THE SYSTEMATIC LAYOUT PLANNING PATTERN

Systematic Layout Planning is an organized way to conduct layout planning, it consists of a framework of phases, a pattern of procedures, and a set of conventions for identifying, rating, and visualizing the elements and areas involved in a planning a layout.

We explained the frame work of four phases in Chapter 1. In this chapter, the systematic layout planning pattern of procedures is described. The conventions will be introduced at the appropriate places in later chapters.

The strictly "layout planning" phases of any facilities rearrangement involve creating a general overall layout and subsequently a detailed layout plan for each portion of the general overall layout. In both Phase II and Phase III. In both Phase II and Phase III, the pattern to be followed is essentially the same. Every layout rests on the three fundamentals:

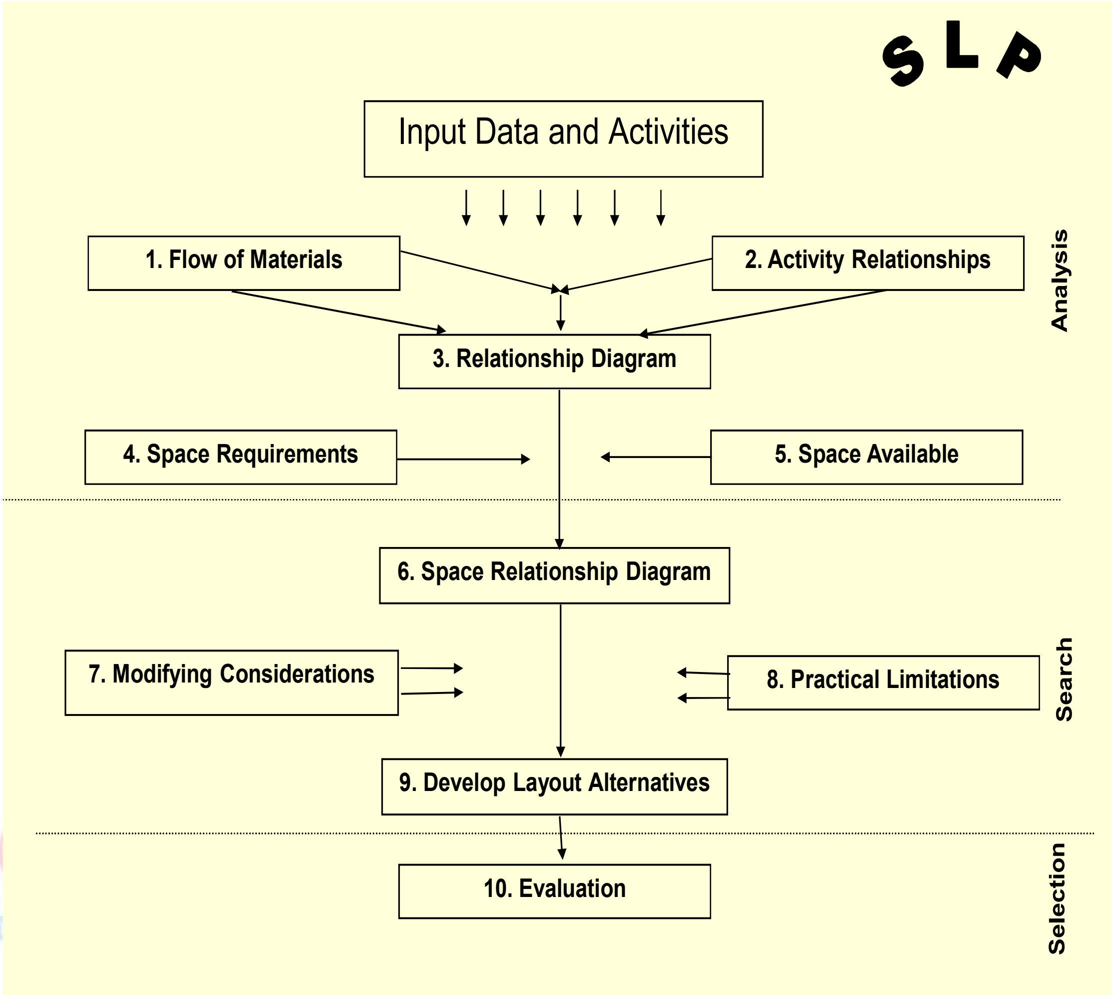
. **Relationships -** the relative degree of closeness desired or required among things.

Space - the amount, kind, and shape or configuration of the things being laid out.

Adjustments - the arrangement of things into a realistic is best fir.

These three are always the heart of any layout planning project, regardless of products, processes, or size of project. It is therefore logical and to be expected that the pattern of layout planning procedures is based directly on these fundamentals.

The SLP Pattern



In the previous chapter, we indicated the importance of Product (P) and Quantity (Q) to any layout. An analysis of them individually and in their "mix" is a necessary preliminary to any real layout planning. Process routing and equipment, supporting services, and timing information are also basic input data. And in addition, identifying the various activities (or areas) included in the layout is a preliminary planning step

Box 1 of the pattern - and in process - dominated industries often the most significant aspect of layout planning - is flow of materials. By planning the layout around the sequence and intensity of material moves, we attain a progressive flow through the areas involved.

In addition to the operating or producing areas, many supporting - service areas must be integrated and planned. As a result, developing or charting the activity relationships - that is, the relationships among the service or support activities or functions is frequently or equal or greater importance then relationships based on flow of materials alone.

These two investigations are then combined into Flow and / or Activity Relationship Diagram. Here the various activities, departments, or areas are geographically related each other without regard to the actual space each requires.

