**Prepared by:** **Assoc. Prof. Dr. Adham MACKIEH**

# PROCESS ANALYSIS

The entire system or process of doing work should be studied before undertaking a thorough investigation of a specific operation in the process. Such an over-all study will ordinarily include an analysis of each step in the manufacturing process or system.

## Process Charts:

The process chart is a device for recording a process in a compact manner, as a means of better understanding it and improving it.
The chart represents graphically the separate steps or events that occur during the performance of a task or during a series of actions.
The chart usually begins with the raw material entering the factory and follows it through every step, such as transportation to storage, inspection, machining operations, and assembly, until it becomes either a finished unit itself or a part of a subassembly.
The process chart might, of course, record the process through only one or a few departments.

A careful study of such a chart, **giving a graphic picture of every step in the process** through the factory, may suggest improvements.

It is frequently found that

- certain operations can be eliminated entirely or that a part of an operation can be eliminated,
- that one operation can be combined with another,
- that better routes for the parts can be found,
- more economical machines used,
- delays between operations eliminated, and
- other improvements made,

all of which serve to produce a better product at a lower cost.

The process chart assist in showing the effects that changes in one part of the process will have on other parts or elements.

Moreover, the chart may aid in discovering particular operations, in the process, which should be subjected to more careful analysis.

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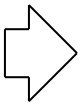
The process chart, like other methods of graphic representation, should be modified to meet the particular situation. For example, it may show in sequence the activities of a person, or the steps that the material goes through. The chart should be either the man type or material type and the two types should not be combined.

Many years ago the Gilbreths devised a set of 40 symbols which they used in making process charts.
The American Society of Mechanical Engineers has established as standard the five symbols listed below. This set of symbols is a modification of the four most widely used symbols of Gilbreths, in that the arrow replaces the small circle and a new symbol has been added to denote a delay.

Operation: An operation occurs when an object is intentionally changed in one or more of its characteristics. An operation represents a major step in the process and usually occurs at a machine or work station.



Transportation: A transportation occurs when an object is moved From one place to another, except when the movement is an integral part of an operation or an inspection.

Inspection. An inspection occurs when an object is examined for identification or is compared with a standard as to quantity or quality.

D Delay. A delay occurs when the immediate performance of the next planned action does not take place.

Storage. A storage occurs when an object is kept under control such that its withdrawal requires authorization.

Combined Symbols. Two symbols may be combined when activities are performed at the same work place or when they are performed concurrently as one activity.

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**Process Chart Example:** Draw a Process chart, to show the binding activities listed below:

| Activities | DESCRIPTIONS |
|---|---|
| 1 | Carry printed sheets to Binding Shop |
| 2 | Place printed sheets on table-1 |
| 3 | Wait for a while on table-1 |
| 4 | Grasp the printed sheets |
| 5 | Carry printed sheets to table-3 |
| 6 | Place printed sheets on Folding Machine |
| 7 | Fold printed sheets |
| 8 | Grasp the printed sheets |
| 9 | Carry printed sheets to table-2 |
| 10 | Wait for a while on table-2 |
| 11 | Grasp & Carry printed sheets to Stitching Machine |
| 12 | Place printed sheets on Stitching Machine |
| 13 | Stitch the printed sheets |
| 14 | Grasp the printed sheets |
| 15 | Carry printed sheets to table-2 |
| 16 | Place printed sheets on table-2 |
| 17 | Wait for a while on table-2 |
| 18 | Count the Stitched Booklets |
| 19 | Grasp the Stitched Booklets |
| 20 | Carry the Stitched Booklets to the Central Storage |
| 21 | Place the Stitched Booklets on the shelves. |

