Production Operations management

Chapter 10

Plant Layout

Plant Layout

Plant Layout

This Technical Measures Document refers to Plant Layout.
Other relevant Technical Measures Documents are:

- Design Codes - Plant
- Design Codes – Pipe work
- Plant Modification / Change procedures
- Maintenance procedures

When a new plant is erected The question of placement of machinery at different places,the location of the store,Plating shop,painting shop is very important.
A good deal of expertise is used by management to secure a proper layout for new or existing plant.

Plant Layout

Meaning,Definition & scope

- A plant Layout refers to the arrangement of machinery & other industrial facilities such as receiving & shipping departments,Employer amenities for achieving quickest and smoothest production at least cost
- The subject of plant layout not only covers the initial layout,but encompasses improvement in ,or revision of existing layout
- A more simple definition is given by Knowles & Thomson they say the plant layout involves
- “Planning & arrangement of machinery & other industrial facilities & services for the first time in completely new plant
- The improvement of layout already in use ,in order to introduce new methods

Objectives of good Plant Layout

- Provide enough Production Capacity
- Reduce material handling cost
- Reduce hazards to personnel
- Increase employee moral
- Reduce accidents
- Utilize available space
- Provide ease of production
- Provide ease of maintenance
- Provide ease of supervision
- Improve productivity
- Allow high machine utilization

Factors Influencing Plant Layout

General principles

Plant layout is often a compromise between a number of factors such as:

- The need to keep distances for transfer of materials between plant/storage units to a minimum to reduce costs and risks;
- The geographical limitations of the site;
- Interaction with existing or planned facilities on site such as existing roadways, drainage and utilities routings;
- Interaction with other plants on site;
- The need for plant operability and maintainability;
- The need to locate hazardous materials facilities as far as possible from site boundaries and people living in the local neighborhood;

Factors Influencing Plant Layout

•The need to prevent confinement where release of flammable substances may occur;
•The need to provide access for emergency services;
•The need to provide emergency escape routes for on-site personnel;
•The need to provide acceptable working conditions for operators.
The most important factors of plant layout as far as safety aspects are concerned are those to:
•Prevent, limit and/or mitigate escalation of adjacent events (domino);
•Ensure safety within on-site occupied buildings;
•Control access of unauthorized personnel;

Factors Influencing Plant Layout

•Facilitate access for emergency services.

In determining plant layout designers should consider the factors in outlined in the following sections.

Inherent safety

The major principle in Inherent Safety is to remove the hazard altogether. The best method to achieve this is to reduce the inventory of hazardous substances such that a major hazard is no longer presented. However, this is not often readily achievable and by definition no COMAH facility will have done so. Other possible methods to achieve an Inherently Safer design are:

Factors Influencing Plant Layout

•Intensification to reduce inventories;
•Substitution of hazardous substances by less hazardous alternatives;
•Attenuation to reduce hazardous process conditions i.e. temperature, pressure;
•Simpler systems/processes to reduce potential loss of containment or possibility of errors causing a hazardous event;
•Fail-safe design e.g. valve position on failure.
Plant layout considerations to achieve Inherent Safety are mainly those concerned with domino effects (see below).

Factors Influencing Plant Layout

The Dow / Mond Indices

These hazard indices are useful for evaluating processes or projects, ranking them against existing facilities, and assigning incident classifications. They provides a comparative measure of the overall risk of fire and explosion of a process, and are useful tools in the plant layout development stage since they enable objective spacing distances to be taken into account at all stages.

The methodology for undertaking a rapid ranking method that is based on the Dow / Mond index is detailed in ILO, PIACT, Major Hazard Control: A practical manual, 1988.

Although these are useful rule-of thumb methodologies for first consideration of plant layout, they do not replace risk assessment.

Factors Influencing Plant Layout

The distances derived between plant units using these systems are based upon engineering judgment and some degree of experience rather than any detailed analysis.

Domino effects

Hazard assessment of site layout is critical to ensure consequences of loss of containment and chances of escalation are minimized. Domino may be by fire, explosion (pressure wave and missiles) or toxic gas cloud causing loss of control of operations in another location.

Fire

A fire can spread in four ways:

- Direct burning (including running liquid fires);
- Convection;
- Radiation;

Factors Influencing Plant Layout

•Conduction.

The spread of fire from its origin to other parts of the premises can be prevented by vertical and horizontal compartmentation using fire-resisting walls and floors. Further information may be found in BS 5908 : 1990. Consideration should also be given to the spread of flammable material via drains, ducts and ventilation systems. Delayed ignition following a release may result in spread of flames through such systems via dispersed flammable gases and vapors.

