS PER UNIT	.00733	IN MINUTES PER UNIT
	DOLLARS PER HOUR	\$10.00	+ % ALLOWANCE
	DOLLARS PER UNIT	\$0.0733	STANDARD TIME
TOTAL	LAYOUT & MOTION PATTERN ON NEXT PAGE		HOURS PER UNIT
OC			0.0733
AVG. OCC			PIECES PER HOUR
LEV. FACT			136
NORM. TIME			

FIGURE 6-1 Operations analysis chart.

Operator/Machine Chart

- See Figures 6-2 and 6-3
- **The operator/machine chart** has two activities – the operator and the machine.
- It shows what each of the operator and the machine is doing at every moment of time.
- Each activity is reduced to a series of elements. These elements of work are placed in order down one side of the chart, and the other activity's elements are placed down the opposite side.
- Each element must be aligned according to time.

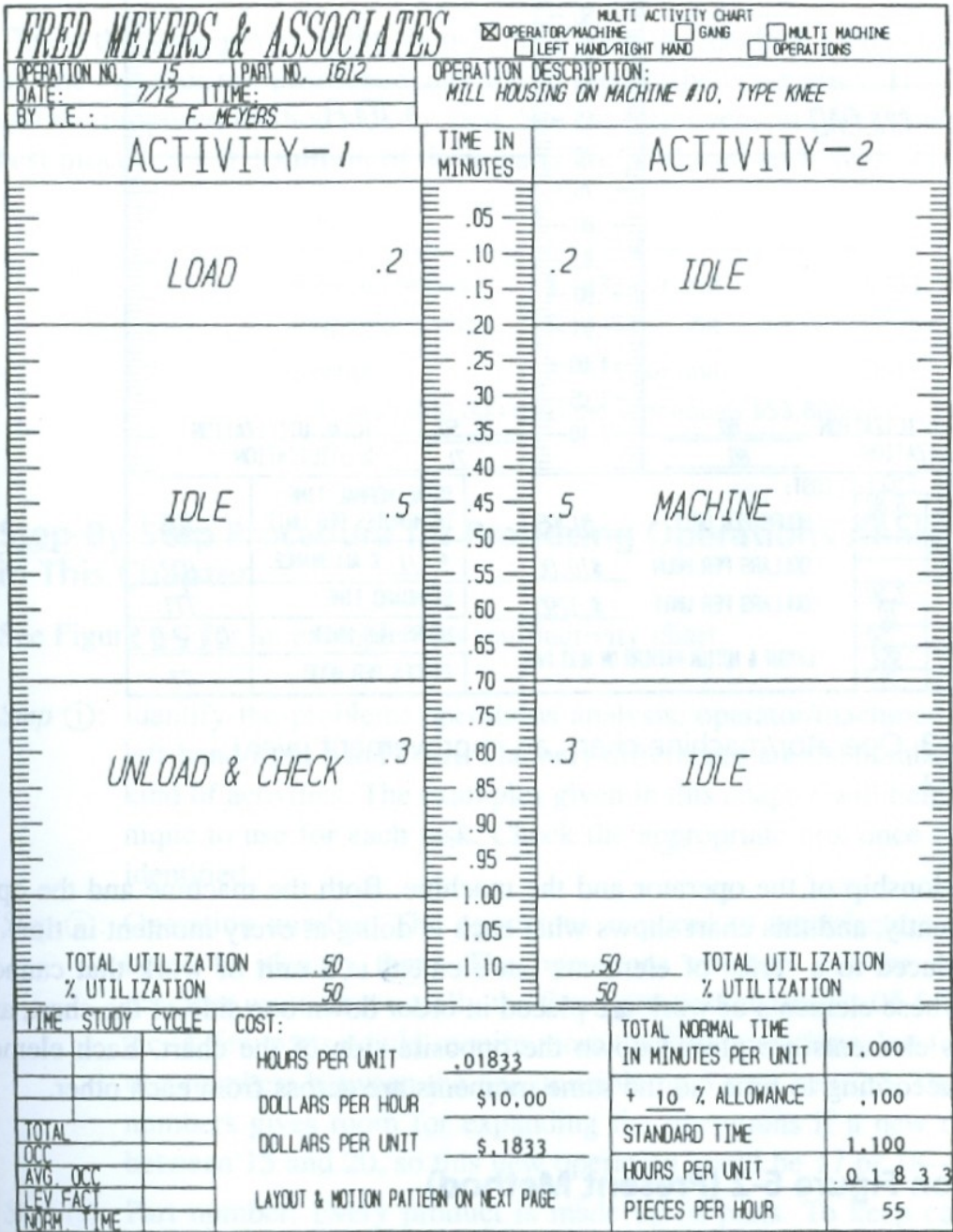
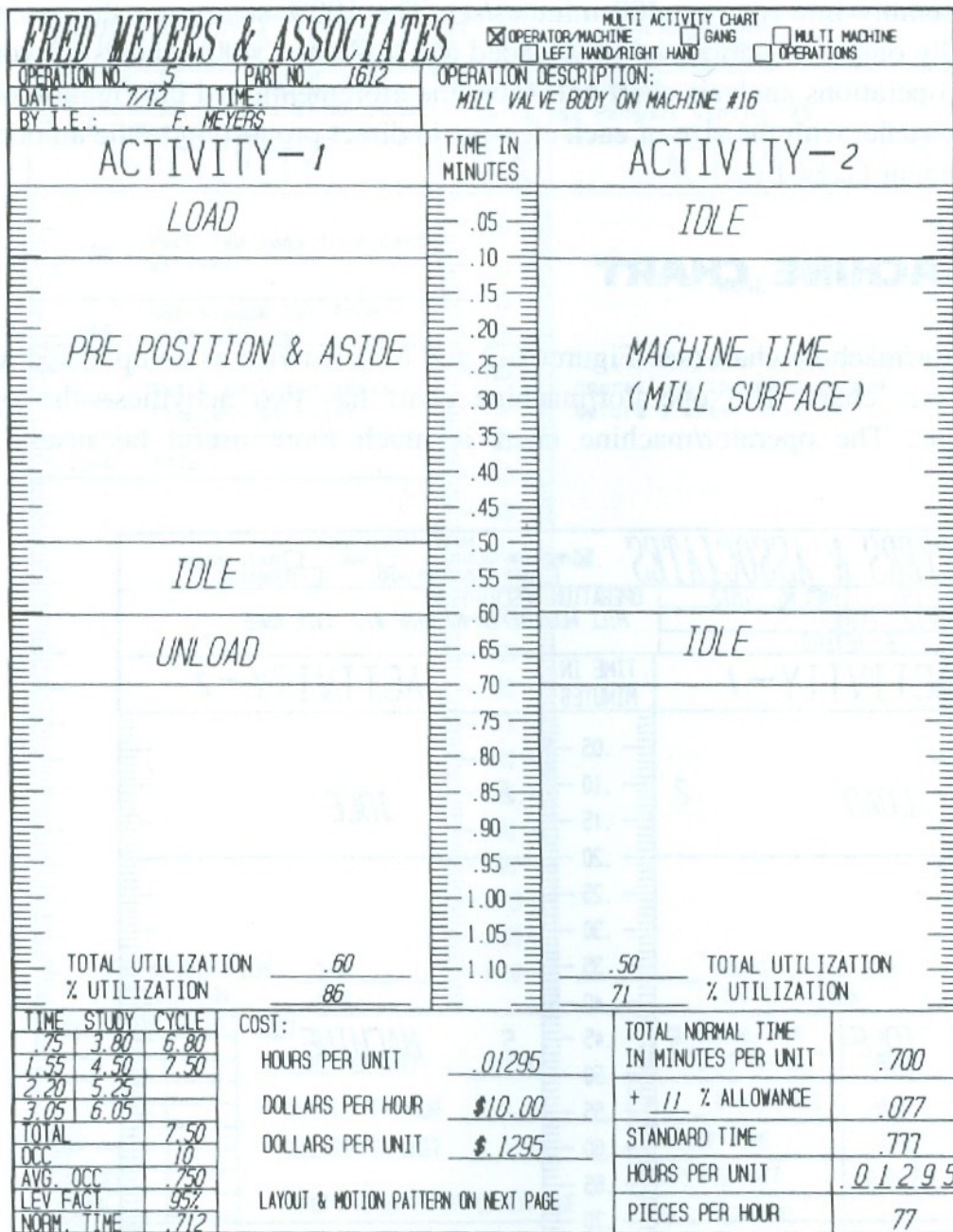


FIGURE 6-2 Operator/machine chart: two activities working together.



