Operations Management

MGT355

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Capacity management

What is capacity?

- C**apacity** is in the static, physical sense means the *scale* of an operation,
- But this may not reflect the operation's processing capability
- So we must incorporate a *time* dimension appropriate to the use of assets.
  - For example 24 000 litres per day.
  - 10,000 calls per day
  - 57 patients per session
  - Etc.

How is capacity measured?

- Either by availability of its input resources or by the output which is created.
- Which of these measures is used partly depends on how stable the mix of output is. It is difficult to aggregate the different types of output from an operation.
- Input measures are usually preferred.

Input and output capacity measures for different operations

Operation	*Input measure of capacity*	*Output measure of capacity*
Air-conditioner plant	Machine hours available	**Number of units per week**
Hospital	**Beds available**	Number of patients treated per week
Theatre	**Number of seats**	Number of customers entertained per week
University	**Number of students**	Students graduated per year
Retail store	**Sales floor area**	Number of items sold per day
Airline	**Number of seats available on the sector**	Number of passengers per week
Electricity company	Generator size	**Megawatts of electricity generated**
Brewery	Volume of fermentation tanks	**Litres per week**

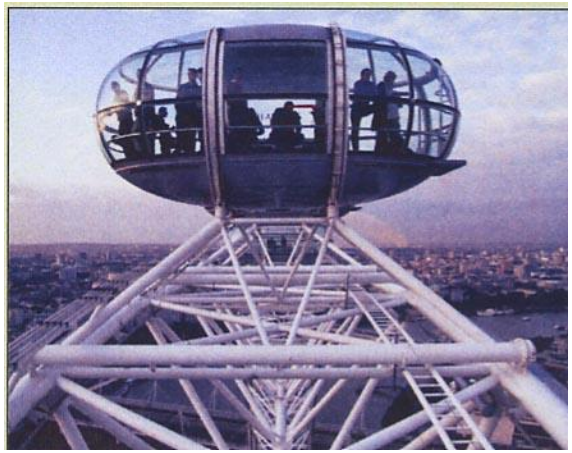
Note: The most commonly used measure is shown in bold.

The objectives of capacity planning and control

To provide an "appropriate" amount of capacity at any point in time.

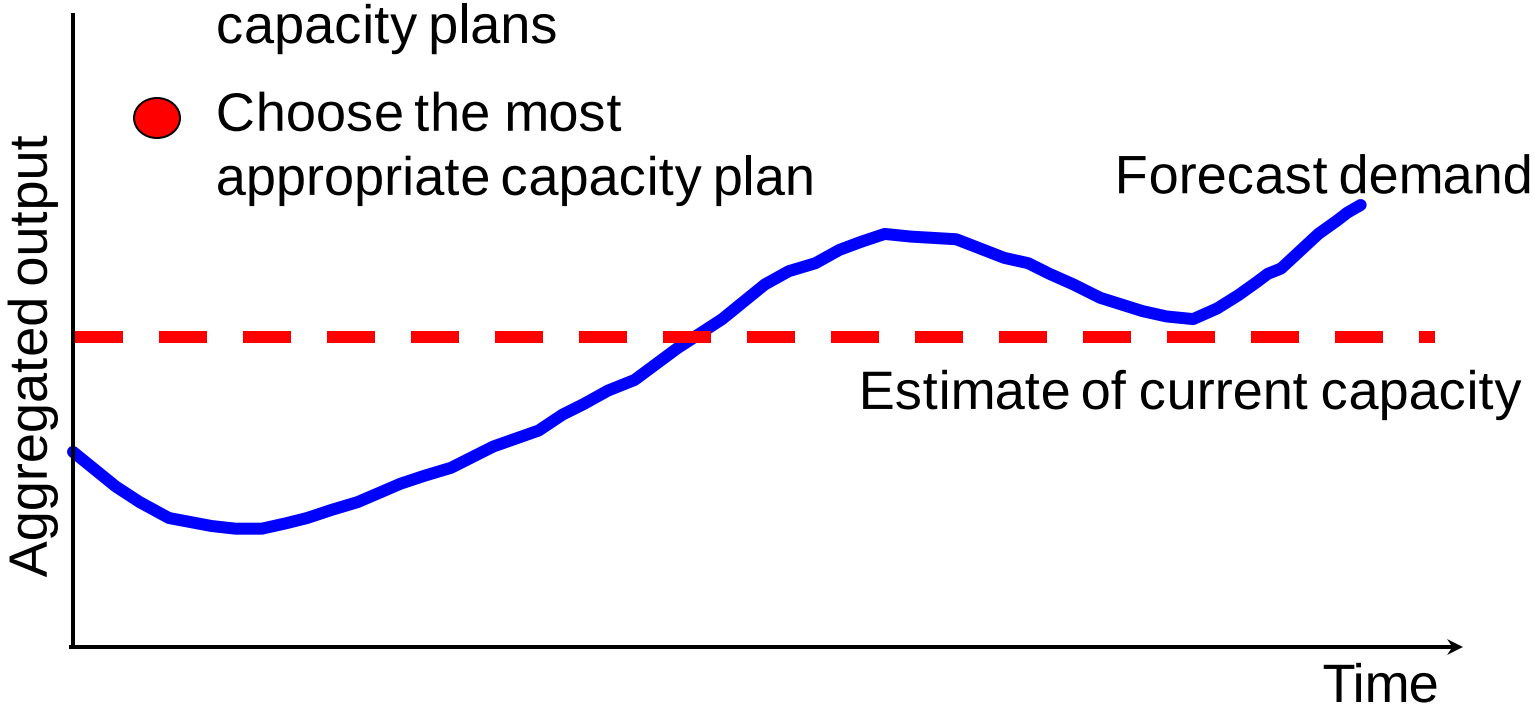
The "appropriateness" of capacity planning in any part of the operation can be judged by its effect on…...

