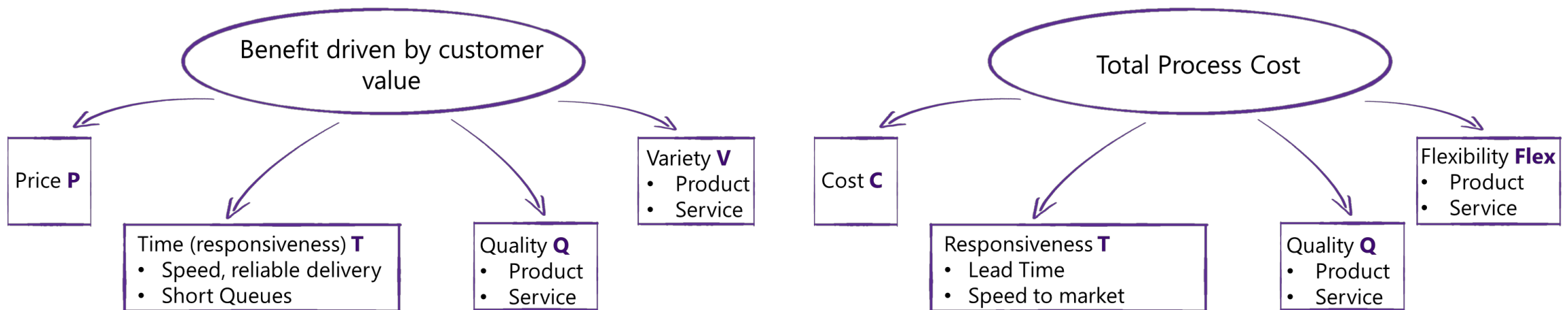


Introduction to Operations Management

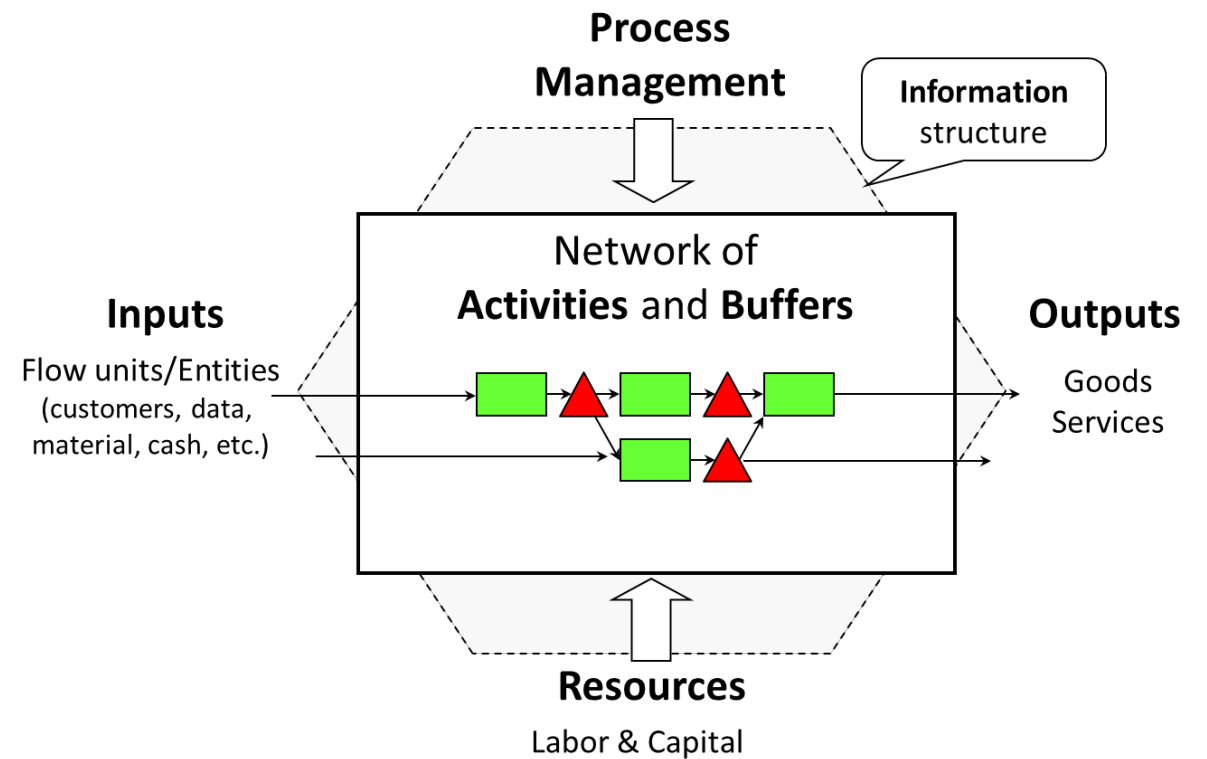
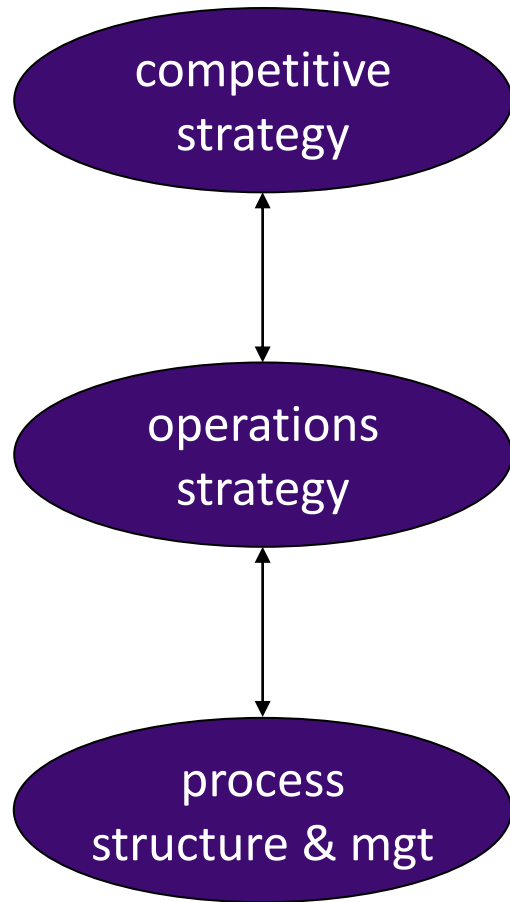
Firms compete on delivered value

