# MENG 344

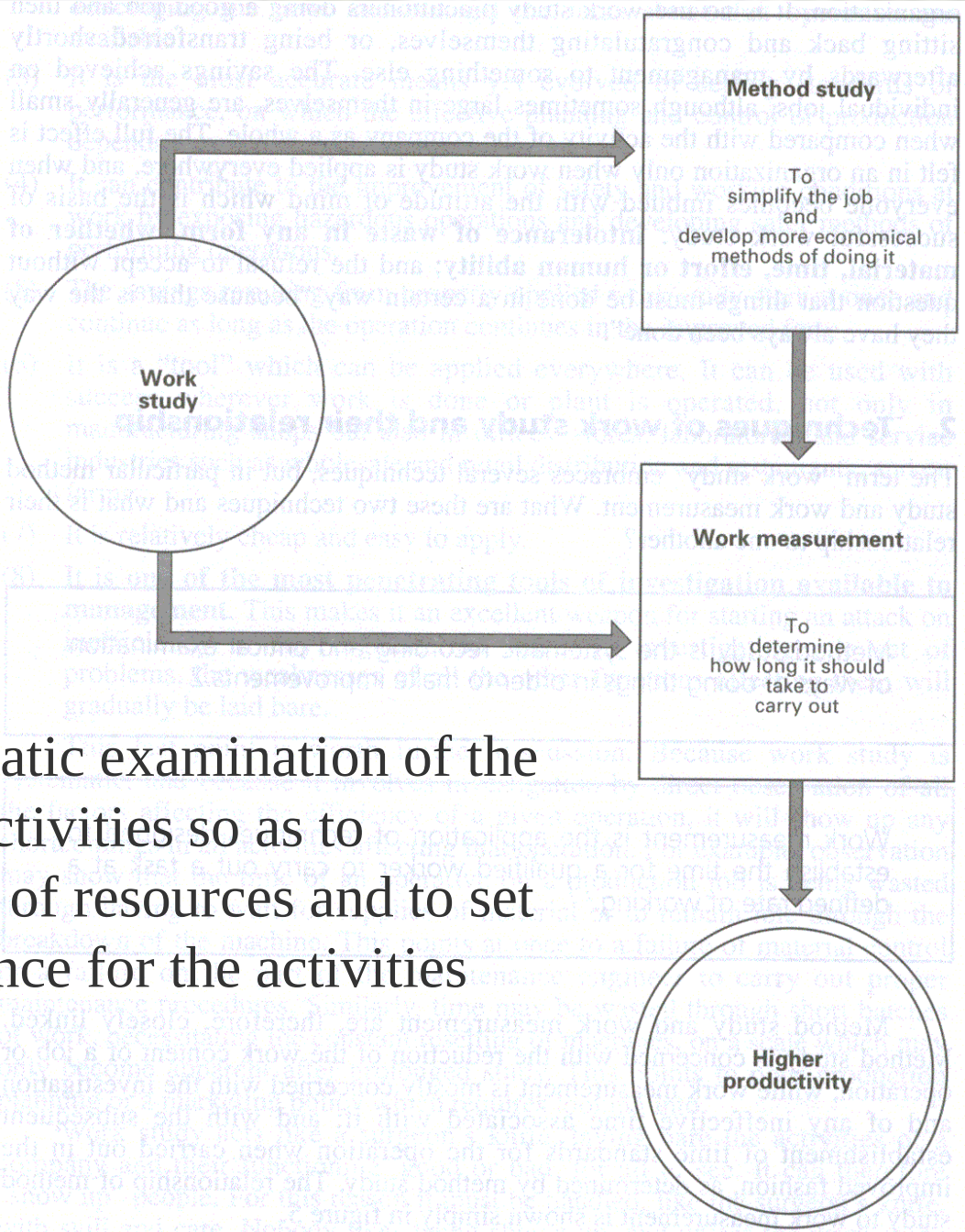
# Work Analysis and Design

## Method Study

*Lotfi K. Gaafar*

Based on *Introduction to work study*. 3rd ed. International Labor Office, Geneva, 1992.

# Work Study



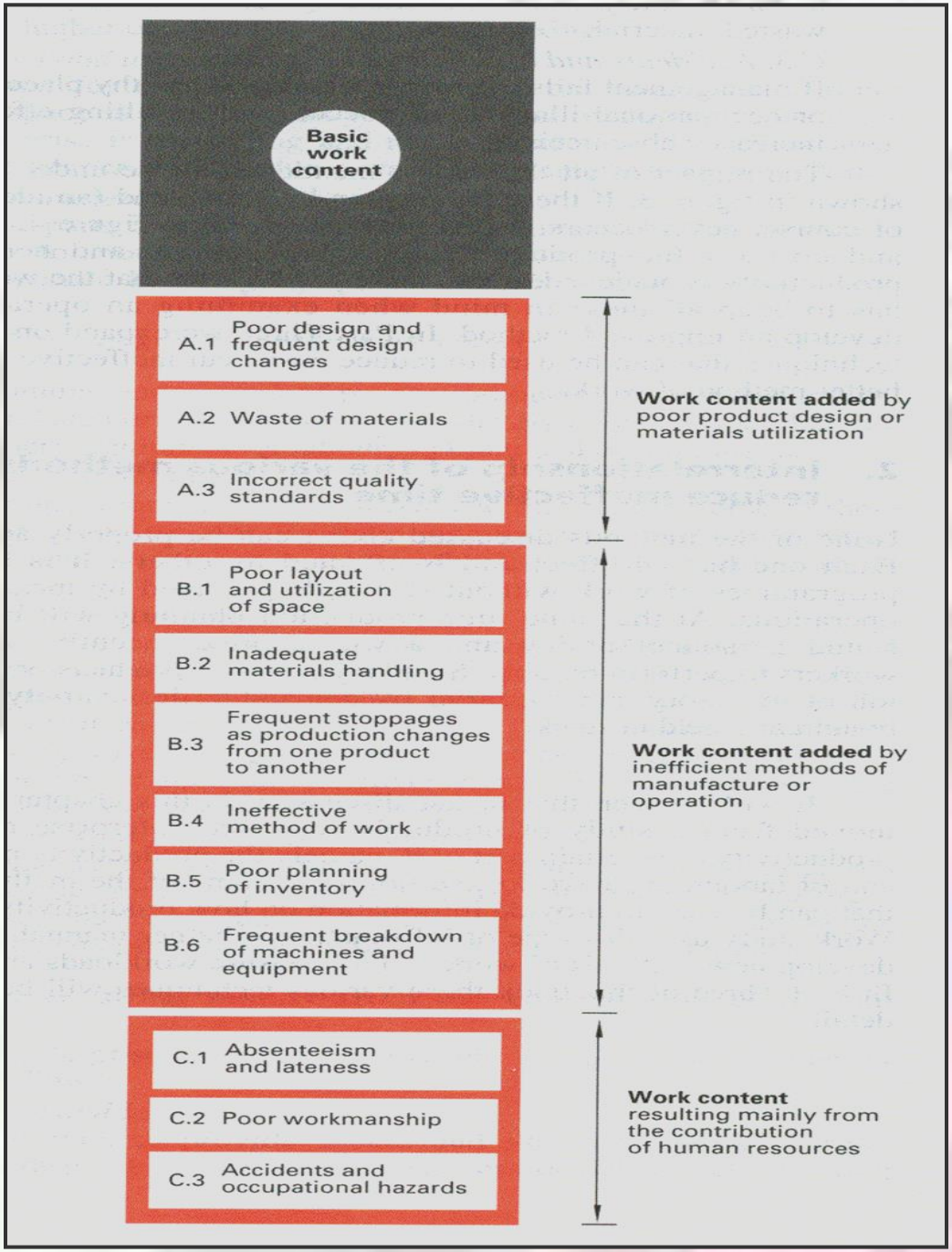

Work Study is the systematic examination of the methods of carrying on activities so as to improve the effective use of resources and to set up standards of performance for the activities being carried out.

# Method Study

Method study examines the way a task (changing the clutch on a car, preparing a flower bed for planting, cleaning a hotel room) is done. The industrial engineer has an eye on operational efficiencies and costs, quality of processes, service reliability, staff safety etc. Method study techniques are applicable from factory/workshop manufacturing to cabin crew activities on an international flight and office clerical work.

A collection of techniques used to examine work - what is done and how it is done - so that there is systematic analysis of all the elements, factors, resources and relationships affecting the efficiency and effectiveness of the work being studied.

# The Human Factor in The Application of Work Study


Basic work content
A.1 Poor design and frequent design changes
A.2 Waste of materials
A.3 Incorrect quality standards
Work content added by poor product design or materials utilization
B.1 Poor layout and utilization of space
B.2 Inadequate materials handling
B.3 Frequent stoppages as production changes from one product to another
B.4 Ineffective method of work
B.5 Poor planning of inventory
B.6 Frequent breakdown of machines and equipment
Work content added by inefficient methods of manufacture or operation
C.1 Absenteeism and lateness
C.2 Poor workmanship
C.3 Accidents and occupational hazards
Work content resulting mainly from the contribution of human resources

# Work study and the Management

- Importance of management.
- How to gain the management support:
  - Make them feel that it is not their fault.
  - Make them understand the purpose and techniques of work study.

# Work Study and the Supervisor

The importance of the supervisor:

- Mostly affected by work study.
- A personal challenge.
- Responsibilities are taken away.

# Work Study and the Supervisor

**Do's and Don'ts**

- Never give a direct order to a worker.
- Always refer worker's questions to the supervisor.
- Never express opinions to workers.
- Don't allow worker's to get you to alter decisions made by the supervisor.
- Seek the supervisor advice whenever possible.
- Always be introduced to workers by the supervisor.

# Work Study and the Worker

- Work study improves industrial relations:
  - Workers feel that the management cares for them.
  - Workers discover that there are managers who highly understand their job.
  - Improving the feeling of confidence.
  - Workers are more able to carry out their jobs.

# Work study and the Worker

- Why workers resist the work study:
  - It will change their familiar work methods.
  - Many workers resent being timed.
  - Fear of being fired.

# Problem Solving

- Problem definition
  - statement of purpose, goal, objective
  - criteria of judging successful solution
  - output requirements
  - completion date
- Analysis of problem
  - constraints or specifications
  - description of the present method
  - review problem definition and criteria

# Problem Solving

- Search for possible solutions
  - identify the basic cause that creates problem;
  - eliminate all unnecessary work
  - combine operations or elements
  - change sequence of operations
  - simplify the necessary operations
- Evaluation of alternatives
  - in terms of criteria and original specification

# Problem Solving

- Recommendation for action
  - written reports to senior managers
  - presentations to senior managers and shop floor employees
  - development of soft skills, listening, negotiating,
- Marketing recommendations
  - target relevant groups

# How do we measure performance?

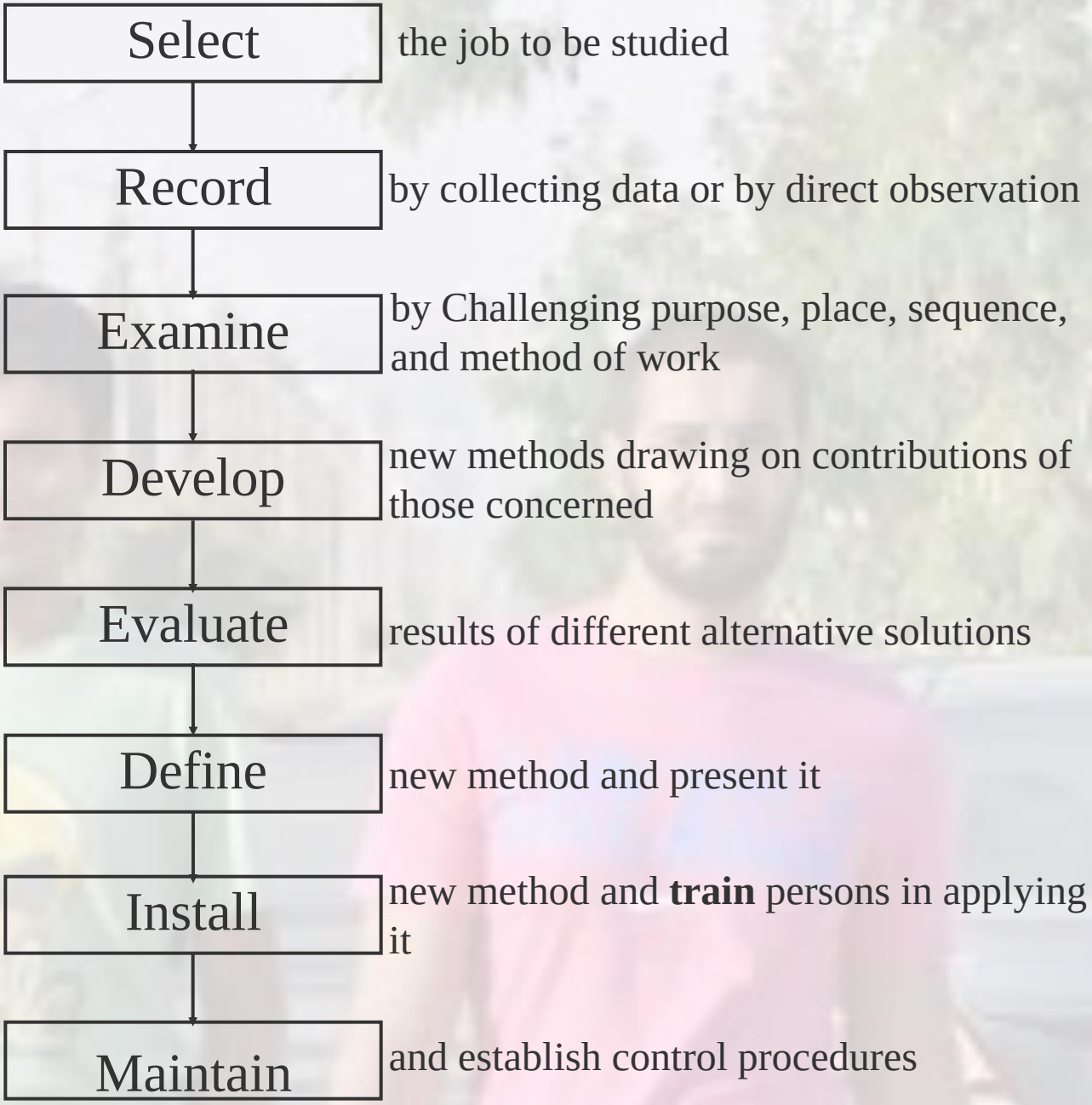
- Profit
- Financial measures
- Productivity – output/input ratios
- Cycle time