Present Method	\$0.1833/unit
Proposed Method	unit/\$0.1295
Savings for one unit	unit/\$0.0538
Savings for 1 million units/year	year/\$53,800

FIGURE 6-3 Operator/machine chart: an improvement over Figure 6-2.

FRED MEYERS & ASSOCIATES

OPERATOR/MACHINE GANG MULTI MACHINE
 LEFT HAND/RIGHT HAND OPERATIONS

OPERATION NO. (2) PART NO. (3) OPERATION DESCRIPTION: (7)
 DATE: (4) TIME: (5)
 BY I.E.: (6)

ACTIVITY	TIME IN MINUTES	ACTIVITY
(8)	(8)	(8)
TOTAL UTILIZATION % UTILIZATION (9)		TOTAL UTILIZATION % UTILIZATION (9)

TIME STUDY CYCLE	COST:	TOTAL NORMAL TIME IN MINUTES PER UNIT (10)
(18)	HOURS PER UNIT (15)	+ ___ % ALLOWANCE (11)
	DOLLARS PER HOUR (16)	STANDARD TIME (12)
	DOLLARS PER UNIT (17)	HOURS PER UNIT (13)
TOTAL (19)	LAYOUT & MOTION PATTERN ON NEXT PAGE (24) (25)	PIECES PER HOUR (14)
OCC (20)		
AVG. OCC (21)		
LEV. FAC. (22)		
NORML. TIME (23)		

FIGURE 6-4 Multiactivity chart: the step-by-step form.

Step-by-step procedure for producing Operations Analysis Charts

- See Figure 6-4 for an example of a multiactivity chart:
- Step 1 : Identify the problem. Operations analysis chart, operator/machine,...
- Step 2 : Operation number. The first NO. is 05 then 10,15,...
- Step 3 : Part number. Every product made up of parts.
- Step 4 : Date
- Step 5 : Time
- Step 6 : By
- Step 7 : Operation description. Should be as complete as possible
- Step 8 : Activity name. the operator's job description, or machine name

Step-by-step procedure for producing .)Operations Analysis Charts (contd

- Step 9 : Total utilization, and % utilization. How much time this activity was working not including idle time. % utilization : how well the operator or the machine being used.
- Step 10 : Total normal time: how long it takes each activity to complete a cycle and includes both working and idle time.
- Step 11 : + % allowance: Allowances are the time we add to normal time to make our time standards realistic. Allowances include time for personal time, fatigue (breaks), and unavoidable delays.
- Step 12 : Standard time: Normal time plus allowances.

Step-by-step procedure for producing .)Operations Analysis Charts (contd

- Step 13 : Hours per unit : calculated by dividing standard time by 60 min/hr
- Step 14 : Pieces per hour: calculated by dividing 1 over hours per unit.
- Step 15 : Hours per unit. The same as step 13
- Step 16 : Dollars per hour: refer to the operator's wage rate in \$/hr. All the employees' salaries of the department are added together and divided by the number of employees to get the average hourly rate. The cost of employee benefits, such as vacation, holiday ,and insurance is calculated yearly and converted to a percentage of hourly rate.
- Step 17 : Dollars per unit: The labor cost for one unit. Multiply hours per unit times dollars per hour.
- Steps 18 -25 will be discussed in detail later.