*Delivered value of a process =
benefit driven by customer value – total process cost*



Introduction to Operations Management

Alignment and the Process View



Introduction to Operations Management

Strategic Trade-offs, Efficient Frontier, Inhibitors



Figure 1.2 The strategic trade-off between responsiveness and productivity

- **Waste** – The consumption of inputs and resources that do not add value to the customer.
- **Variability** – Predictable or unpredictable changes in the demand or the supply process.
- **Inflexibility** – The inability to adjust to either changes in the supply process or changes in customer demand.

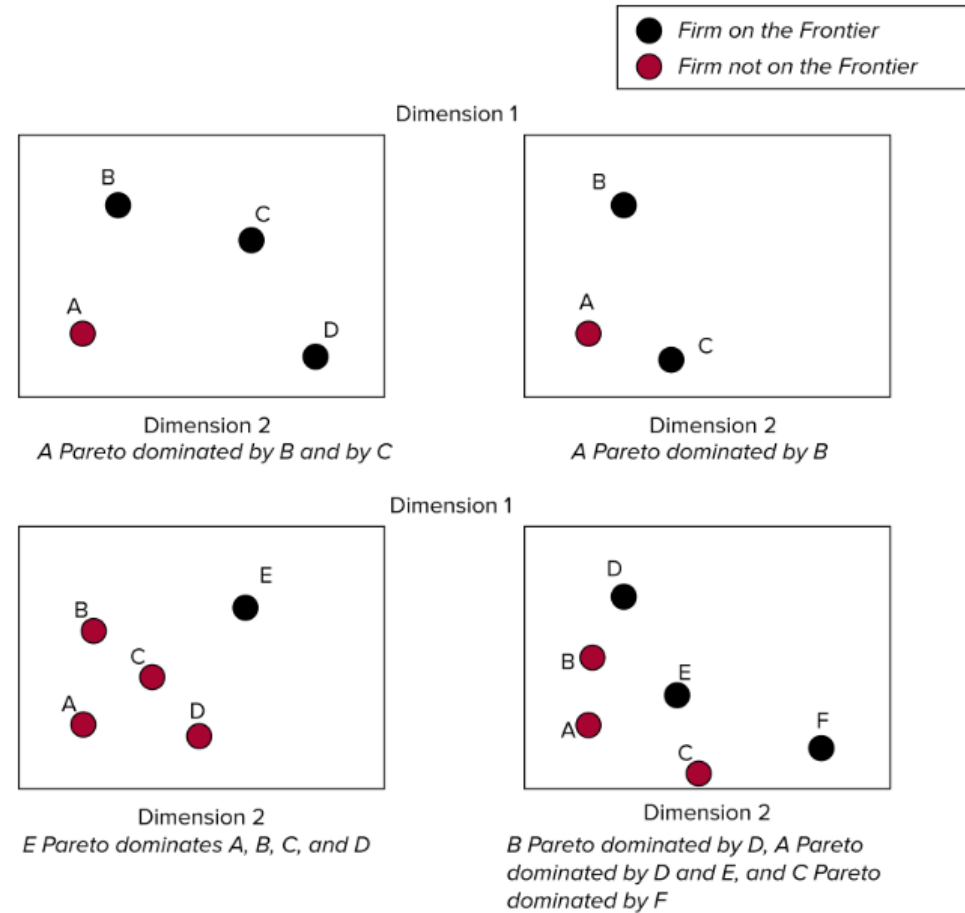
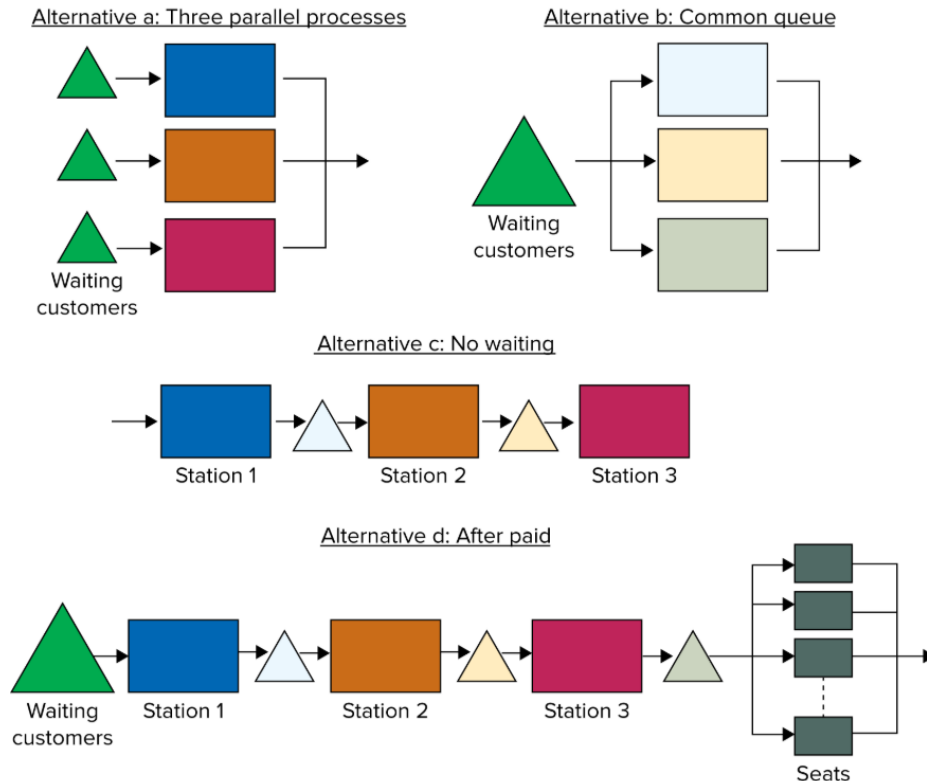