Next, the space requirements: These are developed from analysis of the process machinery and equipment necessary and from the service facilities involved. Area requirements must, however, be balanced against the space available. Then the area allowed for each activity is "hung" on the activity relationship diagram to form a space relationship diagram.

The space relationship diagram is essentially a layout. But, in all likelihood, it is not an effective layout until it is adjusted and manipulated to integrate with its space any modifying considerations. These include such basic considerations as the handling method, operating practices, storage scheduling, and the like. As each potentially good consideration or idea concerning these features is thought up, it must be tested against practical limitations like cost, safety, and employee preference.

As the integrating and adjusting of the various modifying considerations and their limitations are worked out, one idea after another is probed and examined. The ideas that have practical value are retained and those that do not seem worthy, we end up with two, three, four, or five alternative layout proposals. Each of them will work; each has value. The problem lies in deciding which of these plans should be selected. These alternative plans may be termed Plan X, Plan Y and Plan Z.

At this point, a cost analysis of some kind should be made for purposes of comparison and justification. in addition, some evaluation of intangible factors should also be made. This is called an evaluation of alternative layouts or an Evaluation of costs and Intangibles. As a result of this evaluation, one of the alternatives is chosen - although frequently a modification or combination of two or more layouts may actually result from the evaluation process itself.

The alternative layout that is chosen becomes the Selected Layout, the General Overall Layout. With the selection of this general overall layout, phase II is completed.

Tie-in P,Q,R,S and T

We have seen how the pattern of Systematic Layout Planning is constructed. Now lets us relate it to the basic input data, P,Q,R,S AND T. P,Q,R,S AND T underline most of the calculations needed for layout planning. The preparations of the data for the various boxes in the SLP pattern starts with these five basic elements. The product designs and sales forecasts must be woven together and integrated with a P-Q analysis- sometimes called volume-variety or study of product mix. The logical splits and combines of various products or product groups or layout groupings are derived from the P-Q analysis. Specifically, this analysis of product mix, along with analyses of Routing(R), Services(S) and Times (T), leads us to an identification or delineation of the individual activities (areas, machine groups, work places) involved, and thus often to the 4 actual type of layout.

P,Q and R are then woven together to develop the flow of materials P,Q and S are woven together to develop a service activity relationship. From the flow of materials or the activity relationship chart, or a combination of the two, the relationships are then diagrammed. It is Routing(R), together with Time(T), which essentially determines the machinery and equipment required. Similarly, the services (S) called for are translated into the various service facilities required. The process machinery and equipment and the service facilities are then translated into space requirements. These space requirements are then worked into the SLP pattern as described above.

WHY LAYOUT PLANNING?

Many managers ask "Why plan layouts at all?" In some cases it would seem to be about as easy to move the furnishings into an area and then have the fun of arranging them and rearranging them until you are satisfied. For the housewife who likes the freshness of rearranging her house occasionally, this makes sense. But for industry, merely rearranging will, in practically every case, result in lost time, idle equipment, and disruption of personnel. In addition, it may well lead to serious blunders in the use of a company's available land, in costly rearrangements, in actually tearing down buildings, walls or major structures which are still usable but which subsequently turn out to be roadblocks to efficiency and low-cost operation.

A little time spent in planning the arrangement before it is installed can prevent such losses. Moreover, it allows the integration of subsequent moves and rearrangements into a logical program. Planning makes facilities arrangements an orderly, logical sequence. Layout planning pays off: Obviously, it is much easier to move templates or replicas of facilities and equipment around on a piece of paper than it is to move the actual buildings, machinery, or equipment around. As professor School used to say, "You can make as many mistakes as you want in layout planning, and they will all pay for themselves if they avoid mistakes in the physical installation".

Actually, from an installation standpoint, it is about as inexpensive to put in a god layout as to put in a poor one-frequently much less expensive. However, once a poor layout is installed, the cost of rearranging, disrupting production, and fighting your way through a new financial appropriation prohibit remaking it into a good layout.

<u>The Key to Unlocking Layout Problems</u>

There are two basic elements on which every layout problem rests:

1. Product (or material to service) - what is to be made or produced.
2. Quantity (or volume) - how much of each item is to be made.

Directly or indirectly, these two elements underline all other features or conditions in layout work. Therefore, facts, **estimates,** or information about these two elements are essential.

P	**PRODUCT (MATERIAL)**
Q	**QUANTITY (VOLUME)**
R	**ROUTING (PROCESS)**
S	**SUPPORTING SERVICES**
T	**TIME (TIMING)**

By Product (or material or service) we mean the goods produced by the company or area in question, the starting materials (raw materials or purchased parts), the formed or treated parts, the finished goods, and / or service items supplied or processed.

Products may be termed, varieties, models, styles, part numbers, formulations, product groups, or material classes. By Quantity (or volume) we mean the amount of goods or services produced, supplied, or used. Quantity may be termed number of pieces, tons, cubic volume, or value of the amount produced or sold.

In terms or unlocking layout problems these two elements represent the handle of any key we must grasp. For it seems obvious that if we are planning the layout of a Hotel or department, the layout must accomplish something. That "something" is certain products in certain quantities.

After obtaining the product and quantity information, we must next learn about the routing (or process). The routing refers to how the product or material will be made

By routing we mean the process, its equipment, its operations and their sequence. Routing may be defined by operation and equipment lists, process sheets, flow sheets, and the like. The machinery and equipment used will depend on the operations selected to change the form or characteristics of the material. Similarly, the movement of work through the area to be laid out is dependent upon the sequence of the operations. Therefore, the operations involved in the process and their sequence become the body (or stem) of our key. Backing up the direct forming or assembly operations the producing activities or areas are a number of supporting services. In a sense these are the things that give strength to the producing operations, for without adequate support, the producing equipment and workers could not function adequately.
By supporting services we man the utilities, auxiliaries, and related activities or functions that must be provided in the area to be laid out, so that it will function effectively.