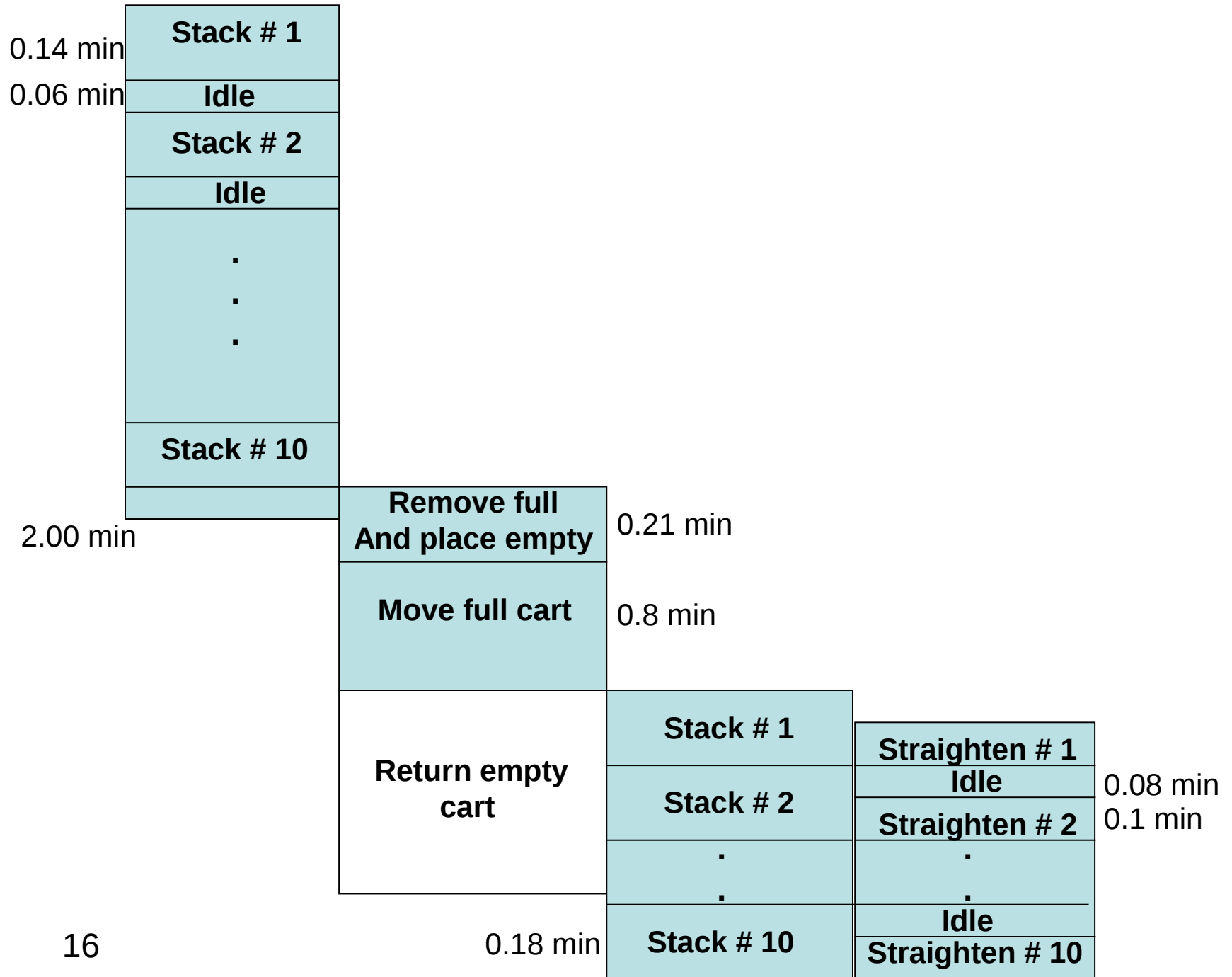
Gang Chart



- See Figure 6-5
- **A gang chart** is used when two or more people work together and their activities intertwine.
- Procedure deviations:
 - Hours per unit will be multiple's of one operator time
 - Pieces per hour will still be calculated from the one person hours per unit
 - Cost must reflect the total crew size, so hours per unit must reflect all the operators.
- Example:
 - Swing sets are packed out in boxes. Finished swing sets must be removed from the pack out line continually, stacked on hand cart using two people, rolled to a storage location, and restacked on the floor.