Figure 1.4 The definition of the efficient frontier

Process Analysis and Improvement

Process Flow Diagram and Little's Law

Process Flow Diagram



Little's Law

Inventory = Flow rate * Flow time

$$I = R * T$$

Inventory = I

Flow Rate = R

Flow Time = T

Process Analysis and Improvement

Process Analysis and Bottlenecks

$$\text{Capacity} = \frac{m}{\text{Processing time}}$$

$$\text{Flow rate} = \text{Minimum} \{ \text{Demand}, \text{Process capacity} \}$$

$$\text{Utilization} = \frac{\text{Flow rate}}{\text{Capacity}}$$

$$\text{Cycle time} = \frac{1}{\text{Flow rate}}$$

$$\begin{array}{l} \text{Time to finish } X \text{ units} \\ \text{starting with an empty system} \end{array} = \begin{array}{l} \text{Time through} \\ \text{an empty process} \end{array} + [(X - 1) \times \text{Cycle time}]$$

Bottleneck – Resource with the lowest capacity in a process. Understanding the location of the bottleneck is critical for improving a process.



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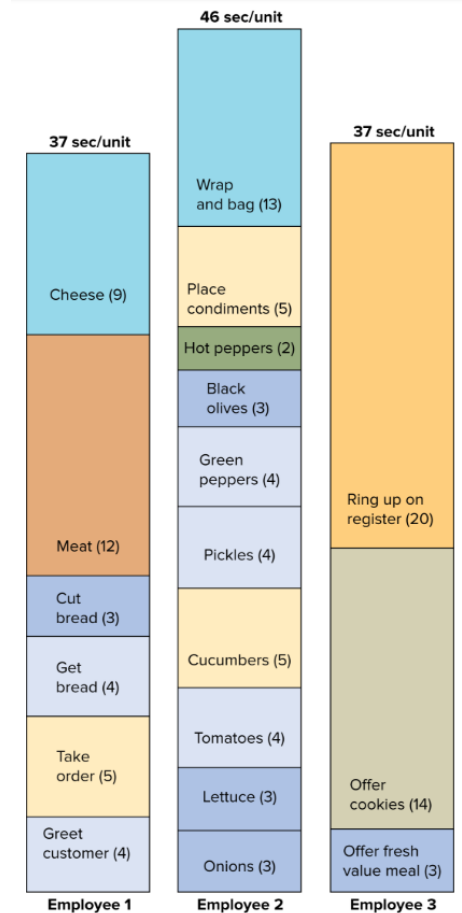


Figure 3.6 Comparison of processing times

Process Analysis and Improvement

Process Improvement

$$\text{Costs of direct labor} = \frac{\text{Wages per unit of time}}{\text{Flow rate}}$$

Labor content = Sum of the processing times involving labor

$$\text{Average labor utilization} = \frac{\text{Labor Content}}{\text{Cycle time} \times \text{Number of employees}}$$

Total idle time = Cycle Time $\times$ Number of employees – Labor Content

$$\text{Takt time} = \frac{1}{\text{Demand rate}}$$

$$\text{Target manpower} = \frac{\text{Labor content}}{\text{Takt time}}$$

Strategies to improve:

