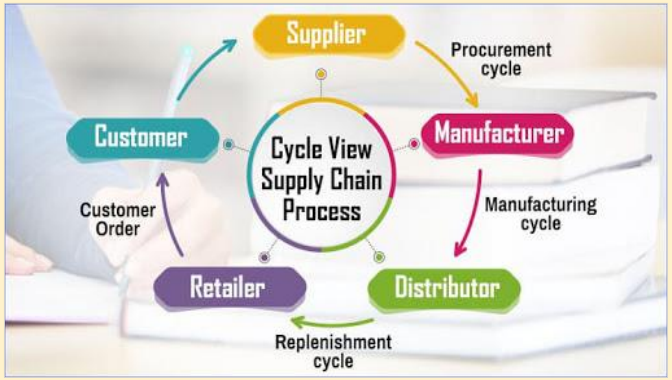
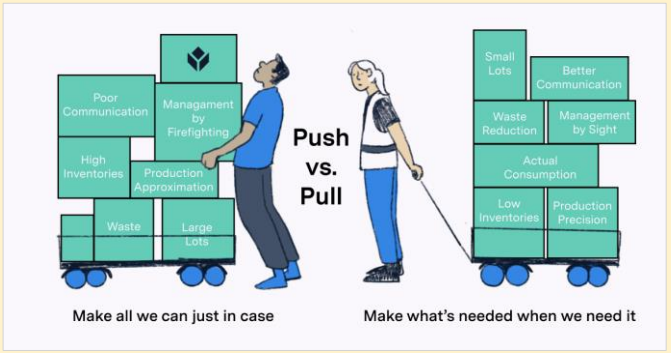
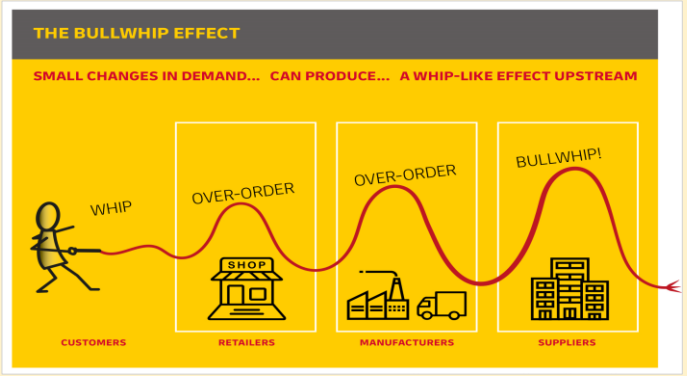
Lecture 4- Matching Demand and Supply