Protection against domino effects by convection, conduction and radiation can be achieved by inherent safety principles

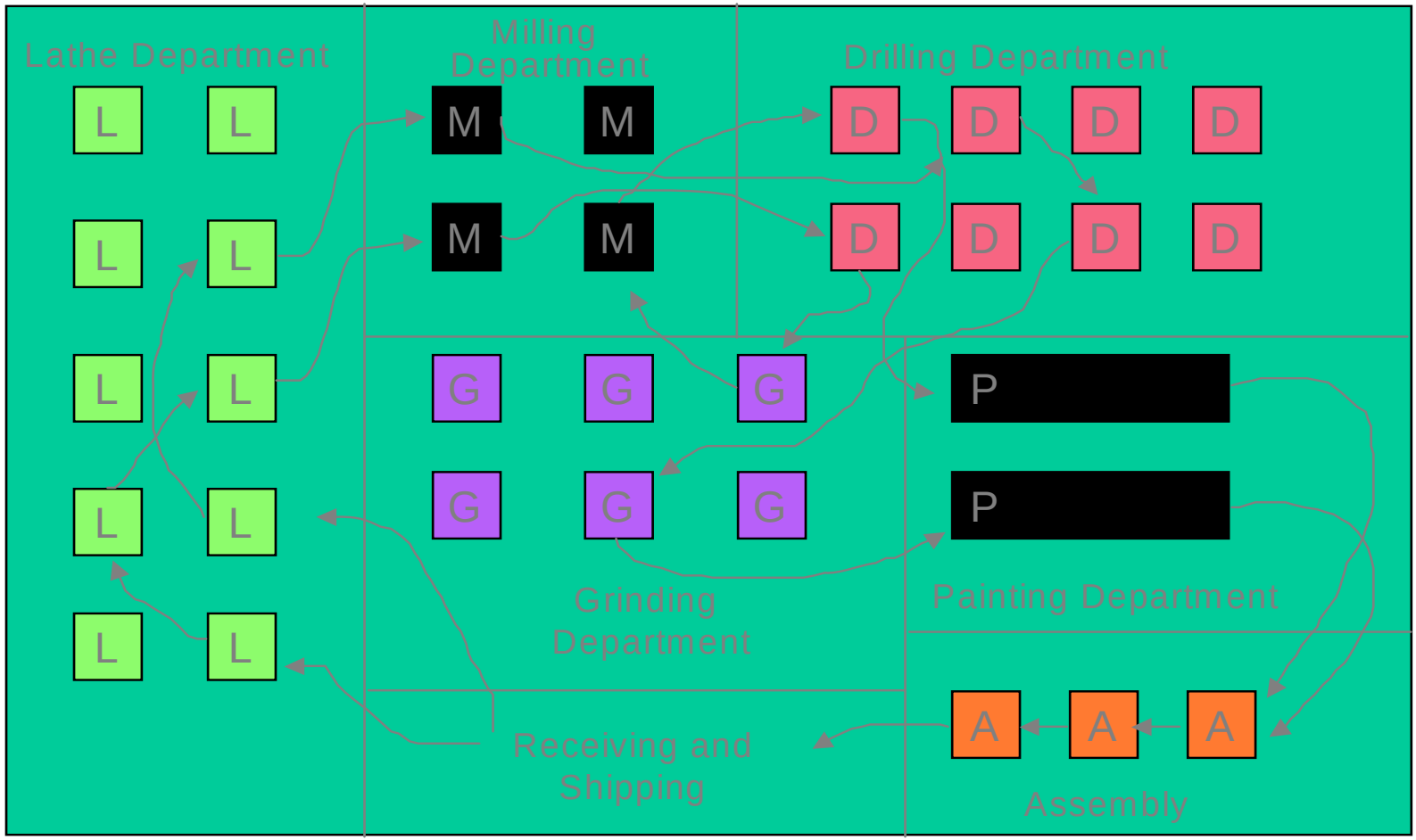
Principles of Plant Layout

- The principle of Minimum travel
- The principle of sequence
- The principle of usage
- The principle of compactness
- The principle of safety
- The principle of satisfaction
- The principle of minimum investment

Types of Plant Layout

- Process lay out,job lay out,functional lay out
- Product layout or line processing lay out
- Fixed position lay out
- Cellular Manufacturing lay out
- Combinational or hybrid layout

Manufacturing Process Layout



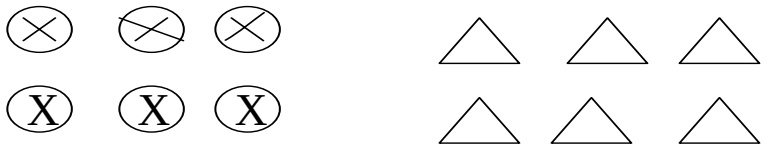
Types of Plant Layout

Service Process Layout

Women's lingerie	Shoes	Housewares
Women's dresses	Cosmetics & Jewelry	Children's department
Women's sportswear	Entry & display area	Men's department

Types of Plant Layout

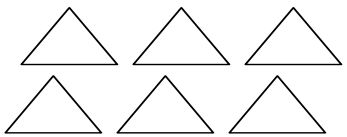
PROCESS LAYOUT IN A FUNCTIONAL APPROACH:



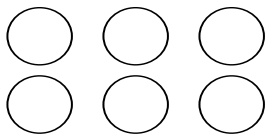
Machine group 1

machine group 2

Movement of product



Machine group 3



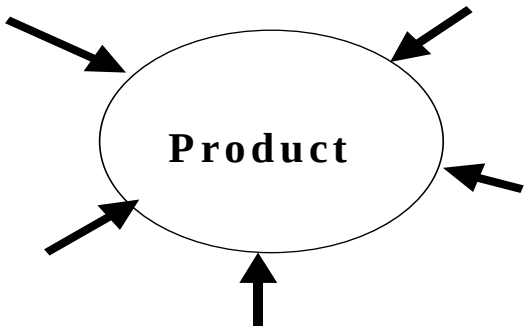
Machine group ‘n’

‘Random’ movement takes place as products are moved according to process requirements.