# Possible Performance Measures

- **Quality** expressed as % scrap value, % returns, % downtime
- **Costs** expressed as inventory turnover, value added to incoming material
- **Delivery** expressed as % on time delivery, cycle time
- **Flexibility** as Average number of setups /day, % of common parts/product
- **Innovation** as % sales from products introduced in last 3 years

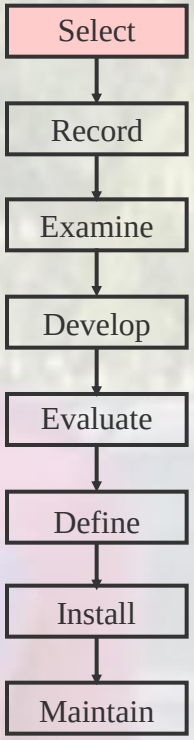
# Method Study

To Simplify the job and develop more economical methods of doing it



# Select – Where to Look

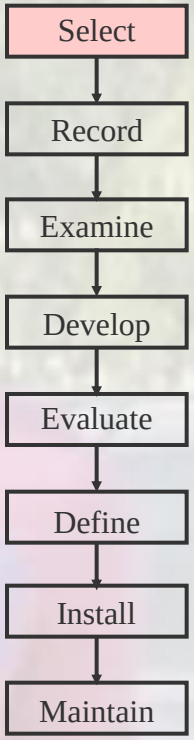
- Poor use of resources
- Bad layout
- Bottlenecks
- Inconsistent quality
- High fatiguing work
- Excessive overtime
- Employee's complaints



# Select – Where to Look

Waste from:

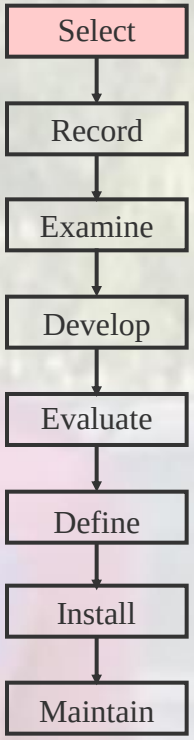
- Overproduction
- Waiting time
- Transportation
- Inventory
- Processing
- Motion
- Defects



# Select – Economic Considerations

*Will it pay to begin, or continue, a method study of this job?*

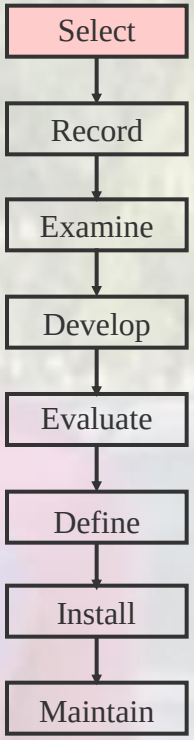
- Key profit- generating operations
- Key costly operations
- Repetitive work
- Long travels
- Excessive overtime



# Select – Technical Considerations

*Desire to acquire more advanced technology*

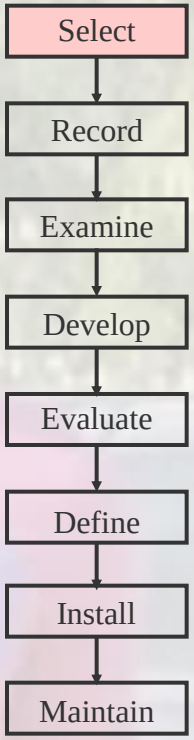
- Extensive paperwork
- Repetitive work (automation)
- Hazardous work
- Inconsistent quality



# Select – Human Considerations

*Workers satisfaction/resentment*

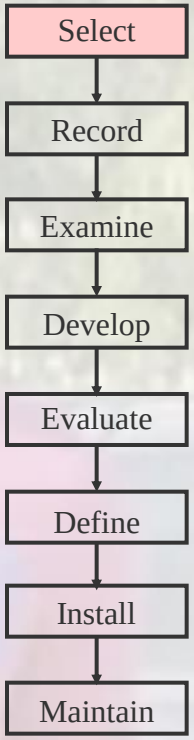
- Satisfaction level
- Start with non-controversial jobs
- HSE



# Select – Limiting the Scope

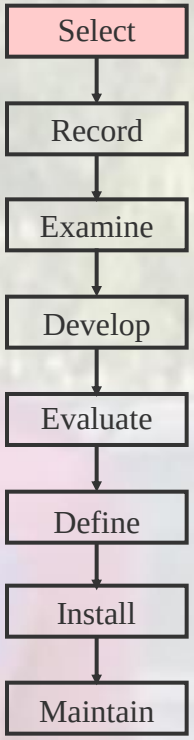
*Setting boundaries and determining content*

- One operation or a sequence
- The whole operation or part
- Which aspect: worker, materials, equipment, … etc.

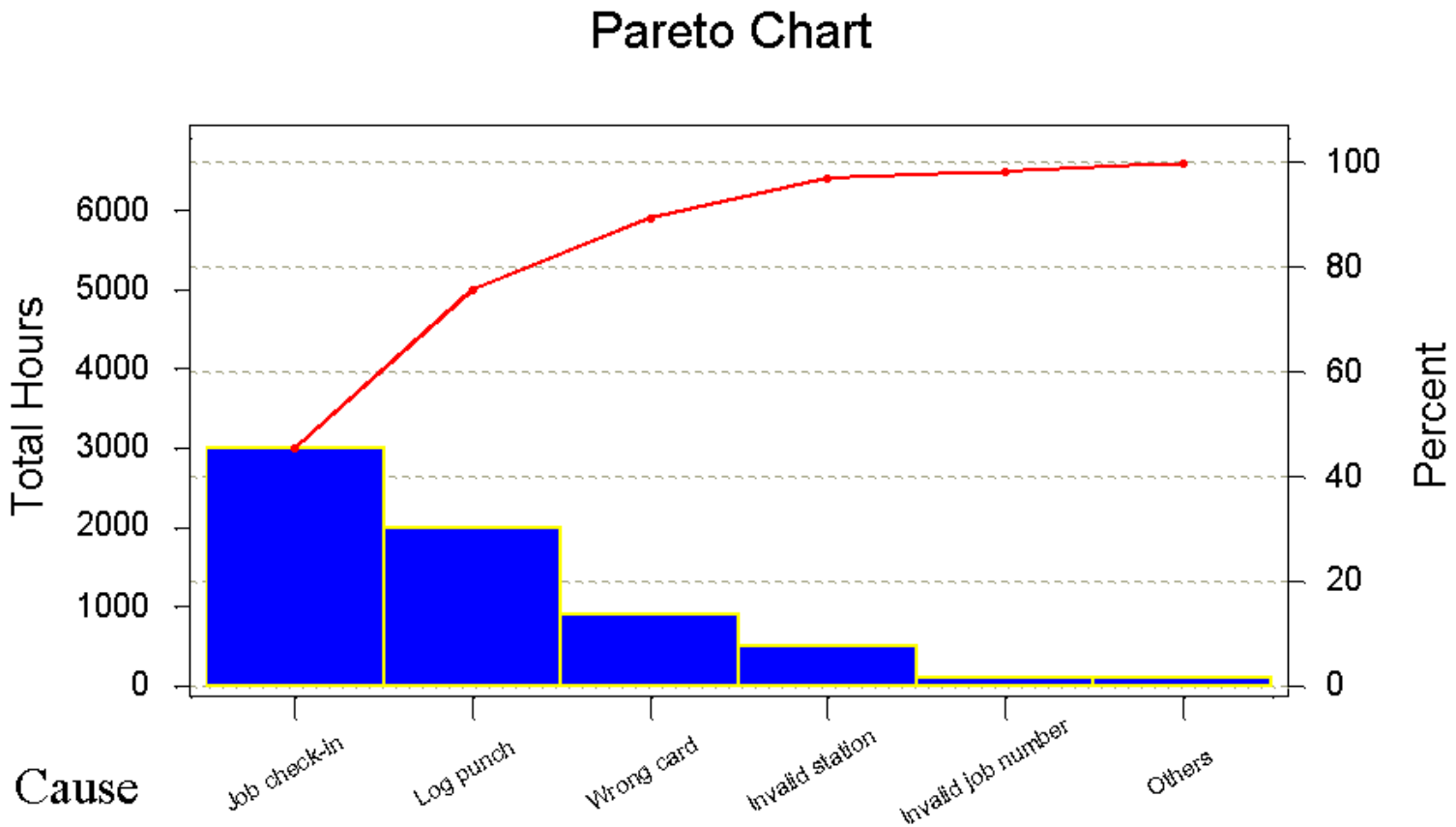


# Select – Possible Results

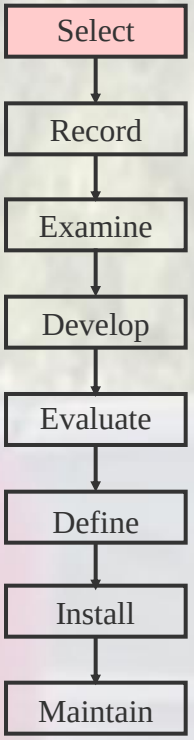
- Increased production rate
- Reduced cost
- Less labor, materials, or equipment
- Improved quality
- Improved safety
- Reduced scrap
- Improved standards of cleanliness



# Select – Pareto Analysis




| Cause | Job check-in | Log punch | Wrong card | Invalid station | Invalid job number | Others |
|---|---|---|---|---|---|---|
| Total Hours | 3000 | 2000 | 900 | 500 | 100 | 101 |
| Percent | 45.4 | 30.3 | 13.6 | 7.6 | 1.5 | 1.5 |
| Cum % | 45.4 | 75.7 | 89.4 | 97.0 | 98.5 | 100.0 |



# Record- Symbols

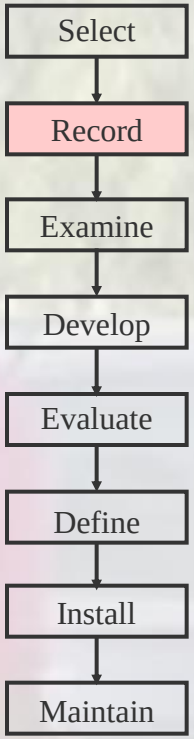
Operation (Make ready, Do, Put away)

Inspection

Transport

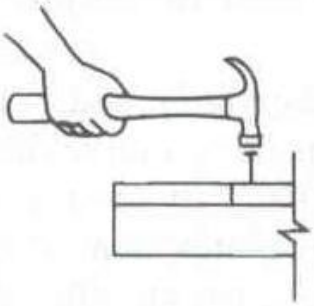
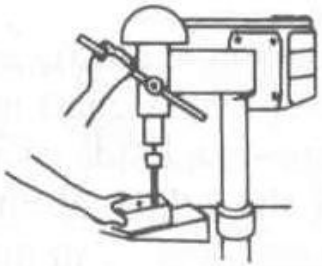
Delay

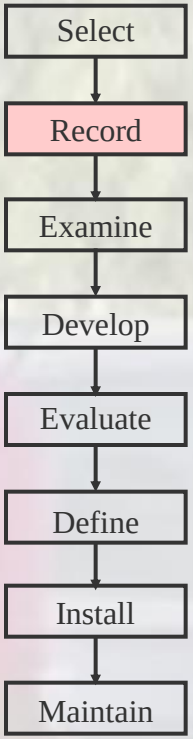
Storage



# Record- Symbols

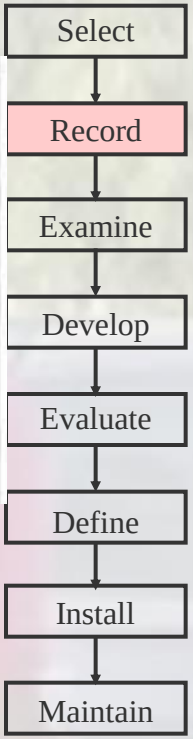
Operation (Make ready, Do, Put away)

| OPERATION<br><br>A large circle indicates an operation, such as |  <br>Drive nail |  <br>Drill hole |  <br>Type letter |
|---|---|---|---|



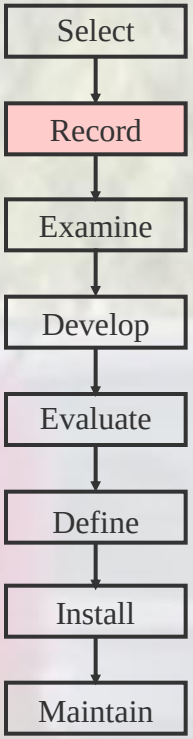
# Record- Symbols

| TRANSPORT | | | |
|---|---|---|---|
|  An arrow indicates transport, such as |  Move material by truck |  Move material by hoist or elevator |  Move material by carrying (messenger) |