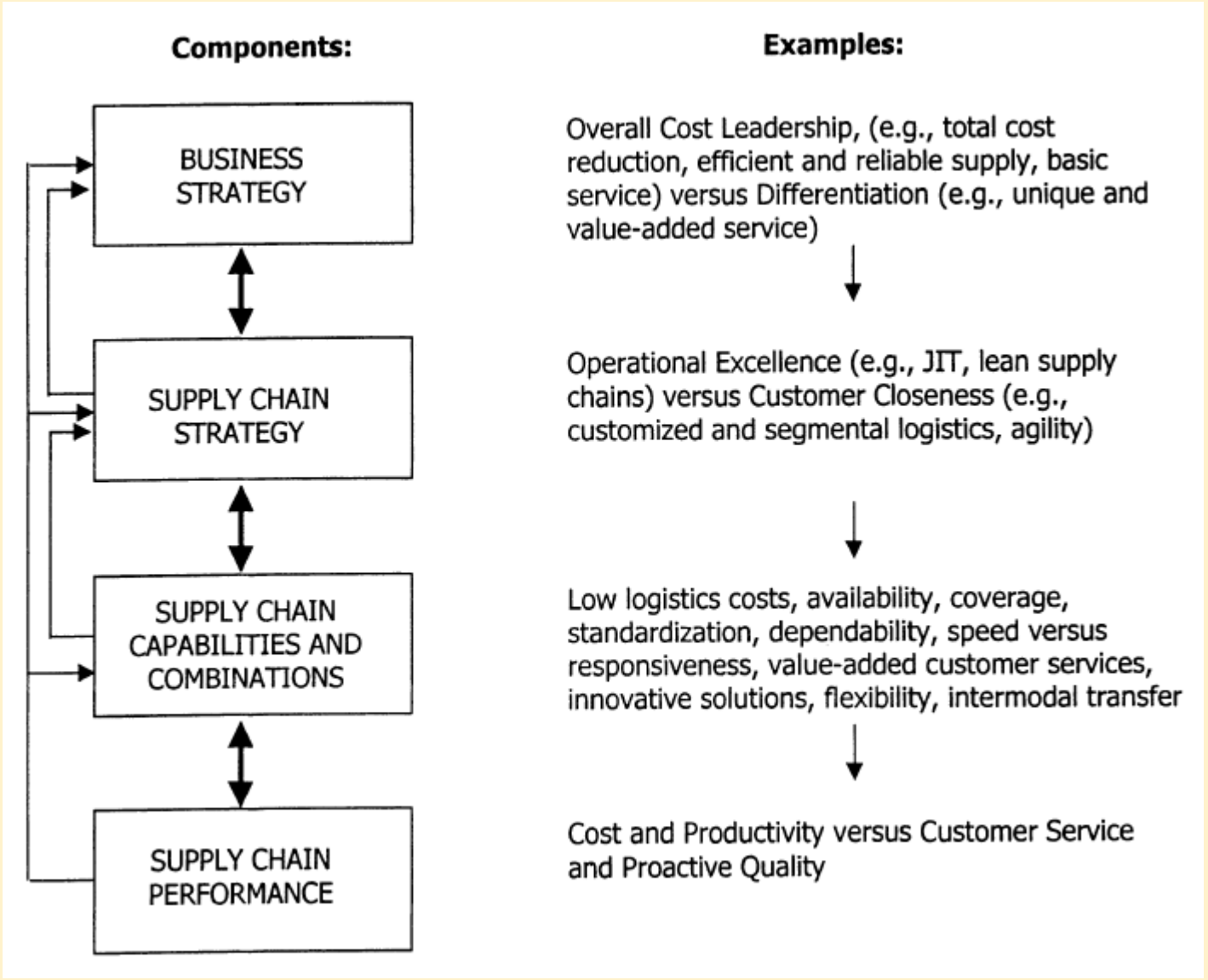




Dr Andre Samuel andre.samuel@sam.edu.tt http://samuellearning.org/scm.html

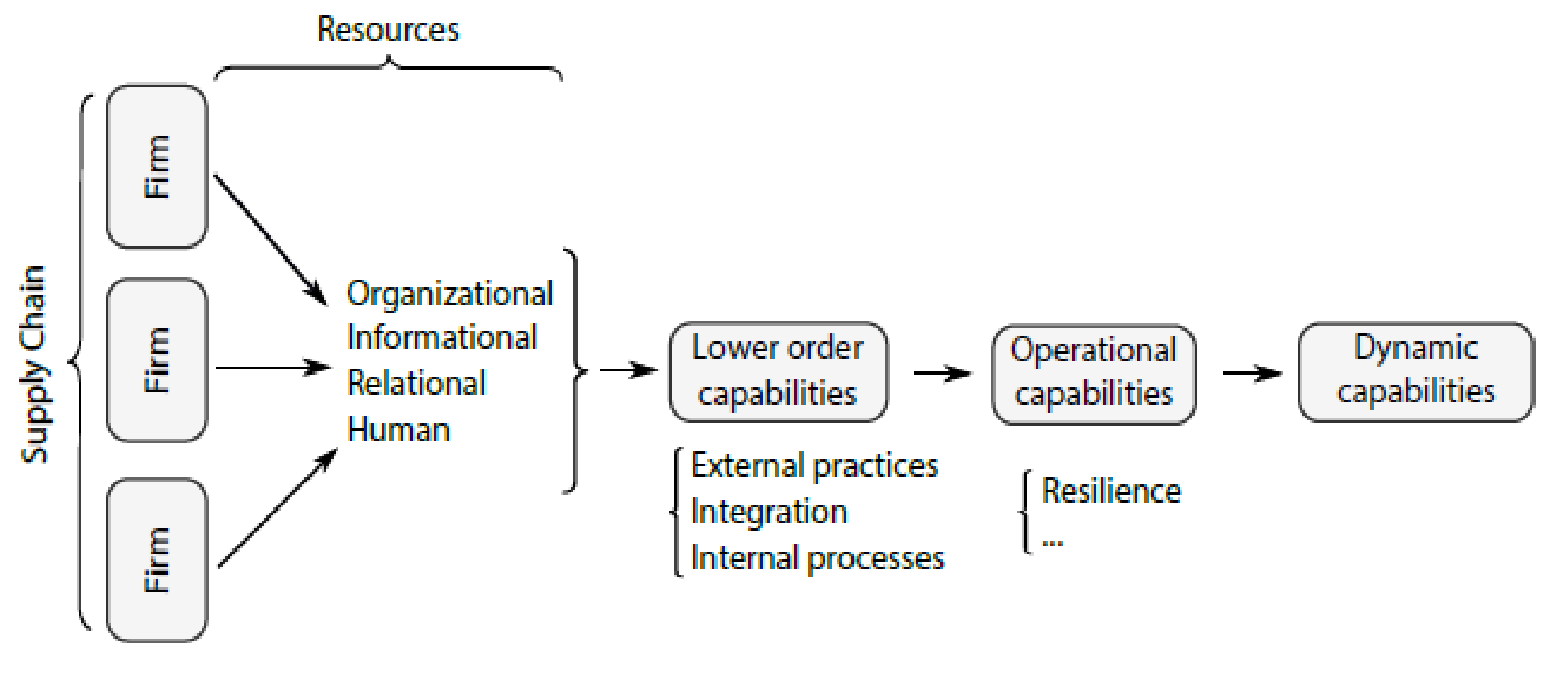
Recap

Model of Supply Chain Strategy, Capabilities and Performance



Source: Morash (2001, pg. 38)

