5

Techniques and Tools for Planning Layout

1. Introduction to Techniques for Analysing Material Flow 2. Assembly Chart 3. Operation Process Chart 4. Multi-Process Chart 5. Flow Process Chart 6. Flow Diagram 7. Man-Machine Chart 8. Two Handed Process chart 9. String Diagram 10. Travel Chart 11. Visualising Layout 12. Drafting and Sketching 13. Template and Block 14. Models (Three Dimensional).

5.1. INTRODUCTION TO TECHNIQUES FOR ANALYSING MATERIAL FLOW

There are many commonly used techniques that are helpful in the flow planning process. Some are peculiarly useful to plant layout, some are useful in material handling phase, some of which are borrowed from the field of motion economy and work simplification. Although most of the techniques were originally devised for analytical purposes, they are also useful in the planning process. The common techniques are :

1. Assembly chart.
2. Operation process chart.
3. Multi product process chart.
4. Flow process chart
5. Flow diagram.
6. Man machine chart.
7. Two handed process chart.
8. String diagram.
9. Travel chart.

Since it is obvious that not all the techniques are useful in every type of facility layout project, it will be seen that most of them are equally useful in either the planning of a new project; or the analysis of an existing one or modification or extention of an existing one.

All the techniques often require a lot of detail work to make an accurate record of all the moves in all the processes. They also require the gathering of many different kinds of data on the several aspects of each move, such as the route over which the move is made, the volume, the distances travelled; the frequency with which the move is made, the rate at which the items travel, and the costs of the move.

The techniques help to

(*a*) Shorten project time.

(*b*) Reduce capital and operating costs.

(*c*) Ensure efficient maintenance.

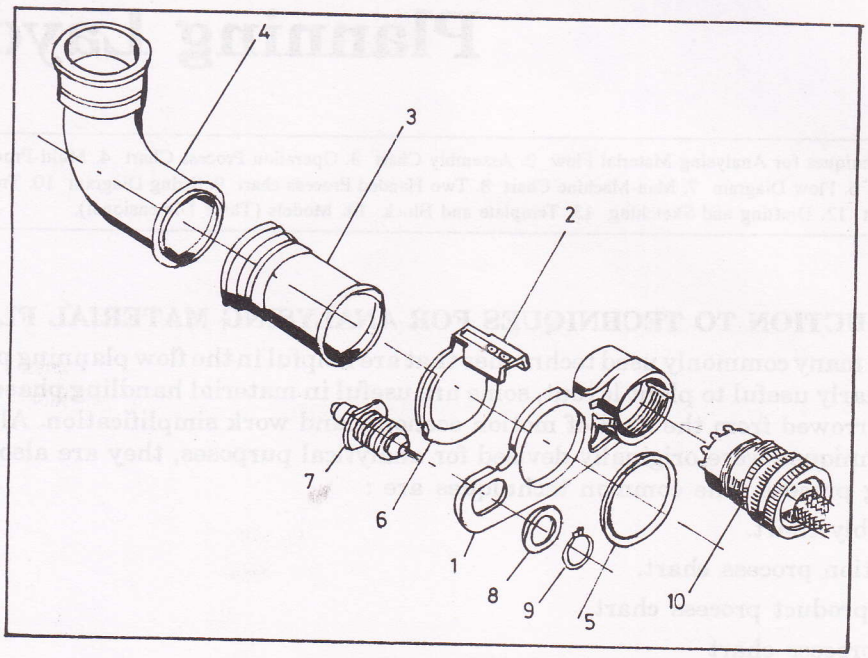
(*d*) Ensure efficient construction.

(*e*) Predict correct initial planning.

(*f*) Reduce alteration.

(*g*) Improve quality of design.

(*h*) Proper use of technical manpower.



Plug Assembly Drawing
Fig. 5.1

5.1.1 Assembly Chart :

An assembly chart shows graphically how the parts of manufacturing product combine or go together to make up subassemblies and completed assemblies. It shows what parts make up each subassembly and gives the order or sequence in which the parts go together. An assembly chart shows the following things in an easily understandable manner:

(*a*) What components make up the product.

(*b*) Relationships between parts.

(*c*) Sequence in which the components are assembled.

(*d*) A preliminary idea of materials flow.

Fig. 5.1 shows a plug assembly drawing and Fig. 5.2 shows the assembly chart for the plug assembly.

5.1.2 An Operation Process Chart :

As operation process chart is an extension of the assembly chart. In addition to showing in greater detail the assembly of parts it also shows in a graphical way and chronological

sequence the operations and inspections to be performed. On each part it offers an overall visualisation of the process and serves as basis for studying possibilities for the improvement of operation by elimination, combination or rearrangement.

Uses of the process chart are :

(*a*) Provides a method of recording all steps in a process.

(*b*) Forces detailed examination of the process.

(*c*) Becomes the basis for analysing the process.

(*i*) Identifying all moves, stores, delays.

(*ii*) Pointing out improvement opportunities.

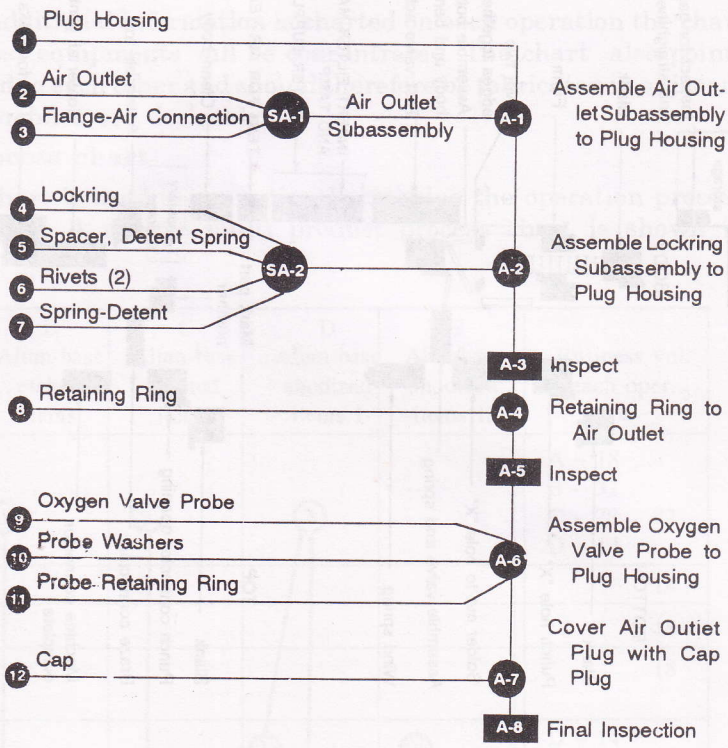
(*iii*) Showing distances, equipment, manpower etc.

(*iv*) Raising question about a process.