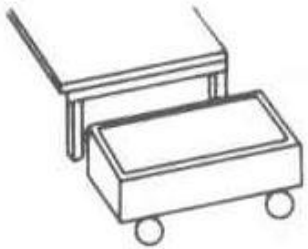
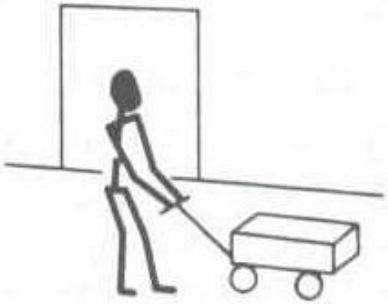


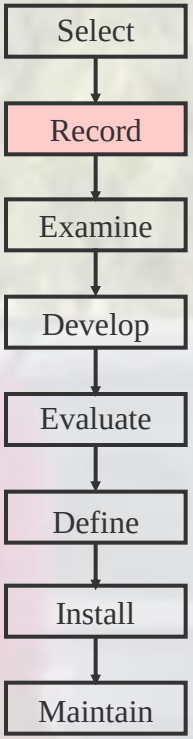
# Record- Symbols

| INSPECTION | | | |
|---|---|---|---|
| A square indicates an inspection, such as | Examine material for quality or quantity | Read steam gauge on boiler | Examine printed form for information |

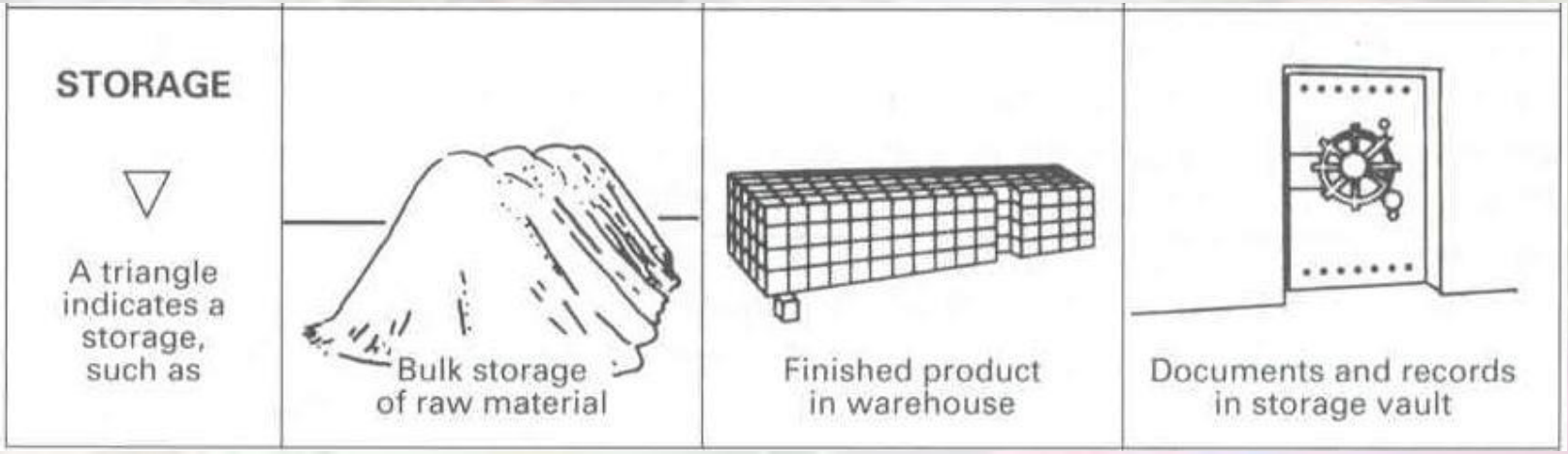


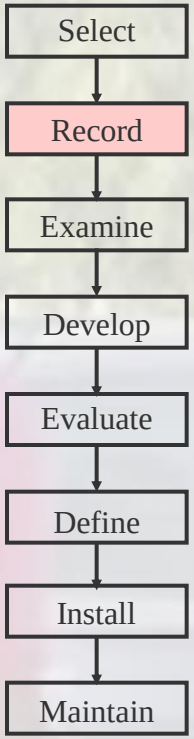
# Record- Symbols

| DELAY<br>D<br>The letter D indicates a delay, such as |  <br>Material in truck or on floor at bench waiting to be processed |  <br>Employee waiting for elevator |  <br>Papers waiting to be filed |
|---|---|---|---|



# Record- Symbols



# Record- Charts and Diagrams

Outline Process Chart

Flow Process Chart (Worker, Material, Equipment)

