Plant Layout Design

1. Overview

There are some criteria that we must follow to design a plant layout. One of those criteria is to minimize the work in process (WIP) inside the plant. To analyze a plant layout based on WIP, we need to know the following inputs:

- The number of products which are made in this plant and for each product, the demand of the products and the sequence of machines which is required by it.
- The number of machines which are used.
- The number of locations where we can place these machines.
- The distances between these locations.
- The speed of the conveyor which transports the product through the plant.
- The processing time for each machine.

Once we have given the inputs, we can evaluate if the plant is well designed.

2. The analytical calculation

The analytical calculation is based on the theory of queuing network. The formula for Expected Work in Process at a particular department is:

\[
E(WIP_i) = \frac{\rho_i (C_{ai}^2 + C_{si}^2)g_i}{2(1-\rho_i)} + \rho_i
\]

where:
- \(\rho_I\) is the average utilization of department I.
- \(C_{ai}^2\) and \(C_{si}^2\) are respectively, the squared coefficients of variation of job inter-arrival and processing time.
- \(g_i\) is a coefficient for department I.

Similarly, the expected WIP at the conveyor is given by:

\[
E(WIP_t) = \frac{\rho_t (C_{at}^2 + C_{st}^2)g_t}{2(1-\rho_t)} + \rho_t
\]
where:
ρₜ is the average utilization of the conveyor.
Cᵣₜ² is the squared coefficient of variation of job inter-arrival at the conveyor.
Cₛₜ² is the squared coefficient of variation of the expected travel time per material transfer.
gₜ is a coefficient for the conveyor.

And so we can calculate the expected WIP for the plant:

$$E(WIP) = \sum_i E(WIP_i) + E(WIP_t)$$