- Costs
- Revenue
- Working Capital
- Service Level



Objectives of capacity planning and control

- Measure aggregate capacity and demand
- Identify the alternative capacity plans
- Choose the most appropriate capacity plan

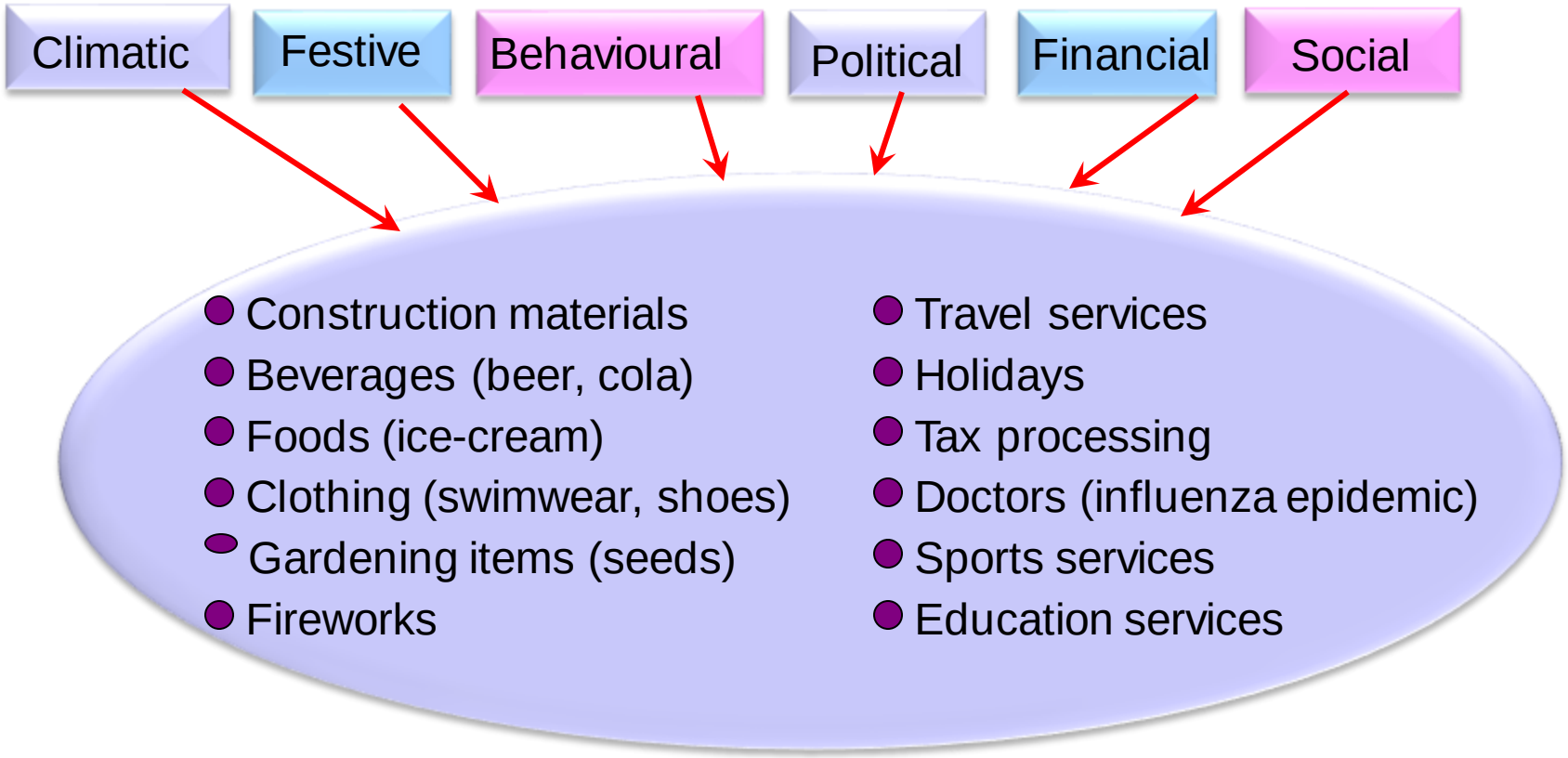