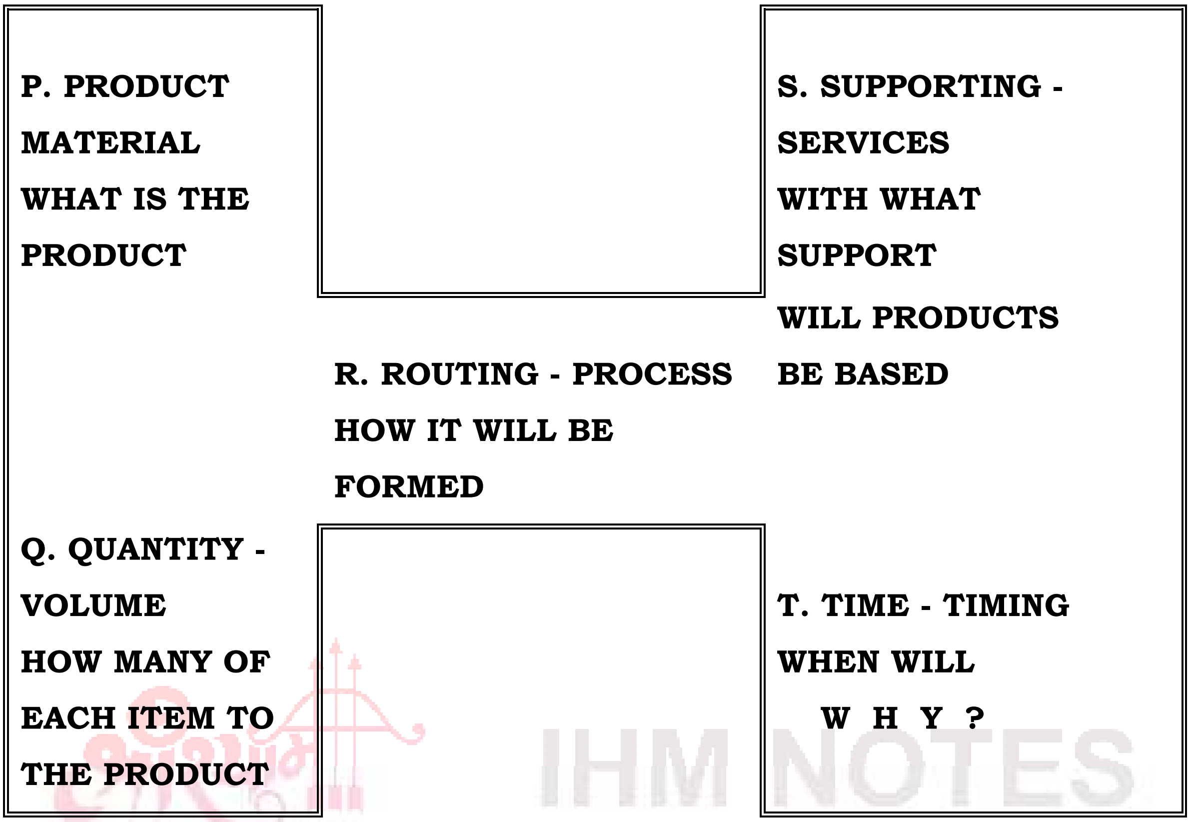
Supporting services include maintenance, machine repair, tool room, toilets and locker rooms, cafeteria, first aid and shop, offices (or "out area"). It is common to include storage areas as a part of the supporting services as well

Taken all together, the supporting services often occupy more floor area than the producing departments themselves. Therefore, adequate attention must be given to them.

One other basic element of the key to unlocking layout problems is time (or timing). By time (or timing) we mean when, how long, how often, and how soon.

Time or timing involves when products will be produced or when the layout being planned will operate (one shift only, during festival season). Operating times for the producing operations determine how many of a given piece of machinery are required, which in turn determines the space required, man power staffing, and operation balancing. Urgency (of delivery of action) is also a part of timing, as the frequency of lot or batch "run" and the response of supporting services.

Perhaps the most important of all, time affects us the layout planners. Every layout project takes a certain amount of time to accomplish, and usually there is deadline to meet.



The above figure shows the elements as a key. But note that these letters at the business end of the key; W H Y. These are an essential reminder to the layout man to question the basic data - to check with reliable sources or his top management find out the basic figures on which lay out planning will depend. Therefore a few challenging "W H Y's"may be necessary to be sure the starting data is sound.

Phases of layout planning

The four steps that the layout planner takes may be translated into what is known as the "Four Phases of Layout Planning". These include the following:

<u>Phase I - Location</u>

Determine the location of the area to be laid out.

This is not necessarily a new site problem. More often it is one of determining whether the new layout (or re-layout) will be in the same place it is now, in a present storage area which can be made free for the purpose, in a newly acquired building, or some other potentially available space.

Phase-II - General Overall Layout

Establish the general arrangement of the area to be laid out.

Here the basic flow patterns and the areas allocated are brought together in such a way that the general size, relationships, and configuration of each major area is roughly established. Phase-II is sometimes termed block layout or area allocation of merely rough layout.

Phase-III - Detailed Layout Plans

Locate each specific piece of machinery and equipment.

In detail planning, the actual placement of each specific physical feature of the area to be laid out is established. And this includes utilities and services as well. The detailed layout plan is customarily a sheet or board with replicas of the individual machines or equipment placed or drawn thereon.