Two-Handed Process Chart

Procedure Chart

Simultaneous motion Cycle Chart

Multiple Activity Chart

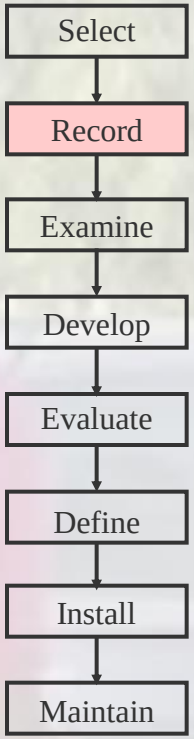
Flow Diagram

String Diagram

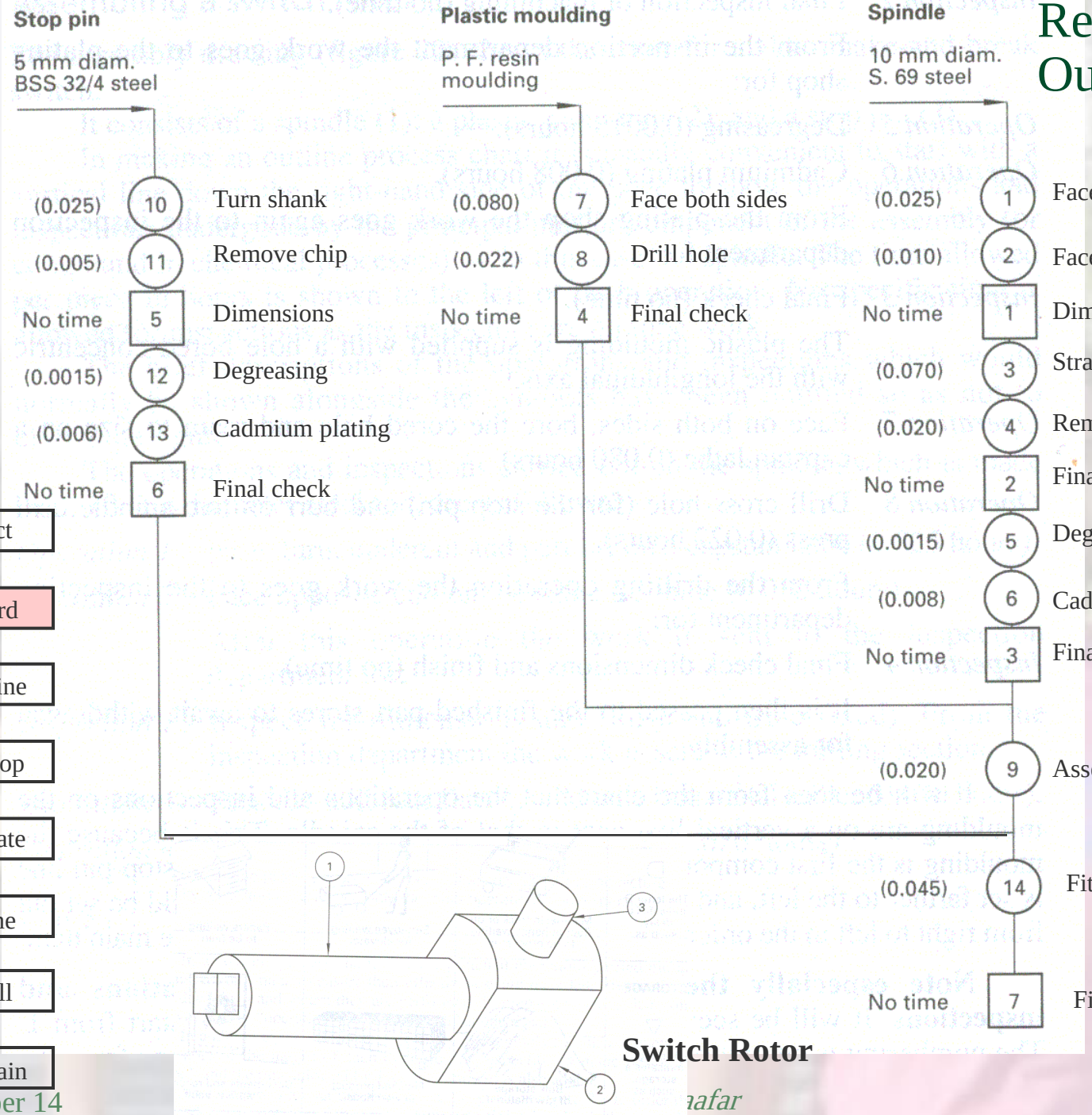
Cyclegraph

Chronocyclegraph

Travel Chart



# Record- Example Outline Chart

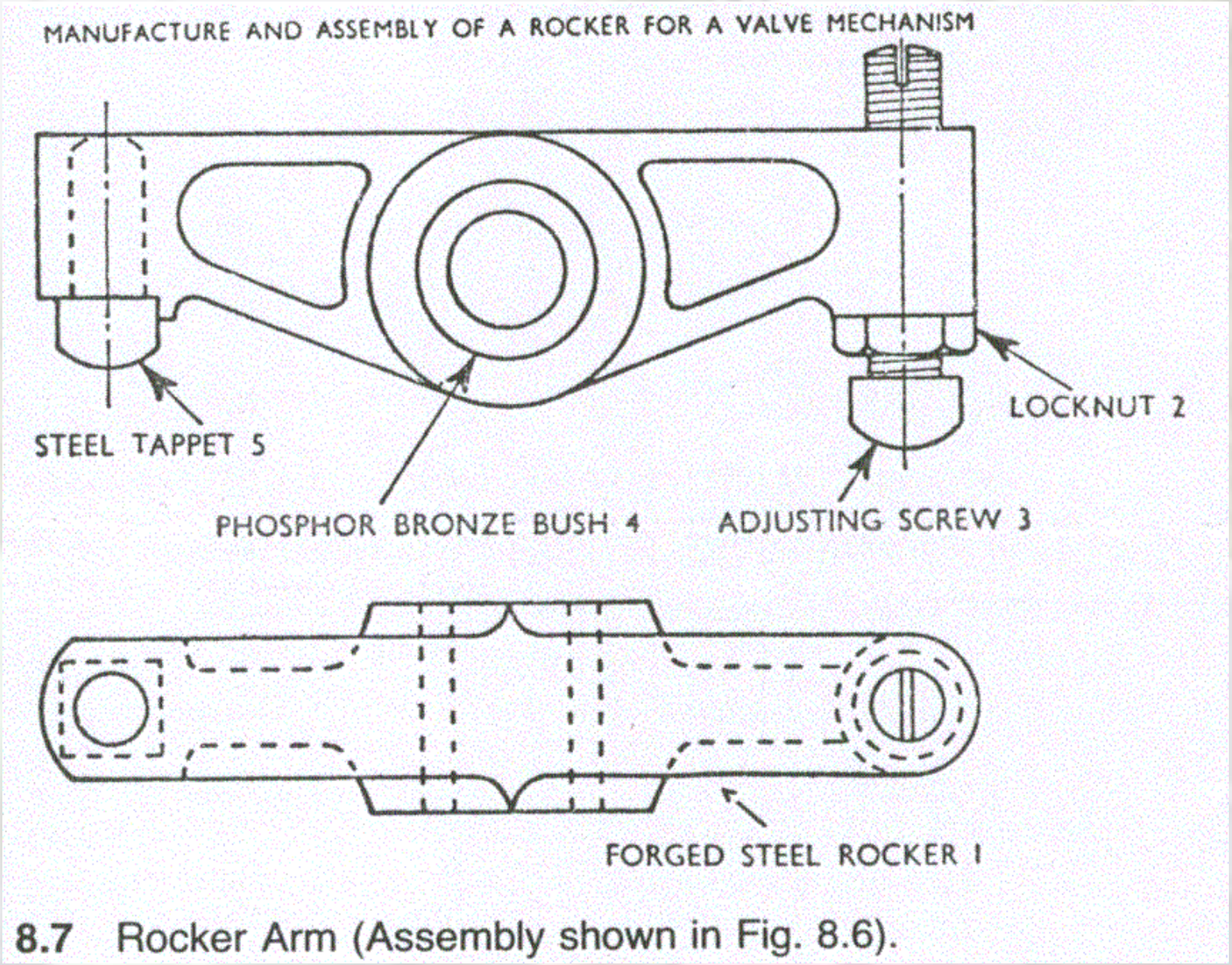



Select
Record
Examine
Develop
Evaluate
Define
Install
Maintain




**Switch Rotor**

# Record- Example




8.7 Rocker Arm (Assembly shown in Fig. 8.6).

- Select
- Record
- Examine
- Develop
- Evaluate
- Define
- Install
- Maintain

# Record- Example Outline Chart

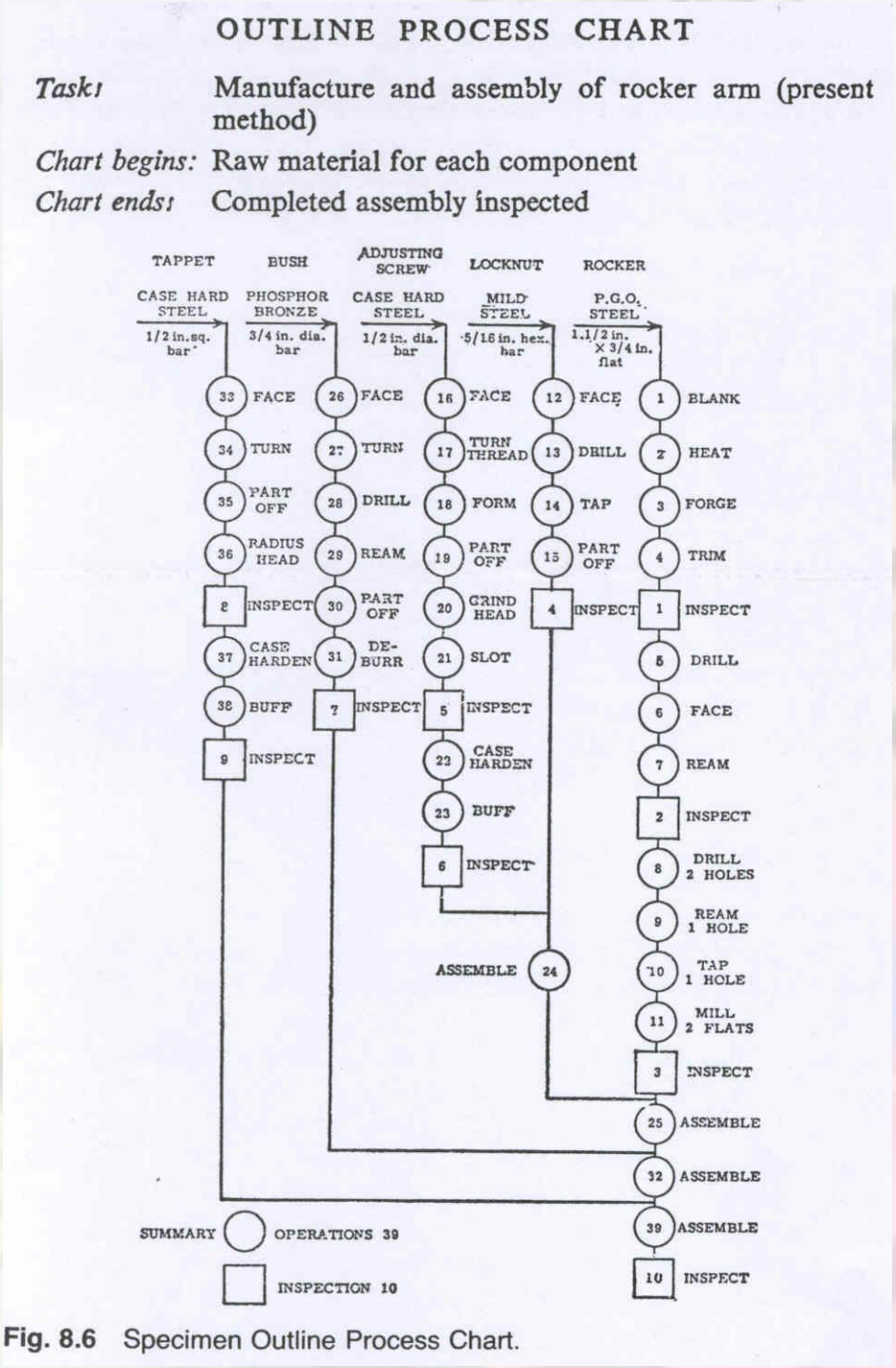
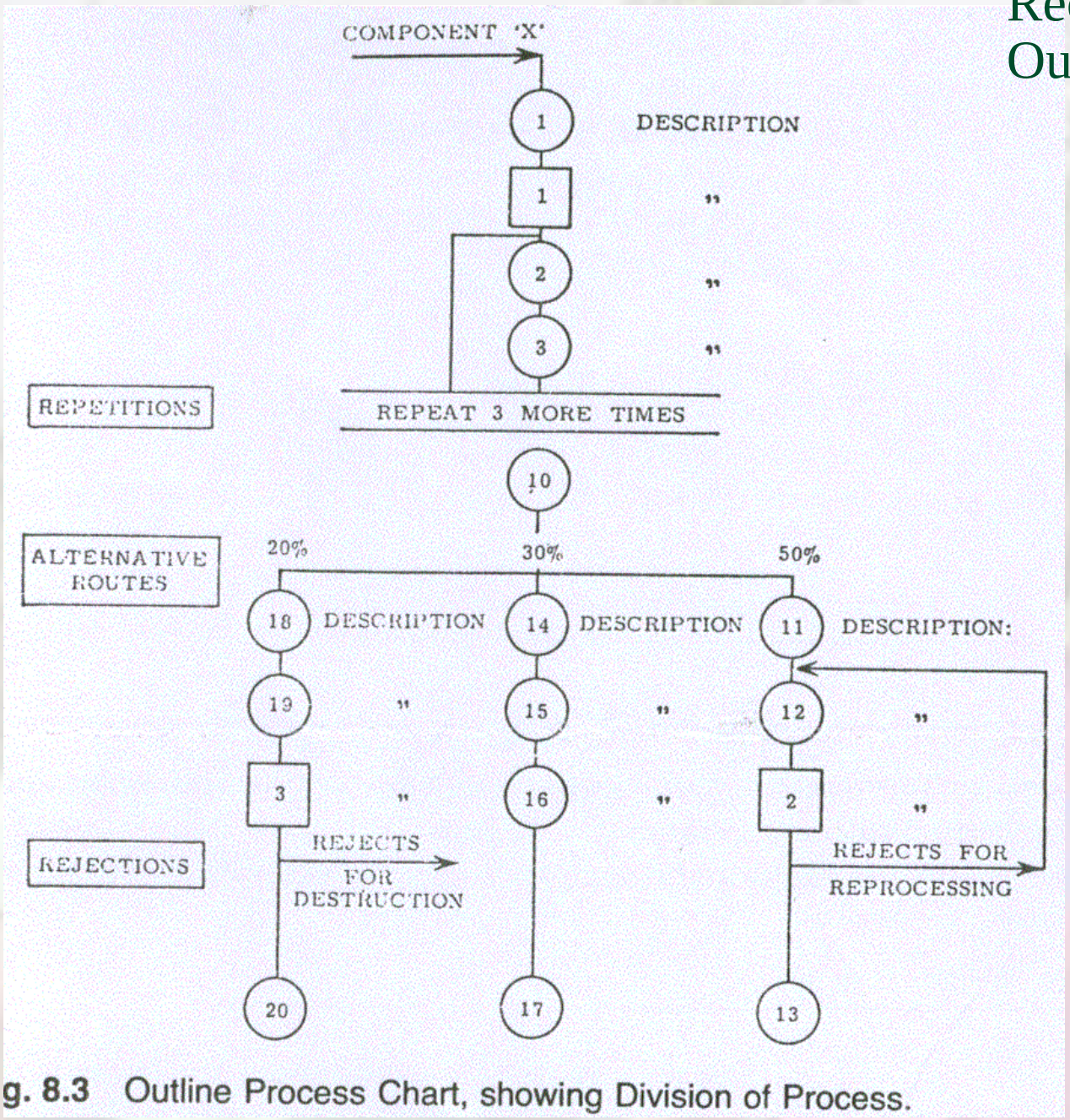



Fig. 8.6 Specimen Outline Process Chart.

- Select
- Record
- Examine
- Develop
- Evaluate
- Define
- Install
- Maintain

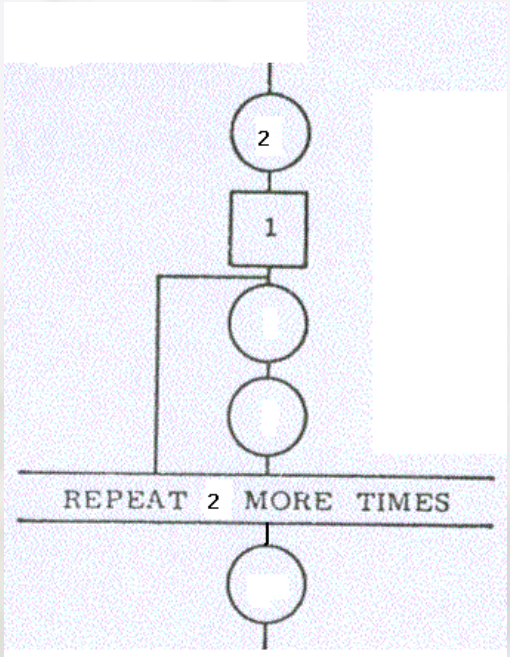
# Record- Example Outline Chart

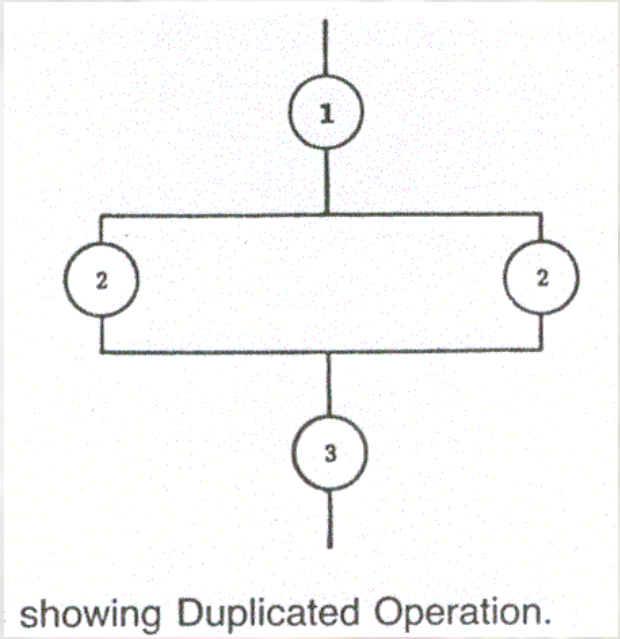



g. 8.3 Outline Process Chart, showing Division of Process.

- Select
- Record
- Examine
- Develop
- Evaluate
- Define
- Install
- Maintain

# Record- Example Outline Chart

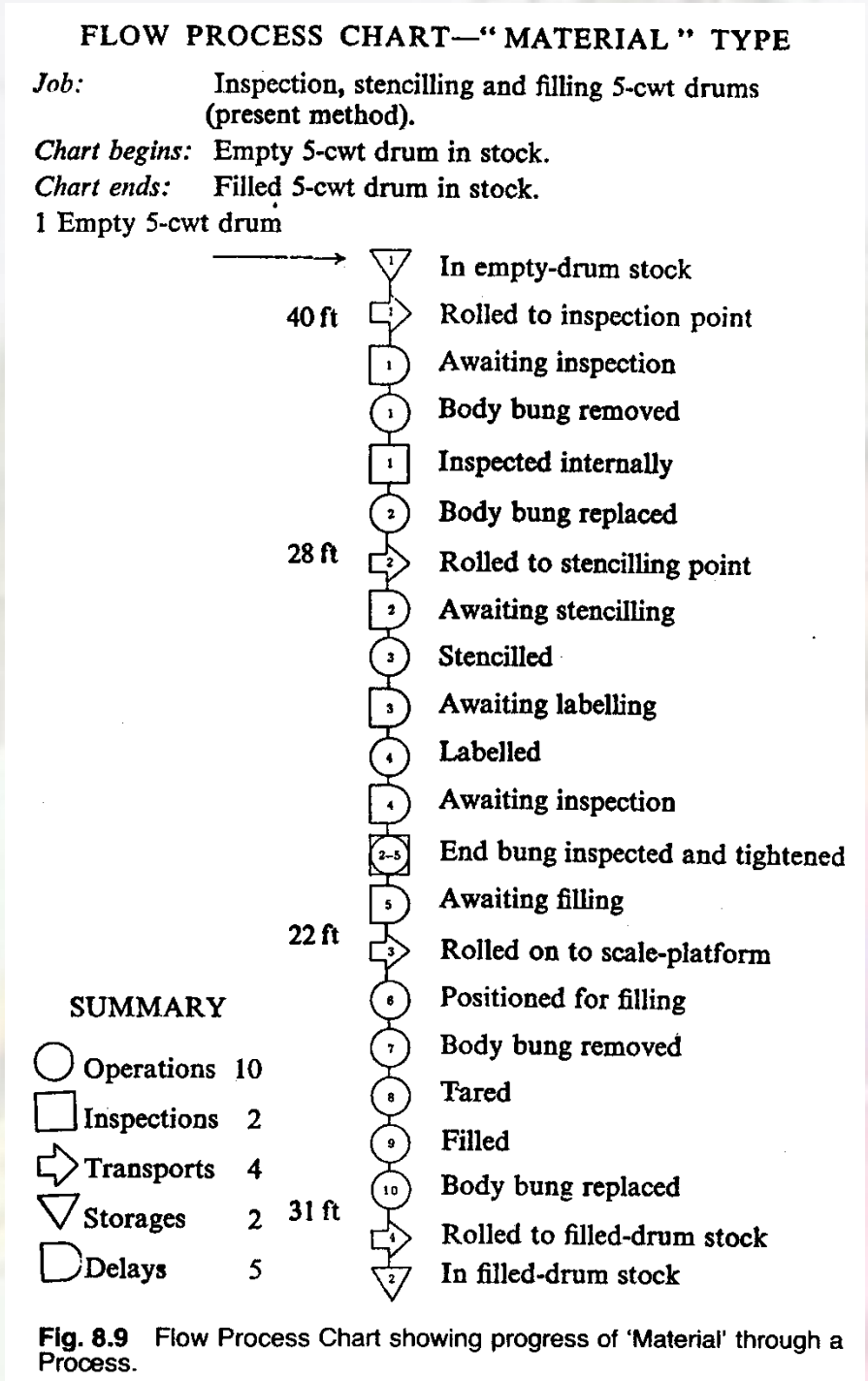



showing Duplicated Operation.