The nature of aggregate capacity

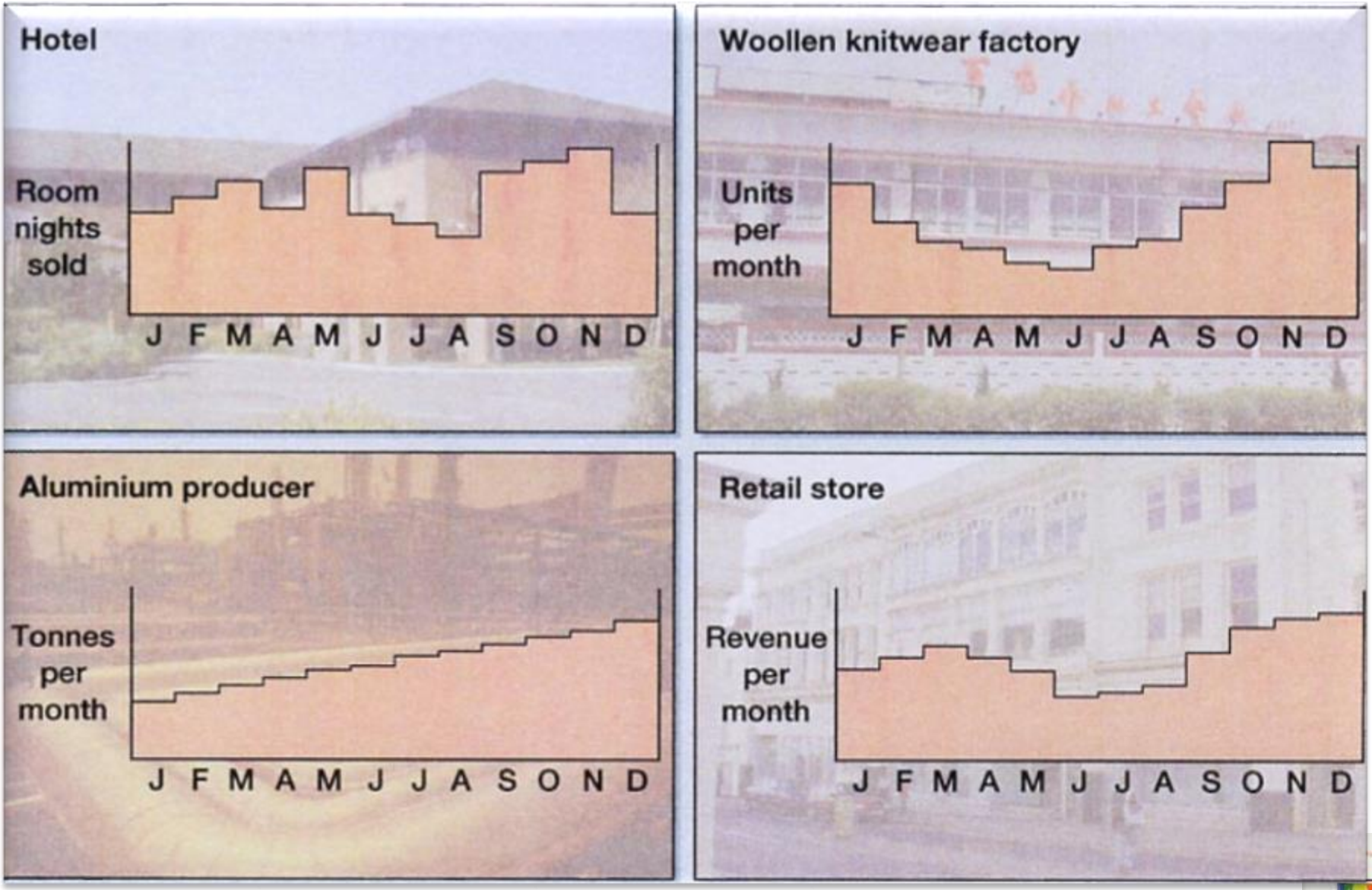
- Aggregate capacity of a hotel:
  - rooms per night;
  - ignores the numbers of guests in each room.

- Aggregate capacity of an aluminium producer:
  - tonnes per month;
  - ignores types of alloy, gauge and batch variations.