Phase-IV - Installation

Plan the installation, seek the approval of the plan, make the necessary physical moves.

Once the detailed layouts are completed (Phase III), considerable detailing of installation drawings and planning of moves must be worked out. Funds for the installation must be appropriated and the actual moves to install the machinery, equipment, and the services as planned must be made.

These four phases come in sequence, but, for best results, they should overlap each other. Every layout project passes through these four phases even though the layout planning analyst may not be specifically charged with the responsibility for Phase I and / or Phase IV. That is, he must make sure that Phase I has been agreed to or that a specific decision has been, or will be made as to where the layout he is planning is to be located. Obviously, he cannot be very specific about his detailed layout planning if he does not have information about number of floors, ceiling heights, column spacing, and building features. All the generally dependent upon a location- or a reasonably acceptable assumption as to the location -having been established.

In many cases, the Phase I work actually involves a plant location study or a new site analysis. In such cases, the person actually responsible for making the layout plan may or may not be involved directly in Phase I.

Likewise, in Phase IV some other group may do the physical installation. However, in any case the layout planning engineer should be aware of this four phase sequence and should be prepared to integrate his work with Phase I and V.

FLOW OF MATERIALS-HEART OF LAYOUT

- The third letter of our Key to unlocking layout planning problems is R (Routing).
- Routing means how an item is made - its process.
- The process is established essentially by selecting the operations and sequences that will best produce P and Q wanted in the optimum operating T.
- The routing yields the basic data for analyzing the flow of materials

Each step in the process routing to be checked

1. Eliminate - Is the operation necessary, or can it be eliminated ?
2. Combine - Can it be combined with some other operation or action ?
3. Change sequence, place, or person - Can these be changed or rearranged ?
4. Improve details - Can the method of performing the operation or action or its equipment be improved ?

Factors that Affect the Flow Pattern

- Number of parts in each product
- Number of operations on each part
- Sequence of operations in each part
- Number of subassemblies
- Number of units to be produced
- Product versus process type layout
- Desired flexibility
- Locations of service areas
- The building

Determining Method of Flow Analysis

The P-Q chart can be used as a guide, for the method of flow analysis varies with the volume and variety of the items being produced.

1. For one or a few standardized products or items, use operation process chart or some similar flow chart.
2. For several products or items, use multi-product process chart, if assembly and disassembly are not involved.
3. For many products of items (a) Combine them into logical groups and analyze as 1 or 2 above; or (b) Select or sample products or items and apply 1 or 2 above.
4. For very many diversified products or items, use the from-to-chart.

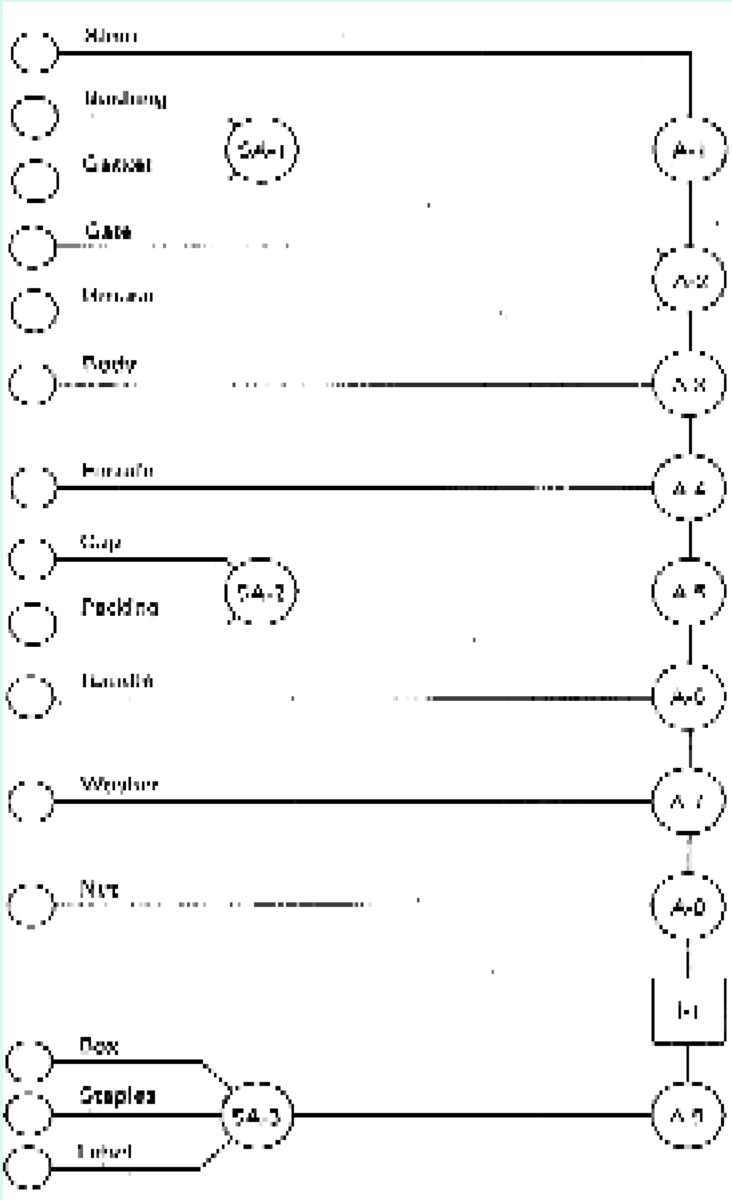
Flow Analysis Information

- Assembly Chart
- Operations Process Chart
- Flow Process Chart
- Multi-Product Process Chart
- Flow Diagram
- From-To Chart

Assembly Chart

It is an analog model of the assembly process. Circles with a single link denote basic components, circles with several links denote assembly operations/subassemblies, and squares represent inspection operations. The easiest method to constructing an assembly chart is to begin with the original product and to trace the product disassembly back to its basic components.