- Off-load the bottleneck
- Balance the line

Pros and Cons of Specialization

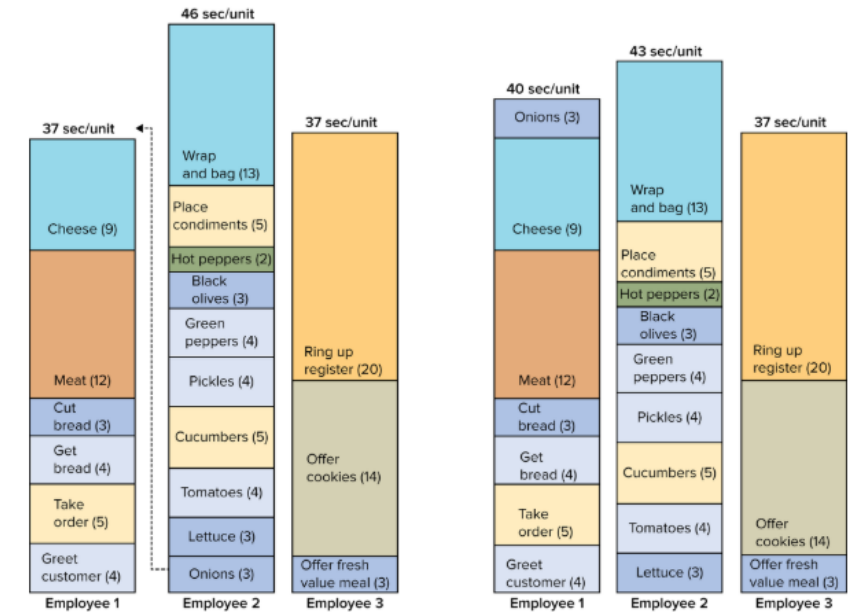
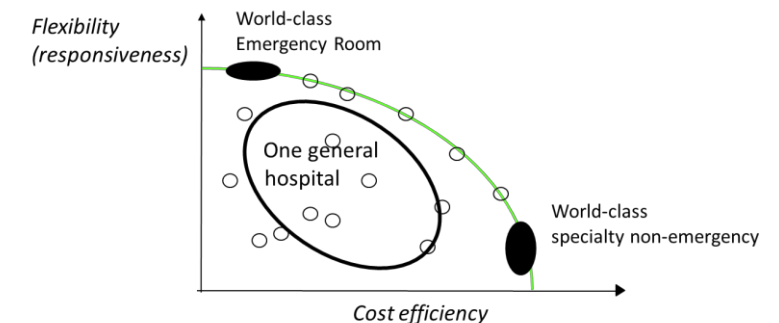
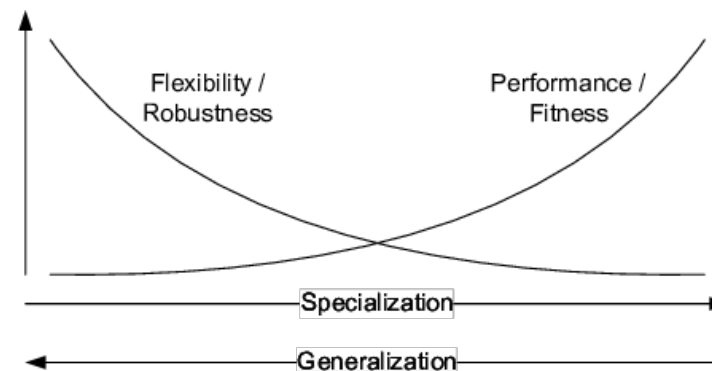
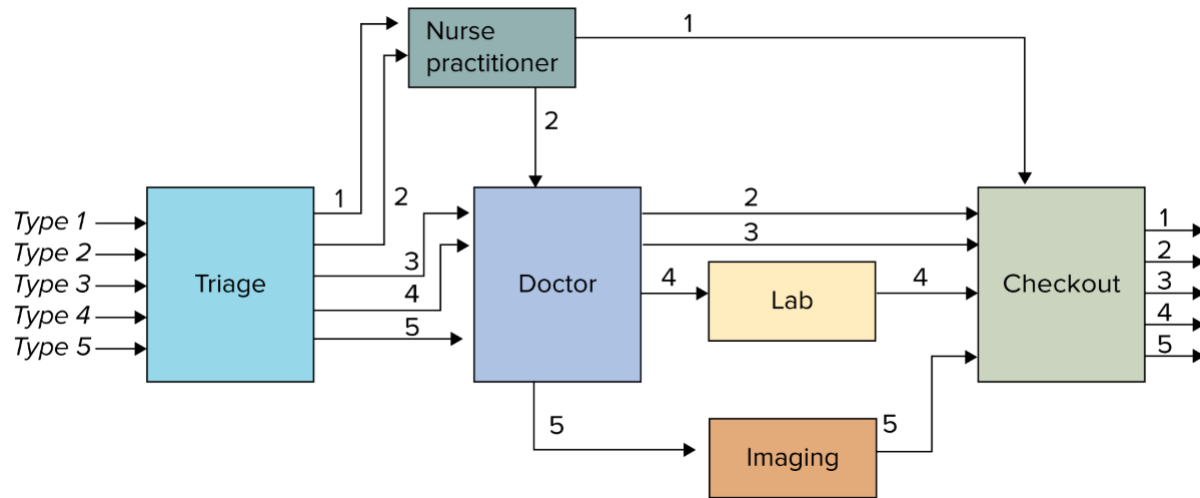


Figure 4.5 By moving an activity away from the bottleneck, we can increase capacity