Causes of seasonality

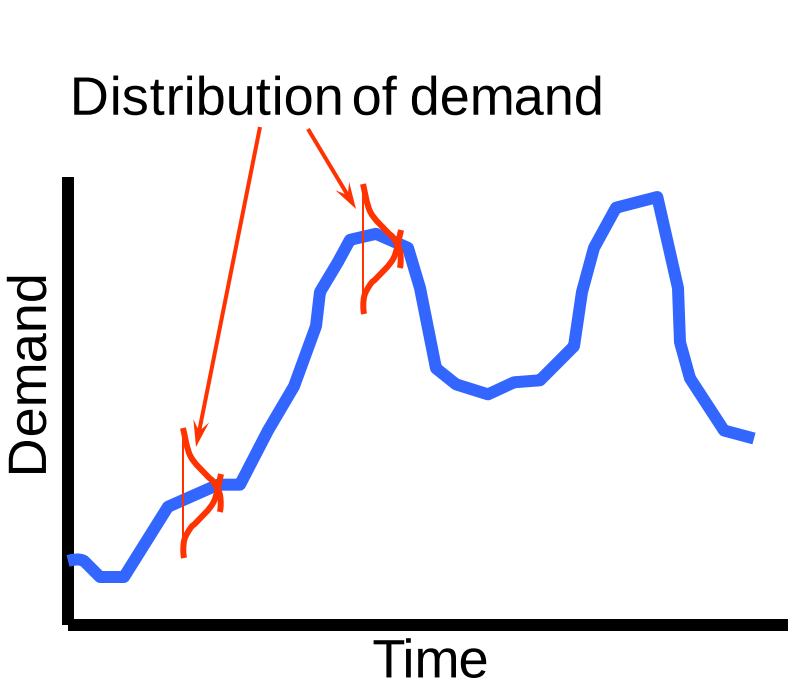


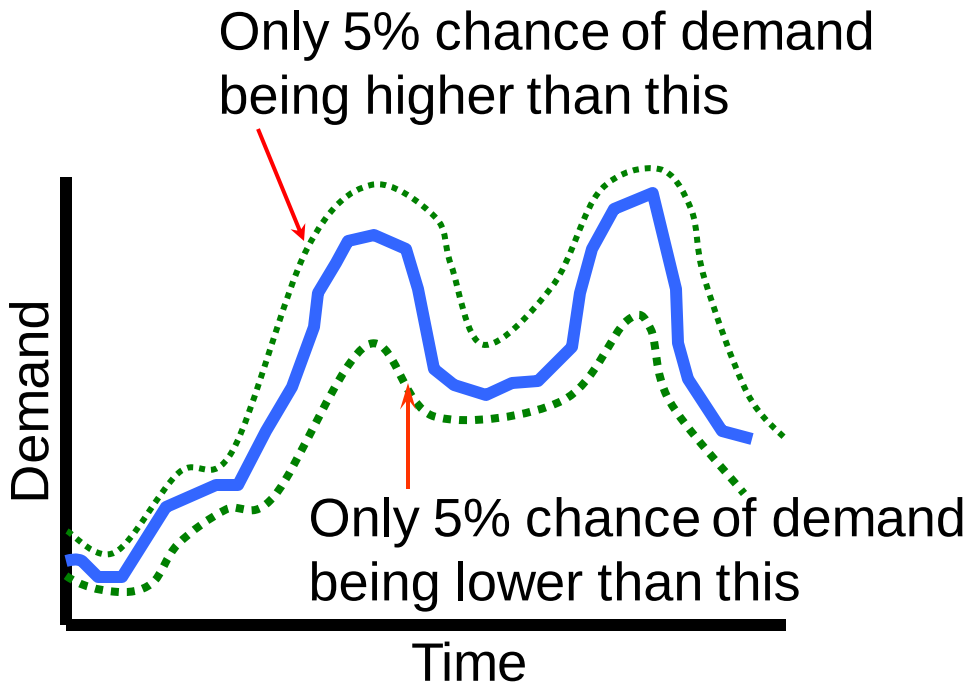
Demand fluctuations in four operations



Good forecasts essential for effective capacity planning

- But so is an understanding of demand uncertainty because it allows you to judge the risks to service level.





When demand uncertainty is high the risks to service level of under provision of capacity are high.

Forecasting Demand

- **Forecasting** is the act of **predicting likely future levels** of demand for products & services
- If future demand can be forecast, **decisions** can be made about what **levels of capacity** to provide
- Forecasting methods can be **quantitative or qualitative**
- The **forecasting data** will come from our information and knowledge collection which may be primary or secondary

(Barnes, 2008)

Forecasting methods

- **Quantitative** methods
  - **Time series** (analysis extrapolates past demand into the future)
  - **Causal analysis** (models any cause and effect relationship between demand data and some other variable)
- **Qualitative** methods
  - Market **surveys**
  - **Delphi** studies (expert opinions)
  - **Scenario** planning
- All methods are **inaccurate**

(Barnes, 2008)

Capacity *Timing*
How we make decisions

When to **invest in additional capacity**

Three generic strategies:

- **Capacity leads demand** – always have ***more capacity than demand***
- **Capacity matches demand** – as far as possible capacity always try to get ***capacity equal to demand***
- **Capacity lags demand** – most of the time allow ***demand to exceed capacity***

(Barnes, 20084)

Capacity *Timing*
Capacity Leads Demand

- **Advantages:**
  - **Copes with extra demand** without deteriorating service, lead times or quality
  - Operations can easily **meet the demands of a growing market**
  - Can **win market share** from those who lack capacity
  - Using **spare capacity reduces unit costs**, which can lead to lower prices
  - **May deter competitors** from adding capacity themselves
  - Can be used as **part of a market entry strategy** into a new country
- **Disadvantages:**
  - **Demand may not increase** as expected
  - **Process technology** may become **outdated**

(Barnes, 2008)

Capacity ***Timing***

Capacity Matches Demand

- Relies heavily upon **accurate forecasting** (which is notoriously difficult)
- Sometimes the **investment in capacity** has to lead the forecast by **long time frames** – many years in some cases

(Barnes, 2008)