(*d*) Familiarizes an analyst intimately with the process.

(*e*) Forms a basis for cost determination.

(*f*) Forms a basis for comparison of alternative methods.

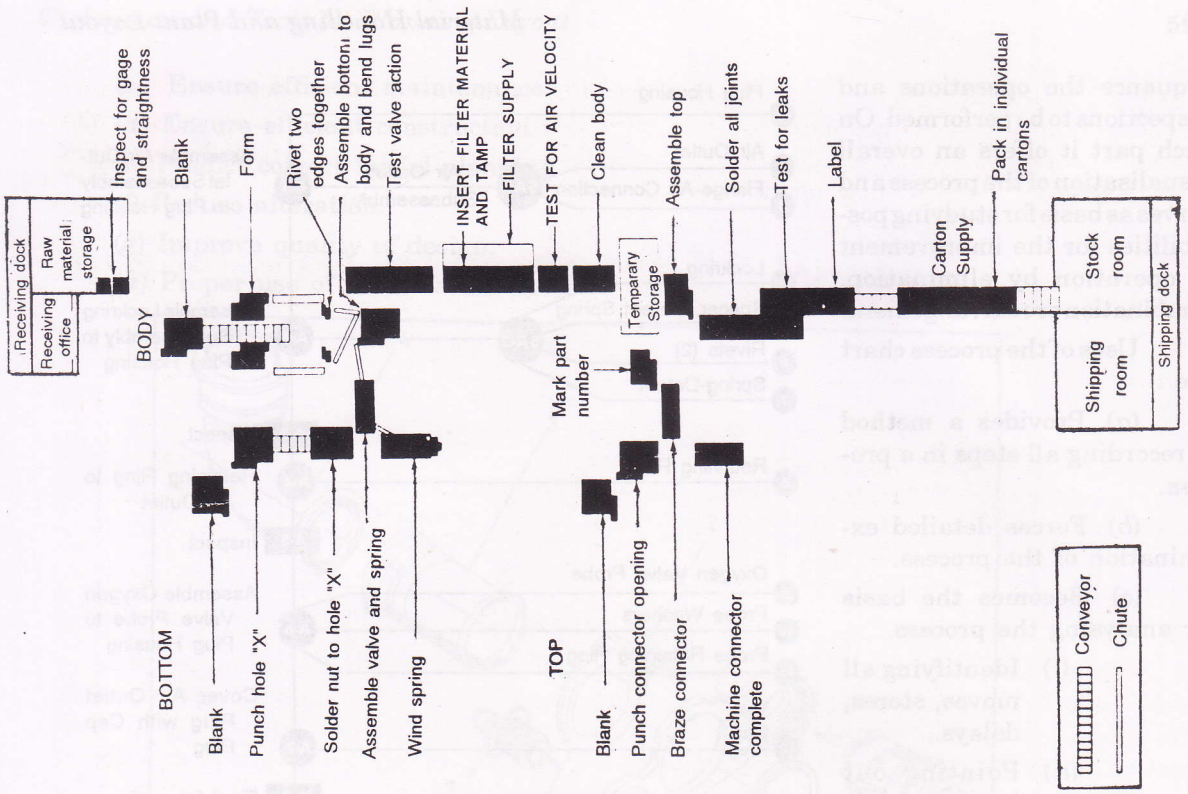


Assembly Chart for Plug Assembly
Fig. 5.2

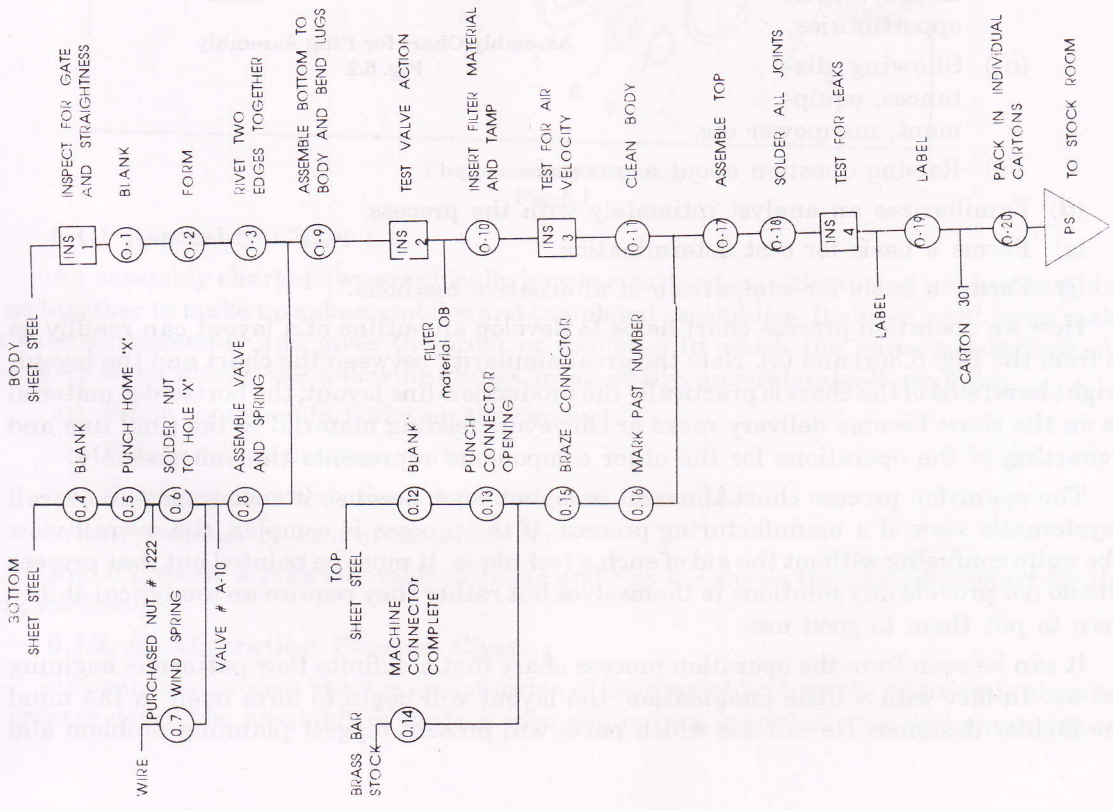
How an operation process chart helps to develop an outline of a layout can readily be seen from the Fig. 5.3(*a*) and (*b*). Note the great similarity between the chart and the layout, the right hand side of the chart is practically the production-line layout; the horizontal material lines on the chart become delivery racks or conveyors feeding material to the final line and the charting of the operations for the other components represents the subassembly.

The operation process chart is useful in layout work because it encourages an overall yet systematic view of a manufacturing process. If the process is complex, the overall view can be quite confusing without the aid of such a technique. It must be pointed out that process charts do not provide any solutions in themselves but rather they require an analytical ability of man to put them to good use.

