

Task precedence
 what task need to be done before the next can go on

series & parallel configurations
 serie dominated = long - thin
 parallel dominated = short - fat

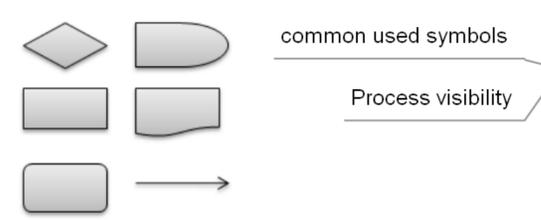
cycle time & process flow
 Cycle time = time until complete units emerges from process = $\frac{\text{Time available}}{\text{number to be processed}} \rightarrow \text{process capacity} = \frac{\text{work content}}{\text{Number of people}}$

Process capacity
 = allocate activities to each stage as equally as possible

process balancing
Principle = Allocating work equally to each stage in a process (balancing) smoothes flow and avoids bottlenecks

Balance loss = $\frac{\text{Idle time total}}{\text{Number of stages} \times \text{Cycle time}} = \frac{5}{4 \times 12} = 0.104 = 10.4\%$

throughput, cycle time & work in process
Little's Law = $\text{throughput time} = \frac{\text{work in process}}{\text{throughput}}$ OR $\text{work in process} = \text{throughput time} \times \text{throughput}$



Process analysis
 Slack et al chapter 5 (2009)

3 Variability

Principle = Variability in a process acts to reduce its efficiency

1 Activity time variability

2 Arrival time variability = **Principle** = Process variability results in simultaneous waiting and resource underutilization

Unit	Arrival time	Start	End	Wait time
A	0	0	10	0
B	12	12	22	0
C	20	22	32	2
D	34	34	44	0
E	43	44	54	1
F	55	55	65	0

3 options to optimize waiting time or utilization



Accept longer waiting time but higher utilization



Accept low utilization and achieve short waiting time



Reduce variability in arrival time, activity times and achieve higher utilization and shorter waiting times

Principle = Process design involves some choice between utilization, waiting time and variability reduction

0 Process objectives

Quality, speed, dependability, flexibility, cost

- Process flow objectives
- Throughput rate
 - Throughput time
 - work-in-process
 - Resource utilization

- Design factors
- Variability of input
 - Configuration of resources
 - Capacity of resources
 - Variability of the activities