Process Analysis and Improvement

Multiple Flows



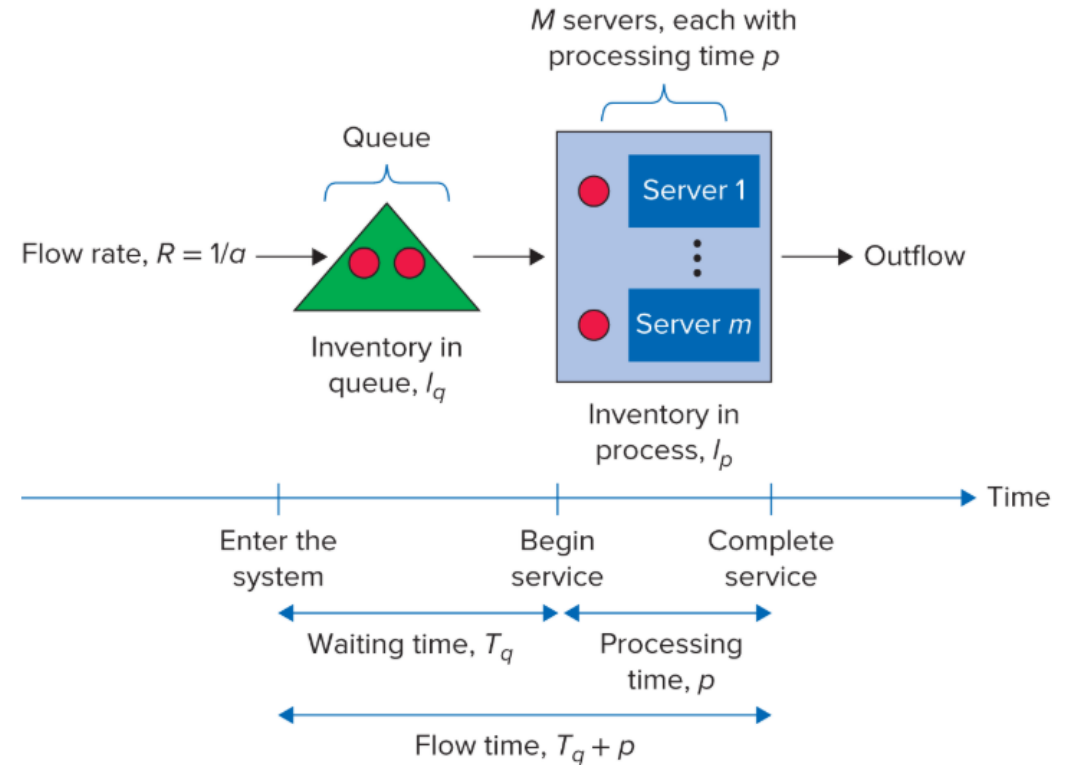
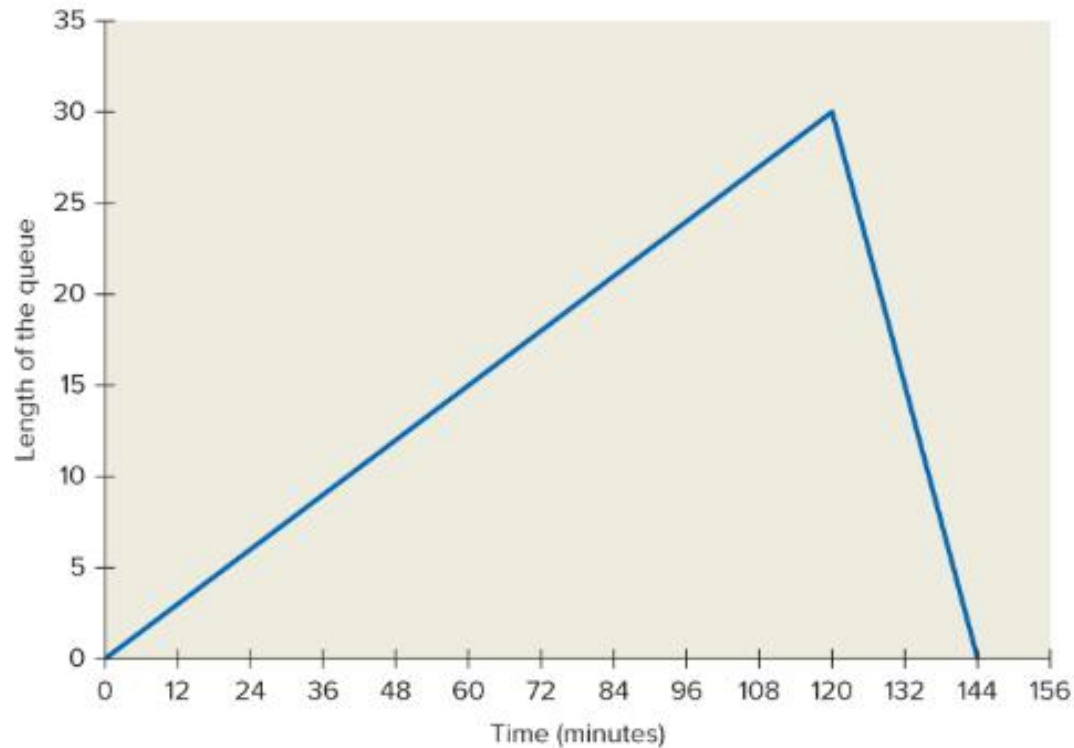
$$\text{Implied utilization} = \frac{\text{Demand rate in minutes of work}}{\text{Capacity in minutes of work}}$$

TABLE 5.5 Calculating the Implied Utilization Based on the Flow Unit “One Minute of Work”

Resources	<i>m</i>	Capacity (Min of work per hour)	Demand (Min of work per hour)					Total	Implied Utilization
			1	2	3	4	5		
Triage nurse	1	60	2×6	0.5×6	1.5×6	1.5×6	0.8×6	37.8	0.63
Nurse practitioner	2	120	2×20	0.5×30	0	0	0	55	0.458333
Doctor	1	60	0	0.5×5	1.5×15	1.5×20	0.8×20	71	1.183333
Lab	1	60	0	0	0	1.5×5	0	7.5	0.125
Images	1	60	0	0	0	0	0.8×20	16	0.266667
Checkout clerk	1	60	2×4	0.5×4	1.5×4	1.5×4	0.8×4	25.2	0.42