It can be seen from the operation process chart that a definite flow pattern is begining to set up. In fact with a little imagination, the layout will begin to form itself in the mind of the facility designer. He can see which parts will present biggest planning problem and



Out Line of a Layout
Fig. 5.3 (*b*)



Operation Process Chart
Fig. 5.3 (*a*)

which will be less i
will then indicate
out which parts ar
areas and stored

5.1.3 Multi

A multi proc
charts for more t
Fig. 5.4.

Operations
1. Cut to Size
2. Polish
3. Wash out
4. Nickel-silver plate
5. Weld
6. Anodize
7. Colour
8. Print
9. Color etch
10. Dry spray
11. Dry spray
12. Deep etch
13. Pickle
14. Rinse
15. Lacquer
16. Spray paint
17. Imbed colors (future consideration
Business vol. (%)

which will be less important. If additional information is charted on each operation the chart will then indicate where the most equipments will be concentrated. The chart also points out which parts are closely related to each other and should therefore be fabricated in adjacent areas and stored where subassemblies are desirable.

5.1.3 Multi product process chart

A multi product process chart is used to conveniently combine the operation process charts for more than one product. A sample multi product process chart is shown in Fig. 5.4.

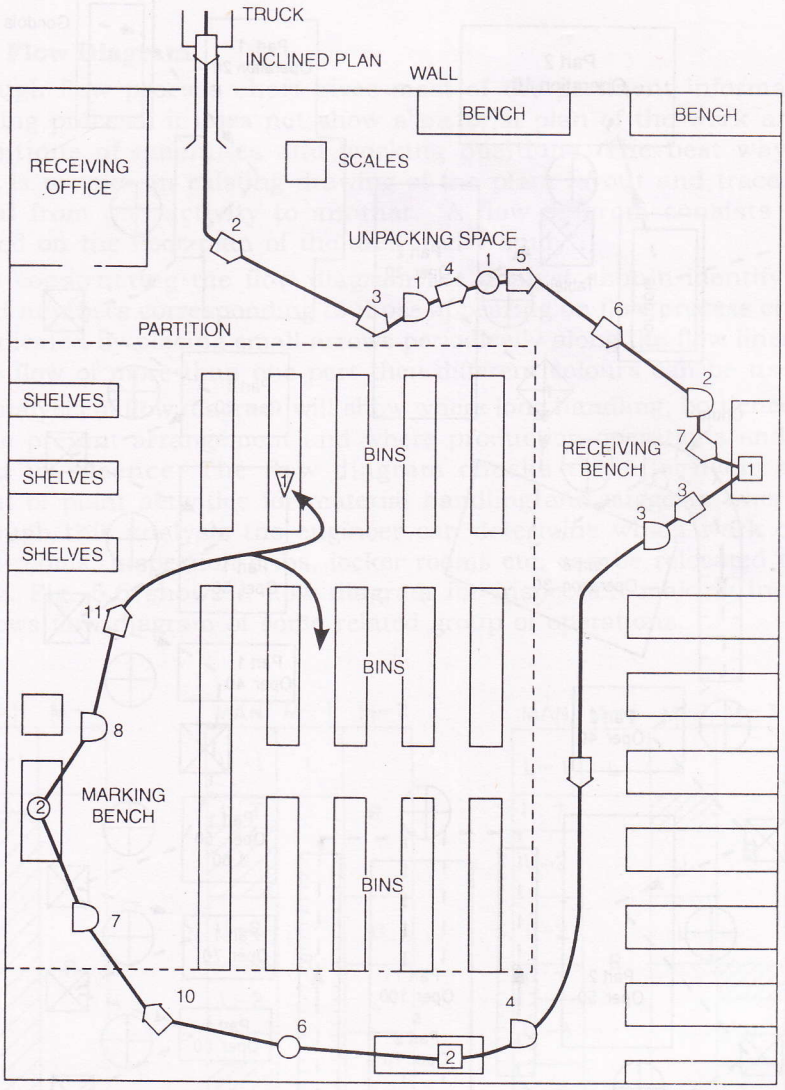
Operations	A Tin-base etched items	B Alum-base etched items	C Alum-base printed items	D Alum-base anodized items I	E Alumbase anodized items II	Business vol. each oper. %
1. Cut to Size	1	1	1	3		A – 18 B – 32 C – 28 92 D – 14
2. Polish	2					18
3. Wash out	3					18
4. Nickel-silver plate	4					18
5. Weld				1 2	1	D – 14 E – 8 22
6. Anodize					2	E – 8 22
7. Colour				5	3	22
8. Print	5	2	2	4	4	100
9. Color etch					5	8
10. Dry spray	6	3				A – 18 50 B – 32
11. Dry spray	7	4				50
12. Deep etch	8	5				50
13. Pickle	9					18
14. Rinse	10	7		6	6	72
15. Lacquer	11	8	3			78
16. Spray paint		6				32
17. Imbed colors (future consideration	9 Alternate	7 Alternate				Future potential 50
Business vol. (%)	18	32	28	14	8	100

Multiproduct Process Chart for Five Products
Fig. 5.4

Chart No. 3 Sheet No. 1 OF 1	S U M M A R Y			
Product Case of BX 487 Tee-pieces (10 per case in cartons)	ACTIVITY	PRESENT	PROPOSED	SAVING
ACTIVITY : Receive, check, inspect and number tee-piaces and store in case	OPERATION O	2		
	TRANSPORT ⇒	11		
	DELAY D	7		
	INSPECTION ❑	2		
METHOD : PRESENT	STORAGE ∇	1		
	DISTANCE (ft.)	185		
LOCATION : Receiving Dept.	TIME (man-hrs.)	1.96		
OPERATTORS(S): CLOCK No. See remarks Column	COST LABOUR MATERIAL	Rs 32.40 –		
CHARTED BY : C.C. DATE : 4.11.88 APPROVED BY: T.H. DATE : 5.11.88	TOTAL	Rs 32.40		

DESCRIPTION	QTY. t case	DIST-ANCE (ft.)	TIME (mins.)	SYMBOL O	⇒	D	❑	∇	REMARKS
Lift from truck: place on inclined plane		4							2 labourers
Slide on inclined plane		20	10						2 labourers
Slide to storage and stock		20							2 labourers
Await unpacking		–	30						
Unstack case		–							
Remove lid and take out delivery note		–	5						2 labourers
Place on hand truck		3							
Truck to reception bench		30	5						2 labourers
Awail discharge from truck		–	10						2 labourers
Place case on bench		3	2						2 labourers
Take cartons from case : open: check									
contents: replace		–	15						Storekeeper
Load case on hand truck		3	2						2 labourers
Delay awaiting transport		–	5						
Truck to inspection bench		54	10						1 labourers
Await inspection		–	10						Case on truck
Remove tee-places from case and cartons:		3	20						Inspector
inspect to drawing: replace									
Await transport labourer		–	5						Case on truck
Truck to numbering bench		30	5						1 labourer
Await numbering		–	15						Case on truck
Withdraw tee-pieces from case and cartons:		–	15						Stores labourer
number on bench and replace									
Await transport labourer		–	5						Case on truck
Transport to distribution point		15	5						1 labourer
Store									
Total		185	174	2	11	7	2	1	

Flow Process Chart: Inspecting and Marking Incoming Parts
Fig. 5.5



Flow Diagram—Inspecting and Marking Incoming Parts
Fig. 5.6

5.1.4 Flow Process Chart

Flow process chart is similar to operation process chart. They represent graphically the sequence of all operations, inspections, transportation, storage and delays occuring during a process or procedure.