- Select
- Record
- Examine
- Develop
- Evaluate
- Define
- Install
- Maintain

# Record- Example Flow Chart



FLOW PROCESS CHART—"MATERIAL" TYPE

*Job:* Inspection, stencilling and filling 5-cwt drums (present method).

*Chart begins:* Empty 5-cwt drum in stock.

*Chart ends:* Filled 5-cwt drum in stock.

1 Empty 5-cwt drum

| | | |
|---|---|---|
| | 1 | In empty-drum stock |
| 40 ft | 1 | Rolled to inspection point |
| | 1 | Awaiting inspection |
| | 1 | Body bung removed |
| | 1 | Inspected internally |
| | 2 | Body bung replaced |
| 28 ft | 2 | Rolled to stencilling point |
| | 2 | Awaiting stencilling |
| | 3 | Stencilled |
| | 3 | Awaiting labelling |
| | 4 | Labelled |
| | 4 | Awaiting inspection |
| | 2–5 | End bung inspected and tightened |
| | 5 | Awaiting filling |
| 22 ft | 3 | Rolled on to scale-platform |
| | 6 | Positioned for filling |
| | 7 | Body bung removed |
| | 8 | Tared |
| | 9 | Filled |
| | 10 | Body bung replaced |
| 31 ft | 4 | Rolled to filled-drum stock |
| | 2 | In filled-drum stock |

SUMMARY

| | |
|---|---|
| Operations | 10 |
| Inspections | 2 |
| Transports | 4 |
| Storages | 2 |
| Delays | 5 |

**Fig. 8.9** Flow Process Chart showing progress of 'Material' through a Process.

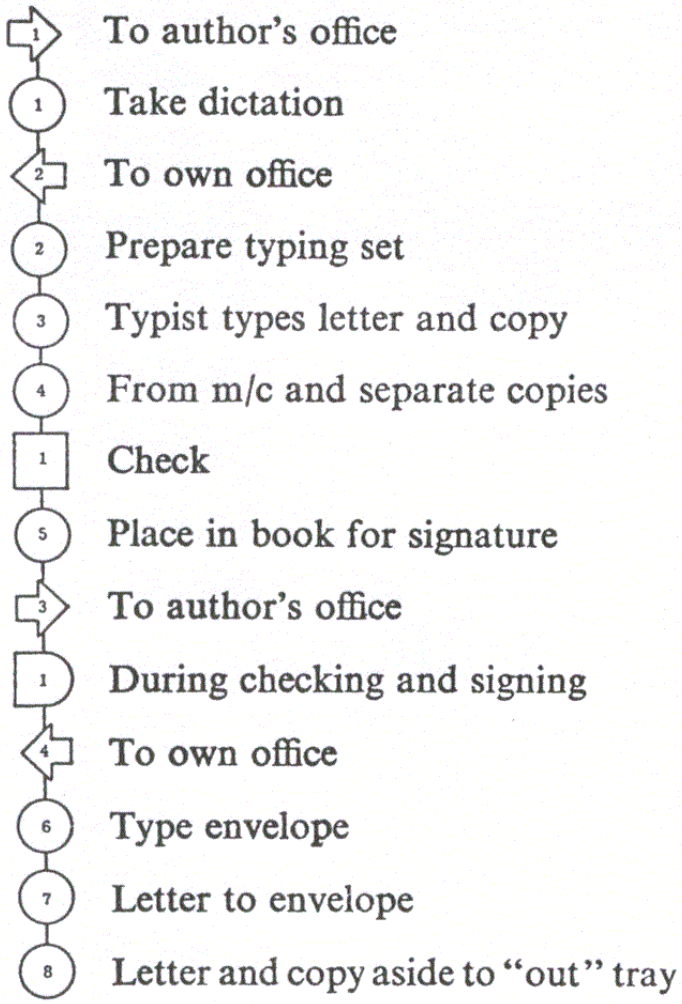
- Select
- Record
- Examine
- Develop
- Evaluate
- Define
- Install
- Maintain

# Record- Example Flow Chart

*Chart begins:* Typist in own office awaiting dictation.

*Chart ends:* Typist puts letter in "out" tray.

*Man*
(Typist)




- Select
- Record
- Examine
- Develop
- Evaluate
- Define
- Install
- Maintain

# Record- Example Flow Chart



FLOW PROCESS CHART (AMPLIFIED)—
"MAN" TYPE

*Job:* Writing a letter using a shorthand-typist (present method).

*Chart begins:* Typist in own office awaiting dictation.

*Chart ends:* Typist puts letter and copy in out tray.

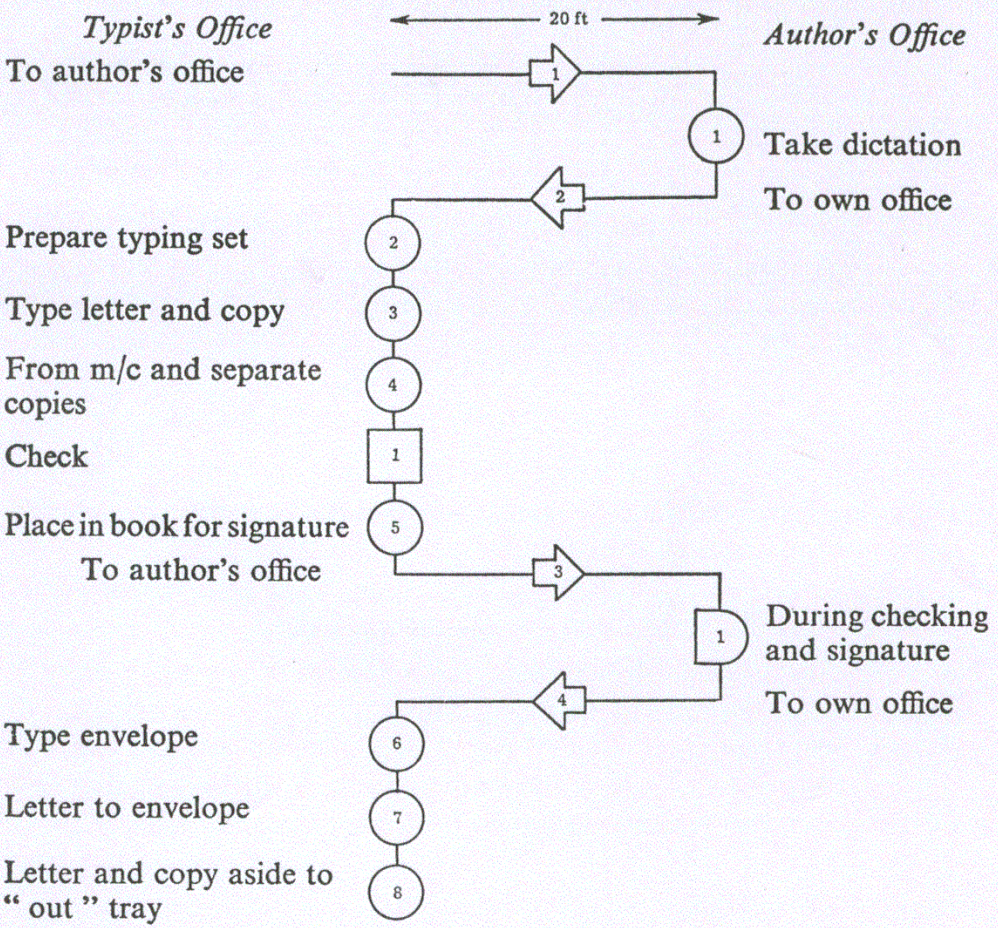
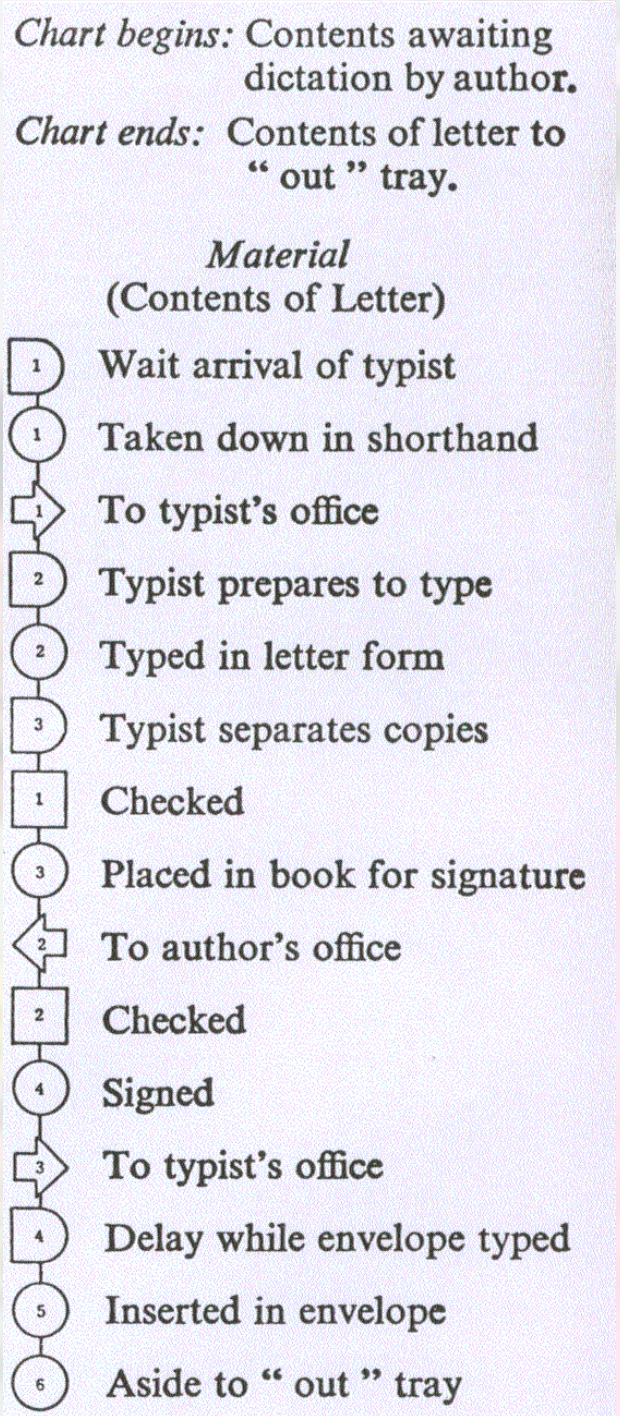



**Fig. 8.11** 'Man' Type Flow Process Chart from Fig. 8.10, amplified to Emphasize Distances Travelled.

Select
Record
Examine
Develop
Evaluate
Define
Install
Maintain

# Record- Example Flow Chart




- Select
- Record
- Examine
- Develop
- Evaluate
- Define
- Install
- Maintain

# Record- Example Flow Chart

## FLOW PROCESS CHARTS—"MAN" TYPE AND "MATERIAL" TYPE

*Job:* Writing a letter using a shorthand-typist (present method).

| *Man* (Typist) | | *Material* (Contents of Letter) |
|---|---|---|
| *Chart begins:* Typist in own office awaiting dictation. | | *Chart begins:* Contents awaiting dictation by author. |
| *Chart ends:* Typist puts letter in "out" tray. | | *Chart ends:* Contents of letter to "out" tray. |
| To author's office | 1 | Wait arrival of typist |
| Take dictation | 1 | Taken down in shorthand |
| To own office | 2 | To typist's office |
| Prepare typing set | 2 | Typist prepares to type |
| Typist types letter and copy | 3 | Typed in letter form |
| From m/c and separate copies | 4 | Typist separates copies |
| Check | 1 | Checked |
| Place in book for signature | 5 | Placed in book for signature |
| To author's office | 3 | To author's office |
| During checking and signing | 1 | Checked |
| To own office | 4 | Signed |
| Type envelope | 6 | To typist's office |
| Letter to envelope | 7 | Delay while envelope typed |
| Letter and copy aside to "out" tray | 8 | Inserted in envelope |
| | | Aside to "out" tray |

**Fig. 8.10** Flow Process Charts, 'Man and Material' for the same job.

Select
Record
Examine
Develop
Evaluate
Define
Install
Maintain

# Record- Example Flow Chart

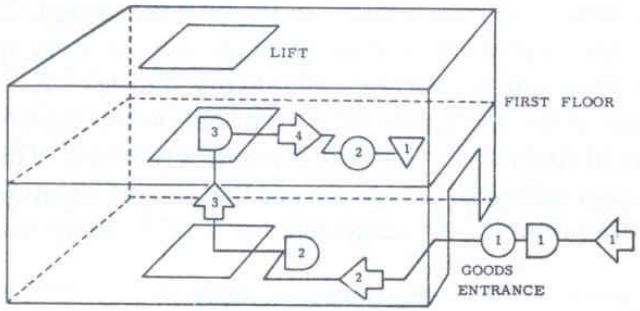
## THREE-DIMENSIONAL FLOW DIAGRAM

*Job:* Unloading goods and removal to storage on first floor (present method).

*Chart begins:* Goods on lorry arriving at goods entrance.

*Chart ends:* Goods in store.