There is no ‘flow’ as such - each product will have its particular process requirements and will move to each machine group as when required

Types of Plant Layout

FIXED POSITION LAYOUT



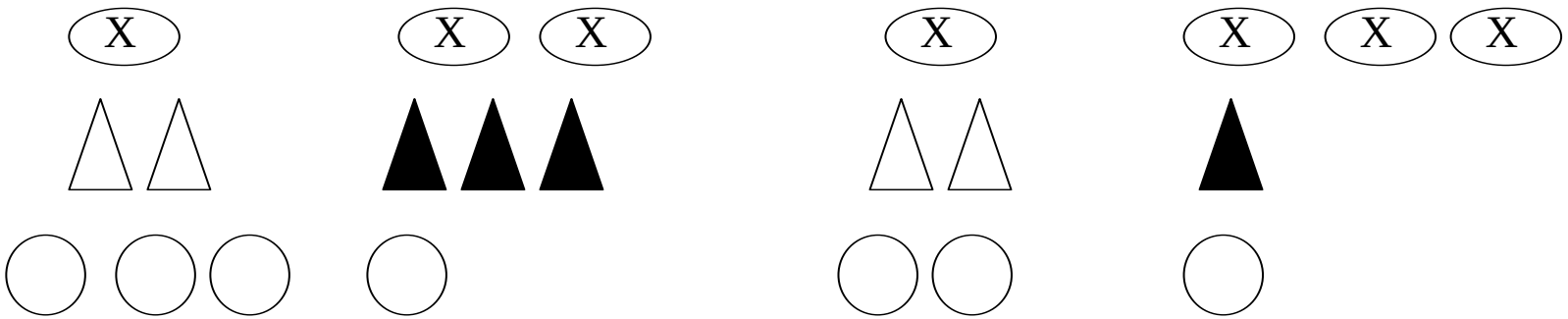
Operators perform processes on the 'fixed' product. There may be more than one operation performed on the product at the same time. Each operation adds to the product until it is completed