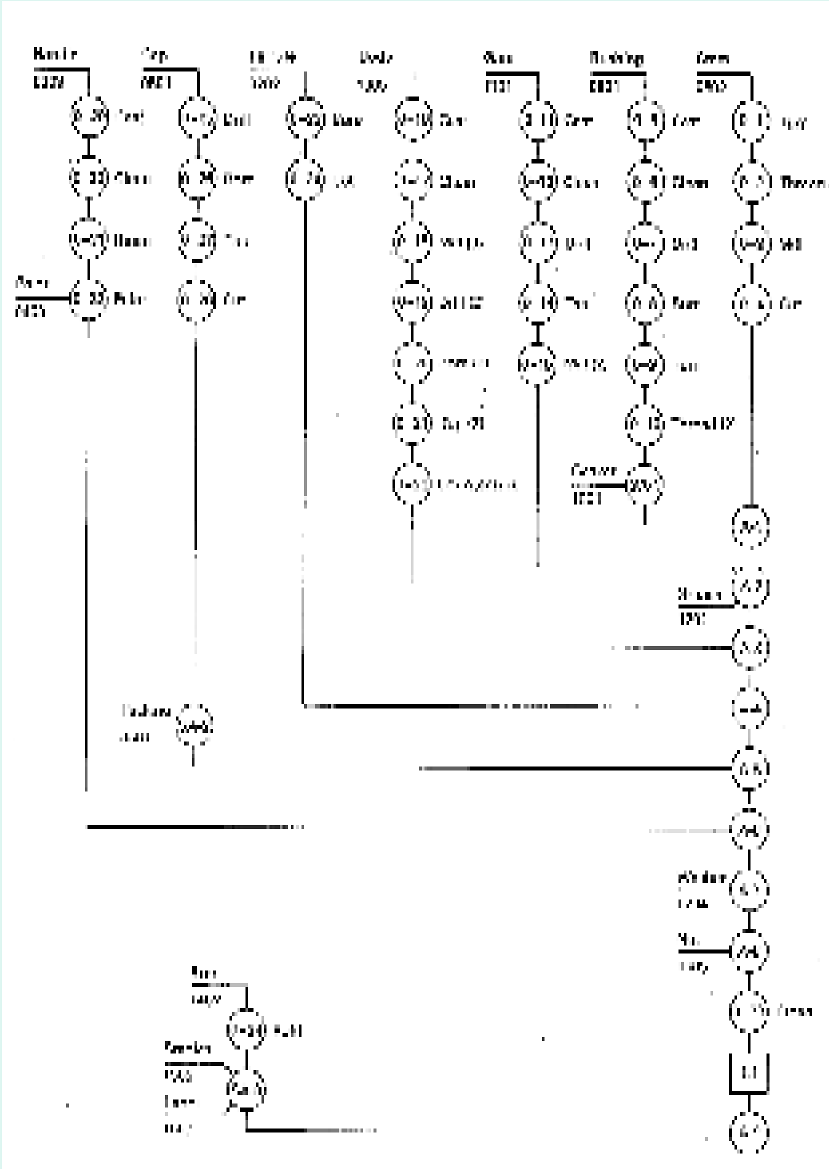
Assembly Chart



Operations Process Chart

By superimposing the route sheets and the assembly chart, a chart results that gives an overview of the flow within the facility. This chart is operations process chart.

Operations Process Chart



Flow Process Chart

This chart uses circles for operations, arrows for transports, squares for inspections, triangles for storage, and the letter D for delays. Vertical lines connect these symbols in the sequence they are performed.