*Flow Diagram*




## FLOW PROCESS CHART

(Material Type)

| | |
|---|---|
| Goods to building on lorry | 1 |
| Await unloading | 1 |
| Unloaded to hand trolley | 1 |
| To goods lift on trolley | 2 |
| Await arrival of lift | 2 |
| Enter lift on trolley and to 1st floor | 3 |
| Await removal of trolley from lift | 3 |
| From lift and to store on trolley | 4 |
| Unloaded from trolley | 2 |
| In storage | 1 |

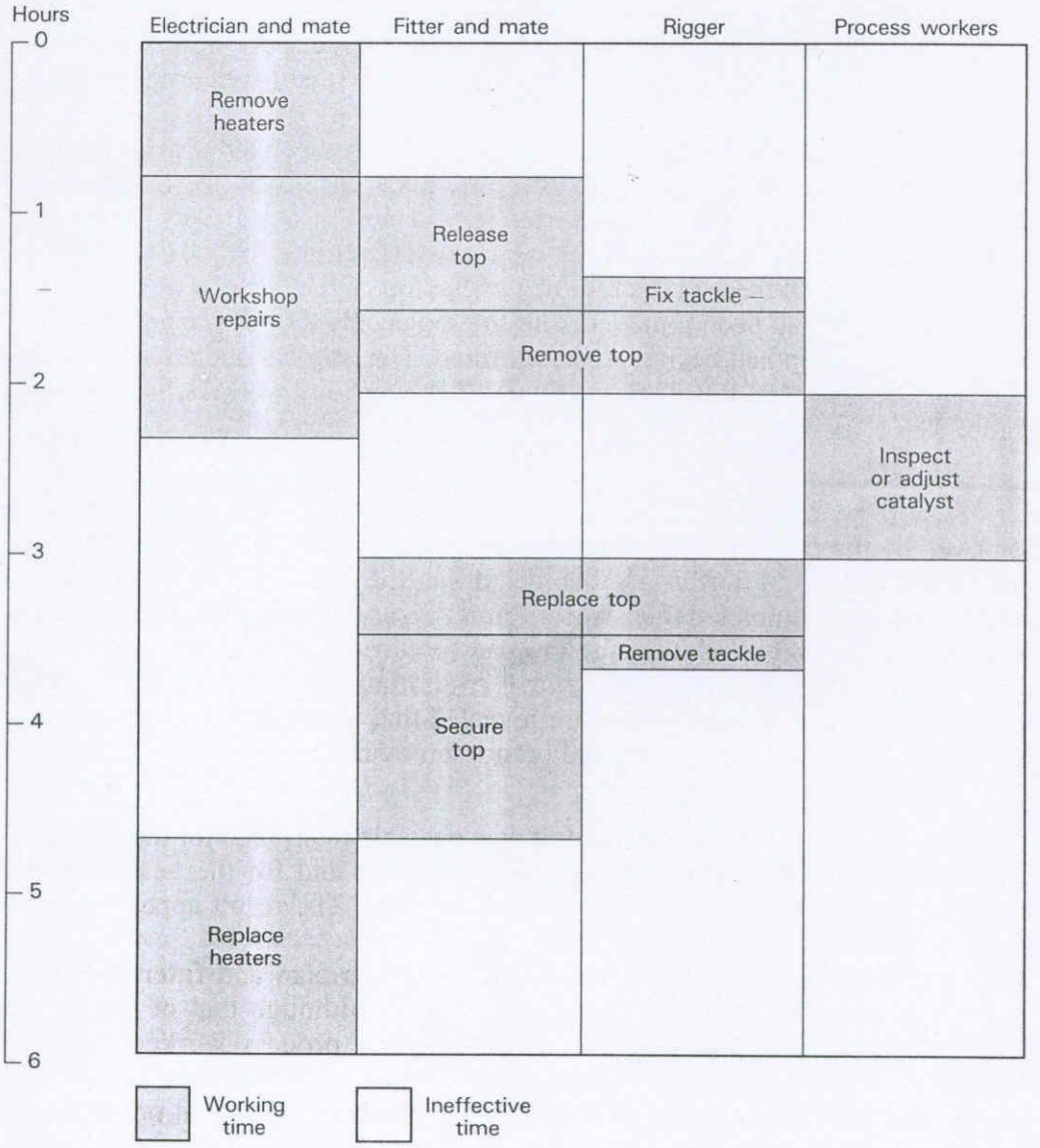
**Fig. 8.20** Flow Diagram with Flow Process Chart of Activities on Two Floor Levels.

- Select
- Record
- Examine
- Develop
- Evaluate
- Define
- Install
- Maintain

# Record- Example Multiple activity Chart

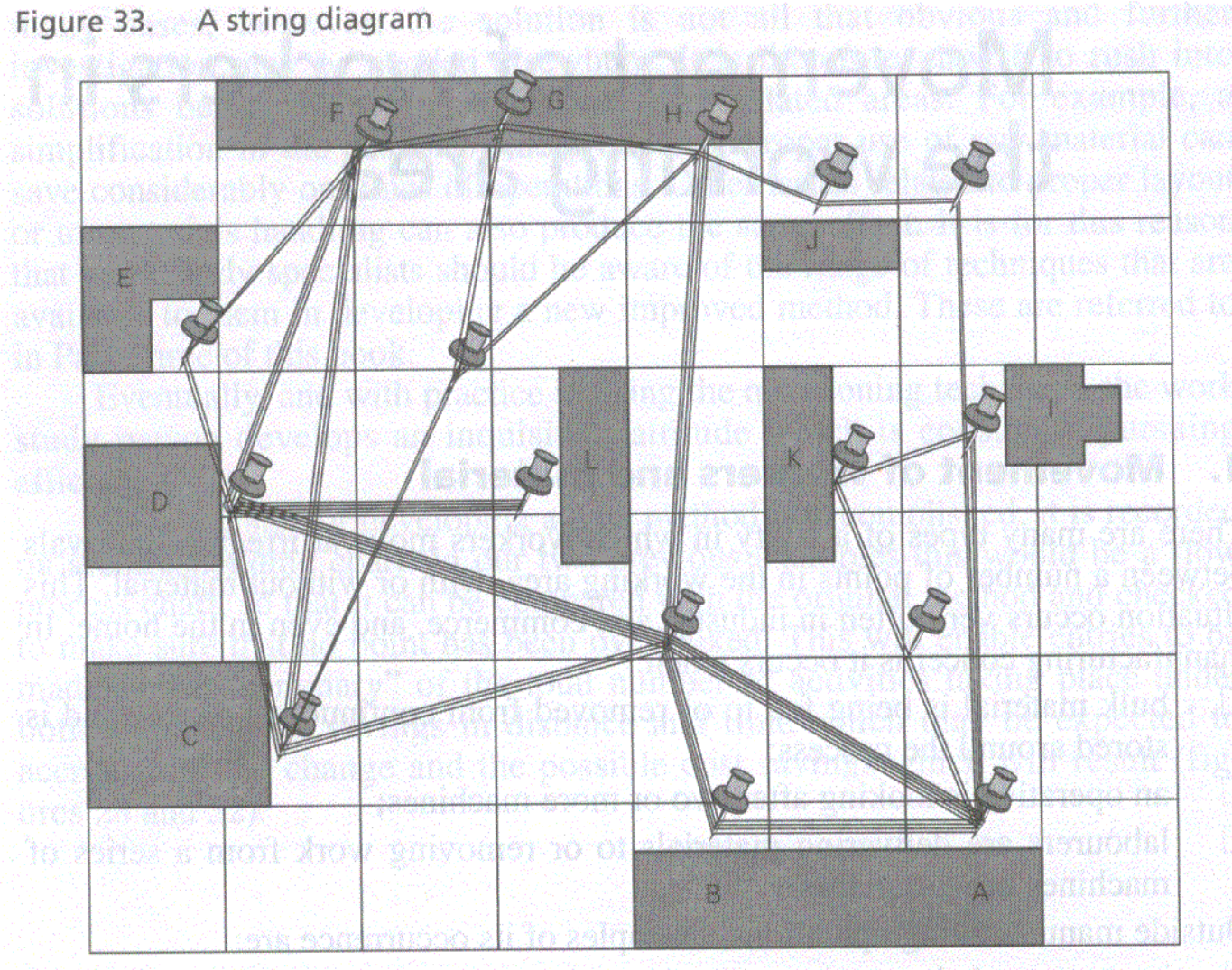


Figure 39. Multiple activity chart: Inspection of catalyst in a converter (original method)




- Select
- Record
- Examine
- Develop
- Evaluate
- Define
- Install
- Maintain

# Record- Example String Diagram




- Select
- Record
- Examine
- Develop
- Evaluate
- Define
- Install
- Maintain

# Record- Example String Diagram

Figure 34. A simple movement study sheet

Movement study sheet

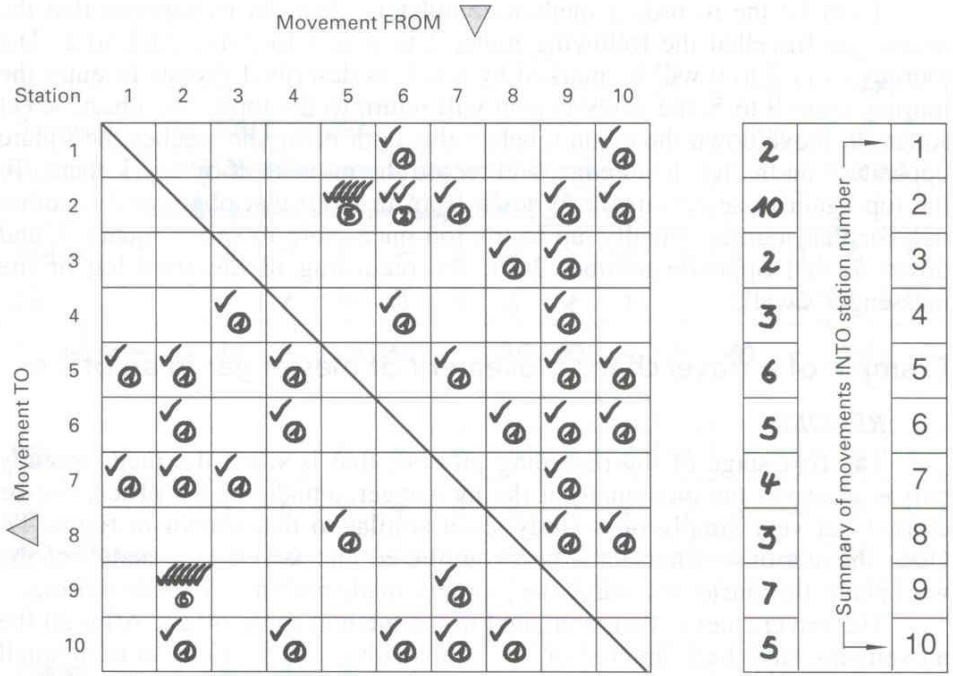
| | |
|---|---|
| Chart No. *1* Sheet No. *1* of *2* | Operative(s): |
| Operation: *Transport biscuit tiles* | |
| *from inspection to storage* | Charted by: |
| *bins and unload into bins* | Date: |
| Location: *Biscuit warehouse* | Cross-reference: *String diagrams* |
| | *1 and 2* |

| 1 Time dep. | 2 Time arr. | 3 Time elapsed | 4 Move to | 5 Notes |
|---|---|---|---|---|
| | | | *Inspection bench (I)* | |
| | | | *to Bin 4* | |
| | | | *I 13* | |
| | | | *I 5* | |
| | | | *I 32* | |
| | | | *I 18* | |

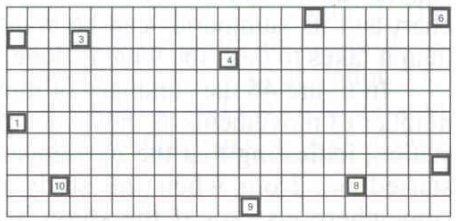
- Select
- Record
- Examine
- Develop
- Evaluate
- Define
- Install
- Maintain

# Record- Example Travel Chart

Figure 46. Travel chart: Movements of messenger in office




Layout sketch of office showing location of stations



- Select
- Record
- Examine
- Develop
- Evaluate
- Define
- Install
- Maintain

# Record- Example

## Two-handed process Chart

Two-handed process chart

Chart No. *2* Sheet No. *1* of *1*

Workplace layout

Drawing and part: *Glass tube 3 mm dia., 1 metre original length*

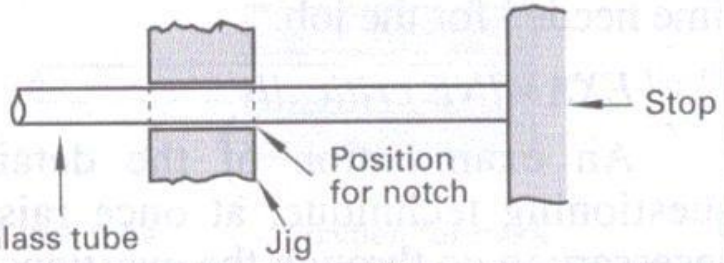
Operation: *Cut to lengths of 1.5 cm*

Location: *General shop*

Operative:

Charted by Date:

Improved method




| Left-hand description | ○ | ⇨ | D | ▽ | ○ | ⇨ | D | ▽ | Right-hand description |
|---|---|---|---|---|---|---|---|---|---|
| *Pushes tube to stop* | | | | | | | | | *Holds file* |
| *Rotates tube* | | | | | | | | | *Notches with file* |
| *Holds tube* | | | | | | | | | *Taps with file: end drops to box* |

- Select
- Record
- Examine
- Develop
- Evaluate
- Define
- Install
- Maintain

# Examine- The Questions

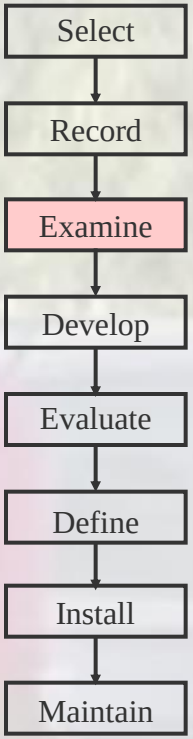
| | |
|---|---|
| Purpose: | What is actually done? |
| | Why is it necessary? |
| Place: | Where? Why? |
| Sequence: | When? Why? |
| Person: | Who? Why? |
| Means: | How? Why? |

With a view to:

Eliminate

Combine or Rearrange

Simplify



# Examine- Secondary Questions

Purpose: **What** is done?