Capacity *Timing*

Capacity Lags Demand

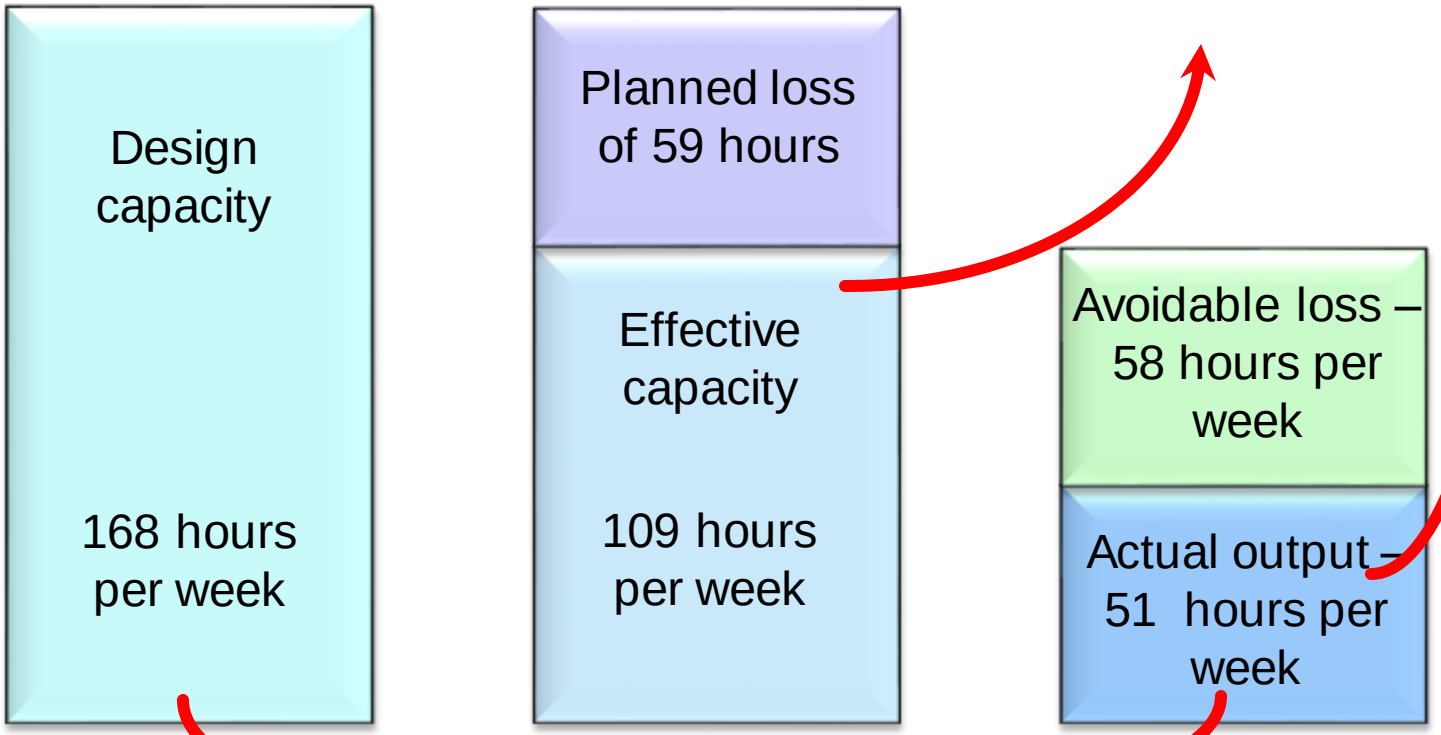
- Advantages:
  - **Delays** capital **investment**
  - Maximises the **return on investment**
  - **High utilization** means low unit costs
- Disadvantages:
  - **Vulnerable** to any **unexpected** upturn in demand
  - Difficult to respond to **price competition**
  - **High utilization** can lead to **poor performance**

(Barnes, 2008)

How capacity is measured

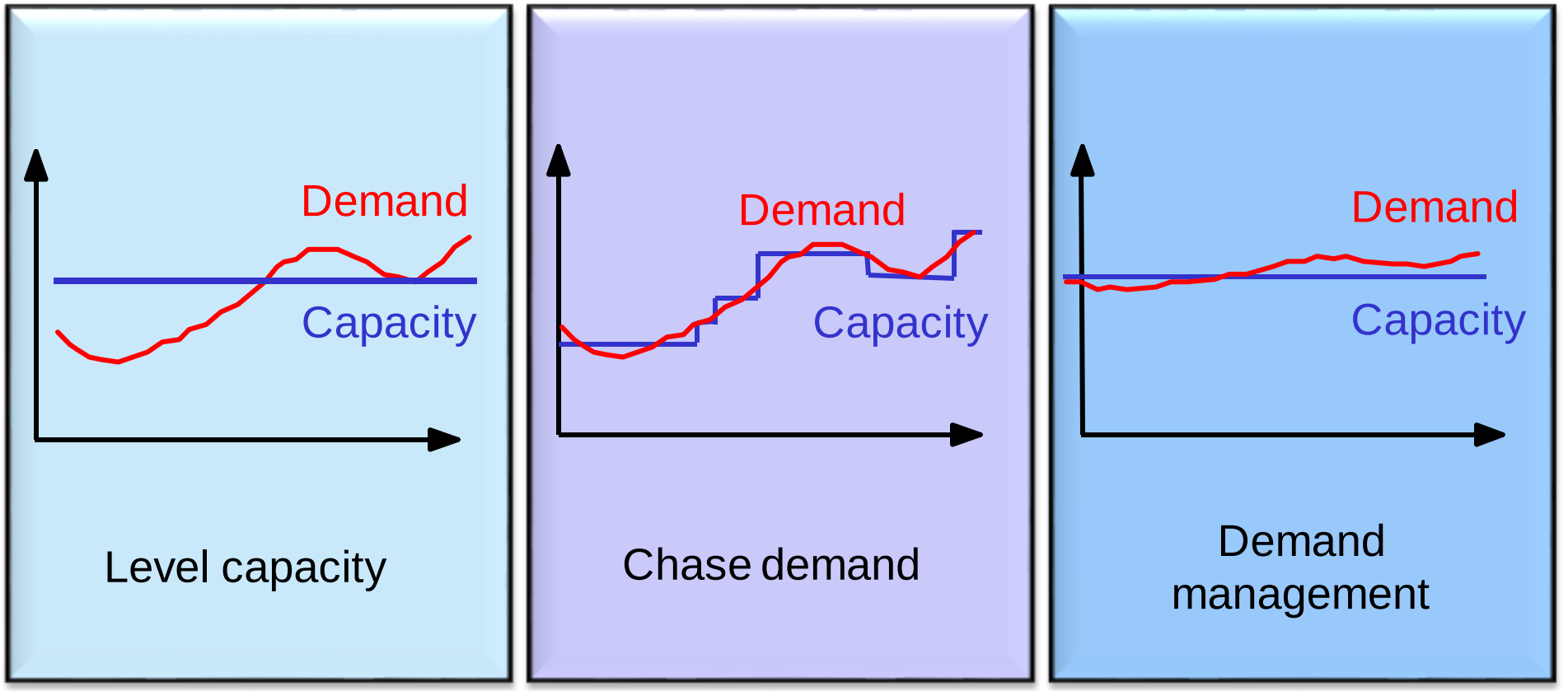
Design capacity = Effective capacity + Planned loss
Effective capacity = Actual output + Avoidable loss