Flow process chart is used as a tool of analysis for eliminating the hidden cost of a component. Since the flow chart clearly shows all transportation, delays and storage it is helpful in reducing either the quantity or duration of these elements.

Flow process chart provides an important basis for revising an existing layout. The chart is also used to check the efficiency of a proposed flow plan for a new plant layout. Fig. 5.5 shows a flow process chart for inspecting and marking incoming parts.

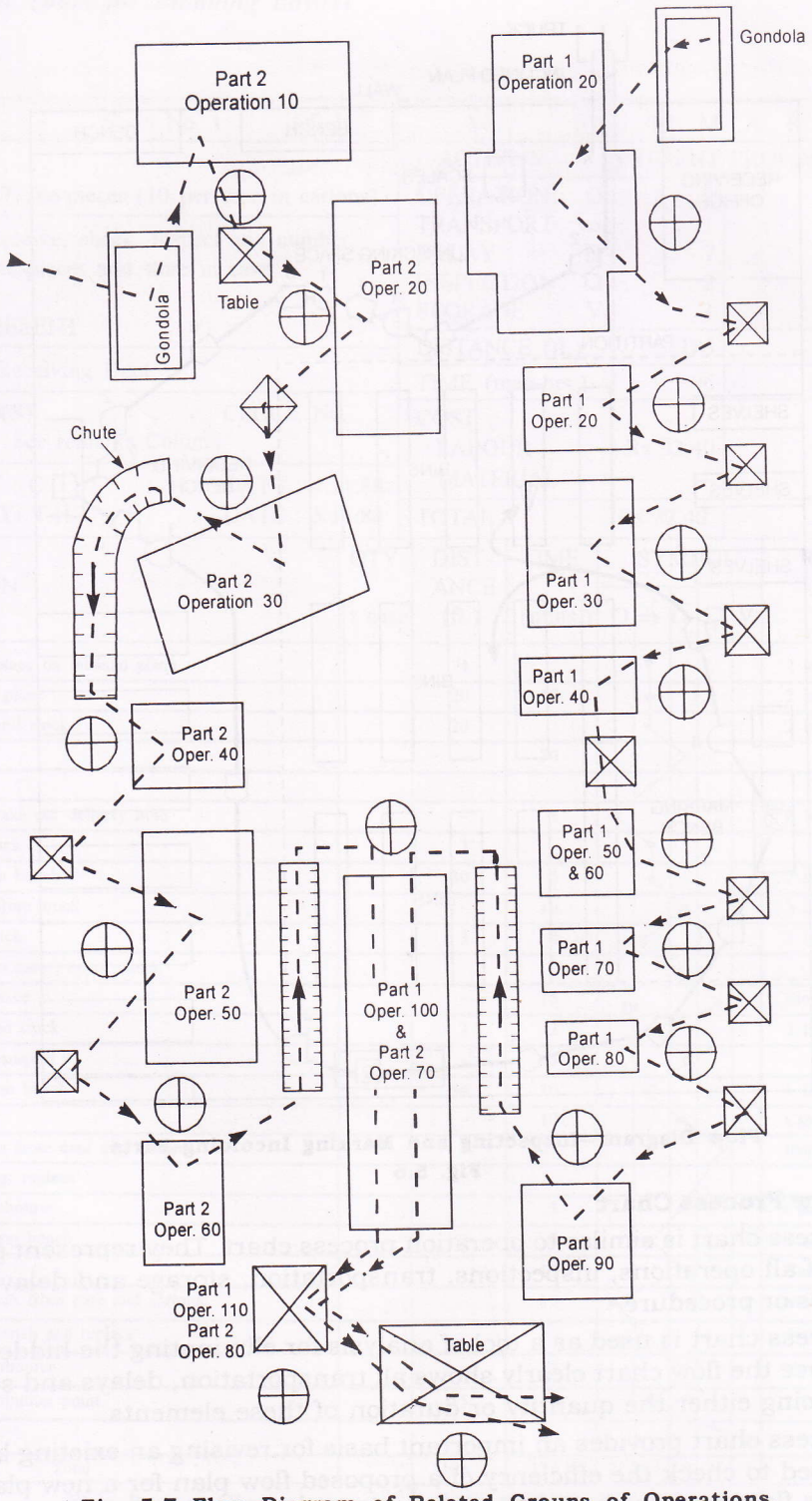


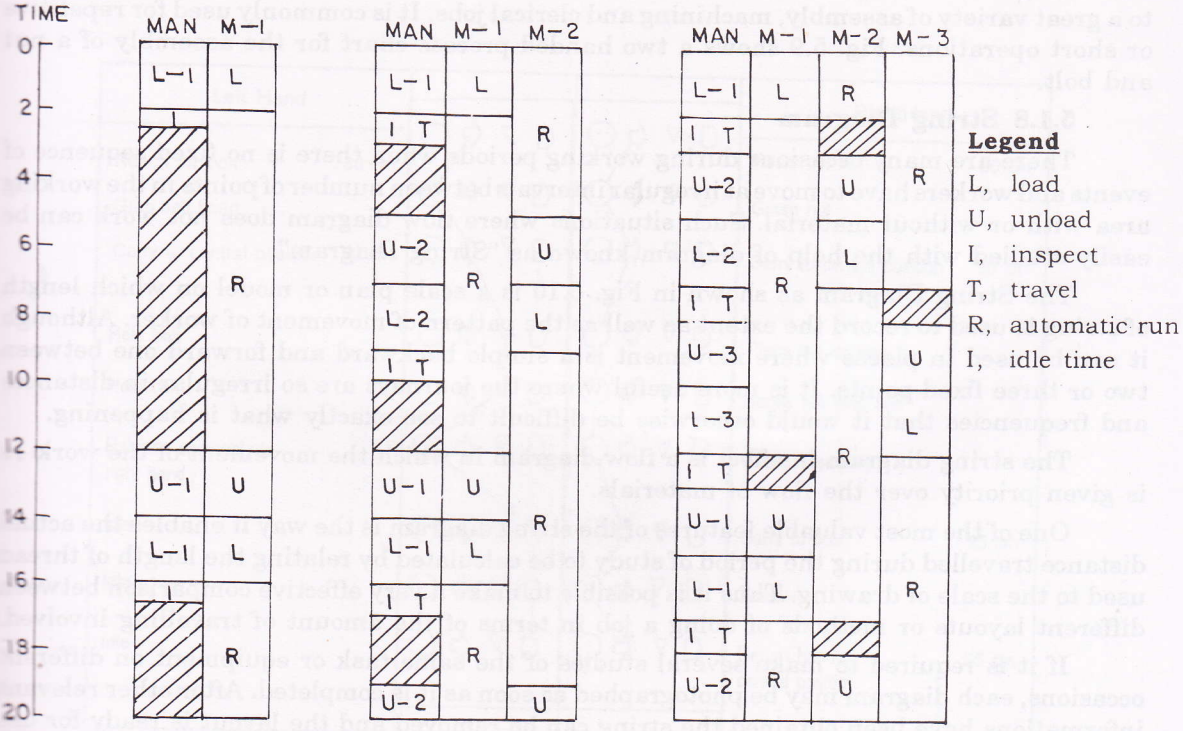
Fig. 5.7 Flow Diagram of Related Groups of Operations.