**Why** is it done?

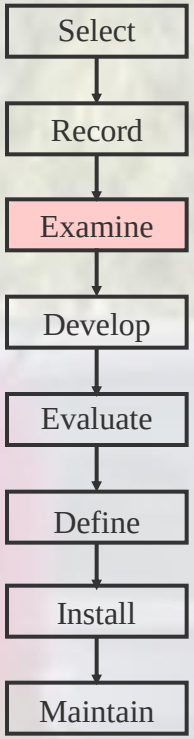
What **else** might be done?

What **should** be done?

With a view to:

Eliminate

Simplify



# Examine- Secondary Questions

Place: **Where** is it done?

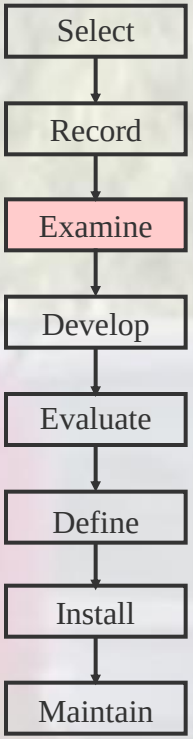
Why is it done **there**?

where **else** might it be done?

Where **should** it be done?

With a view to:

Combine or Rearrange



# Examine- Secondary Questions

Sequence: **When** is it done?

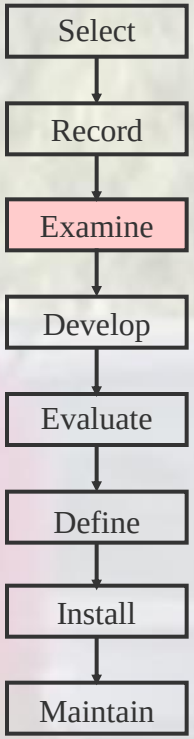
Why is it done **then**?

when **might** it be done?

When **should** it be done?

With a view to:

Combine or Rearrange



# Examine- Secondary Questions

Person: **Who** does it?

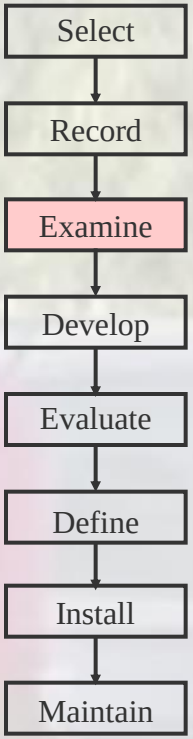
Why does **that** person do it?

Who **else** might do it?

Who **should** do it?

With a view to:

Combine or Rearrange



# Examine- Secondary Questions

Means: **How** is it done?

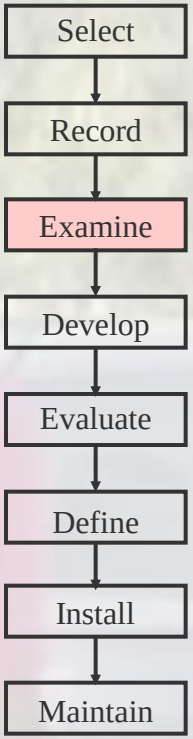
Why is it done **that** way?

How **else** might it be done?

How **should** it be done?

With a view to:

Simplify



# Develop

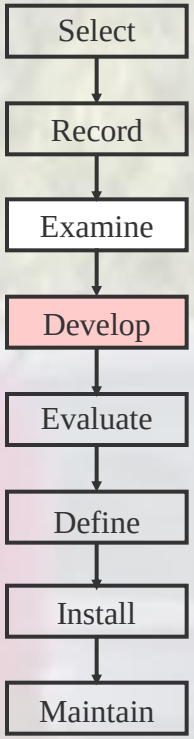
New Designs

Multidisciplinary Teams

Worker Involvement

Quality Circles

Simple Ideas (Spring Loaded Table)



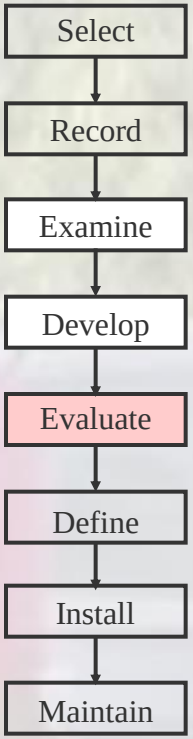
# Evaluate

Multiple Improvement Ideas

Consider costs, benefits, and drawbacks

Report (ABC, Accurate, Brief, and Clear)

Example

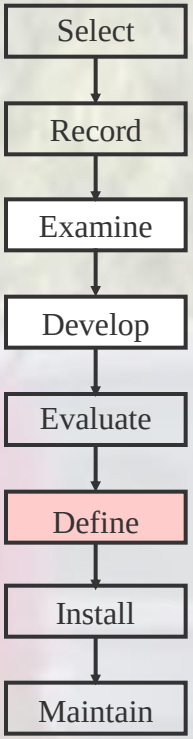


# Define

## The written standard practice

Prepare a written standard practice, also known as an "operative instruction sheet". This serves several purposes

1. It records the improved method for future reference.
2. It can be used to explain the new method to management, supervisors and operatives. It also advises all concerned, including the works engineers, of any new equipment required or of changes needed in the layout of machines or workplaces.
3. It is an aid to training or retraining operatives.
4. It forms the basis on which time studies.



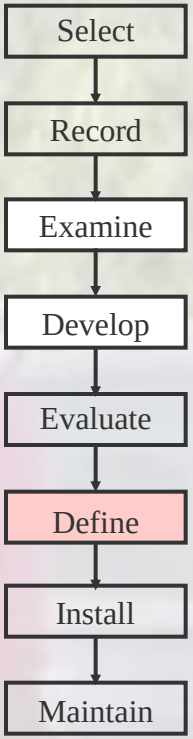
# Define

The written standard practice outlines in simple terms the methods to be used by the operative. Three sorts of information will normally be required:

(1) The tools and equipment to be used and the general operating conditions.

(2) A description of the method. The amount of detail required will depend on the nature of the job and the probable volume of production. For a job which will occupy several operatives for several months, the written standard practice may have to be very detailed, going into finger movements.

(3) A diagram of the workplace layout and, possibly, sketches of special tools, jigs or fixtures.

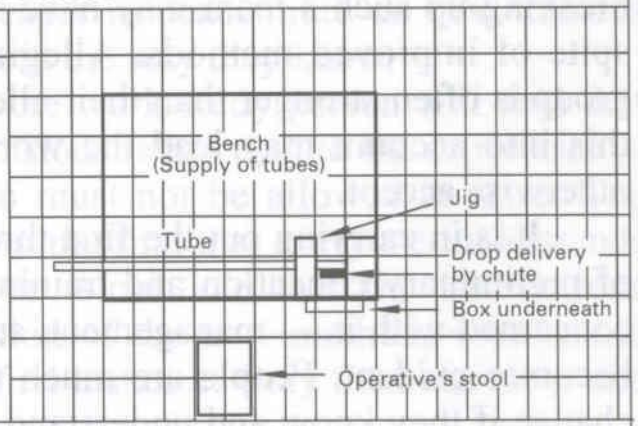


# Define

Figure 56. Standard practice sheet

**Standard practice sheet**

| | |
|---|---|
| Product: *3 mm diam. glass tube, supplied in 1 metre lengths* | Equipment: *Jig No. 231 Half-round 15 cm* |
| Operation: *File and break to lengths of 1.5 cm* | |
| Working conditions: *Light good* | |




| | |
|---|---|
| Location: *Fitting shop* | Ref. studies Nos. *12, 13* |
| Operative: Clock No. *54* | Charted by: Date: |
| | Approved by: Date: |

| EL | Left hand | Right hand | EL |
|---|---|---|---|
| 1 | *Take tube between thumb and first two fingers: push forward to stop* | *Hold file: wait for L.H.* | 1 |
| 2 | *Rotate tube between thumb and fingers* | *Notch tube all round with edge of file hard up against face of jig* | 2 |
| 3 | *Hold tube* | *Tap notched end of tube sharply with file so that it falls into chute* | 3 |
| | | | |

- Select
- Record
- Examine
- Develop
- Evaluate
- Define
- Install
- Maintain

# Install

Installation can be divided into five stages, namely:

(1) Gaining acceptance of the change by management.

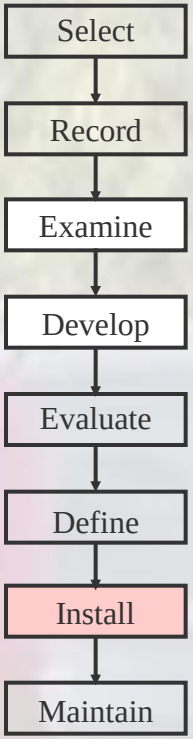
(2) Gaining acceptance of the change by the departmental supervision.

*There is no point in trying to go any further if this approval and acceptance have not been obtained.*

(3) Gaining acceptance of the change by the workers and their representatives.

(4) Preparing to make the changes.

(5) Controlling the changeover.



# Install

**Training**

May use films to demonstrate the old and the new methods.

Films are particularly valuable when retraining.

Develop **the habit** of doing the job in the correct way.

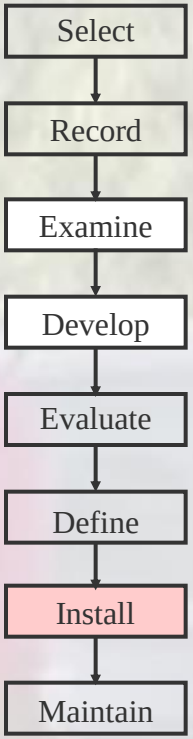
Train to follow a numbered sequence illustrated on a chart.

Learning curves

In the first stages of learning, rests between periods of practice should be longer than the periods of practice themselves.

When the operative has begun to grasp the new method and to pick up speed, rest periods can be very much shorter.

Nursing the new method.



# Install

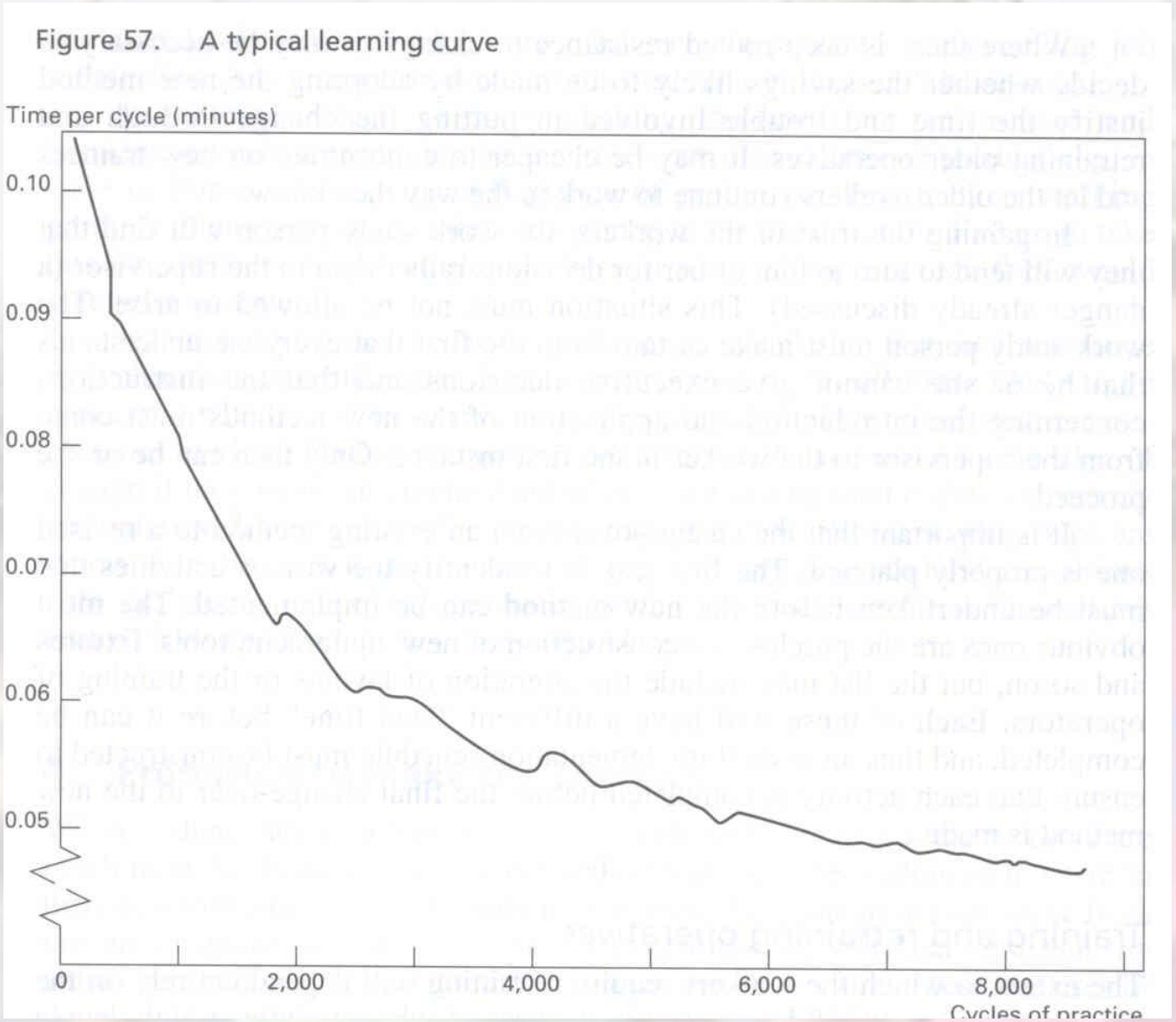
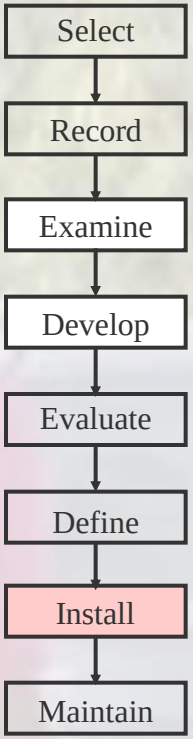


Figure 57. A typical learning curve
Time per cycle (minutes)
0.10
0.09
0.08
0.07
0.06
0.05
0
2,000
4,000
6,000
8,000
Cycles of practice


Select
Record
Examine
Develop
Evaluate
Define
Install
Maintain

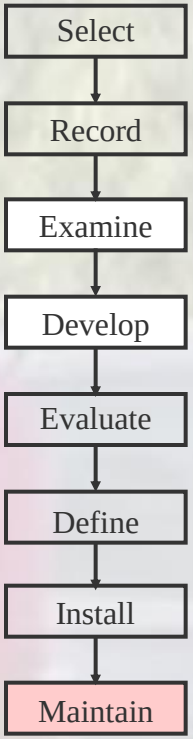
# Maintain

workers should not be permitted to slip back into old methods, or introduce elements not allowed for, unless there is very good reason for doing so.