Types of Plant Layout

Fixed position layout

Types of Plant Layout

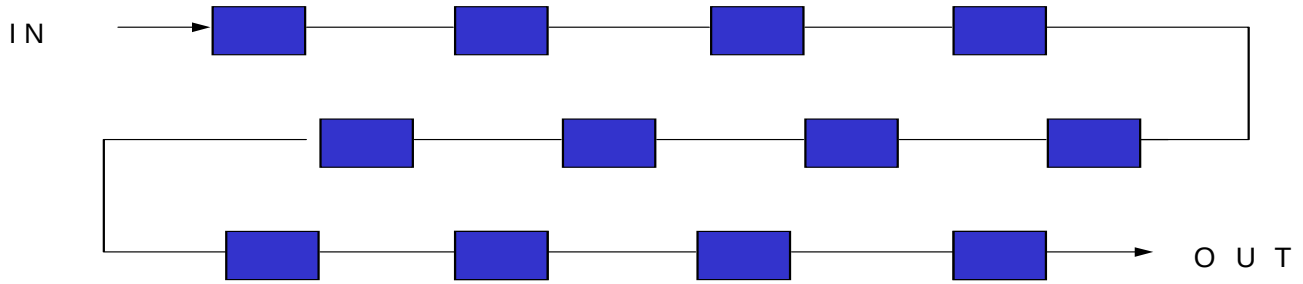
PROCESS LAYOUT IN A *PRODUCT FAMILY* CELL



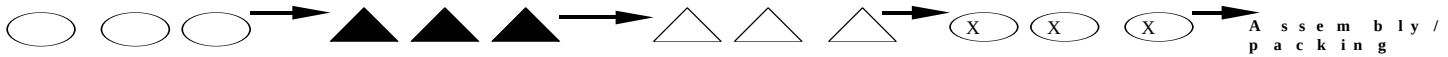
group 1 group 2 group 3 group 4

Types of Plant Layout

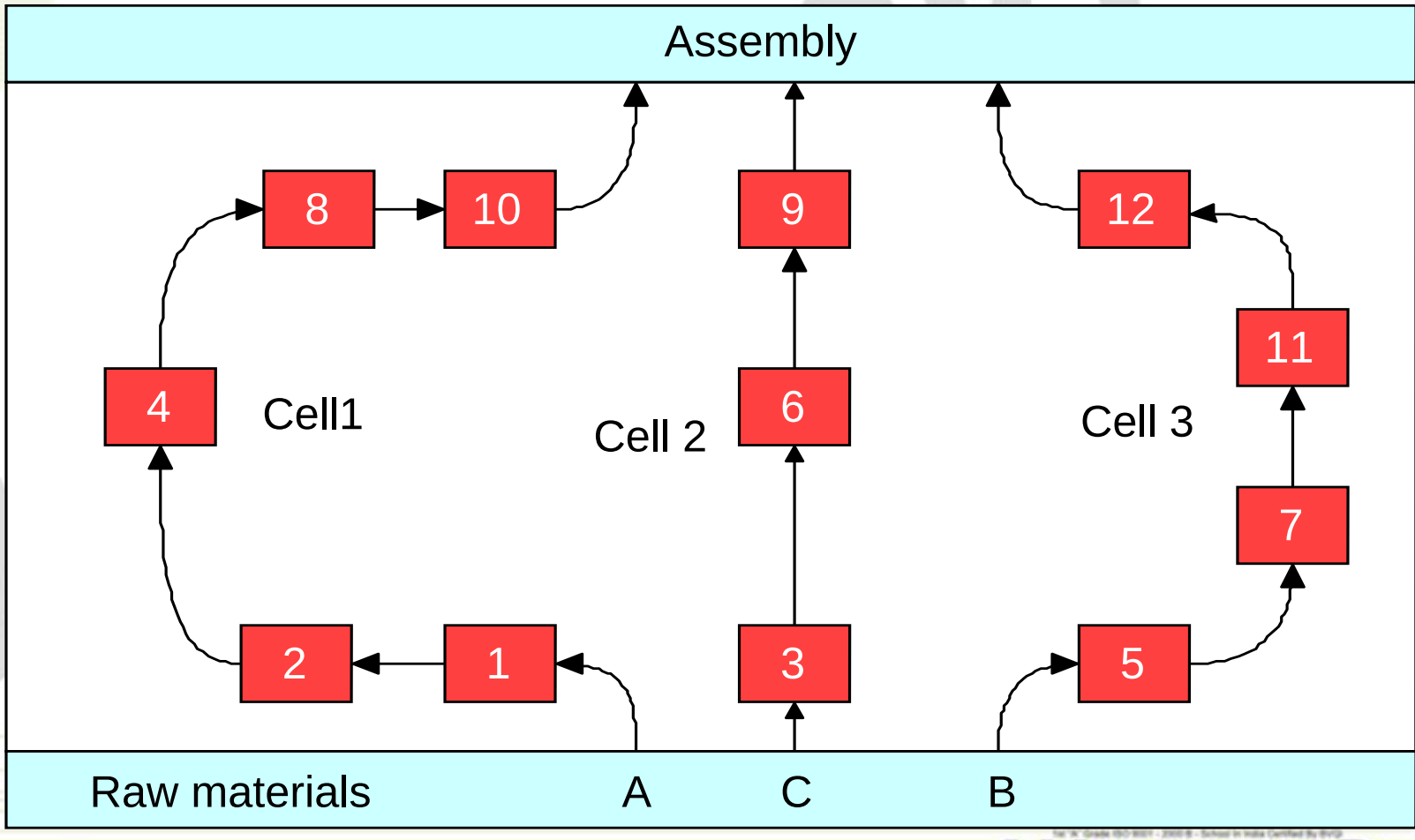
A Product Layout



PRODUCT LAYOUT



Cellular Layout Solution



Comparison Of Product And Process Layouts

	PRODUCT LAYOUT	PROCESS LAYOUT
1. Description	Sequential arrangement of machines	Functional grouping of machines
2. Type of Process	Continuous, mass production, mainly assembly	Intermittent, job shop batch production, mainly fabrication
3. Product	Standardized made to stock	Varied, made to order
4. Demand	Stable	Fluctuating
5. Volume	High	Low
6. Equipment	Special purpose	General purpose
7. Workers	Limited skills	Varied skills

Comparison Of Product And Process Layouts

	PRODUCT LAYOUT	PROCESS LAYOUT
8. Inventory	Low in-process, high finished goods	High in-process, low finished goods
9. Storage space	Small	Large
10. Material handling	Fixed path (conveyor)	Variable path (forklift)
11. Aisles	Narrow	Wide
12. Scheduling	Part of balancing	Dynamic
13. Layout decision	Line balancing	Machine location
14. Goal	Equalize work at each station	Minimize material handling cost
15. Advantage	Efficiency	Flexibility

Special arrangements for particular type of plants (*JOB PROCESSES*)

1.Investment in automation is for general purpose technology rather than product specific investment.

2.Many different products are run throughout the plant and materials handling has to be modified and adjusted to suit many different products and types

3.Detailed planning will evolve around sequencing requirements for each product, capacities for each work centre and order priorities: because of this scheduling is relatively complicated, in comparison to repetitive ‘line’ manufacture.

Special arrangements for particular type of plants (*BATCH PROCESSES*)

1. Automation, especially for lower volumes of batch manufacturing, tends to be general purpose, rather than dedicated to a particular product whose volume does not demand product-specific investment in automation.

2. Scheduling is complicated and has to be completely reviewed on a regular, on-going basis - this applies to new products, ‘one-off’s’ that may be required, together with relatively high volume, standard products: all of these types will need to be scheduled.