$$\text{Efficiency} = \frac{\text{Actual output}}{\text{Effective capacity}}$$

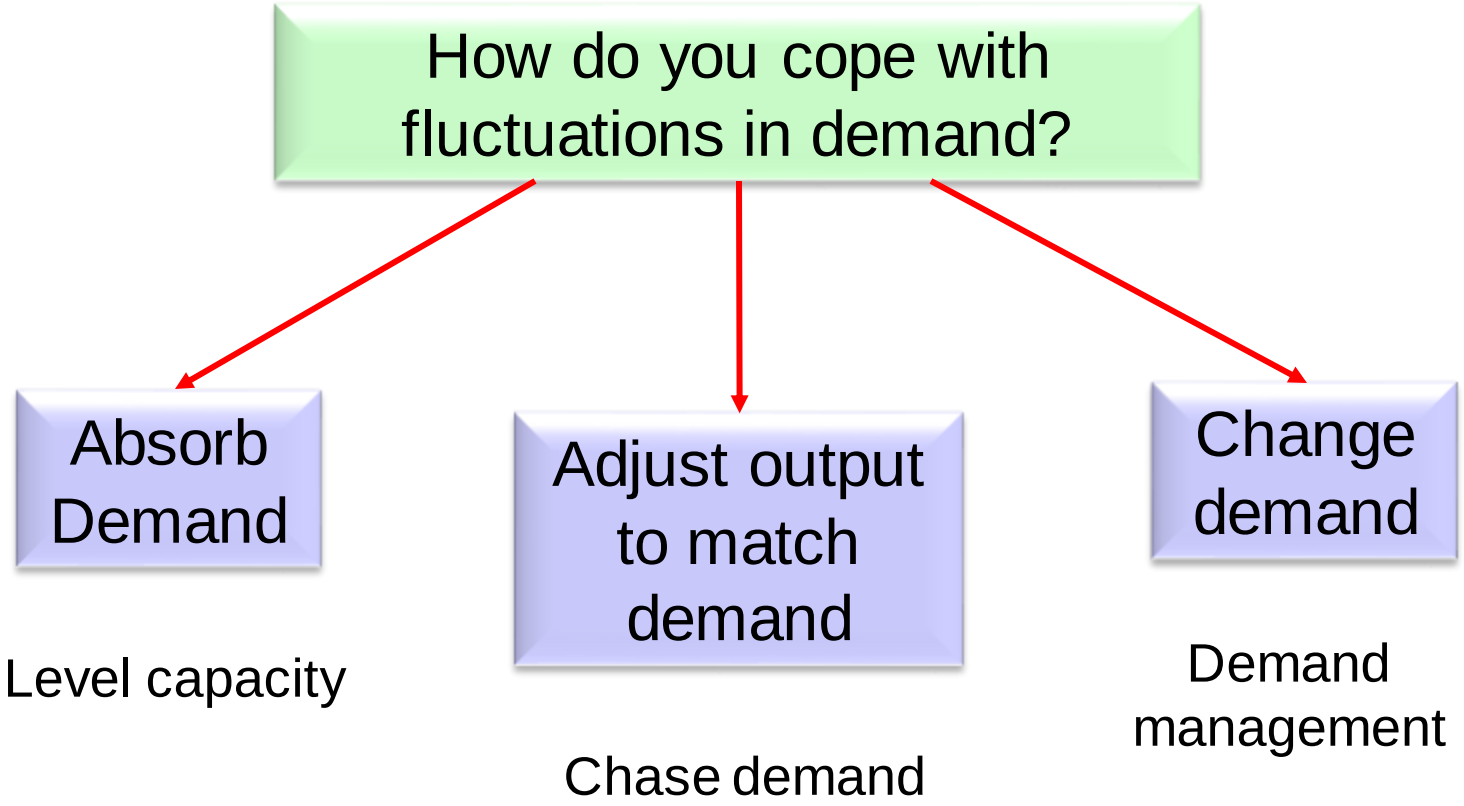


$$\text{Utilization} = \frac{\text{Actual output}}{\text{Design capacity}}$$

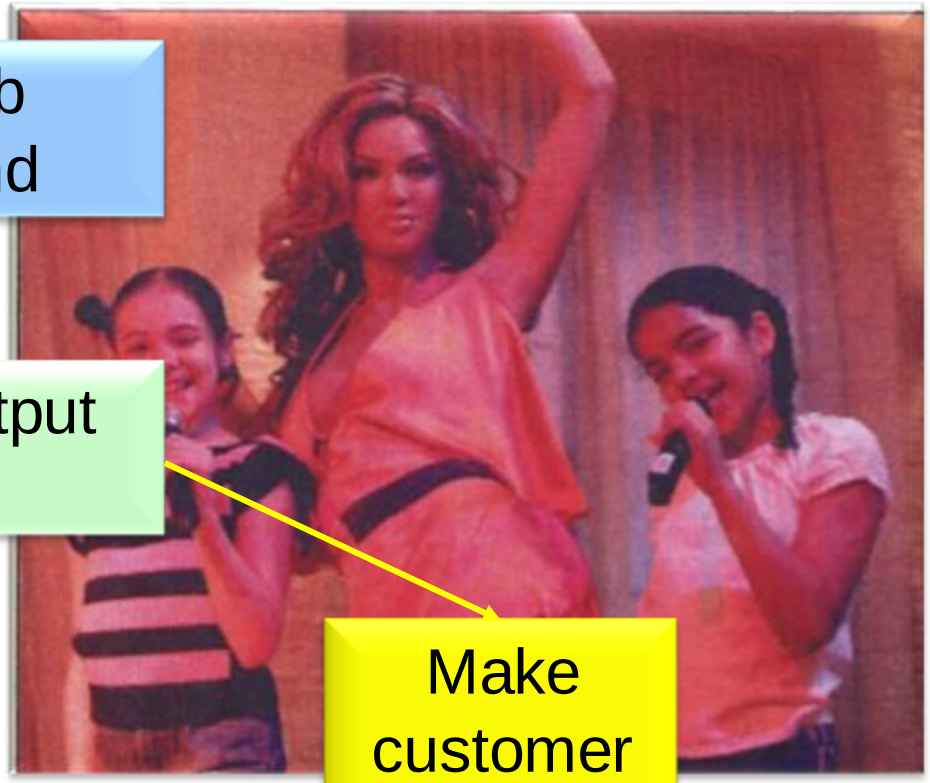
Ways of reconciling capacity and demand



Ways of reconciling capacity and demand



Absorb demand



Absorb demand

Have excess capacity