To be maintained, a method must first be very clearly defined and specified.

Assign a specialists permanently.

Formal review.



# Method Study in the Office

Offices use resources, must be used efficiently.

Percentage of workers in offices continues to increase.

Administrative costs (overheads) must be controlled.

Introduction of advanced technology (machinery).

In most offices, most of the work is routine.

Look for areas or activities that:

Account for a significant proportion of office labor costs.

Are producing large numbers of errors or serious errors.

Are creating high levels of dissatisfaction.

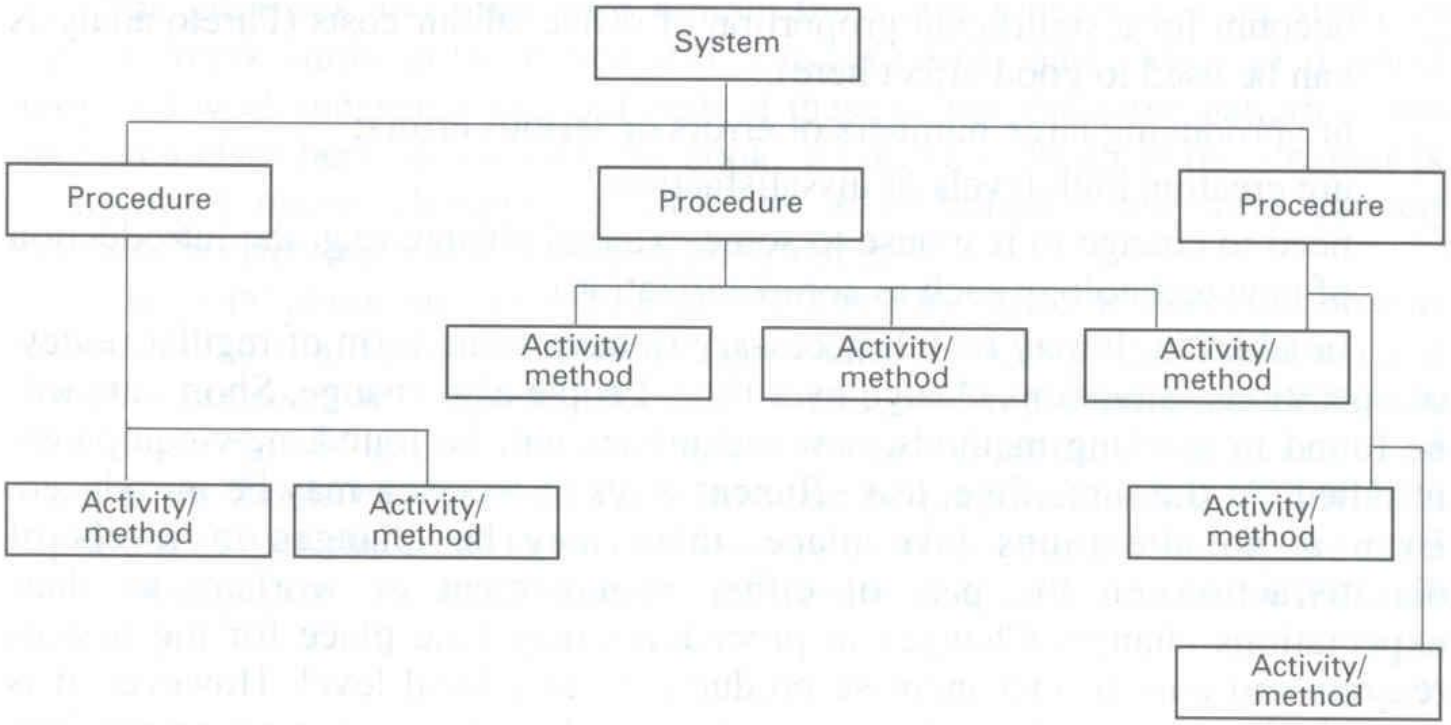
Need to change in response to some external change.

Quality circle.

# Method Study in the Office

Most office work can be placed on a hierarchy which includes systems, procedures, activities and methods.

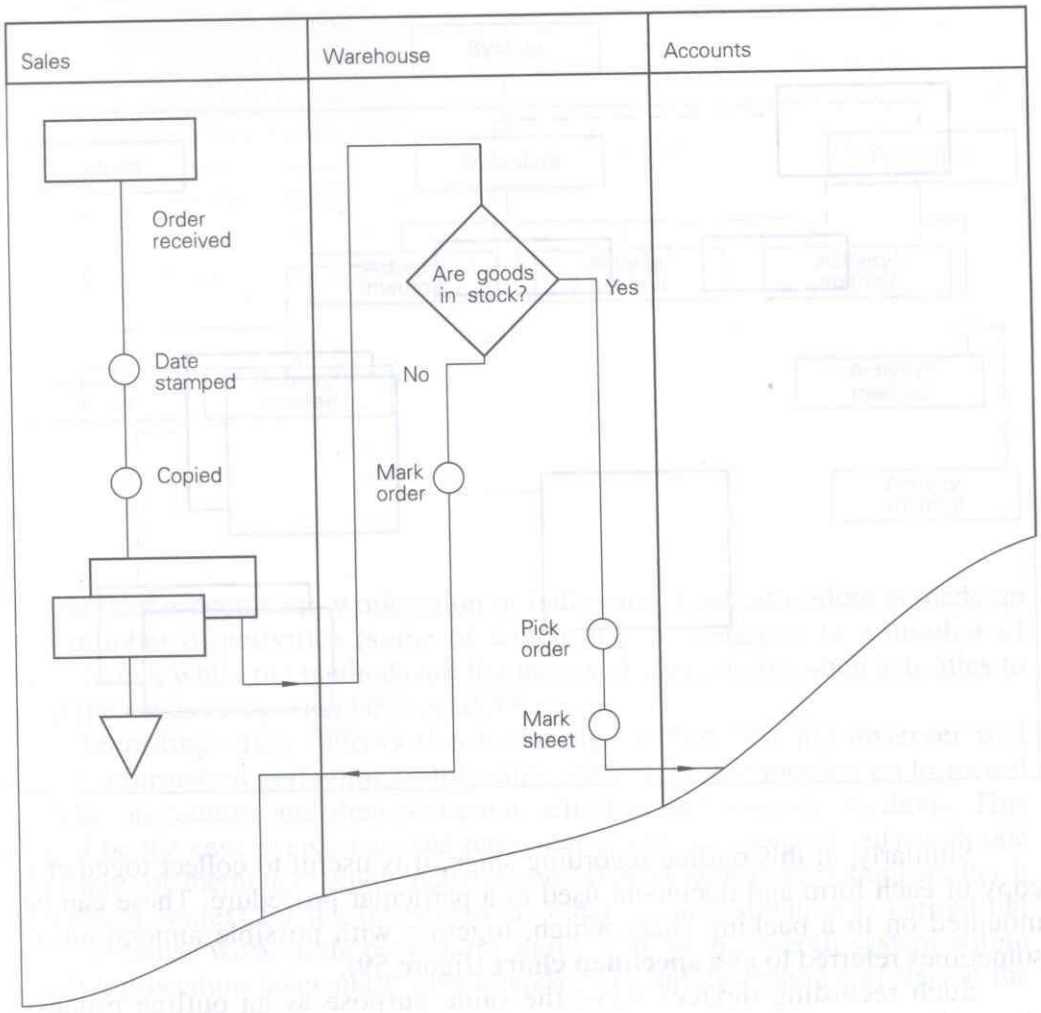
Figure 58. The hierarchy of office systems, procedures and methods



# Method Study in the Office

Use the columnar chart form in which each column represents one department or section of the organization (figure 60).

Figure 60. A procedure flowchart



# Method Study in the Office

## Design of forms

Naturally, a document or form should be examined together with the procedure in which it is used. Changing a system or procedure may have automatic implications for forms used. Forms themselves should be examined when the procedure itself has been examined and improved or validated. Examination of a form follows the basic critical examination process, asking:

Why is the form necessary?

**What** information does it convey? Who uses it?

**When** do they use it? **Where** is it used?

How is it used? (Is the form produced by a computer, are entries typed on to the form, is it filled in manually, etc.?)

Then examining and evaluating alternatives.

# Method Study in the Office

**Design of forms**

When designing forms we are trying to make the form:

compatible with its intended use

easy to complete

easy to use

**Consideration must be given to: paper size; paper weight;**

shape;

color;

maintaining any house style or corporate identity;

and balancing these with the cost involved.

# Method Study in the Office

**Details that affect design are:**

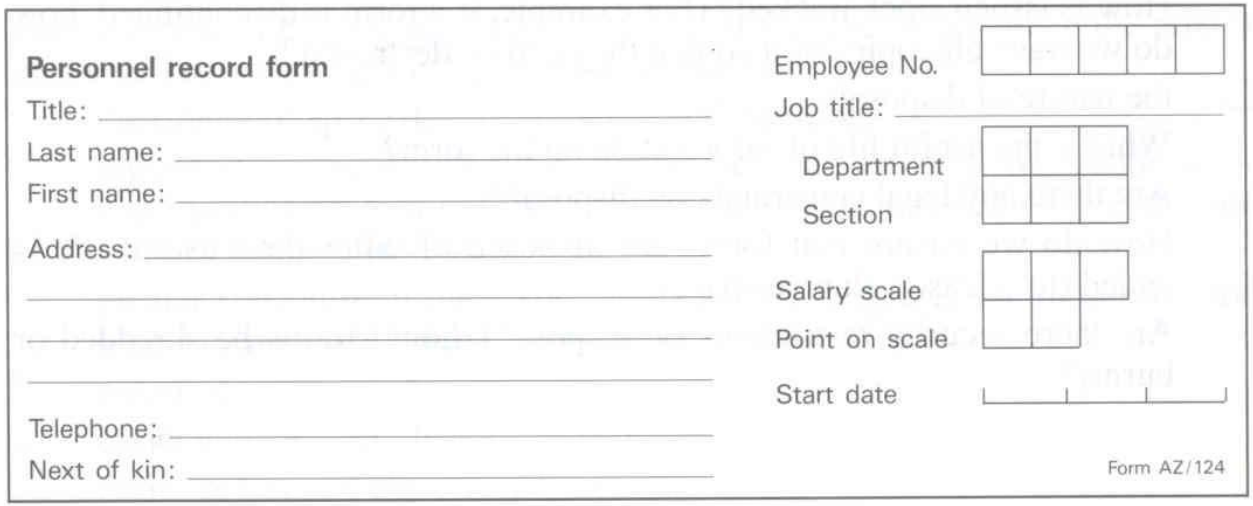
the filing/retrieval process;

the routing of the form throughout the organization

the degree to which additional entries are made on the form at subsequent stages);

the nature of data entered on the form and the degree to which they can be grouped.

Figure 62. A personnel record form



# Method Study in the Office

**Control of forms**

The most important part of controlling forms is to undertake regular audits to discover if each form is still necessary to serve a particular business function (MAINTAIN).

Where the purpose of the form is still valid, questions must be asked about the environment in which the form operates and whether changes here, for example, in technology or filing methods require changes to be made to the form.

# Method Study in the Office

Control of forms

Other items to be considered are:

The production method:

How is the form produced and are there now better or cheaper ways?

How much stock of each form is held, and where is it held? Is this appropriate to the use of the form?

How are supplies to users reordered?

How is stock issued to users?

How is issued stock tracked?

# Method Study in the Office

**Control of forms**

What is the useful life of information on the form? Are there any legal constraints on disposal?

How do we ensure that forms are disposed of, after their useful life is ended (to release valuable space)?

Are there security restrictions on disposal (should forms be shredded or burnt)?

# Office Layout

**Office layout study should consist of the following steps:**

**Record details of the major systems in use in the office.**

**Record details of the clerical procedures that support those systems.**

**Examine the working methods of those procedures and carry out a basic method study of each one.**

**Carry out a capacity assessment of each part of the procedure**

**Analyze volumes of output and question the senior managers to discover likely future trends.**

**Identify communication and contact paths and frequencies.**

**Design individual workstations ( ergonomics)**

**From volume and capacity data, calculate total workstation requirements.**

**Decide on basic type of layout.**

**Identify any "external" constraints.**

**Draw up a schematic layout**

**Investigate available hardware solutions**

**Discuss the provisional layout with both the users**

**Modify the layout in accordance with the results of discussions and prepare the proposed layout.**