Special arrangements for particular type of plants (*BATCH PROCESSES*)

3.Operators have to be able to perform a number of functions - this is obviously true of ‘job’ types processes. In batch, though, this flexibility is crucial in that it will allow operators to move to various workstations as required.

4. Where automation is being used, set-up time should be short: the ideal set up times is quick enough to accommodate run lengths of just one unit, switching over to other models and volumes as, and when, required.

Special arrangements for particular type of plants (Line *PROCESSES*)

1. Process times should be fast - which is critical in order to satisfy delivery speed requirements

2. There should be simplification in production planning and control and the tasks themselves should also be simplified for each workstation.

3. There should be small amounts of work in process: in fact, work in process (which, in accounting terms, can be viewed as an asset) is a liability to the company which can ruin cash-flow and stifle quick response to market requirements

Special arrangements for particular type of plants (Line *PROCESSES*)

4. Materials handling between stations should be placed as closely as possible to each other.

5.Materials flow and control are critical : Just-in Time lends itself most noticeably to ‘line’ or very high volume batch production. Stock-outs have to be avoided although, at the same time, excess stock is a waste and a liability, rather than an asset (materials can be viewed as an asset on the balance sheet which is misleading and alien to world class manufacturing.

Special arrangements for particular type of plants (Continuous *PROCESSES*)

1.The volume of a product is very high and the process is dedicated to making, typically, only one product.

2.Huge investment in dedicated plant is often required.

3.Much automation tends to be evident and labour input is one of ‘policing’ rather than being highly skilled as an integral input to the overall process.

