are arranged in rank wise (high to low from left to right)? If not go to step 5 otherwise go to step 7

step 5. Rearrange the columns of the matrix rank wise and compute the binary equivalent of each row

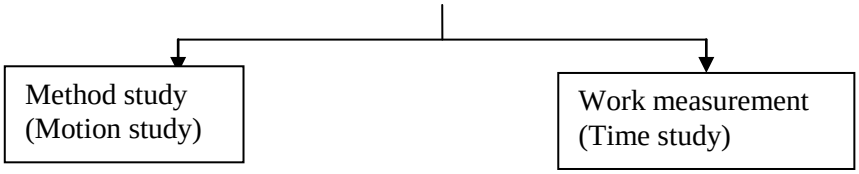
Step 6. Check whether the rows of the matrix are arranged rank wise? If not go to step 3; Otherwise, go to step 7

Step 7. Print the final machine component incidence matrix.

By following this steps the problems can be solved.

Chapter 5: Motion Study

- Work study is a technique which is employed to ensure the best possible use of men, machine, materials and energy in carrying out a specific activity. It deals with the techniques of method study and work measurement.



- Work study is based on the principle that for every job, there is:
  a) One best way of doing it.
  b) A scientific method is the best and surest way of finding this best way. — Motion study
  c) The time taken for doing the job by the best way can be measured and set as standards. — Time study

5.1 Motion study:

- It is defined as a systematic and critical study of existing method of doing a task with a view to evolve the most efficient and economic method of doing it.
- It is a method for setting up employee productivity standards in which:
  - A complex job is broken down into small or simple steps.
  - The sequence of movements taken by the employee in performing those steps is carefully observed to detect and eliminate wasteful motion.
  - Precise time taken for each correct movement is measured.

From these measurements, production and delivery times and prices are computed and incentive schemes are devised. Generally it is appropriate only for repetitive tasks. Time and motion studies were pioneered by the US industrial engineer Frederick Winslow Taylor (1856-1915) and developed by the husband and wife team of Frank Gilbreth (1868-1924) and Dr. Lillian Gilbreth (1878-1972).

Objectives of motion study

The objectives of motion study are:
- To improve the procedure of doing a work.
- To improve the workplace layout (ultimately plant layout).
- To minimize the human motion for minimum fatigue of operators.
- To maximize the utility of resources (men, m/c, materials).
- To improve the overall working environment.

5.2 Principles of motion economy

- Analysis of an operation when carried out in terms of individual motion of a worker is known as Motion analysis.
- The purpose of motion analysis is to design an improved method which would eliminate unnecessary motion and employs human effort more productively. In doing so, the Principle of motion economy is very much helpful.
- It consists of a set of rules designed by Gilbreth and later rearranged and amplified by others (Branes Lowry et al) to develop better methods.

(i) It is classified into following 04 categories: Rules concerning human body, workplace layout and material handling, Tools and Equipment Design and time conservation.

(ii) Rules concerning human body

1. Both hands should be used for productive work.
2. Both hands should start and finish their motion at the same time.
3. Except for the rest period, the two hands should not be idle at one time.
4. Motion of both the hands and arms are symmetrical, simultaneous and opposite to each other.
5. Motions should be simple and involve minimum number of limbs. (The purpose-shortest duration and minimum fatigue)
6. Motion should be smooth and continuous. There should not be sharp direction change and frequent stop.
7. It is desirable for a worker to employ momentum to assist him.
8. A worker may use mechanical aids to assist him to overcome muscular effort.

(iii) Rules concerning workplace layout and material handling

1. There should be a definite, fixed and easy accessible location for materials and tools.
2. As far as possible, materials, tools and other mechanical devices should be kept close to work place.
3. Gravity should preferably be employed wherever feasible with a conveyor for transportation and delivering materials at the workplace between various workstations and departments.
4. An assembled and final product should preferably be dropped on a conveyor near the workplace so that gravity delivers the job at the required place.
5. Tools and materials should preferably be located in the order/sequence in which they will be required for use.
6. Good illumination is required for proper seeing, fast operating and reducing the accidents.
7. In order to impart rest to some of the limbs, an operator may sometimes sit or stand while working. This necessitates a relationship between his chair, height of table or workpiece.
8. In order to reduce fatigue, the sitting arrangement of the worker should be comfortable and adjustable.
9. All heavy parts should be lifted by mechanical devices.

(iv) Rules concerning Tools and Equipment Design

1. Jigs, fixtures and foot operated devices should be employed to reduce the work load on hand.
2. Tools should be multipurpose and easy to handle.
3. Foot-operated switches and controls should be designed as far as possible to reduce the workload on the hands.
4. Tools and materials should be properly arranged and located near the workpiece.
5. Tools and materials should be located in the order of their use.
6. There should be maximum surface contact between the tool handle and hand. It helps proper application of hand force and minimizes fatigue.
7. Gravity should be used for delivery of materials and finished goods.
8. Where the work is supposed to be carried out by fingers, the load distribution on each finger should be as per normal capacity of finger.
9. A worker should have the flexibility to stand or sit comfortably while working.
10. A worker should be able to operate levers and handles without changing the body position.
11. The workplace should have proper ergonomics in terms of illumination, proper conditions of heat, cold and humidity, reduced dust and noise, etc.

(v) Rules concerning time conservation

1. Even temporary ceasing of work by a man or m/c should not be encouraged.
2. Machine should not run idle as it leads to loss of production and power.
3. Two or more jobs should be done at the same time, or two or more operations should be carried out on a job simultaneously.
4. Number of motions involved in completing a job should be minimized.
5. The loading and unloading of the job and the cycle time should be synchronized in such a manner that one operator can be multi-functional or can simultaneously operate a number of machines.

6 Procedure in Motion Analysis

The steps in motion analysis are as follows:

a) Select: Select the work to be studied.
b) Record: Record all the relevant facts of the proposed work by direct observation.
c) Examine: Examine the facts critically in sequence, using special critical examination sheet.
d) Develop: Develop the best method i.e. the most practical, economic and effective method under prevailing circumstances using the principle of motion economy.
e) Install: install that method as standard practice.
f) Maintain: maintain that standard practice by regular routine check.

Recording

The recording may trace the movements of men, material or details of various processes. The principle is to use the simplest technique which will contain all relevant information needed for investigation.

The different recording techniques are charts, diagrams, models and photographic aids. The most commonly used recording techniques to cover most of the activities are shown in Table 5.1. The different symbols which are used in process charts are shown in Table 5.2.