Capabilities- Resource Based View



Source: Brusset, Xavier & Teller, Christoph 2016

Supply Chain SWOT Analysis- Generic

Strengths

This section will outline the supply chain processes that are working well.

What is the company good at?

Examples:

- Good QC
- Inventory turnover
- Low returns
- Happy employees
- Loyal customers
- High productivity
- Quick order turnaround
- Solid carrier partnerships
- Lean operations

Weaknesses

This section will outline the processes that aren't working well.

What areas need to be improved?

Examples:

- Too many returns
- Inventory churning
- High labour costs
- Poor space utilization
- Poor stock management
- High human error rate
- Workforce skill gap
- Poor use of technology

Opportunities

This section identified the opportunities for growth.

What should the company invest on?

Examples:

- Outsourcing fulfiment
- Partnering with new key suppliers
- Growth in demand for company's products
- Product line expansion
- DC Automation
- Supply Chain software

Threats

This section identified the external threats to the company's objectives.

What should the company watch for?

Examples:

- Raw material cost fluctuation
- New market players
- Supply chain disruption
- Stock depletion
- Market demand
- Gap between company culture and business processes

https://www.iwmsglobal.co.nz/blog/supply-chain-swot

VRIO/VRIN Analysis

- Value, Rarity, Imperfect Imitability, Organization (VRIO),
- and Non-substitutability (N in the VRIN)

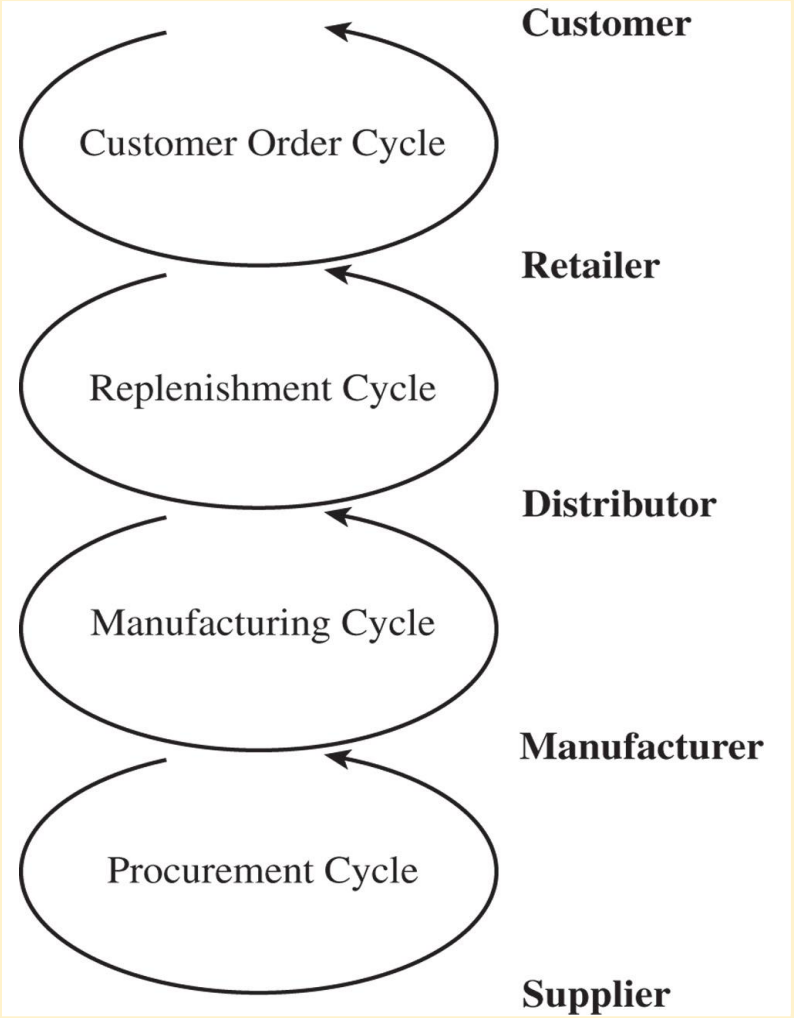
Amazon's Organizational Resources & Capabilities	V	R	I	O
– Growing brick-and-mortar presence	✓			
– Growing diversity of online services	✓			
– Growing portfolio of private label products	✓			
– Extensive delivery network involving domestic, regional, and international partnerships	✓	✓		
– Expertise based on a considerable history of e-commerce	✓	✓		
– Strategic warehouses and distribution hubs	✓	✓		
Sustained Competitive Advantage(s):				
– High global brand equity	✓	✓	✓	✓
– High market capitalization	✓	✓	✓	✓
– International network of affiliates that expand international market reach	✓	✓	✓	✓
– Artificial intelligence capabilities	✓	✓	✓	✓