Importance of layout

1.Economics of handling

2. Effective use of available area

3. Minimization of product delay

4.Improved Quality control

5.Minimum Equipment investment

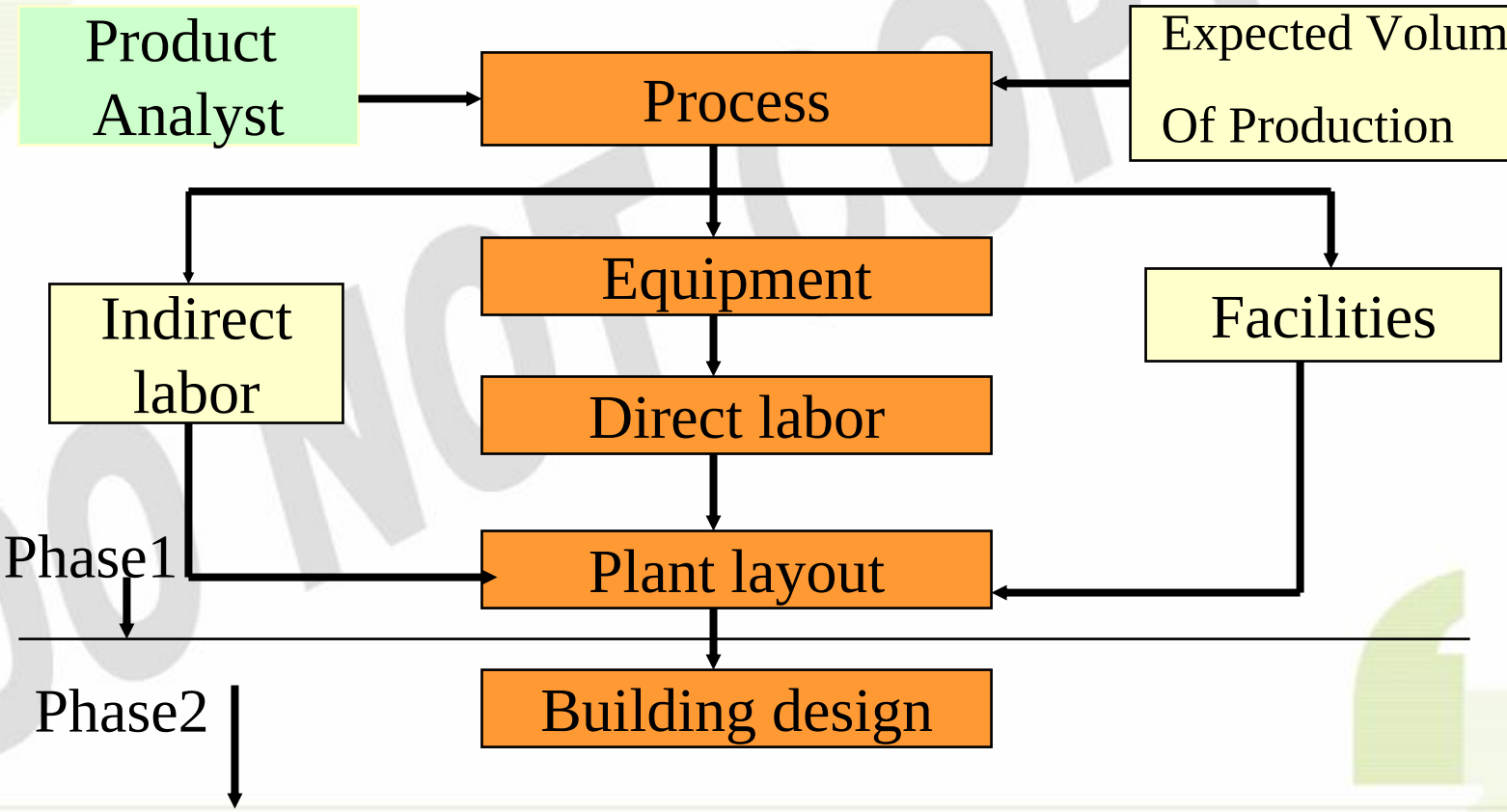
6.Avoidance of bottleneck

7.Better production control

8.Improve employee moral

Layout Planning

Steps in layout Planning and design



Layout Tools and techniques

- Various tools & techniques are available for planning layouts
- The most common is to use two dimensional template.
- Templates are patterns which consists of a thin plate of wood or metal which serves as a gauge or guide in mechanical work.A plant layout template is a scaled representation of a physical object in a layout

Criteria for selection & Design layouts

Facility layouts must integrate work center location ,office,computer facilities.Two of major criteria for selecting and designing and layout are:

- ❖Material handling cost: These costs are minimized by using mechanized handling of materials
- ❖Worker effectiveness:Good layouts provide workers with satisfying job & permit them to work effectively at highest skill levels

Criteria for selection & Design layouts

The various methods used for selecting the best layout are

Travel Chart method

- The travel chart which is also known as from to chart is helpful in analyzing overall flow of material
- It shows number of moves made between the department& identifies most active department
- The solution is provided by trial & error method & which attempts to minimize non adjacent flow by centrally locating the Active department

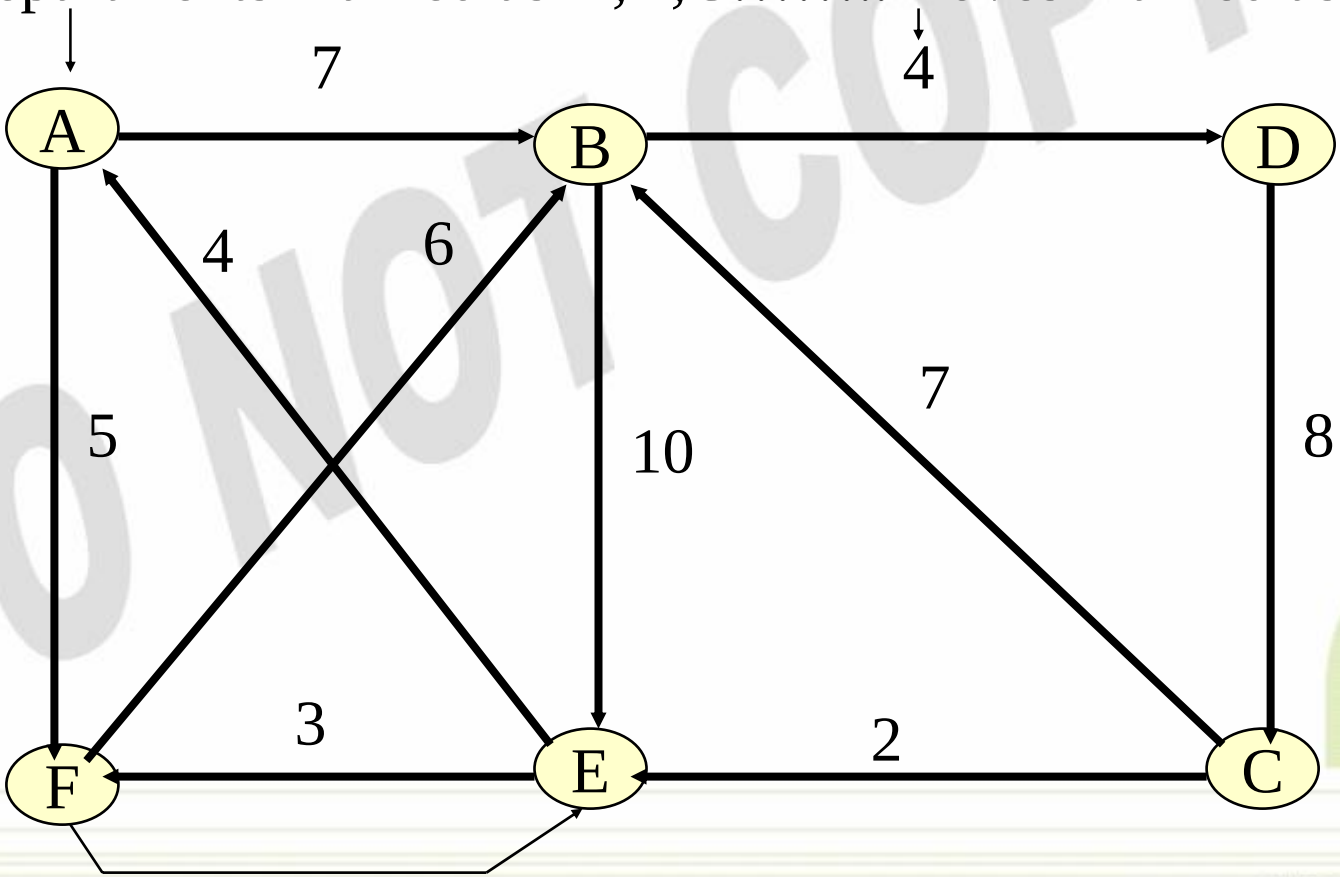
Criteria for selection & Design layouts

Travel Chart method(Procedure)

- Step1 Determine which departments have the most frequent links with other department This can be done in totaling entries in each row and column
- Step2 Try to locate Most active department in the central position in the outline
- Step3 by trial & error method locate other departments so that non adjacent flows are minimized
- Step4 If all the non adjacent moves are eliminated ,the solution is complete.