5.1.5 Flow Diagram

Although flow process chart gives most of the pertinent information related to a manufacturing process, it does not show a pictorial plan of the work area indicating the correct positions of machines and working positions. The best way to provide this information is to take an existing drawing of the plant layout and trace the movement of the material from one activity to another. "A flow diagram consists of the flow lines superimposed on the floor plan of the area under study".

While constructing the flow diagram the analyst should identify each activity by symbols and numbers corresponding to those appearing on flow process chart. The direction of flow is indicated by placing small arrows periodically along the flow lines. If it is desirable to show the flow of more than one part then different colours can be used for each part.

The analysis of flow diagram will show where long handling; bottlenecks and confusion exists in the present arrangement and where production operations and service activities are located in essence. The flow diagram checks the effectiveness of the overall arrangement of plant activities for material handling and suggests where revision can be made. Through this analysis the engineer can determine which work centres, assembly areas, store-rooms, inspection cribs, locker rooms etc. can be relocated to attain economy in handling. Fig. 5.6 shows a flow diagram for inspection making incoming parts and Fig. 5.7 shows flow diagram of some related group of operations.



Man-machine Chart Analysis of Multimachine
Fig. 5.8

5.1.6 Man-Machine Chart

Man-Machine chart is useful in analysing the man-machine relationships especially when more than one machines are being supervised by one operator. The chart helps to find the number of machines each operator can operate efficiently and also the utilisation factor of the machine. Man-machine chart is a graphical representation of the co-ordinated activities of man and machine described in terms of independent work, combined work and wait. Fig. 5.8 shows a man-machine chart analysis of multi machine assignment. The duration of the activities is represented by bars drawn to length against a time scale.

5.1.7 Two Handed Process Chart

A two handed process chart is the most detailed type of flow process charts in which the activities of the worker's hands are recorded in relation to one another. Unlike the previous recording methods, the two handed process chart is normally confined to work carried out at a single place. The ordinary symbols are used except that inspection is omitted because the hand movements when inspecting an article may be classified an "Operation", and the symbol "storage" is taken as "hold". The two handed process chart can be applied to a great variety of assembly, machining and clerical jobs. It is commonly used for repetitive or short operations. Fig. 5.9 shows a two handed process chart for the assembly of a nut and bolt.

5.1.8 String Diagram

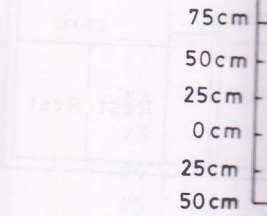
There are many occasions during working periods when there is no fixed sequence of events and workers have to move at irregular intervals between number of points in the working area with or without material. Such situations where flow diagram does not work can be easily studied with the help of diagram known as "String Diagram".

The String Diagram as shown in Fig. 5.10 is a scale plan or model on which length of string is used to record the extent as well as the pattern of movement of worker. Although it can be used in places where movement is a simple backward and forward one between two or three fixed points. It is more useful where the journeys are so irregular in distances and frequencies that it would otherwise be difficult to see exactly what is happening.

The string diagram in effect is a flow diagram in which the movement of the work rs is given priority over the flow of materials.

One of the most valuable features of the string diagram is the way it enables the actual distance travelled during the period of study to be calculated by relating the length of thread used to the scale of drawing. Thus it is possible to make a very effective comparison between different layouts or methods of doing a job in terms of the amount of travelling involved.

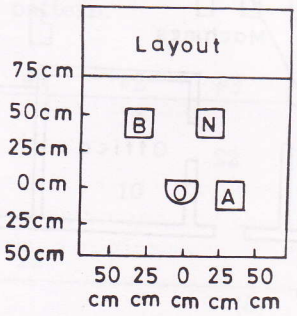
If it is required to make several studies of the same task or equipment on different occasions, each diagram may be photographed as soon as it is completed. After other relevant informations have been obtained the string can be removed and the layout is ready for use with the next study.



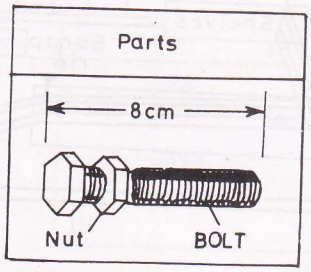
Left H
Reach for bolt
Grap bolt head
Carry to central po
Hold bolt
Hold bolt
Release assembly to right hand
Idle
Idle
Idle

Two

Summary per 1 pieces	Present		Proposed	
	L.H.	R.H.	L.H.	R.H.
O Operations	2	5		
⇨ Transports	2	4		
▽ Holds	2	0		
D Delays	3	0		
Total	9	9		
Distance	100 cm	150 cm		