Source: Johnson and Scholes (2011)

Cycle View of a Supply Chain

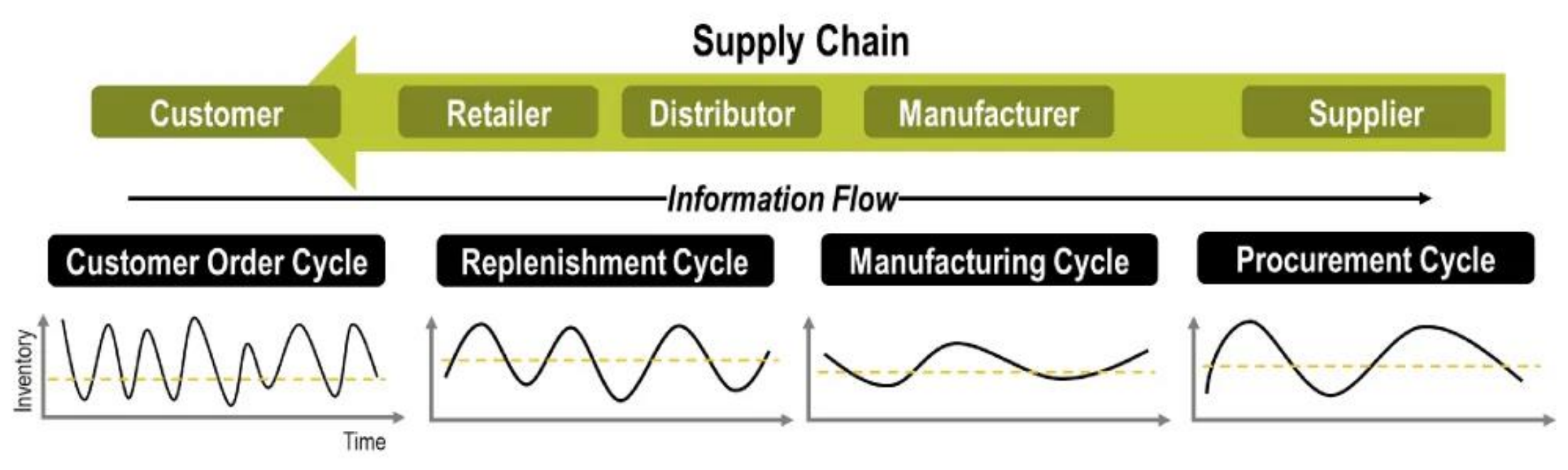
Cycle View of Supply Chain Processes

- The processes in a supply chain are divided into a series of cycles
- Each cycle occurs at the interface between two successive stages of a supply chain
- Not every supply chain will have all four cycles clearly separated
- For Example:
  - A Grocery supply chain is likely to have all four cycles separated.
  - Dell, in contrast, bypasses the retailer and distributor when it sells directly to customers.



Chopra and Meindl (2013, p. 8)