Criteria for selection & Design layouts

Departments marked as A,B,C……..Moves marked as 1,2,3…



Criteria for selection & Design layouts

The various methods used for selecting the best layout are

Long Distance Analysis method

❖When designing a new assembly plant or retrofitting an existing plant, it is critical to determine where all the materials will be received, stored and used.

❖Variable width and color material flow diagrams created by Factory FLOW are especially useful for presenting this information.

❖Factory FLOW automatically finds the shortest route from origin to destination along an aisle network for all materials/parts involved.

Criteria for selection & Design layouts

❖Once routes are determined. Factory FLOW draws the routes, outputs travel distances, times, and costs to report files and scales the thickness of flow lines according to the flow intensity of each part.

❖The input data required by Factory FLOW is the kind of basic from-to information typically already available in a database or spreadsheet.

❖Among other output reports, Factory FLOW generates detailed reports on manpower requirements by equipment type. Factory FLOW's from-to chart shows the flow intensities and distances between ail from-to locations analyzed.

Criteria for selection & Design layouts

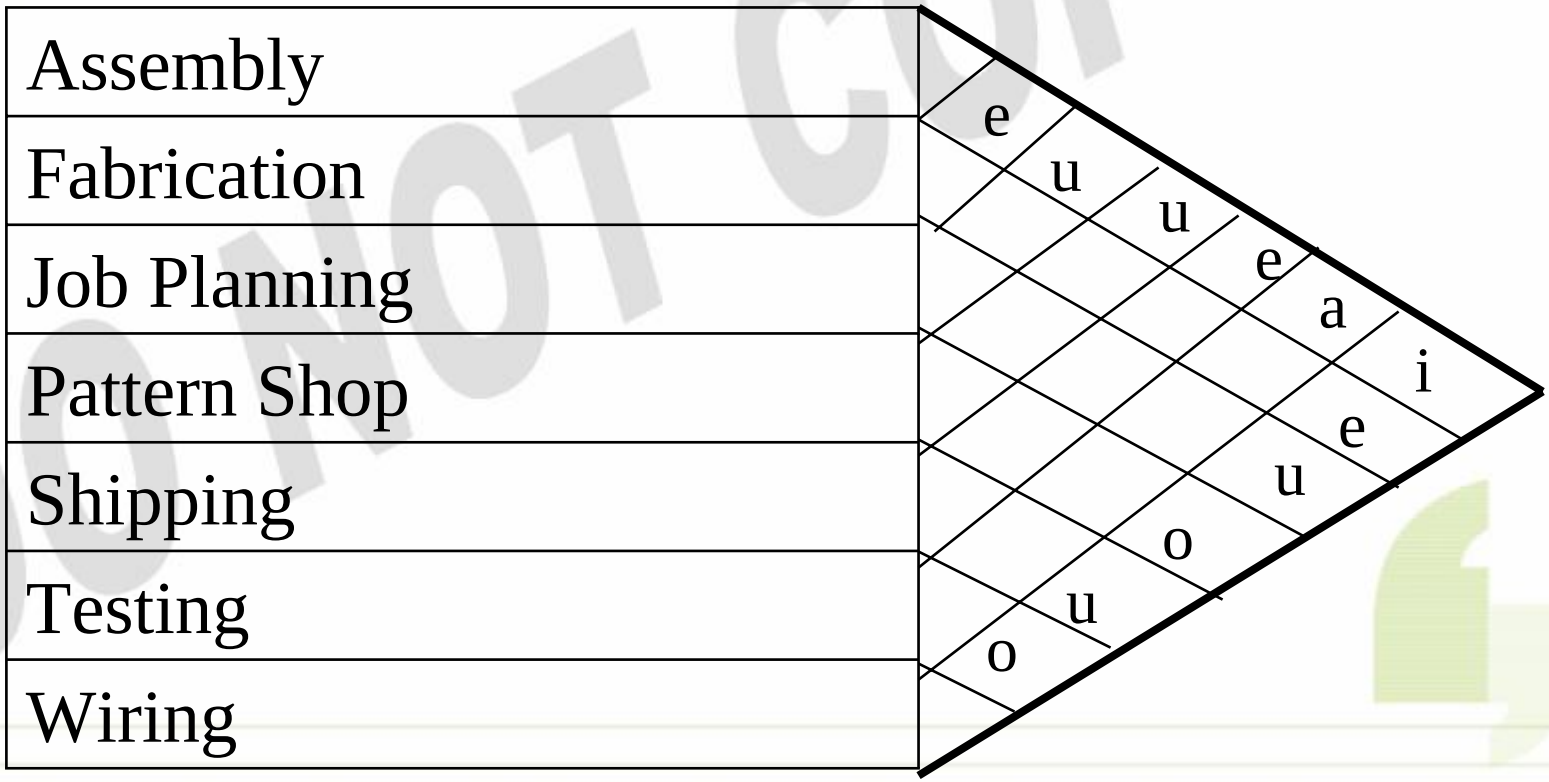
- The distance intensity chart plots each part's move intensity against its travel distance on an X-Y graph.
- With the help of powerful personal computer systems and user friendly graphical environments, material flow studies of over 10,000 parts within facilities of over 5 million square feet can be accomplished by a novice user in under an hour.