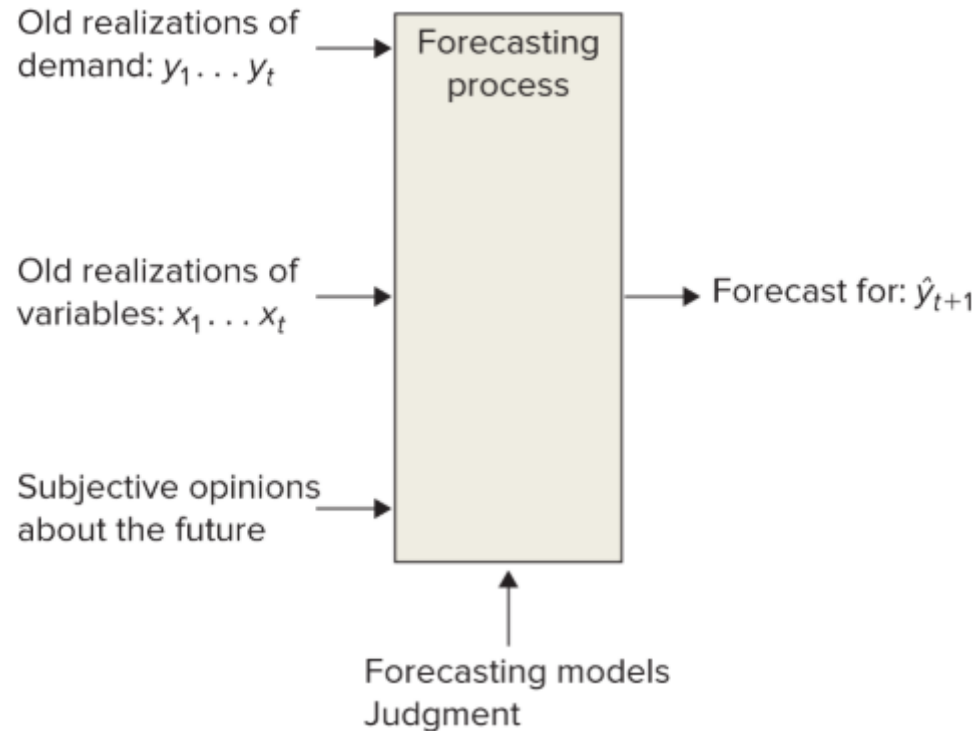
Process Analysis and Improvement

Introduction to Queuing



Forecasting

Forecasting



$$\text{MSE} = \frac{\sum_{t=1}^N \text{FE}_t^2}{N}$$

$$\text{MAE} = \frac{\sum_{t=1}^N |\text{FE}_t|}{N}$$

$$\text{MAPE} = \frac{\sum_{t=1}^N \left| \frac{\text{FE}_t}{y_t} \right|}{N}$$

Inventory Management

Introduction to Inventory

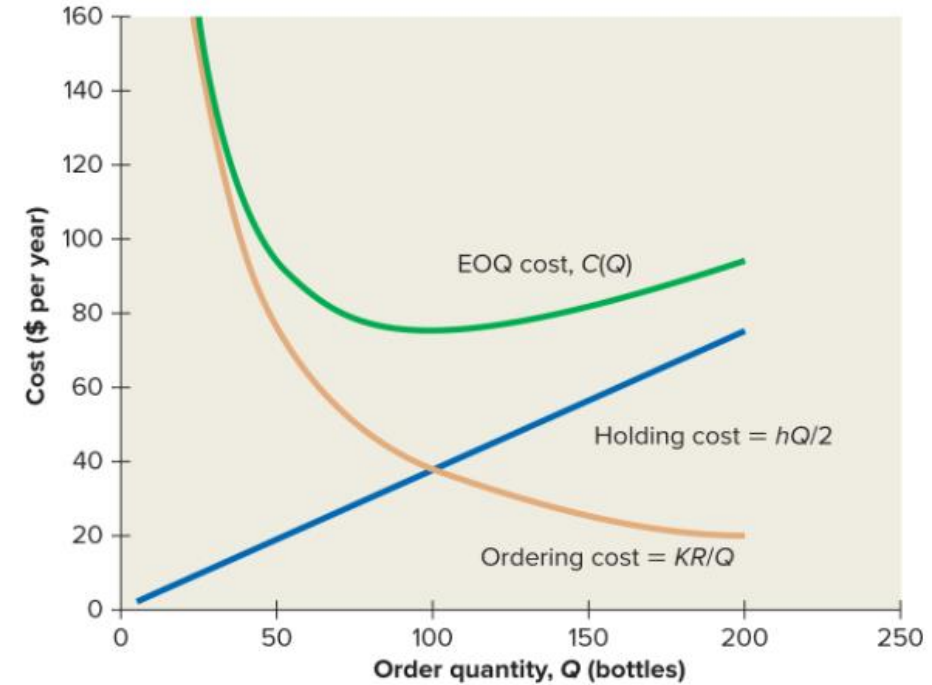
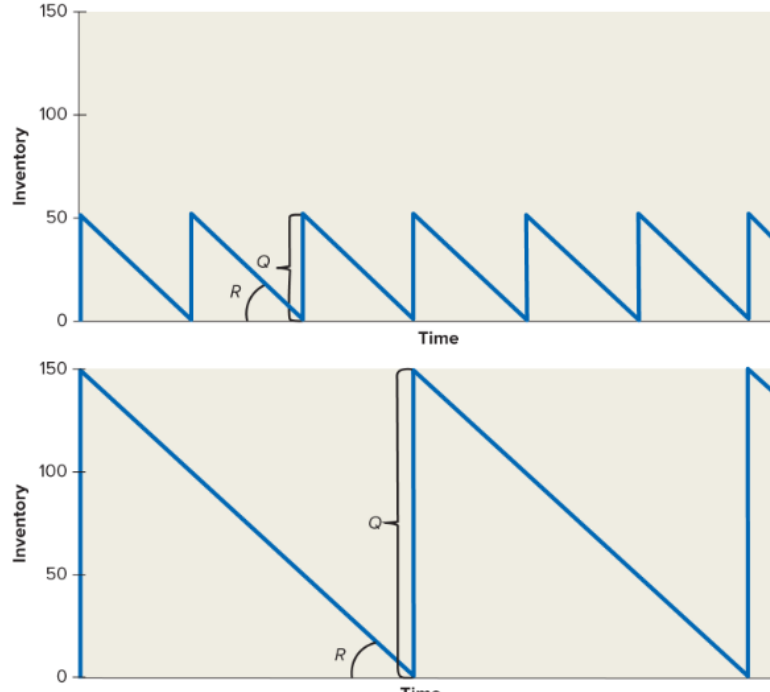