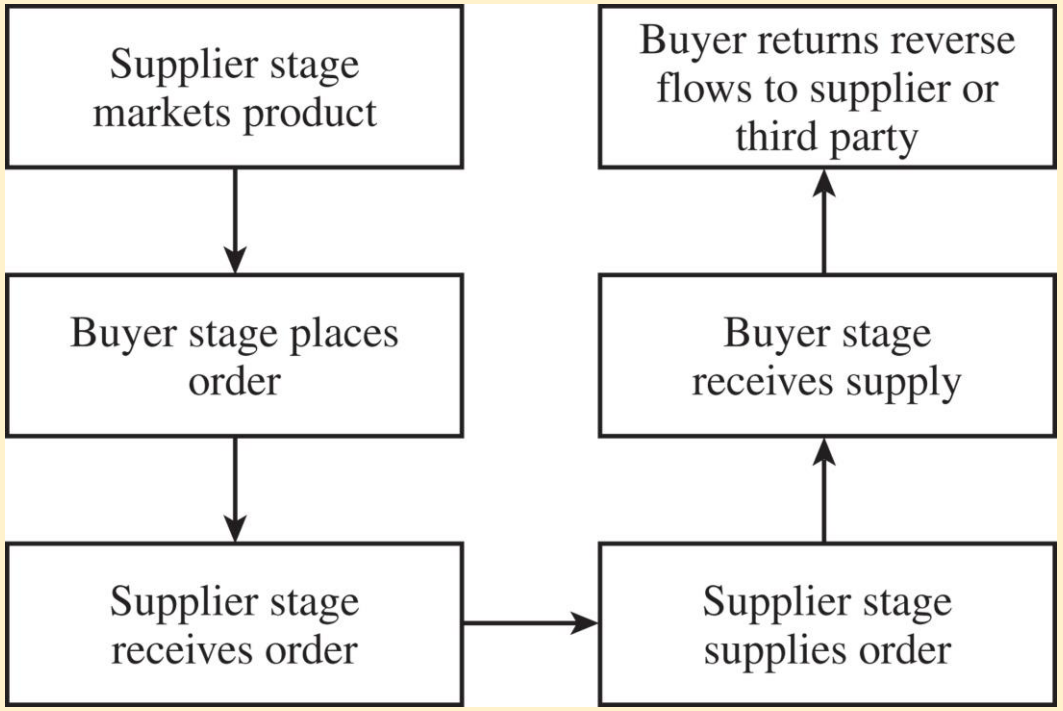
Supply Chain and its Cycles



Rodrigue (2020)

Each cycle consists of six subprocesses

- Each cycle starts with the supplier marketing the product to customers.
- A buyer then places an order that is received by the supplier.
- The supplier supplies the order, which is received by the buyer.
- The buyer may return some of the product or other recycled material to the supplier or a third party.
- The cycle of activities then begins all over again.



Chopra and Meindl (2013, p. 8)

Goal of Each Cycle

- Within each cycle, the goal of the buyer is **to ensure product availability** and to achieve economies of scale in ordering.
- The supplier attempts to **forecast customer orders** and **reduce the cost** of receiving the order.
- The supplier then works to **fill the order on time** and improve efficiency and accuracy of the order fulfillment process.
- The buyer then works **to reduce the cost of the receiving** process.
- Reverse flows are managed to reduce cost and meet environmental objectives.

Differences among the Cycles

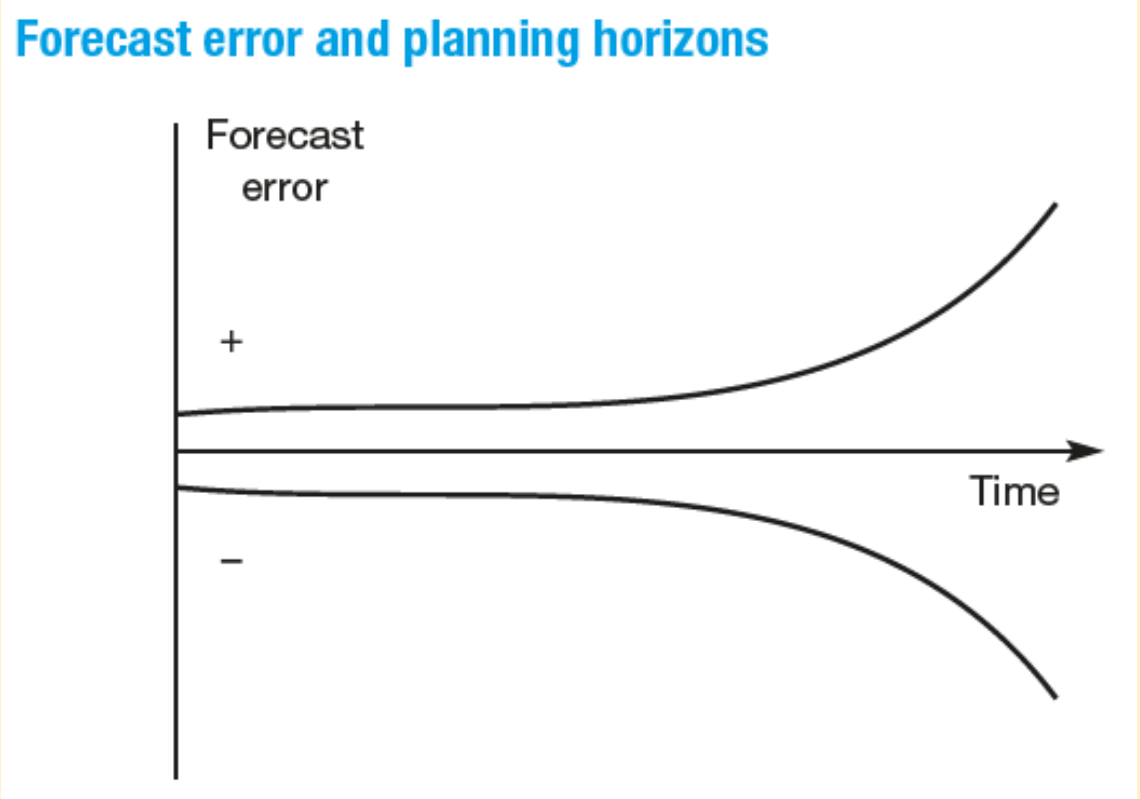
- In the customer order cycle:
  - **demand is external** to the supply chain and thus uncertain.