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Process Chart** | | | **Type:** Man Type | | | | |
| **Present Method** | ☐ | | | | | | |
| **Proposed Method** | ☐ | | | | | | |
| **Subject Charted** | **Binding Process** | | | | **Date:** | 03-03-1993 | |
| | | | | | **Chart By:** | Mr. X | |
| | | | | | **Chart No:** | 1010 | |
| **Department** | **Time study** | | | | **Sheet No:** | **1** | |
| | | | | | | | |
| **Distance (m)** | **Time (min)** | **Operation** | **Transportation** | **Inspection** | **Delay** | **Storage** | **DESCRIPTIONS** |
| 80 | | ○ | → | ☐ | D | ▽ | Carry printed sheets to Binding Shop |
| | | ○ | → | ☐ | D | ▽ | Place printed sheets on table-1 |
| | | ○ | → | ☐ | D | ▽ | Wait for a while on table-1 |
| | | ○ | → | ☐ | D | ▽ | Grasp the printed sheets |
| 24 | | ○ | → | ☐ | D | ▽ | Carry printed sheets to table-3 |
| | | ○ | → | ☐ | D | ▽ | Place printed sheets on Folding Machine |
| | | ○ | → | ☐ | D | ▽ | Fold printed sheets |
| | | ○ | → | ☐ | D | ▽ | Grasp the printed sheets |
| 12 | | ○ | → | ☐ | D | ▽ | Carry printed sheets to table-2 |
| | | ○ | → | ☐ | D | ▽ | Wait for a while on table-2 |
| 16 | | ○ | → | ☐ | D | ▽ | Grasp & Carry printed sheets to Stitching Machine |
| | | ○ | → | ☐ | D | ▽ | Place printed sheets on Stitching Machine |
| | | ○ | → | ☐ | D | ▽ | Stitch the printed sheets |
| | | ○ | → | ☐ | D | ▽ | Grasp the printed sheets |
| 16 | | ○ | → | ☐ | D | ▽ | Carry printed sheets to table-2 |
| | | ○ | → | ☐ | D | ▽ | Place printed sheets on table-2 |
| | | ○ | → | ☐ | D | ▽ | Wait for a while on table-2 |
| | | ○ | → | ☐ | D | ▽ | Count the Stitched Booklet |
| | | ○ | → | ☐ | D | ▽ | Grasp the Stitched Booklet |
| 90 | | ○ | → | ☐ | D | ▽ | Carry the Stitched Booklet to the Central Storage |
| | | ○ | → | ☐ | D | ▽ | Place the Stitched Booklet on the shelves. |
| | | ○ | → | ☐ | D | ▽ | The Booklet on the shelve |
| | | ○ | → | ☐ | D | ▽ | |

## Flow Diagram

Sometimes a better picture of the process can be obtained by putting **flow lines on a plan drawing of the building or area** in which the activity takes place. This is called a flow diagram.

Sometimes, both a process chart and a flow diagram are needed to show the steps in a manufacturing process, office procedure, or other activity.



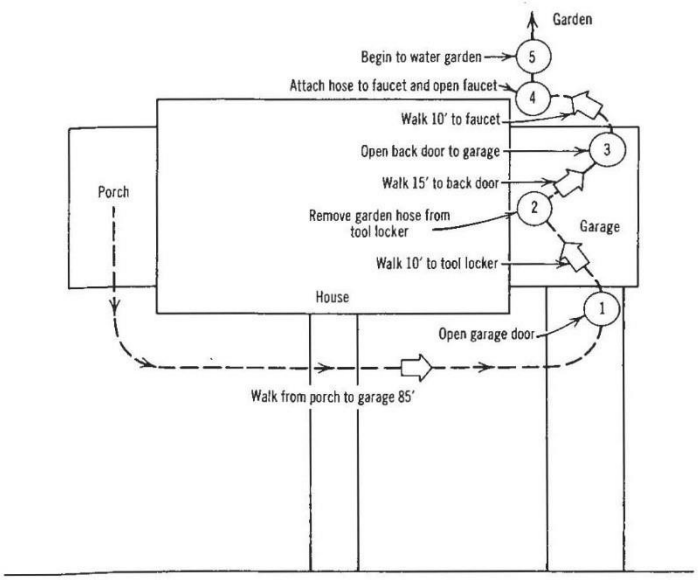



**Figure 31** Flow diagram of watering garden.

## Process Chart for an Office Procedure

In the office the process chart might show the flow of a time card, a material requisition, a purchase order, or any other form, through the various steps.