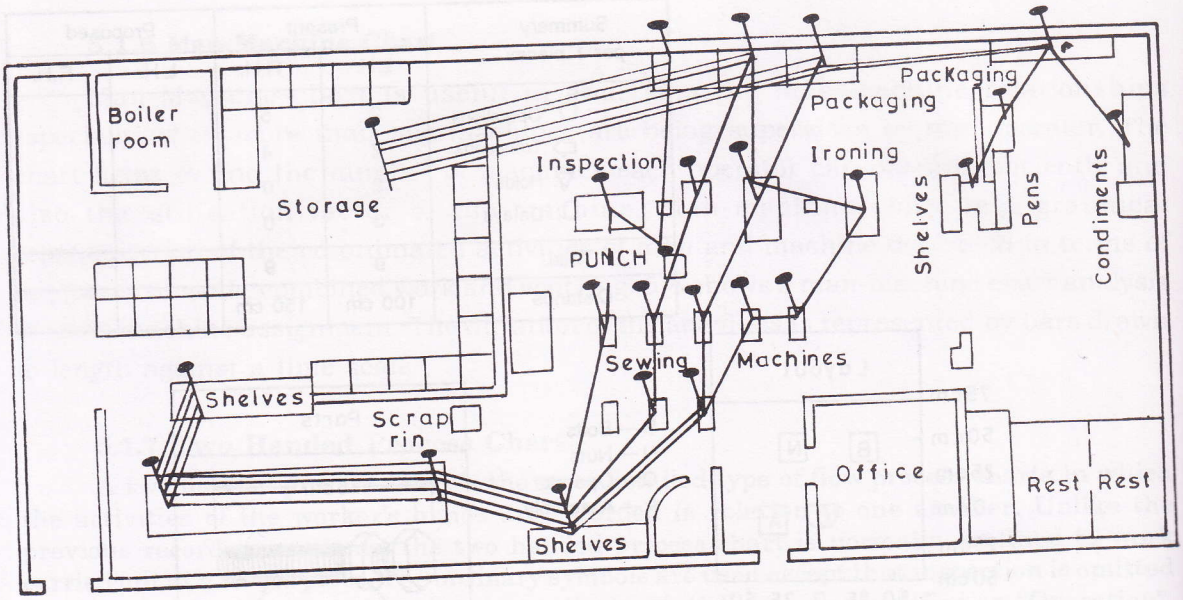


B — Bolts
N — Nuts
O — Operator
A — Assembly



Left Hand			RightHand	
Reach for bolt	50 cm		Reach for nut	50 cm
Grap bolt head			Grasp nut	
Carry to central position	50 cm		Carry to central position	50 cm
Hold bolt			Place nut on bolt	
Hold bolt			Screw nut onto bolt	
Release assembly to right hand			Grasp assembly	
Idle			Carry to box	25 cm
Idle			Release	
Idle			Return hand to central position	25 cm

Two Handed Process Chart for the Assembly Nut and Bolt
Fig. 5.9



A String Diagram
Fig. 5.10

The principal uses of string diagram are to investigate movements in the following circumstances :

(*a*) When a team is working.

(*b*) When one worker is attending several machines in an irregular sequence controlled by the demand of machines.

(*c*) In processes where several sub-assemblies have to be moved to another assembly.

(*d*) Where process necessitates the worker moving from one work place to another.

5.1.9 Travel Chart

When multiple movements along with complex paths are involved a travel chart is an easier and quicker method to calculate total movements. It is a technique which can reduce large quantities of data into a compact form so that it may become readable to the user.

A travel chart is a tabular record for presenting quantitive data about the movement of workers or materials between a number of work locations over a given period of time.

Travel charting points out graphically the inefficiencies of material handling such as back tracking and indicates potential bottlenecks where special attention may be required. Travel charting makes it possible to actually measure how efficient the layout is with respect to material handling. Travel charting is very useful in analysing the movement of material and the location aof different departments. The departments to which there is high frequency of movements are studied and situated nearest to reduce the handling of material and to shorten the manufacturing cycle.

The following types of travel charts as shown in Fig. 5.11 are in common use :

(*a*) Travel Chart showing distances between departments.

(*b*) Travel Chart showing material handling trips per day.

(*c*) Travel Chart showing material handling cost per day.

Department (from \ to)	# 1	# 2	# 3	# 4	# 5
# 1		30	71	98	10
# 2	30		41	68	80
# 3	82	52		27	39
# 4	109	79	27		12
# 5	10	91	39	12	

(*a*)

The distance between two departments differ if there are one-way lanes or obstacles in the flow pattern.

from \ to	#1	#2	#3	#4	#5
#1		14		1	3
#2			22	6	
#3		10		18	
#4				13	
#5	25				

(*b*)

from \ to	#1	#2	#3	#4	#5
#1		23		2	3
#2			53	21	
#3		27		28	
#4					11
#5	16				

(*c*)

(*a*) From-to chart showing distances between departments, (*b*) From-to chart showing the number of material handling trips per day, (*c*) From-to chart showing material-handling cost per day. These costs reflect the distance travelled quantity moved, and transportation charge rate.
Fig. 5.11

As indicated in the figures the numbers in the cells can represent other values than just the number of moves which makes a travel chart considerably more useful.

The travel charts help in planning a better plant layout. They show the frequency of movements and the departments having more movements from one to another can be placed near to each other so that it reduces the cost of material handling as well as minimises the unnecessary movement of the workers between the departments.

Travel charts have been found to be useful also in :

1. Selling the layout.
2. Analyzing material movement.
3. Developing departmental block plans.
4. Developing detailed layout arrangements.
5. Evaluating layout alternatives.
6. Demonstrating the dependency of one area upon another.
7. Improving the use of floor space.
8. Showing the interrelationship of product lines.

5.2. VISUALISING LAYOUT

The techniques like operation process chart, flow process chart and flow diagrams are helpful for the preparation of layout, to get an impression about the types of equipment and

machinery that would be used, the physical movement of the material through the plant and for developing the arrangement of these physical facilities. However, in giving the final shape to layout, it is important for the layout engineer to visualise how the layout will look like, how much actual space will be occupied,how it is going to work ? Before the plan is installed, the proposed layout should be reproduced on a smaller scale so that the plans could be seen and understood easily by the others. The reproduction will help in discussing the things with others and improve the things. The checking by seeing with the help of visualising techniques will help in bringing the layout to suit the ideal situation, change and adjust the arrangement which is still on paper stage. It helps to point out the mistakes in the layout, improve the equipment without costing anything. It is far easier to correct mistakes on paper than after the machinery and equipment has been installed. Visualisation helps in eliminating the cost of relayout after the machines are installed. The ways of visualisation are:

1. Drafting and Sketching.
2. Templates and Blocks (Two dimensions).
3. Models (Three dimensions).

5.2.1 Drafting and Sketching

Although in recent years the use of templates and models has become very popular for developing the layouts, the use of the conventional drafting methods is still very helpful and advisable. They are the simplest way of clarifying the arrangement of space and facilities. The technique is very suitable when layout is not big and it is expected that the acceptable solution will be arrived after the consideration of two or three alternatives. However, in a large scale project, where, many possible alternatives have to be considered the drafting technique is not advisable for the visualisation of those alternatives, as it will be difficult to visualise and is more expensive to change once the drafting is over.

The technique is used widely and is more common as these are ready made, easily altered and are less expensive. It is easier to reproduce the copies of the drawings and easier to carry them from place to place in the same plant or to distant locations. It can be kept as a record very conveniently and referred to later on at any time.