- In all other cycles:
  - **order placement is uncertain but can be projected** based on policies followed by the particular supply chain stage
  - For example, in the procurement cycle, a tire supplier to an automotive **manufacturer can predict tire demand precisely once the production schedule at the manufacturer is known**.

- The second difference across cycles relates to the **scale of an order.**
- Whereas a **customer buys a single car**, the dealer orders multiple cars at a time from the manufacturer, and the **manufacturer, in turn, orders an even larger quantity** of tires from the supplier.
- As we move **from the customer to the supplier**, the number of **individual orders declines and the size of each order increases.**
- Thus, **sharing of information and operating policies across supply chain stages becomes more important** as we move further from the end customer.
- Natural DEMAND AMPLIFICATION- volume

The Challenge- Forecast Error

- The goal is very simple – to try to match supply and demand.
- However, there is the **presence of uncertainty** in the practice of running a business on the basis of a forecast.
- The levels of **volatility and turbulence** that typify today's business environment add to the problem
- All forecasts as prone to error and the further ahead the forecast horizon is, the greater the error

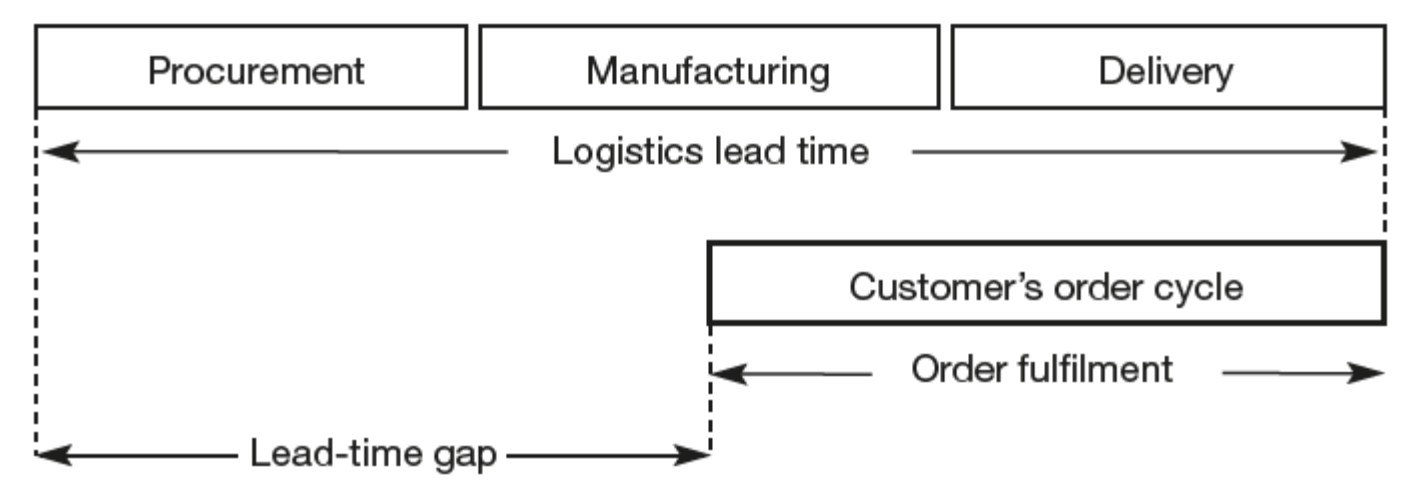


Source: Christopher (2016)

The lead-time Gap

The lead-time Gap Problem

- The time it takes to procure, make and deliver the finished product to a customer is longer than the time the customer is prepared to wait for it.



Source: Christopher (2016)

Customer’s Order Cycle

- The **customer’s order cycle** refers to the length of time that the customer is prepared to wait, from when the order is placed through to when the goods are received.
- This is the maximum period available for order fulfilment. In some cases
- This may be measured in months but in others it is measured in weeks, days or hours.