Keep output level

Make to stock

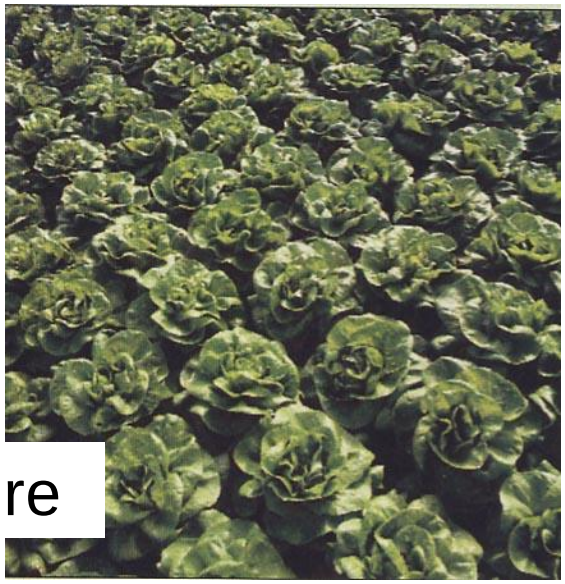
Make customer wait

- Part finished
- Finished goods, or
- Customer Inventory

- Queues
- Backlogs

Adjust output to match demand

Adjust output to match demand



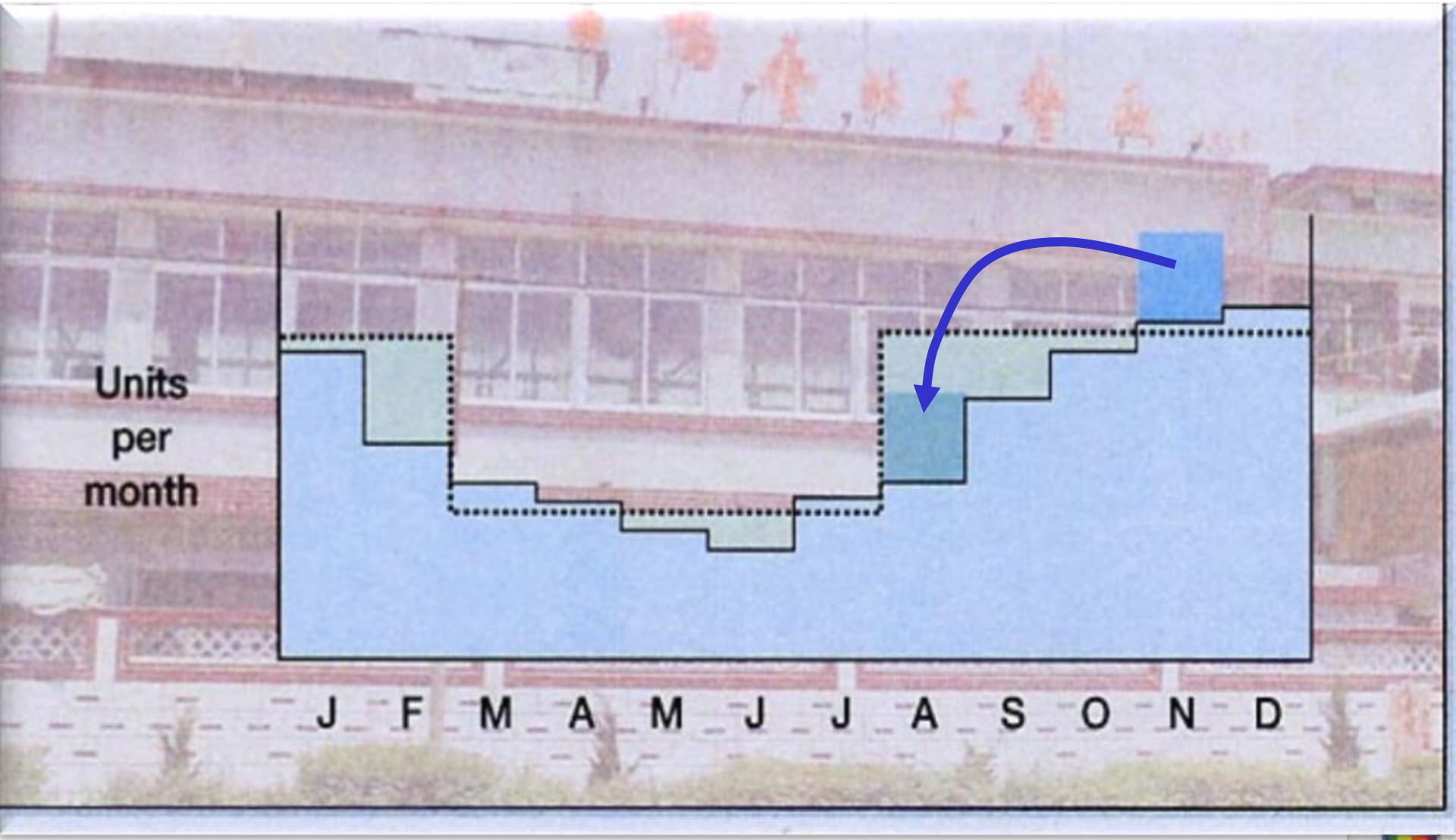
Hire	Fire
Temporary labour	Lay-off
Overtime	Short time
Subcontract	3rd party work