Systematic Layout Planning

- Systematic Layout Planning(SLP) method is used in some production system such as service system,where the amount of material that flows between department may not be critical for developing a good facility layout.
- This method develops a chart known as “Relationship chart”or “Richard Muther’s half Matrix.
- Important ratings are indicated by a,e,i,o,u,x known as “nearness code”
- a- absolutely necessary,e-essential
- I-important,o-o.k
- U-unimportant
- X-undesirable

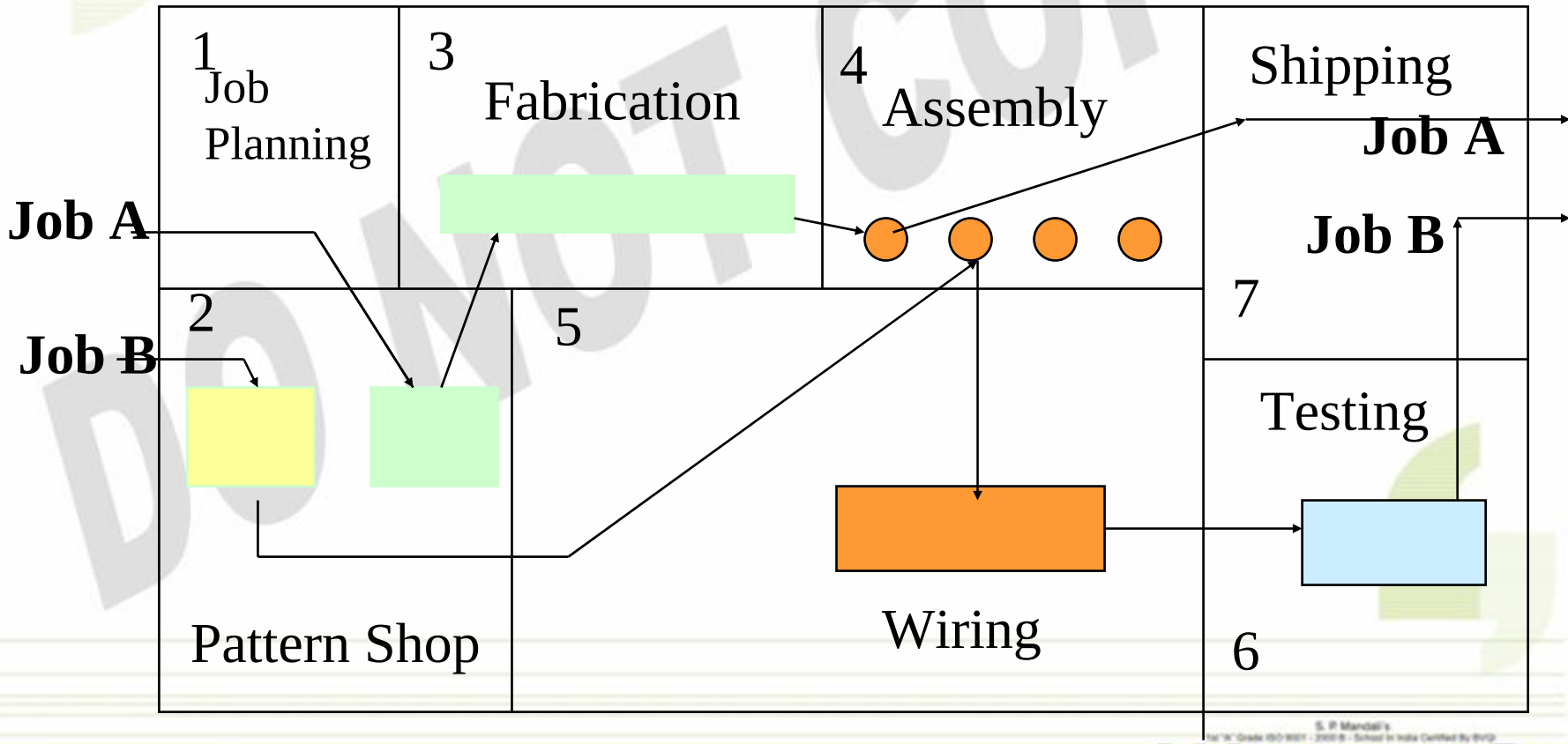
Systematic Layout Planning

Richard Muther's half Matrix



Systematic Layout Planning

Richard Muther's half Matrix



Plant Location

End Of

Chapter 10