What is Order Fulfilment? | NetSuite

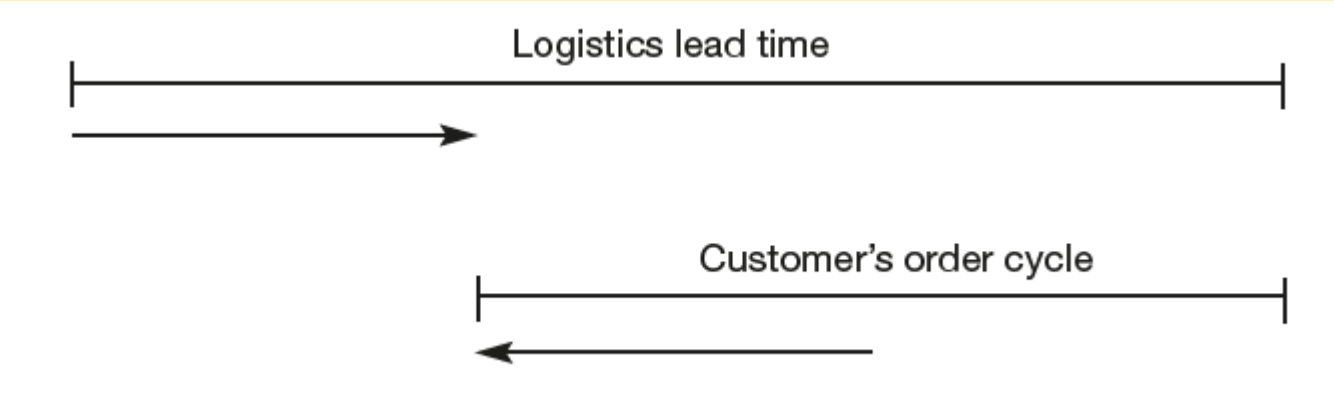
https://www.youtube.com/watch?v=Usn8qJuesrU

Reducing the Lead Time Gap- The Problem

- In the conventional organization the only way to bridge the gap between the logistics lead-time and the customer's order cycle is by **carrying inventory**.
- This normally implies a forecast.
- Hence the way most companies address this problem is by seeking to forecast the market's requirements and then to **build inventory ahead of demand**
- **BUT** forecast accuracy is always less than perfect
- Resulting in inventory problem –too much or too little!

Reducing the Lead Time Gap- The Solution

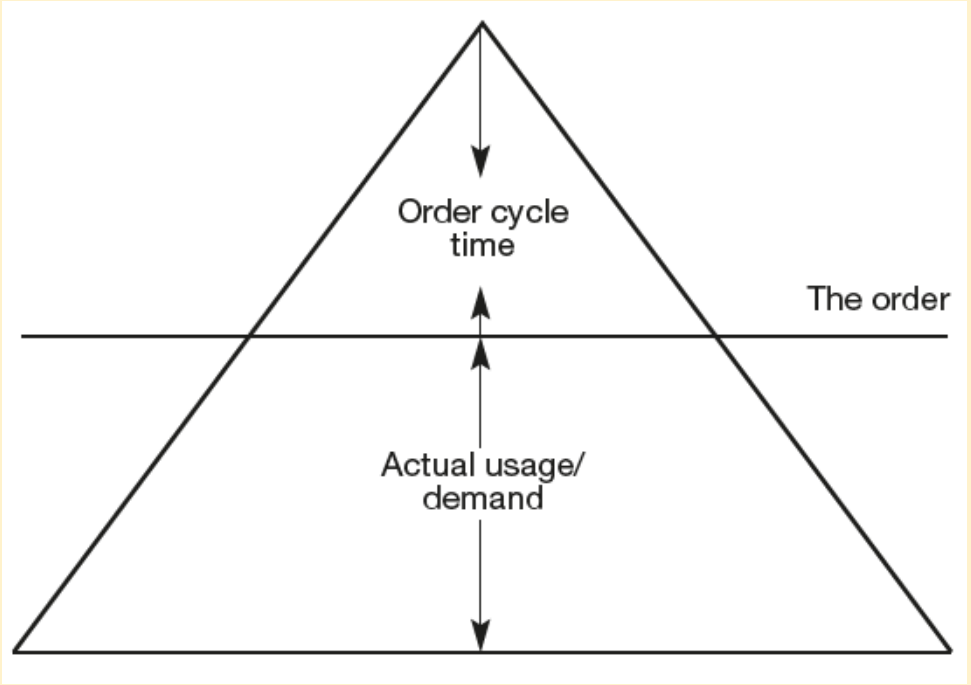
- Reducing the gap can be achieved by:
  - **shortening the logistics lead-time** (end-to-end pipeline time)
  - whilst simultaneously trying to move the customer's order cycle closer by gaining earlier warning of requirements through improved **visibility of demand**



Source: Christopher (2016)

The information iceberg

- In so many cases the supplying company receives **no indication of the customer's actual usage until an order arrives**
- For example the customer may be using ten items a day but because he orders only intermittently the supplier sometimes receives an order for 100, sometimes for 150 and sometimes for 200.
- **If the supplier could receive 'feed-forward'** on what was being consumed he could **anticipate the customer's requirement and better schedule** his own logistics activities



