Creating Factory Layout

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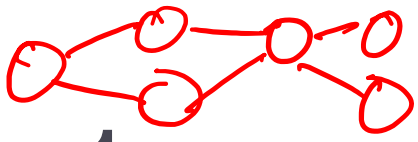


Designing Product Layouts

CPM?

PERT?

- Goal is to balance the assembly line
- Precedence requirements are physical restrictions in the order in which operations are performed
  - Specify which operations must precede others, which can be done concurrently, and which must wait until later
- Another objective is to attain the required output rate as efficiently as possible
  - For this, first, each job is to be broken down into the smallest indivisible proportions called as work elements
  - The work elements are then grouped to work stations so that product flow is smooth through the assembly line

Workstation

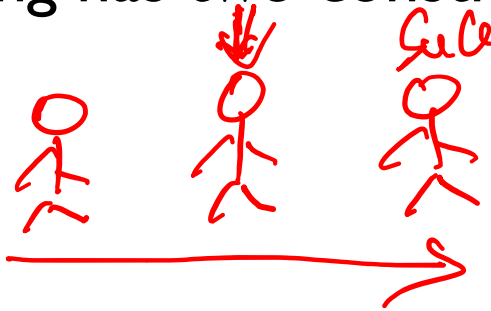
- Is any area along the assembly line that requires at least one worker or one machine

- If each work station on the assembly line takes the same amount of time to perform the work elements that are assigned
  - Then products will move successively from workstation to workstation without waiting
  - Also no need for worker to be idle

- This process of equalizing the amount of work at each workstation is called line balancing

Line Balancing

- Assembly line balancing has two constraints
  - Precedence
  - Cycle time



- Precedence requirements are usually expressed as precedence diagram
  - Precedence diagram is a network that describes any restrictions on the order in which work elements must be performed
  - Work elements represented by nodes and precedence relationships represented by directed line segments (arcs)