The chart might begin with the first entry on the form and show all the steps until the form is permanently filed or destroyed.

Present Method ☒ PROCESS CHART
Proposed Method ☐

SUBJECT CHARTED Requisition for small tools — DATE
Chart begins at supervisor's desk and ends at typist's desk in purchasing department — CHART BY J. C. H.
CHART NO. R 136
DEPARTMENT Research laboratory — SHEET NO. 1 OF 1

| DIST. IN FEET | TIME IN MINS. | CHART SYMBOLS | PROCESS DESCRIPTION |
|---|---|---|---|
| | | ● ⇨ □ D ▽ | Requisition written by supervisor (one copy) |
| | | ○ ⇨ □ D ▽ | On supervisor's desk (awaiting messenger) |
| 65 | | ○ ⇨ □ D ▽ | By messenger to superintendent's secretary |
| | | ○ ⇨ □ D ▽ | On secretary's desk (awaiting typing) |
| | | ● ⇨ □ D ▽ | Requisition typed (original requisition copied) |
| 15 | | ○ ⇨ □ D ▽ | By secretary to superintendent |
| | | ○ ⇨ □ D ▽ | On superintendent's desk (awaiting approval) |
| | | ○ ⇨ ■ D ▽ | Examined and approved by superintendent |
| | | ○ ⇨ □ D ▽ | On superintendent's desk (awaiting messenger) |
| 20 | | ○ ⇨ □ D ▽ | To purchasing department |
| | | ○ ⇨ □ D ▽ | On purchasing agent's desk (awaiting approval) |
| | | ○ ⇨ ■ D ▽ | Examined and approved |
| | | ○ ⇨ □ D ▽ | On purchasing agent's desk (awaiting messenger) |
| 5 | | ○ ⇨ □ D ▽ | To typist's desk |
| | | ○ ⇨ □ D ▽ | On typist's desk (awaiting typing of purchase order) |
| | | ● ⇨ □ D ▽ | Purchase order typed |
| | | ○ ⇨ □ D ▽ | On typist's desk (awaiting transfer to main office) |
| | | ○ ⇨ □ D ▽ | |
| | | ○ ⇨ □ D ▽ | |
| | | ○ ⇨ □ D ▽ | |
| | | ○ ⇨ □ D ▽ | |
| | | ○ ⇨ □ D ▽ | |
| | | ○ ⇨ □ D ▽ | |
| | | ○ ⇨ □ D ▽ | |
| 105 | | 3 4 2 8 | Total |

**Figure 44** Process chart of an office procedure—present method.

**Assembly Process charts:** A special type of process chart, sometimes called an assembly process chart, is useful for showing such situations as the following: 1)- when several parts are processed separately and are then assembled and processed together, 2)- when a product is disassembled and the component parts are further processed, 3)- when it is necessary to show a division in the flow of work, such as separate action on different copies of an office form.