Flow

Process

Chart

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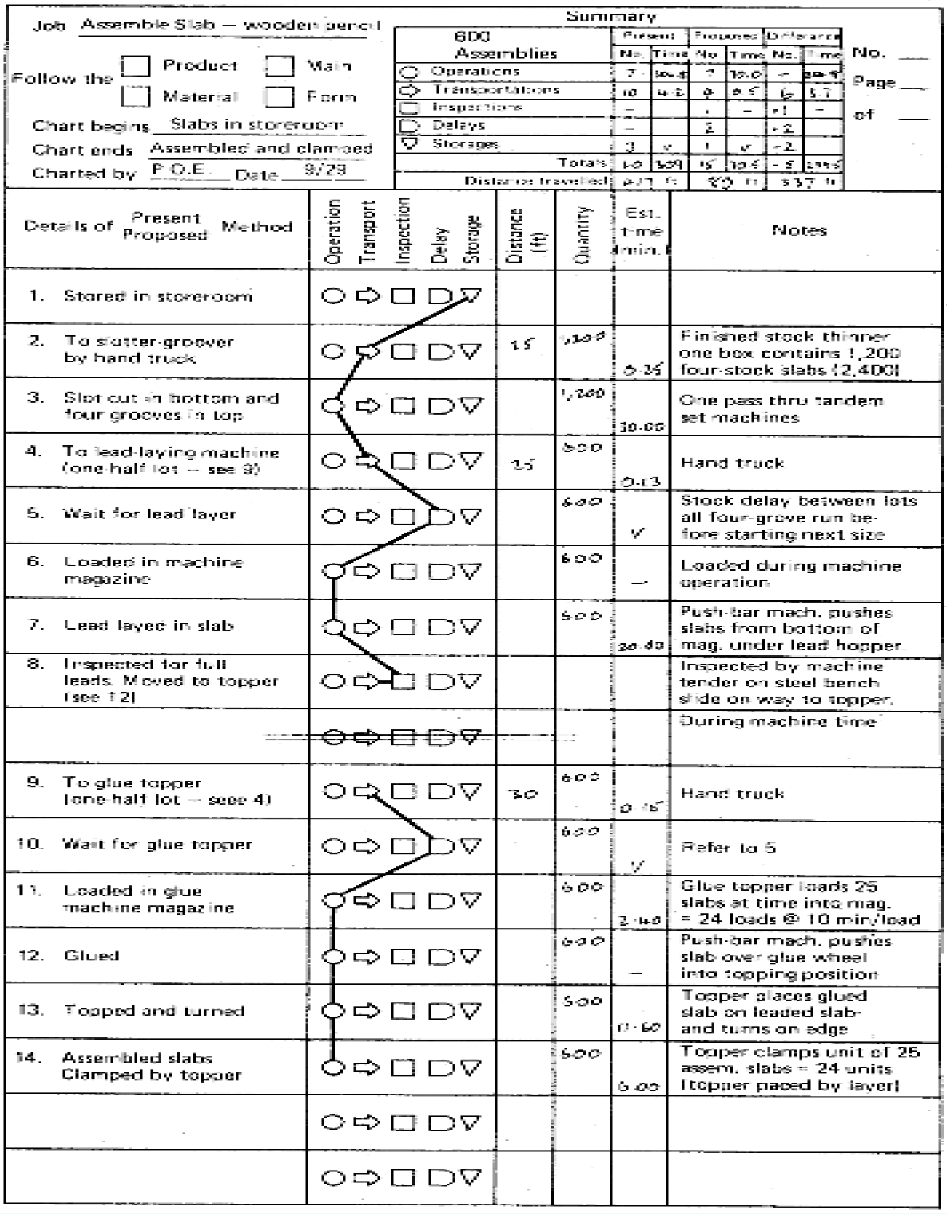

Job: Assemble Slab — wooden pencil

Follow the: Product / Material / Man / Form

Chart begins: Slabs in storeroom

Chart ends: Assembled and clamped

Charted by: P.O.E. Date: 9/28

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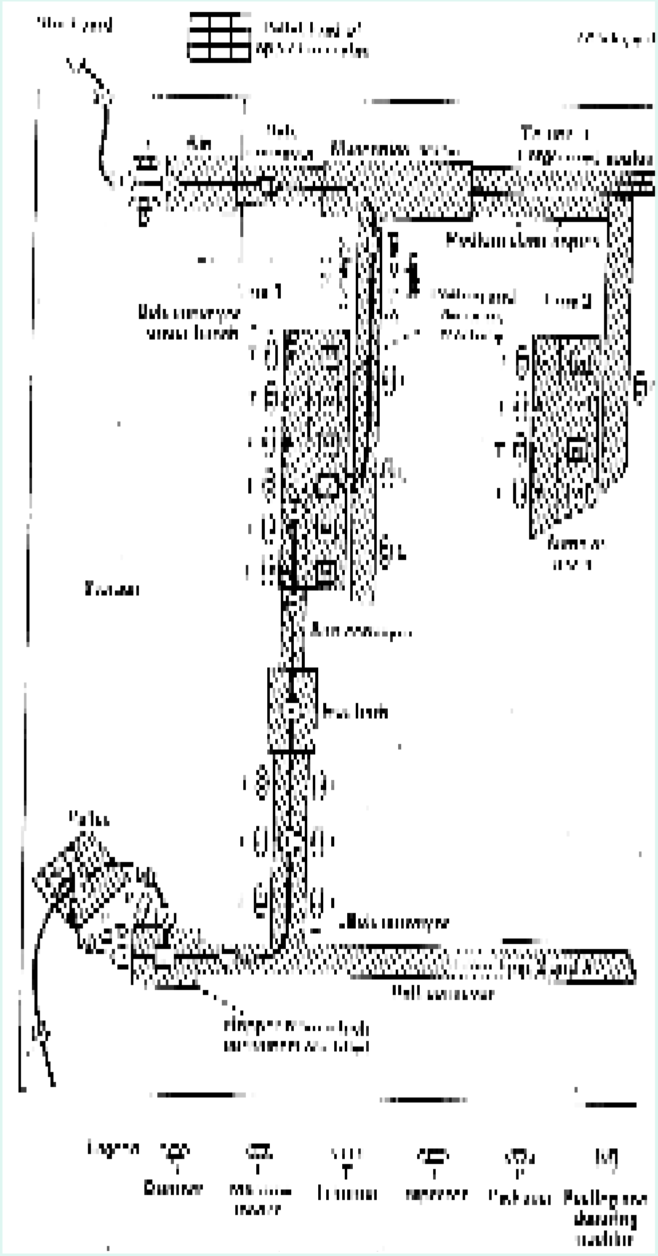
Summary: 600 Assemblies	Present No.	Present Time	Proposed No.	Proposed Time	Difference No.	Difference Time
Operations	7	[illegible]	7	[illegible]	—	[illegible]
Transportations	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Inspections	—		1	—	+1	—
Delays	—		2		+2	
Storages	3	✓	1	✓	-2	
Totals	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Distance travelled	[illegible] ft		[illegible] ft		[illegible] ft	