Gang Chart (contd.)

- Example (contd.):
- The activities are:
 - Two people remove the sets and stack them on cart
 - Carts are rolled to the stacks and an empty cart is brought back
 - Two people remove the sets from a roller cart and hand them to a stacker.
 - The person on top of the stack straightens the sets to align



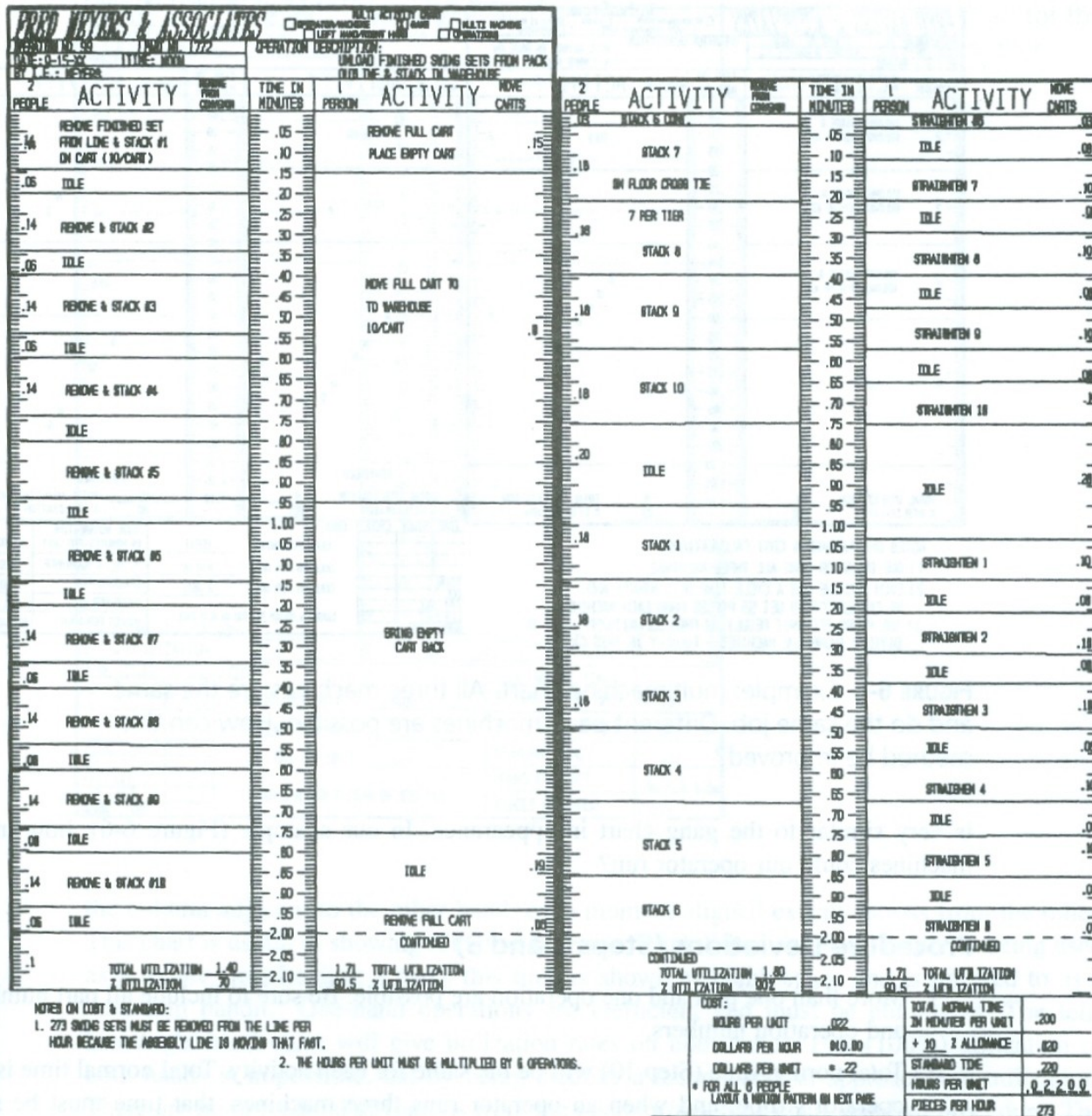


FIGURE 6-5 Example: gang chart. These people are a team. Is there any way to improve the balance of work?