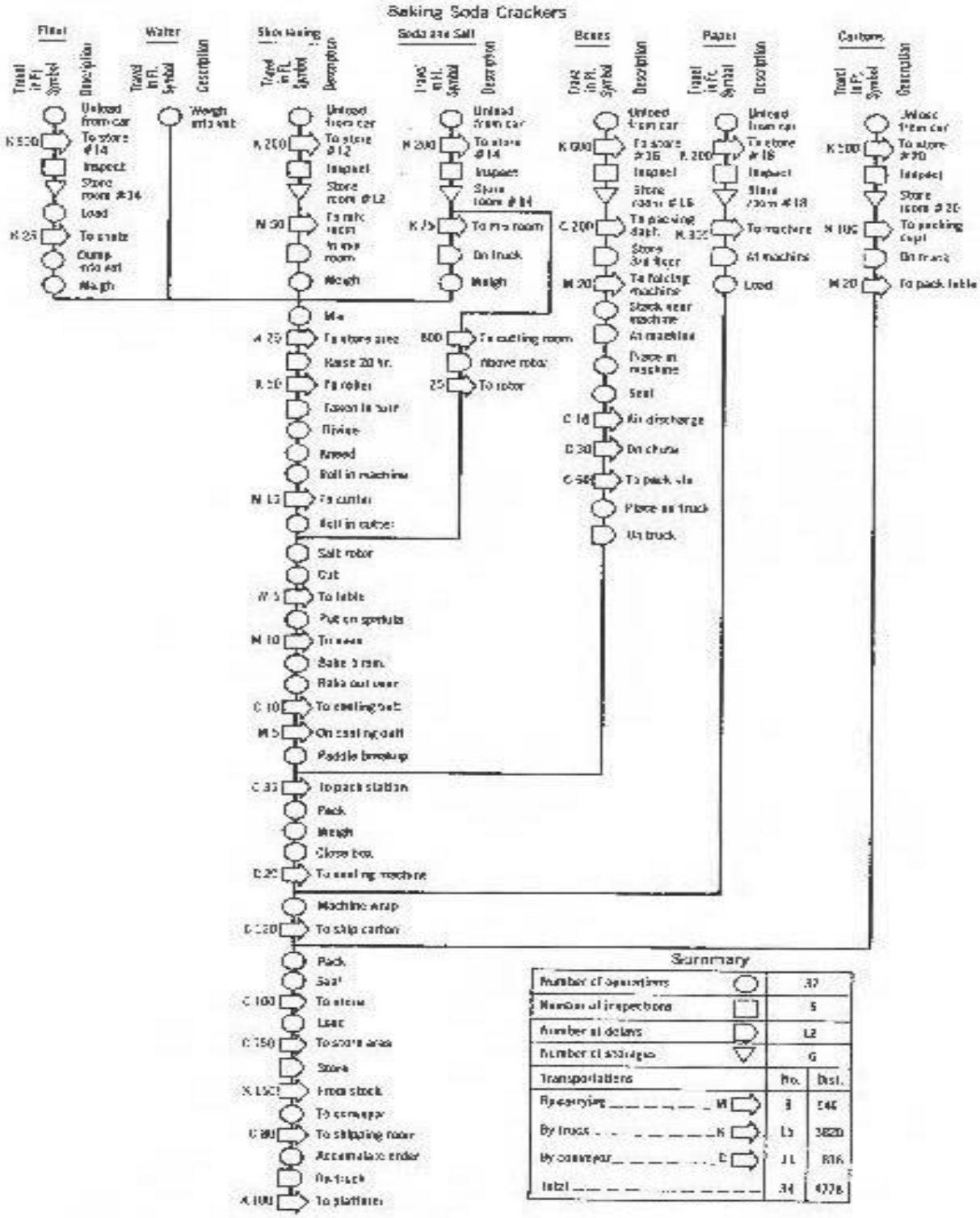
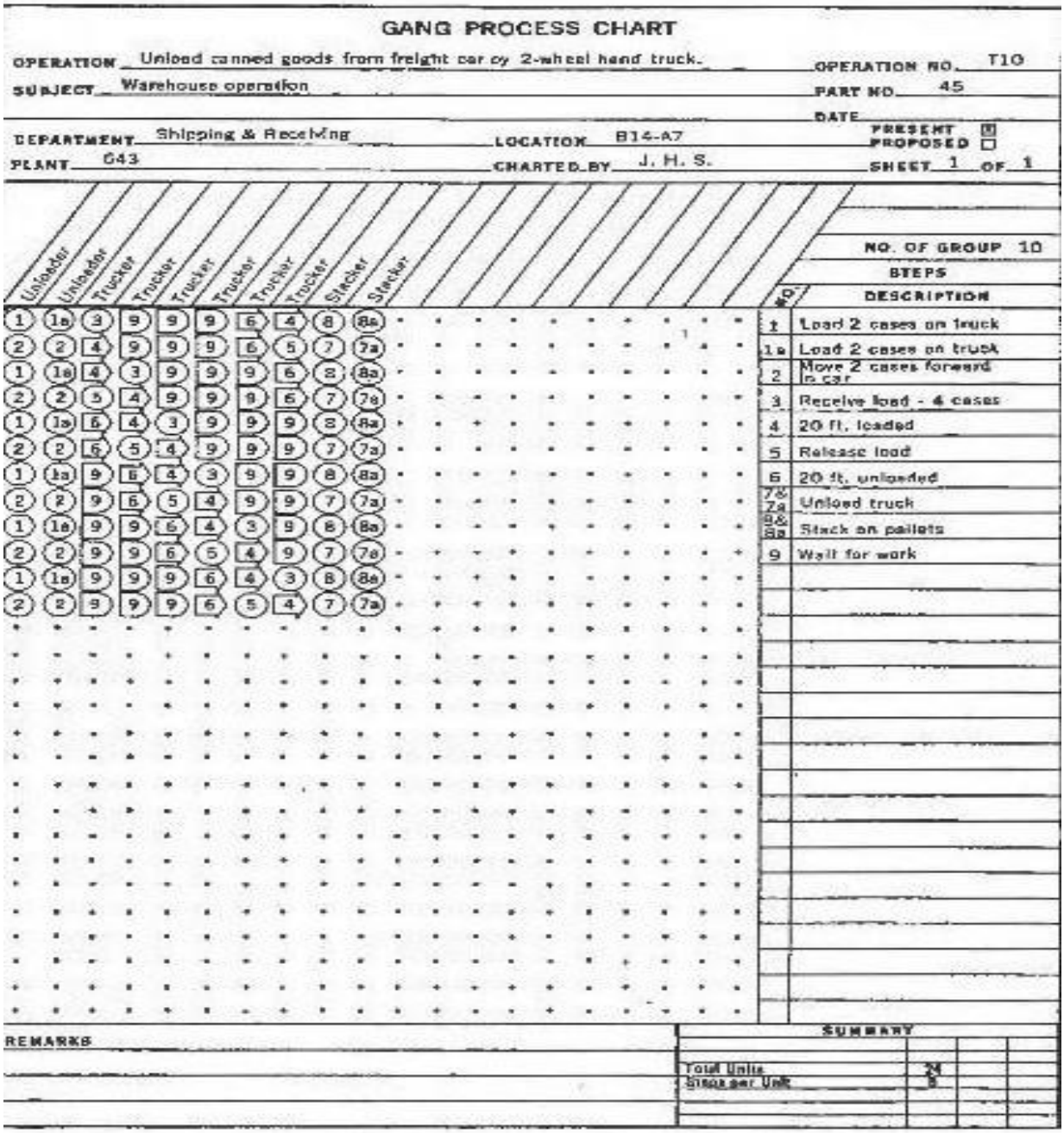