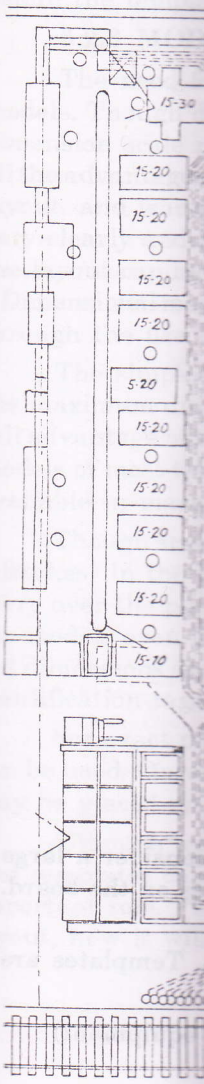
If some alterations are to be done, the same drawing can be used by sketching the moved equipment in colours and leaving the unremoved or unchanged facilities uncoloured on the drawings.

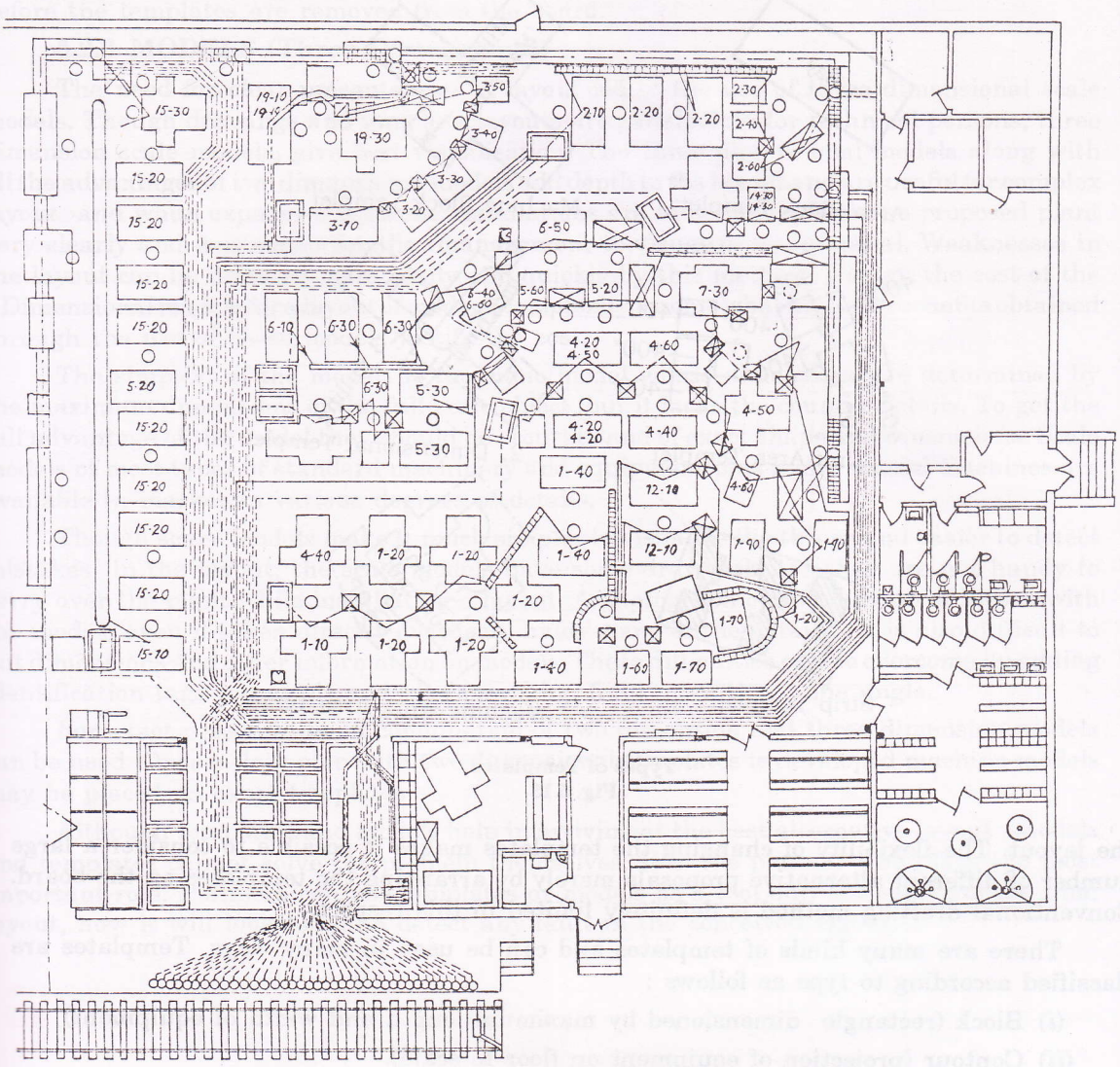
For improving the visualisation of drawings different colours can be used to represent different kinds of facilities as machinery (salmon), handling equipment (yellow), storage rack (red) etc. Coloured lines can be helpful for areas outline or for flow path of different products. Figure 5.12 shows a typical plant layout drawing.

5.2.2. Template and Block (Two dimensional)

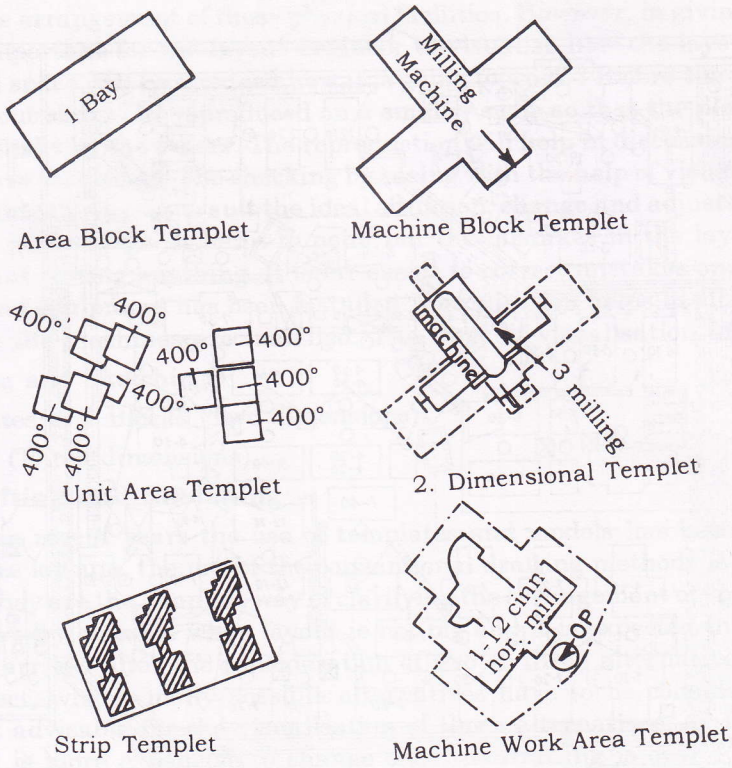
Template is a scale representation, standard scale being 1 : 50 of a physical object. The object may be any machine, material handling equipment storage area or even a worker. The area required by these objectives may be cut to scale from a heavy sheet, bristol board, plywood or other fibre which must be durable.