Days-of-supply = T = Flow time

$$\text{Turns} = \frac{R}{I}$$

Inventory Management

EOQ Model – constant demand with non-perishable inventory



$$\text{EOQ cost per unit of time} = C(Q) = \left(K \times \frac{R}{Q}\right) + \left(\frac{1}{2} \times h \times Q\right)$$

$$Q^* = \sqrt{\frac{2 \times K \times R}{h}}$$

Inventory Management

Newsvendor Model



PHOTO 13.1 O'Neill's Hammer 3/2 wet suit and logo for the surf market

Source: O'Neill

Generate forecast
of demand and
submit an order
to TEC

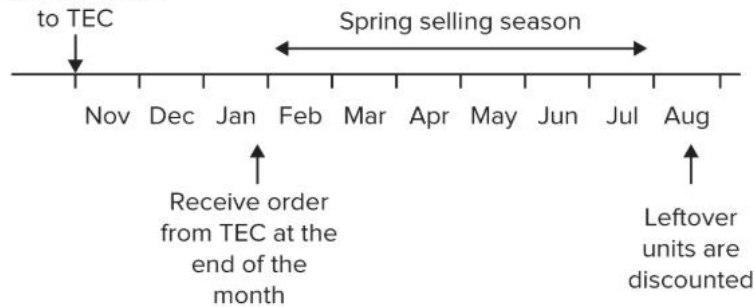
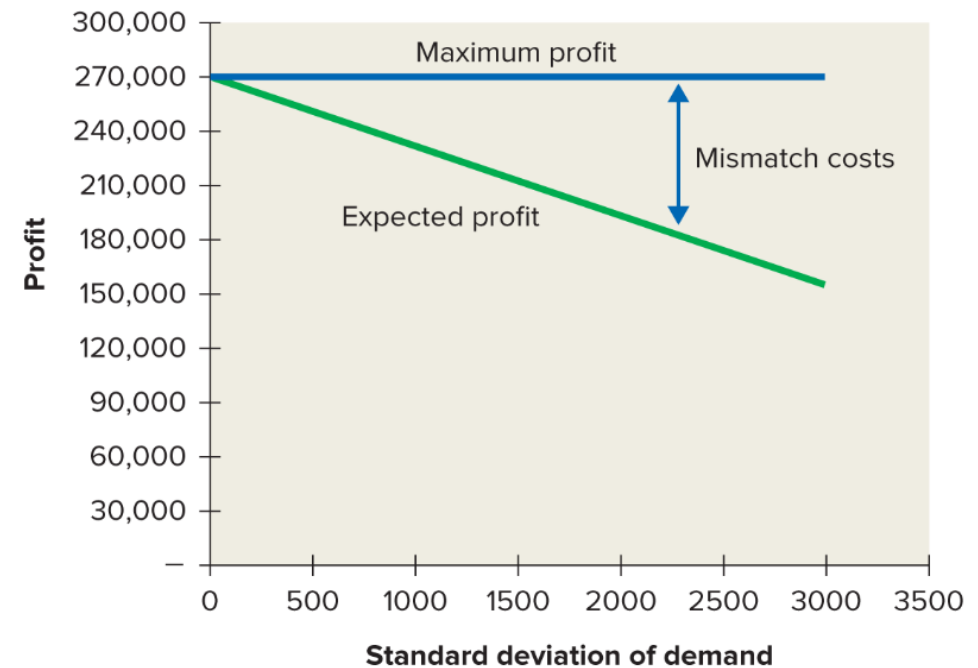


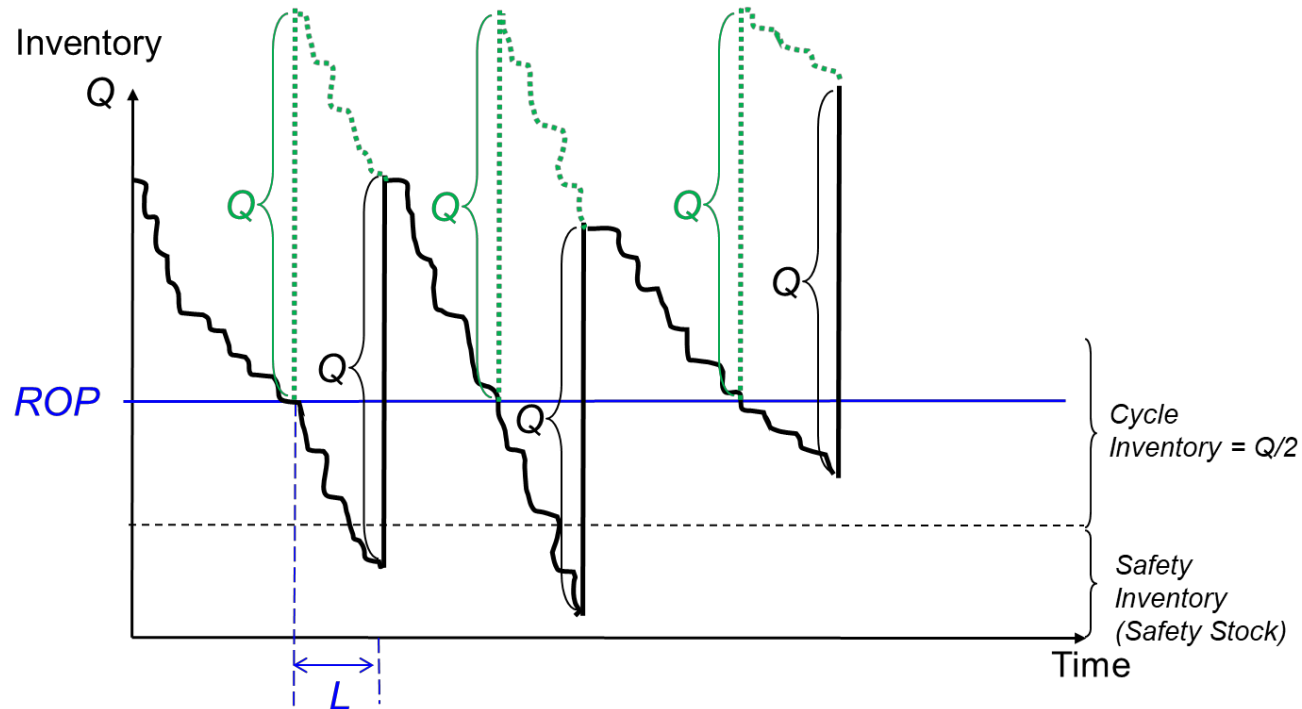
Figure 13.1 Timeline of events and economics for O'Neill's Hammer 3/2 wet suit