**Figure 47** Assembly process chart—baking soda crackers.

**Gang Process Charts:** The gang process chart is an aid in studying the activities of a group of people working together. This chart is a composite of individual member process charts, arranged to permit thorough analysis. Those operations which are performed simultaneously by gang members are indicated side by side.
The basic purpose of the chart is to analyze the activities of the group and then compose the group so as to reduce to a minimum all waiting time and delays.



GANG PROCESS CHART

OPERATION Unload canned goods from freight car by 2-wheel hand truck. OPERATION NO. T10
SUBJECT Warehouse operation PART NO. 45
DATE
DEPARTMENT Shipping & Receiving LOCATION B14-A7 PRESENT ☒ PROPOSED ☐
PLANT 643 CHARTED BY J. H. S. SHEET 1 OF 1

Unloader | Unloader | Trucker | Trucker | Trucker | Trucker | Trucker | Trucker | Stacker | Stacker

NO. OF GROUP 10

| NO. | STEPS DESCRIPTION |
|---|---|
| 1 | Load 2 cases on truck |
| 1a | Load 2 cases on truck |
| 2 | Move 2 cases forward in car |
| 3 | Receive load - 4 cases |
| 4 | 20 ft. loaded |
| 5 | Release load |
| 6 | 20 ft. unloaded |
| 7& 7a | Unload truck |
| 8& 8a | Stack on pallets |
| 9 | Wait for work |