.)Gang Chart (contd

- In figure 6-5:
 - Total normal time = 2.0 min / 10 units = 0.200 min per unit
 - Standard time = .2 + .0 2 (allowances) = 0.22 min per unit
 - Hours per unit (for one operator) = 0.22 /60 = 0.00367
 - Pieces per hour = 1/0.00367 = 273

 - Hours per unit (6 operators) = 0.00367 * 6 = 0.02200
 - Dollar per hour \$10.00
 - Dollar per unit = \$ 0.22 (labor cost)

Multimachine Chart

- See Figure 6-6
- **Multimachine chart** is used when an operator is asked to run more than one machine.
- The operator/machine chart is expanded so that each machine has a column of its own.
- Procedure deviations:
 - More than one part and one operation are possible.
 - Total normal time will be the same for each activity. Total normal time is the operator's time (for one cycle). This time must be split among the machines by dividing the hours per unit by the number of machines.

PRESENT METHOD

FRED MEYERS & ASSOCIATES		MULTI ACTIVITY CHART							
OPERATOR-MACHINE <input type="checkbox"/> GAND <input type="checkbox"/> MULT. MACHINE <input type="checkbox"/>		LEFT HAND/RIGHT HAND <input type="checkbox"/> OPERATIONS <input type="checkbox"/>							
OPERATION NO. 10 PART NO. 1610		OPERATION DESCRIPTION: MILL KEYWAY IN BASE ON K-T KNEE MILL							
DATE: 5-15-44 TIME: 2 pm									
BY: L.E.: MEYERS									
OPERATOR	ACTIVITY	TIME IN MINUTES	MACH. #1	ACTIVITY	MACH. #2	TIME IN MINUTES	MACH. #3	ACTIVITY	
.2	UNLOAD, ASIDE & RELOAD MACHINE #1	.05				.05			
		.10		IDLE	.2	.10			
		.15				.15		RUNNING	
		.20				.20			
.2	UNLOAD, ASIDE & RELOAD MACHINE #2	.25				.25			
		.30		IDLE	.2	.30			
		.35				.35		RUNNING	
		.40				.40			
.2	UNLOAD, ASIDE & RELOAD MACHINE #3	.45				.45			
		.50				.50		IDLE	
		.55		RUNNING	.8	.55			
		.60				.60		RUNNING	
		.65				.65			
.4	IDLE	.70				.70		RUNNING	
		.75				.75			
		.80				.80		RUNNING	
		.85				.85			
		.90				.90		RUNNING	
		.95				.95			
		1.00				1.00		RUNNING	
		1.05				1.05			
		1.10				1.10		RUNNING	
TOTAL UTILIZATION .60				CONTINUED				CONTINUED	
% UTILIZATION 60%				TOTAL UTILIZATION .8				TOTAL UTILIZATION 80%	
				% UTILIZATION 80%				% UTILIZATION 80%	

NOTES ON STANDARD & COST CALCULATIONS:

- 1) ONE OPERATOR RUNS ALL THREE MACHINES.
- 2) EACH MACHINE HAS A CYCLE TIME OF 1 MINUTE AND WE CAN EXPECT TO GET 55 PIECES FROM EACH MACHINE.
- 3) THE HOURS PER UNIT RESULTING FROM 55 UNITS/HR. MUST BE DIVIDED AMONG THE MACHINES - EQUALLY IN THIS CASE.