Templates are most valuable in actually putting together a reproduction of a proposed layout. Templates have two main values for the layout work, first is the flexibility and the ease of changing the layout for a better one on the board, and the second is the ease of visualing





Typical Plant Layout Drawing
Fig. 5.12



Types of Templates
Fig. 5.13

the layout. The flexibility of changing the templates makes it possible to consider a large number of different alternative proposals merely by arranging the templates on the board. Conventional drafting method is definitely limited in this respect.

There are many kinds of templates and can be used in many ways. Templates are classified according to type as follows :

(*i*) Block (rectangle dimensioned by maximum length and width of equipment)

(*ii*) Contour (projection of equipment on floor to scale).

(*iii*) Clearance contour (colour templets with clearance for movable part.)

Few types of templates for layout planning are shown in Fig. 5.13.

In reality two dimensional templates present an outline drawing of the machines showing actual floor space and clearance required. It is drawn by tracing the maximum physical contours in heavy lines. Other projections relevant to layout may be drawn in light broken lines. Additional clearance for loading and unloading and maintenance can also be projected. These templates are conducive to a better understanding of the layout draft.

After the templates have been arranged it is only a simple step further to check the flow of materials by running colored strings between the machines and the work place of the successive operations. The resulting pattern provides a guide test for the effectiveness

of the layout. To record the plan, the arrangement of the templates should be photographed before the templates are removed from the board.

5.2.3 MODELS (Three Dimensional)

The need for clear presentations of layout led to the use of three dimensional scale models. Though drawings and template layouts are satisfactory for technical persons, three dimension scale models, give best visualisation. The three dimensional models along with all the advantages of two dimensional models add depth to the layout and are useful for complex layout and when expansive machine installations are to be made. It shows proposed plant very clearly and it is easier for the management to visualize the proposal. Weaknesses in the layout can be detected more easily and quickly by this method. Though the cost of the 3 Dimensional models for a layout of modern complexity is some what high, the benefits obtained through the use of these models justify the cost.

The simplest of the models is the cubic model whose dimensions are determined by the maximum dimensions of the full scale object, but it lacks the counter details. To get the full advantage of the model they should be accurate and of exact shape and dimensions. Scale models of most types of standard machinery and equipment plus many special machines are available in market in various degrees of details.

Though scale models make it much simpler to visualize the things and easier to detect mistakes in the layout, the scale models have some drawbacks, as they are not handy to carry over the plant while installating a layout. A photographic reproduction of layout with the models even if taken directly overhead, hides many of the details. It is also difficult to put dimensions and other information on models. These difficulties can be overcome by adding identification tags to models and photographing from more than one angle.

For exact presentation, a combination of two dimension and three dimension models can be used. Once a floor plan with two dimensional templates is developed machine models may be placed on exact templates.

Although templates and models help in arriving at the best alternative layout , models and templates cannot solve the problem themselves. It is the planner who plays the most important role. Planners can use templates or models as a tool only for checking the final layout, how it will look like and detect any fault in the conceived layout.

	DRAFTING	BLOCK	2-DIMENSIONAL	3-DIMENSIONAL	COMBINATION OF 2 AND 3 DIMENSIONS
Engineering value.	Good technical data can be included.	Poor, does not permit good visualisation of effective arrangement of layout.	Good, makes effective layout in hands of proficient engineers. Accurate and detailed layout.	Very good, makes faster development for effective layout. Easy interpretation.	Best combines all the characteristics of two and three dimension models.
Cost.	Low if few changes are made, but much more alternative.	First cost low, can be made by inexperienced personnel.	First cost high, requires services of a skilled draftsman with knowledge of machine tools.	Cost of model in quantity not appreciably high than good two dimensional template.	Very high.
Advantages.	For two or three alternative it is very good.	Can be made quickly at low cost.	Gives accurate, detailed layout requires less time to produce final layout than drawing. Serves as permanent record if made properly. Economical upkeep. Prints easily produced. Flexibility permits easy changes. Layouts easily made and used. Eliminates drafting. Reduces possibility of errors as compared to block templates. Trial layout can be printed, alternative arrangement worked out compared with original and remade into original form, using trial layout. Prints and records the original layout.	Permits highly accurate layout to be made quickly. Gives full visualisation of layout. Enables full visualisation of layout. Enables non-technical personnel to study and evaluate the layout. Quickly rearranges to study alternative layouts. Photos of alternative programs are shown. Only one set of models is necessary to make any number of layouts. Shows overhead details and clearance. Assumes more correct location of each piece of equipment. Exposes design errors and potential danger spots. Facilitates study of congested areas specially where overhead conveyors, pipes etc are involved. More accurate visualisation of space utilisation making it easier for proper use of building cube. Leaves less planning to the imagination. Shows plans in all planes. Aids in selling the project. Makes entire organisation layout conscious. Reduces executive time to study and approve. Provides a better understanding of the process. Models can be used indefinitely. Reduces layout and drafting cost. Saves expensive moving of equipment after installation.	
Limitations.	Height dimensions are ignored or else must be write in. Does not contain technical data. Does not permit easy interpretation of layout by non-technical personnel.			Does not contain technical information that can be included on templates.	None.
Disadvantages.	Difficult to be understood by non-technical person.	Does not provide for accuracy of layout, effective or economical arrangement of floor space. Difficult to visualise. Requires tracing for reproduction. Increases drafting time and cost. Fosters energy discrepencies.	Cost is considerably higher than block templates. Does not provide ease of perceptibility inherent in models. Requires engineers to carry all vertical details 'in their heads'.	Difficult to obtain copies unless templates reproduction is made. Does not carry the engineering information provided by the two dimensional templates. Does not show machine clearances required for operation or service. Increased drafting time. Costs more than two dimensional template.	Highest initial cost than all others.

Comparative Engineering Value, Cost, Advantages, Limitations and Disadvantages of Different Types of Templates and Models
Table 5.1

1. Enumerate t
2. Briefly descr
   (*a*) Assemb
   (*b*) Flow di
   (*c*) Travel
   (*d*) Flow pr
3. When are op
4. Distinguish b
5. Why must the
6. How are ma
7. Describe the
   the diagonal?
8. By what mea
9. Why are tem
10. Discuss the r