Change demand

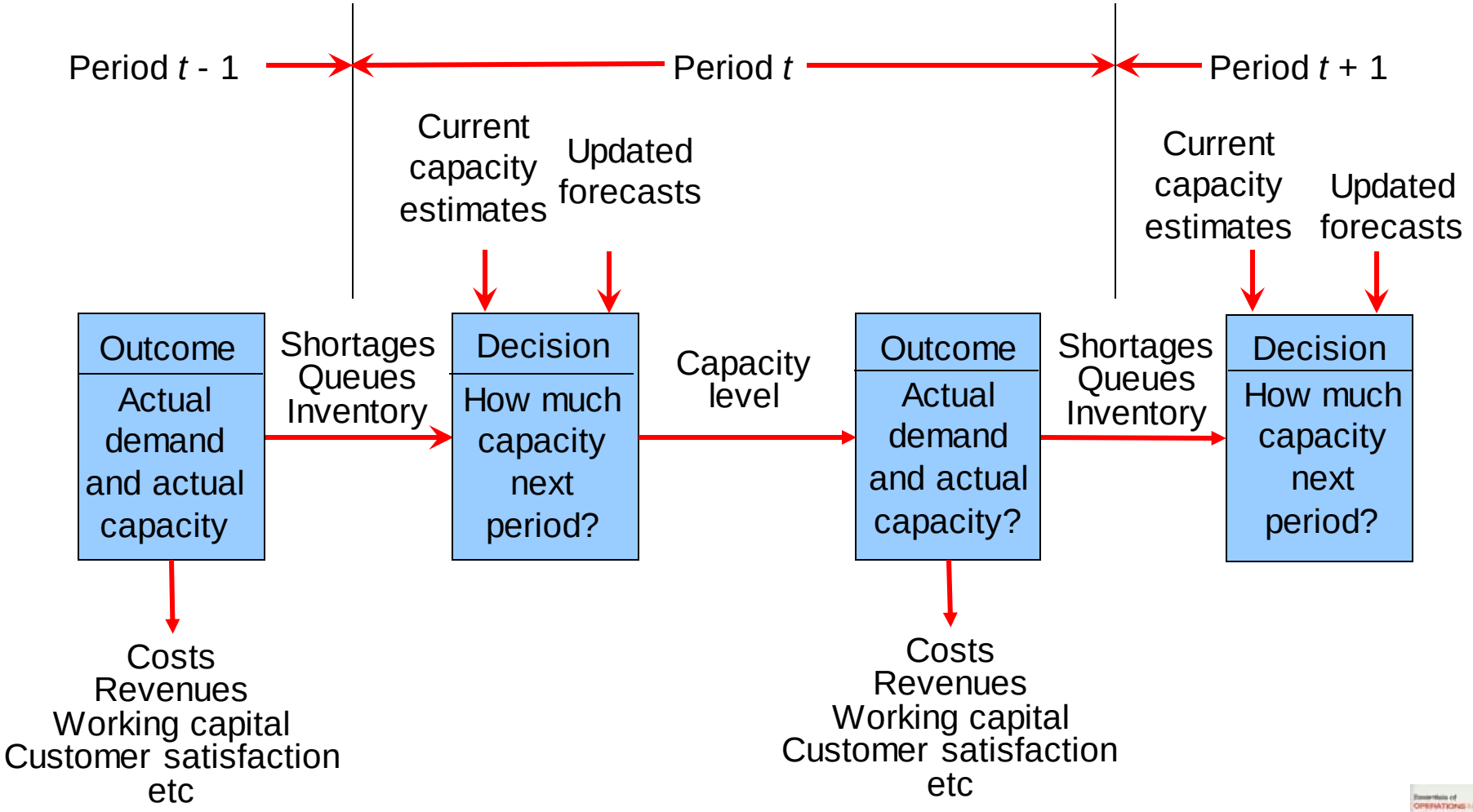
Change demand

- Change pattern of demand
- Develop alternative products and/or services

Moving a peak in demand can make capacity planning easier



Capacity planning and control as a dynamic sequence of decisions



Queuing – the range of behaviours