Details of Present / Proposed Method	Operation / Transport / Inspection / Delay / Storage	Distance (ft)	Quantity	Est. time (min.)	Notes
1. Stored in storeroom					
2. To slotter-groover by hand truck		15	1,200	5.35	Finished stock thinner one box contains 1,200 four-stock slabs (2,400)
3. Slot cut in bottom and four grooves in top			1,200	30.00	One pass thru tandem set machines
4. To lead-laying machine (one half lot — see 9)		25	600	0.13	Hand truck
5. Wait for lead layer			600	✓	Stock delay between lots all four-grove run before starting next size
6. Loaded in machine magazine			600	—	Loaded during machine operation
7. Lead layed in slab			600	20.40	Push-bar mach. pushes slabs from bottom of mag. under lead hopper
8. Inspected for full leads. Moved to topper (see 12)					Inspected by machine tender on steel bench slide on way to topper.
					During machine time
9. To glue topper (one half lot — see 4)		30	600	0.15	Hand truck
10. Wait for glue topper			600	✓	Refer to 5
11. Loaded in glue machine magazine			600	2.40	Glue topper loads 25 slabs at time into mag. = 24 loads @ 10 min/load
12. Glued			600	—	Push-bar mach. pushes slab over glue wheel into topping position
13. Topped and turned			600	0.60	Topper places glued slab on leaded slab- and turns on edge
14. Assembled slabs Clamped by topper			600	6.00	Topper clamps unit of 25 assem. slabs = 24 units (topper paced by layer)

Flow Diagram

It depicts the probable movement of materials in the floor plant. The movement is represented by a line in the plant drawing.



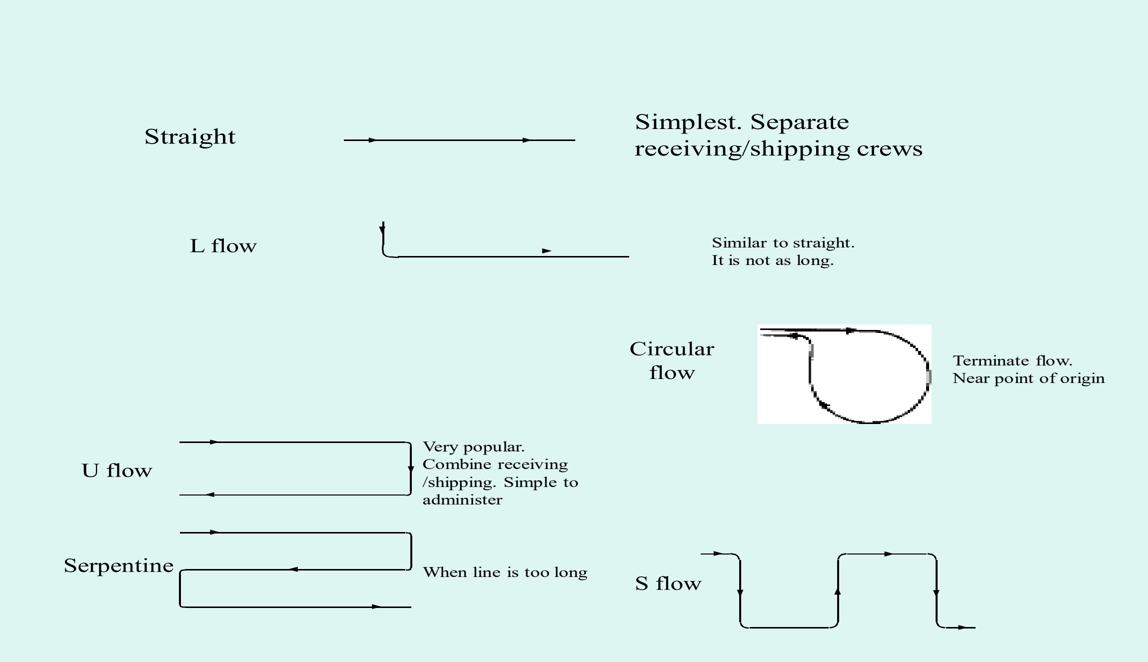
From-To Chart

This chart is a matrix that contains numbers representing a measure (units, unit loads, etc.) of the material flow between machines, departments, buildings, etc.

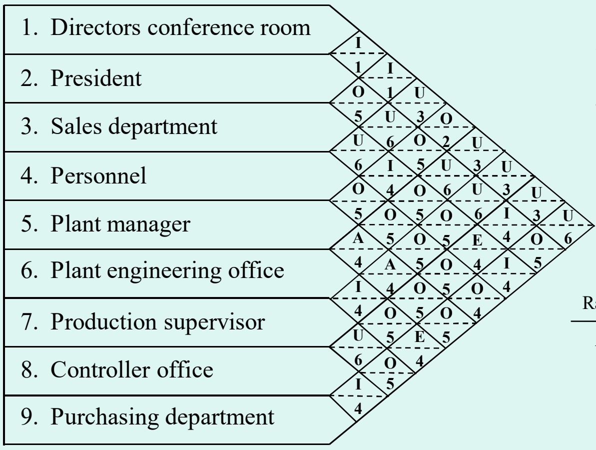
To / From	Stores	Saw	Grind	Weld	Lathe	Mill	Drill	Paint	Assemble	W'house	Total
Stores		500	100	200							800
Saw					300	200					500
Grind					200	100					300
Weld			200								200
Lathe						300	200				500
Mill							600				600
Drill								300	500		800
Paint									300		300
Assemble										800	800
W'house											-
Total		500	300	200	500	600	800	300	800	800	

Flow Pat.: Flow between Departments

- Flow between departments is a criterion often used to evaluate flow within a facility.
- Flow typically is a combination of the basic horizontal flow patterns shown below. An important consideration in combining the flow patterns is the location of the entrance (receiving department) and exit (shipping department).