REMARKS

SUMMARY

| | | | | |
|---|---|---|---|---|
| Total Units | 24 | | | |
| Steps per Unit | 9 | | | |

g 50 Gang process chart of unloading canned goods from freight car—present me

## Construction( Gang Process Charts)

1- The same symbols are used as for ordinary process charts.
2- A process chart covers the cycle or routing followed by each member of the gang. Member charts are placed side by side, with steps are performed simultaneously shown on the same horizontal line.
3- Symbols of member charts may be placed close together, the various steps are given code numbers rather than entering descriptions beside each symbol. Numbers are entered in the center of each symbol and corresponding explanations are placed at the side of the chart. This eliminates repetition of the description when similar steps are repeated, and at the same time permits the member charts to be placed close together.
4- Attention must be paid to entering simultaneous steps side by side. It may be found that an operation performed by one member of the group continues while another is performing more than one operation. In such instances, the symbol is repeated at each step for the operation which occupies the larger number of steps.
5- The chart should cover a complete cycle for the member performing the largest number of steps. Other gang members usually repeat their cycles during the largest member cycle.
6- Elements, which do not occur in every cycle, may be omitted from the chart. This includes preparatory work, which is done before a cycle is started, such as obtaining supplies for an entire shop. On the other hand, if an operational step occurs at periodic intervals within the cycle, it should be included on the chart. If such an operation occurs every two or three cycles, enough cycles should be shown to include the operation.
7- Steps per unit before and after study are used in gang chart summaries. This ratio is obtained by dividing the total steps on the chart by the total units handled for the cycles represented on the chart.
8- A chart should not be constructed from observation of a single cycle. A number of cycles should be observed, as the amount of waiting time may vary from cycle to cycle. The average condition should be reflected by the chart.

**Analysis of the Gang Process Charts:** Four steps are followed in analyzing a gang process chart.

First, the six questions what, who, where, when, how, and why are asked of the entire process.

Second, each operation and inspection is analyzed by utilizing the same six questions.

Third, the remaining transportations and storage are studied.

Fourth, the how question should be applied in a new way after refinements have been completed under step1, 2, and 3. This question is asked: "How should the gang be composed to reduce waiting time to minimum?" The following will assist the analyst to "balance" the gang under step 4:

1. Determine the class of operator having the largest amount of waiting time per cycle, and the class having the least.
2. Adjust the gang by decreasing number of operators least busy and increasing number of operators most busy. Generally, it is preferable to work toward a smaller rather than a larger gang.

## Steps to be Followed in Making a Process Chart and Flow Diagram

1. Determine the activity to be studied. Decide whether the subject to be followed is a person, product, part, material, or printed form. Do not change subjects during the construction of the process chart.
2. Choose a definite starting point and ending point in order to make certain that you will cover the activity that you want to study.
3. Draw the process chart on a sheet of paper of sufficient size to allow space for the heading, description, and summary. The heading should identify the process being studied.The body of the process chart should contain a column for Travel (distance in feet), Symbol, Description, and possible Time. The five process chart symbols should be used. Every step in the process should be shown if the analysis is to be of real value. Unnecessary steps and inefficiencies in the work must first be "seen" before they can be eliminated.
4. Include on the process chart a tabular summary showing the number of operations, number of moves of each kind, distance the part was moved, number of inspections, and number of storages and delays. After improvements have been made, a combined summary should be compiled giving this information for the old method, the proposed method, and the difference.
5. Obtain floor plans of the department or the plant, showing location of machines and equipment used in making the part. It is frequently desirable to mount the floor plans on a drawing board or table, cut out cardboard templates the size of the machines (Use a proper scale), and use these when new arrangements for the equipment are suggested. Sometimes three-dimensional scale models of machines and equipment are used instead of templates.
6. Draw on the floor plans in pencil the path of the part through the plant, noting the direction of travel by means of arrows. The flow diagram should

be made on location and not from memory at a desk. Distances should be measured or paced off.