$$F(Q^*) = \frac{C_u}{C_o + C_u}$$



Inventory Management

ROP for Frequent Orders



Safety stock = $z^* \sigma^* \sqrt{L}$

$$ROP = D * L + z * \sigma * \sqrt{L}$$



Lean Operations and Quality

Lean Operations and Toyota Production System

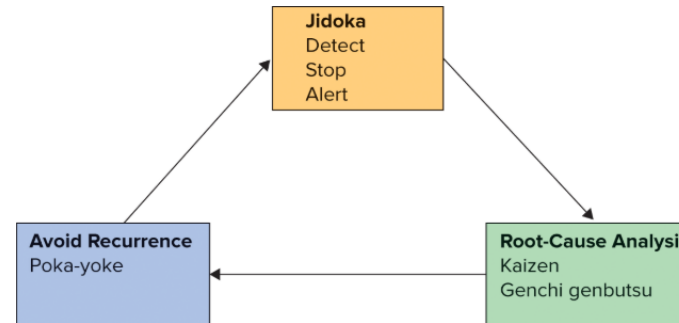
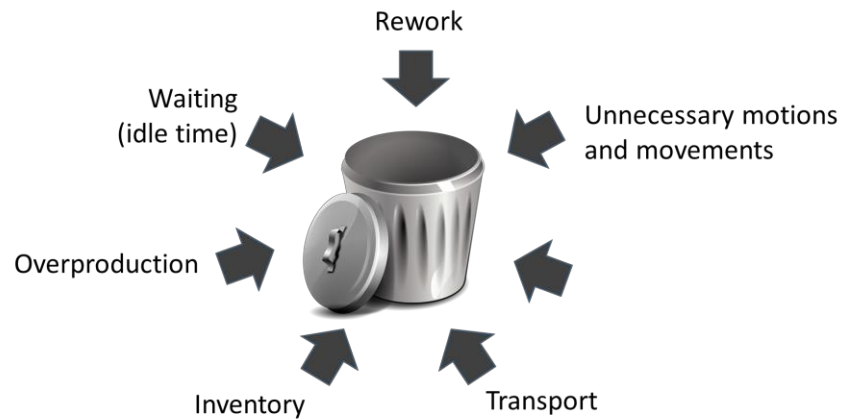


Figure 8.10 The TPS quality improvement framework

$$OEE = \frac{\text{Value-added time}}{\text{Total available time}}$$

$$\text{Value-added percentage} = \frac{\text{Value-added time of a flow unit}}{\text{Flow time}}$$

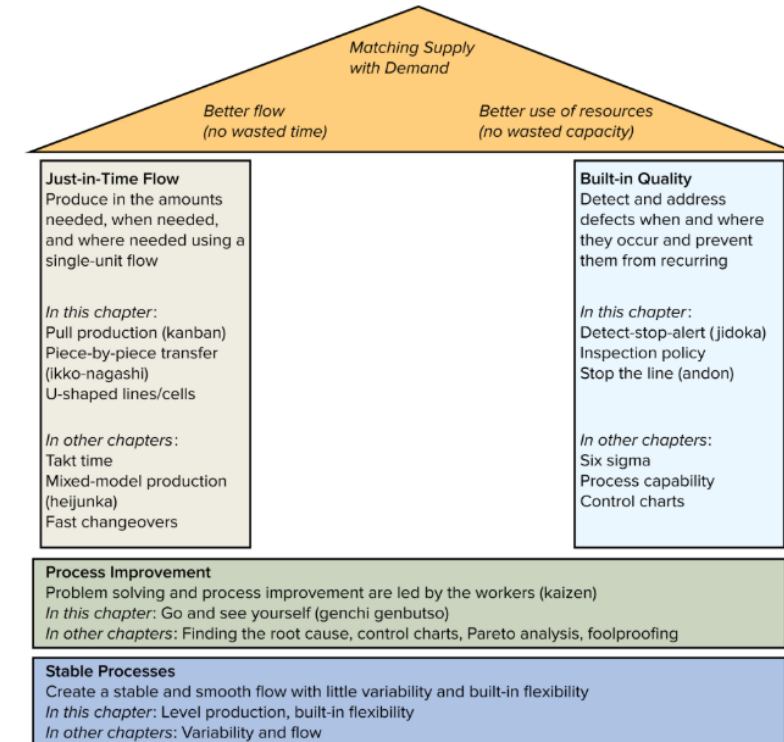
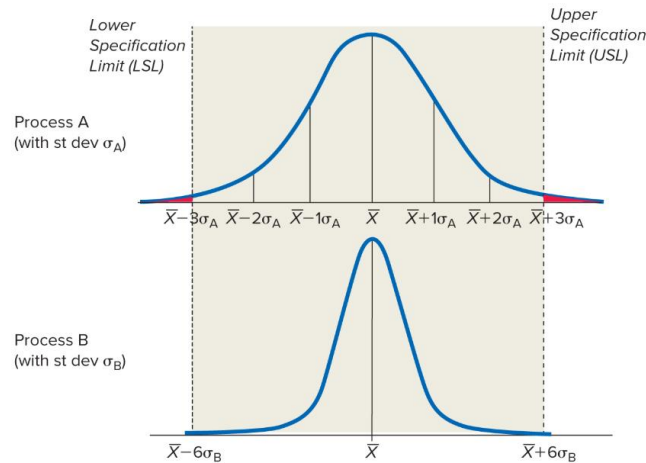


Figure 8.4 Overview of the Toyota Production System

Lean Operations and Quality

Statistical Process Control and Six-sigma



$$C_p = \frac{USL - LSL}{6\hat{\sigma}}$$