TIME STUDY CYCLE	COST:		TOTAL NORMAL TIME IN MINUTES PER UNIT	1.000
	HOURS PER UNIT	.0611	+ 10% ALLOWANCE	.100
	DOLLARS PER HOUR	\$10.00	STANDARD TIME	1.100
	DOLLARS PER UNIT	\$.611	HOURS PER UNIT	0.0611
TOTAL	LAYOUT & MOTION PATTERN ON NEXT PAGE		PIECES PER HOUR	55/MACHINE
AVG. DLT.				
TRV. FACT.				
WORK. TIME				

Multimachine Chart (contd.)

- Example (figure 6-6):
 - Total normal time (min per unit) = 1.00
 - Standard time (min per unit) = $1.00 + 0.100 = 1.1$
 - Hours per unit (1 machine) = $1.1 / 60 = 0.01833$
 - Pieces per hour = $1 / 0.01833 = 55$ /machine

 - Hours per unit (3 machines) = $0.01833 / 3 = 0.00611$
 - Dollars per hour = \$10.00
 - Dollars per unit = \$ 0.0611

 - How many machines could our operator run (in this example)?

Left-Hand/Right-Hand Chart

- See Figure 6-7
- It is for one operator only.
- It is different from operations chart because it treats each hand as an activity.
- Each hand's activity is broken into elements and is plotted in the column adjacent to the other hand.
- When one hand is idle or being used as a fixture (just holding a part), this time is shown as blank space and is referred to as a “one-arm bandit”.
- One-hand operations are insufficient and must be eliminated.

FRED MEYERS & ASSOCIATES		MULTI ACTIVITY CHART	
<input type="checkbox"/> OPERATOR/MACHINE		<input type="checkbox"/> GANG	
<input checked="" type="checkbox"/> LEFT HAND/RIGHT HAND		<input type="checkbox"/> MULTI MACHINE OPERATIONS	
OPERATION NO. 90	PART NO. 1500	OPERATION DESCRIPTION:	
DATE: 4-10-xx	TIME: 9 a.m.	Assemble muffler clamp - 2 at a time	
BY I.E.: Mary Tuttle			
ACTIVITY	TIME IN MINUTES	ACTIVITY	
Left Hand		Right Hand	
Get and place "U" bolt	.05	Get and place "U" bolt	
Get and assemble bracket and 2 washers	.10	Get and assemble bracket and 2 washers	
Get and assemble 2 nuts - run down 8 turns	.25	Get and assemble 2 nuts - run down 8 turns	
Aside completed unit	.30	Aside completed unit	
	.35		
	.40		
	.45		
	.50		
	.55		
	.60		
	.65		
	.70		
	.75		
	.80		
	.85		
	.90		
	.95		
	1.00		
	1.05		
	1.10		
TOTAL UTILIZATION	.34	.34	TOTAL UTILIZATION
% UTILIZATION	100	100	% UTILIZATION
TIME STUDY CYCLE	COST:		TOTAL NORMAL TIME
	HOURS PER UNIT	.00312	IN MINUTES PER UNIT
	DOLLARS PER HOUR	7.50	+ 10% ALLOWANCE
	DOLLARS PER UNIT	.023	STANDARD TIME
TOTAL	LAYOUT & MOTION PATTERN ON NEXT PAGE		HOURS PER UNIT
ACC			.0 0 3 1 2
AVG. OCC			PIECES PER HOUR
LEV FACT			321
NORH TIME			

FIGURE 6-7 Example left-hand/right-hand chart for the assembly of two muffler clamps.

SIMO Chart

- See Figures 6-8, 6-9,6-10
- The SIMO chart (simultaneous motion chart) was invented by the Gilbreths.
- When evaluating human effort and resultant fatigue, it was important to determine which body member was used.
- The left-hand/right-hand chart was given a new column next to the center time line and begins with the easiest motion , and the most difficult farthest out.
- The body members represented on the SIMO chart are finger, wrist, forearm, full arm, and shoulder.

SIMO Chart (contd.)

- Finger motions required the least effort and shoulder motions the most effort.
- One of the Gilbreths many principles of motion economy is that the body member requiring the least effort be used.
- The SIMO chart must be evaluated for two conditions:
 - Potential stress on trunk (using shoulders)
 - Potential repetitive stress on fingers and wrist.