Relationship Chart



Code	Reason
1	Frequency of use high
2	Frequency of use medium
3	Frequency of use low
4	Information flow high
5	Information flow medium
6	Information flow low

Rating	Definition
A	Absolutely Necessary
E	Especially Important
I	Important
O	Ordinary Closeness OK
U	Unimportant
X	Undesirable

e cost distribution in percentage (in comparison to the total cost of the hotel)	
Civil work	35
Plumbing	5
Electrical work	10
Air condition & Ventilation	12
Elevators	3
Hotel equipments	12
Interior	18
Operational supplies	3
Consultancy charges	2

SPACE ALLOCATION GUIDELINES FOR HOTEL FACILITIES

I Guest Rooms: The total square footage of the guest room block is typically 65-75 percent of the total floor area of the entire hotel.

-The net guest room area (includes living space, bathroom, and closet) for typical room:

Square feet

Budget	200-275 (1&2 star including Motel)
Standard	275-325 (3&4 star)
First Class	325-375 (5 star)
Luxury	375-450 (5 Deluxe)

To determine the total square footage of the guest room, block (including corridors, elevators, stairways, linen closet, vending areas and storage) generally add 50 per cent to the net guest room are (assumes & single-loaded corridor).

For atrium hotels, add 60 percent of the net guest room area (assumes a single loaded corridor).The total square footage for some extremely efficient hotels may be as low as 35 percent of the net guest room area (assumes a double-loaded corridor). Very inexpensive hotels very too dramatically for a general rule; consider them on a case by case basis. The minimum finished width of a room is generally 12 feet. The minimum finished width of corridors on guest room floors is usually 6 feet, which may be reduced to 5 feet if the guest room doors are recessed.

II<u>Public Facilities:</u> The amount of space allocated to the various public facilities shown below will fluctuate dramatically. However, except for budget hotels or those with no restaurant or meeting facilities, it typically approximates 10 to 20 per cent of the total floor area of the entire hotel.

Lobby: typically 2 to 6 percent of the hotel's total floor area.

<u>Square feet Per Guest Room</u>

Main Lobby (general circulation)	7.0 - 10.0
Seating Area	0.7 - 1.0
Front desk and related	3.0 - 4.0
Baggage storage	0.5 - 1.0
Public washrooms (lobby)	0.5 - 1.0

Retail Shops: A gift/sundry shop is generally included with 1.0 to 1.5 square foot per guest room; the size of other retail outlets can range from 100 to 1,200 sq. ft. or more depending on whether they are "desk" operations for car rentals or airline tickets, or regular shops. The scope of what is recommended in dependent on market requirements.

Dining rooms and lounges: typically 4 to 6 percent of the total floor area of the hotel, the
size of outlets will be dependent on the market and assumed utilization.

Square feet Per Seat

Coffee Shop	15-18
Specialty Restaurant	18-20
Formal Dining	20-22
Cocktail Lounges	15-18

Function space: Can range from none to extensive depending on market requirements; when
meeting space is included, it typically ranges between 1.0 & 2.0 meeting seats per guest room

	Square feet required
Ballroom	10-12 per person (seat)
Meeting rooms	10-12 per person (seat)
Boardrooms/hospitality suites	12-16 per person (seat)
Pre-function area	25-40 per percent of Ballroom area

Public washrooms:

Men	4 per meeting seat

Women	6 per meeting seat
Coatroom	4-5 per meeting seat

<u>Recreational facilities</u>**:** can range from none to extensive depending on market requirements.

	Square ft. required
Swimming pool & deck	10-20 per guest room
Lockers/Shower/Toilet Area	2 per guest room
Health Club	2 per guest room
Putting Green	1500

Circulation: from 15 to 20 percent of the total public area (excluding the ballroom) should Be added to allow for circulation; the circulation related to the ballroom was included above in the "pre-function area" allocation.

III <u>Support Facilities and Services:</u> the amount of space allocated to various support facilities and services will vary considerably based on the public facilities included, the concept of operation (full-service versus no frills), and the facilities provided for employees. The space required typically ranges between 10 and 15 percent of the total floor area of the hotel.

Food Preparation	**Sq.Ft. Required**
Coffee shop kitchen	10-25% of coffee shop
Main Dining Room Kitchen	30-45% of dining room area
Banquet Kitchen	20-30%of ballroom meeting space
Room Service	1 per guest room
Food & Beverage Storage Area	30-45% total kitchen space

-Receiving:	**Sq. ft. required**
Office	0.3-0.5 per guest room
Platform	100-250 per bay

-Hotel Employee Facilities:	**Sq. ft. required**
Lockers/Restrooms	6-10 per guest room
Cafeteria	4 per employee
Lounge (if any)	1 per guest room

Housekeeping	**Sq. ft. per Guestroom**
Laundry	7
Linen Storage (not on guest floor)	3
Guest laundry	08.1.5
Uniform Issuing	1

Other Storage, Maintenance and Miscellaneous	**Sq. ft. required**
Hotel general storage	3-7 per guest room
Ballroom/meeting room storage	1.0-1.5 per seat or 10-20% of ballroom area
Miscellaneous storage (garbage, Empty bottles)	1.0-1.8
Telephone Switchboard/Equipment	1.3-2.0 per guest room
Computer Room	1.0-1.5 per guest room
Mechanical, electrical and air handling Rooms and systems	13.18 per guest room
Maintenance Shop	5 per guest room
Security	3.6 per guest room
Circulation Facilities and services	10% total area for support

IV Hotel Administration: the amount of space allocated to administrative offices typically ranges between 1 and 2 percent of the total floor area of the hotel. It includes the executive offices as well as the sales, accounting, personnel and any other administrative support offices. A total of 10 square feet per guest room is generally allocated to this category.