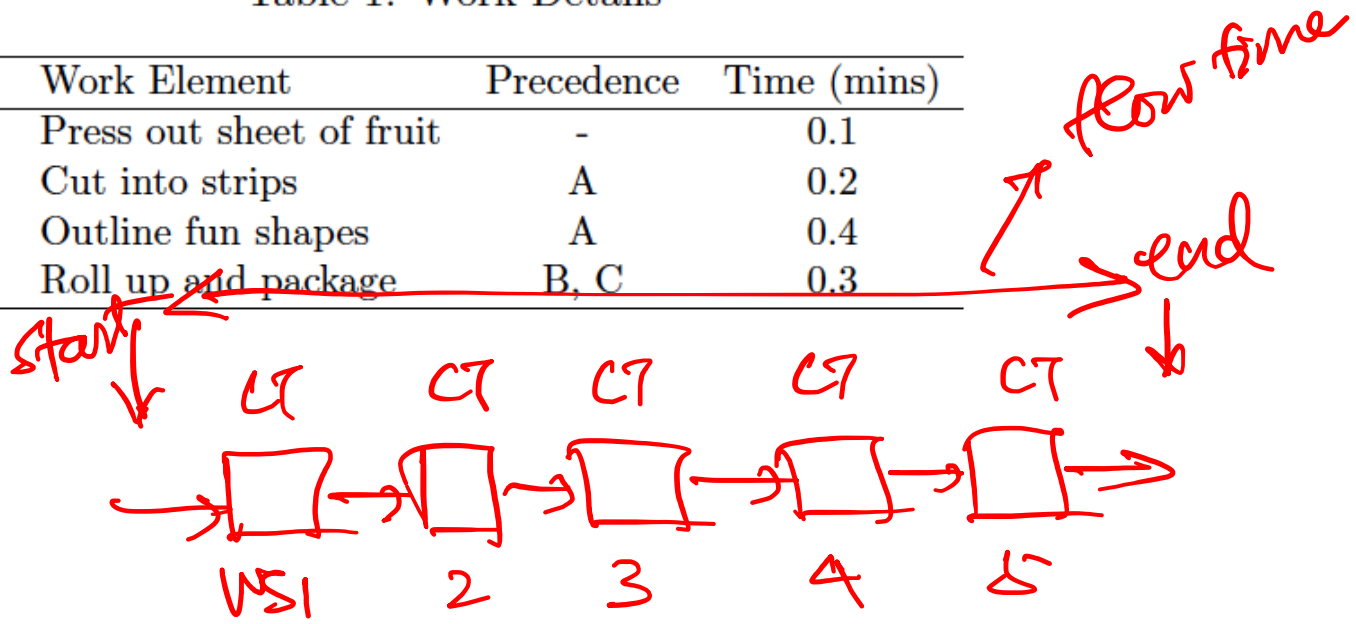
Example 1

1 Problem - 1

Given the following information on work elements and time and precedence requirements, draw and label a precedence diagram for the assembly of fruit strip snacks.

Table 1: Work Details

	Work Element	Precedence	Time (mins)
A	Press out sheet of fruit	-	0.1
B	Cut into strips	A	0.2
C	Outline fun shapes	A	0.4
D	Roll up and package	B, C	0.3



Cycle Time

- It is the maximum amount of time a product is allowed to spend at each workstation
  - Mathematically: max{ individual time at workstations}
- Calculated by dividing the time available for production by the number of units to be produced
- Cycle time can also be viewed as the time between completed items rolling off the assembly line
- Time required to complete an item is known as flow time or lead time

Line Efficiency

- For small layout problems, method of trial and error will work, but not for large problems some guideline is a must

- Line efficiency along with theoretical minimum number of workstations can be used as a guideline to create workstations

$$Efficiency = \frac{\sum_{i=1}^{j} t_i}{nC} \qquad \#WS = \frac{\sum_{i=1}^{j} t_i}{C}$$

- Where t_i is the completion time of element i, j is the number of work elements, n is the actual number of work stations, and C is the cycle time

Example 2

2 Problem - 2

Suppose the assembly process diagrammed before requires the production of 6000 fruit strips every 40-hour week. Group the elements into the smallest number of workstations that will achieve the production quota without violating precedence constraints.

Balance Delay

- Total idle time of the line is called as balance delay
- Balance delay is calculated as (1 – efficiency) in percentage

100-83.33%

- Actual cycle time is the maximum workstation time on the line
- Actual efficiency is obtained by dividing with the actual cycle time
  - It is very difficult to attain 100% efficiency or theoretical number of workstations

Computerized Line Balancing

- COMSOAL – Computer Method for Sequencing Operations for Assembly Line by IBM
- ASYBL – Assembly Line Configuration Program by GE
- Both can assign hundreds of work elements to workstations on assembly line

- They do not guarantee optimal solutions, instead they use various heuristics to balance line at an acceptable efficiency

- Most common is ranked positional weight technique

Ranked Positional Weight Technique

- Compute the cycle time.
- Construct the precedence network.
- Compute the positional weight for each element, which is the element's operation time plus the operation time of all elements following that element in the network.
- Sort the positional weights in the descending order and create the ranking.
- Start assigning elements to workstations in the rank order. Keep on adding elements to the workstation until time on workstation is less than or equal to the cycle time.
- If no more elements can be added, create the workstation
- Repeat until all elements are assigned.

Example 3

An insurance corporation has set a processing quota of eighty insurance claims per 8 hour day. The claims process consists of five elements, which are detailed in the table below. The corporation has decided to use an assembly line arrangement to process the forms and would like to make sure they have set-up the line in the most efficient fashion.

1. Construct a precedence diagram for the claims process and calculate the cycle time required to meet the processing quota.
2. Balance the assembly line using the ranked positional weight technique and show your arrangement of workstations.
3. Calculate the efficiency of the line.
4. Determine how many claims can actually be processed on your line.

Table 1: Work Details

	Precedence	Time (mins)
A	-	4
B	A	5
C	B	2
D	A	1
E	C, D	3