Source: Christopher (2016)

Improving Visibility of Demand

- In many cases, companies have an inadequate ‘visibility’ of real demand
- The challenge is to **find a way to receive earlier warning** of the customers’ requirements:

1. Since the **demand penetration point** is too far down the pipeline and
2. **Real demand is hidden** from view and all we tend to see are orders

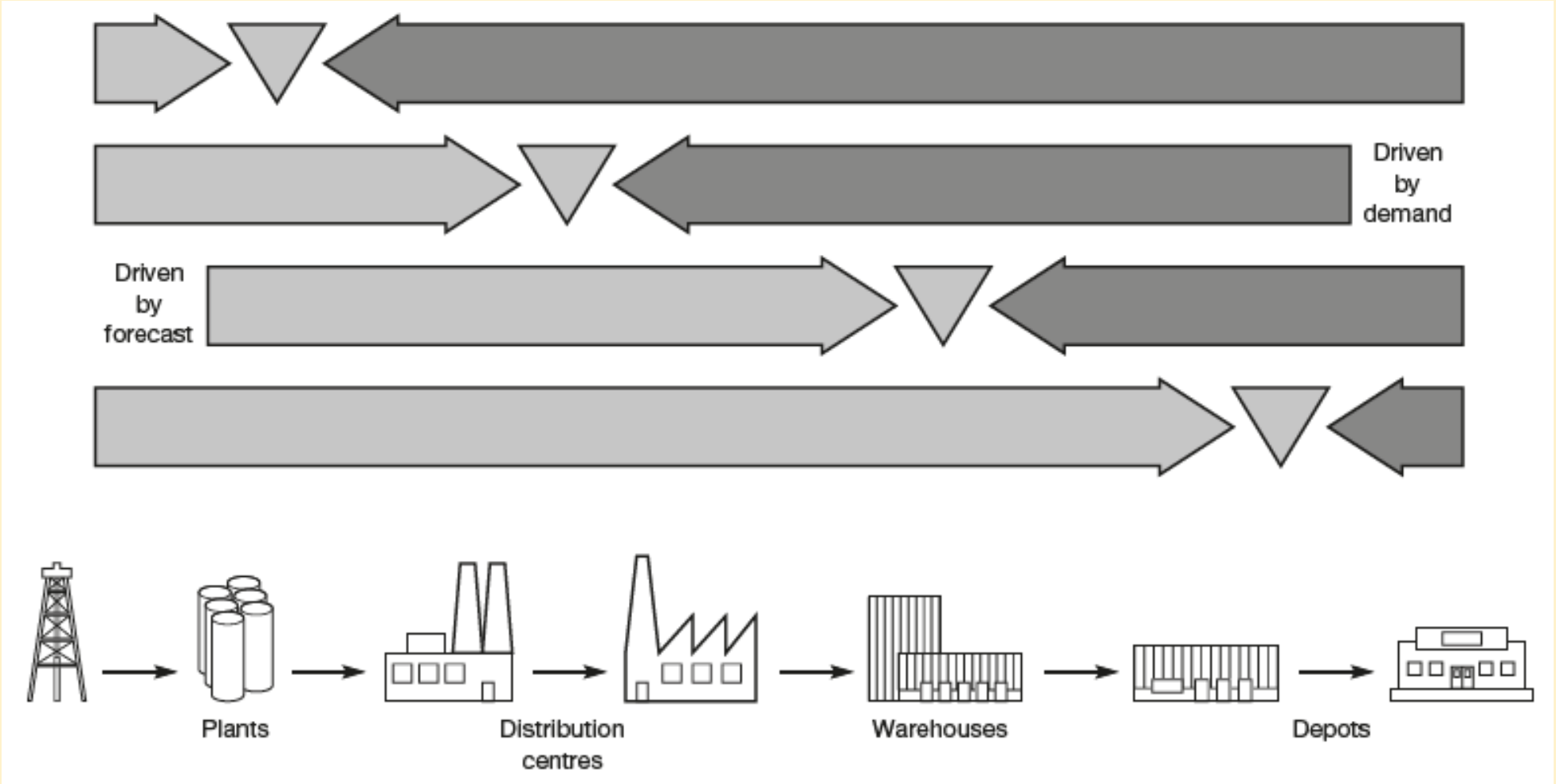
Demand penetration point and Strategic Inventory

- Also known as Order Penetration Point (OPP), Decoupling Point
- The **demand penetration point occurs at that point in the chain where real demand meets the forecast/plan**
  - Upstream from this point everything is driven by a forecast and/or a plan.
  - Downstream of that point we can respond to actual customer demand

Aka Customer Order De-Coupling Point (CODP)

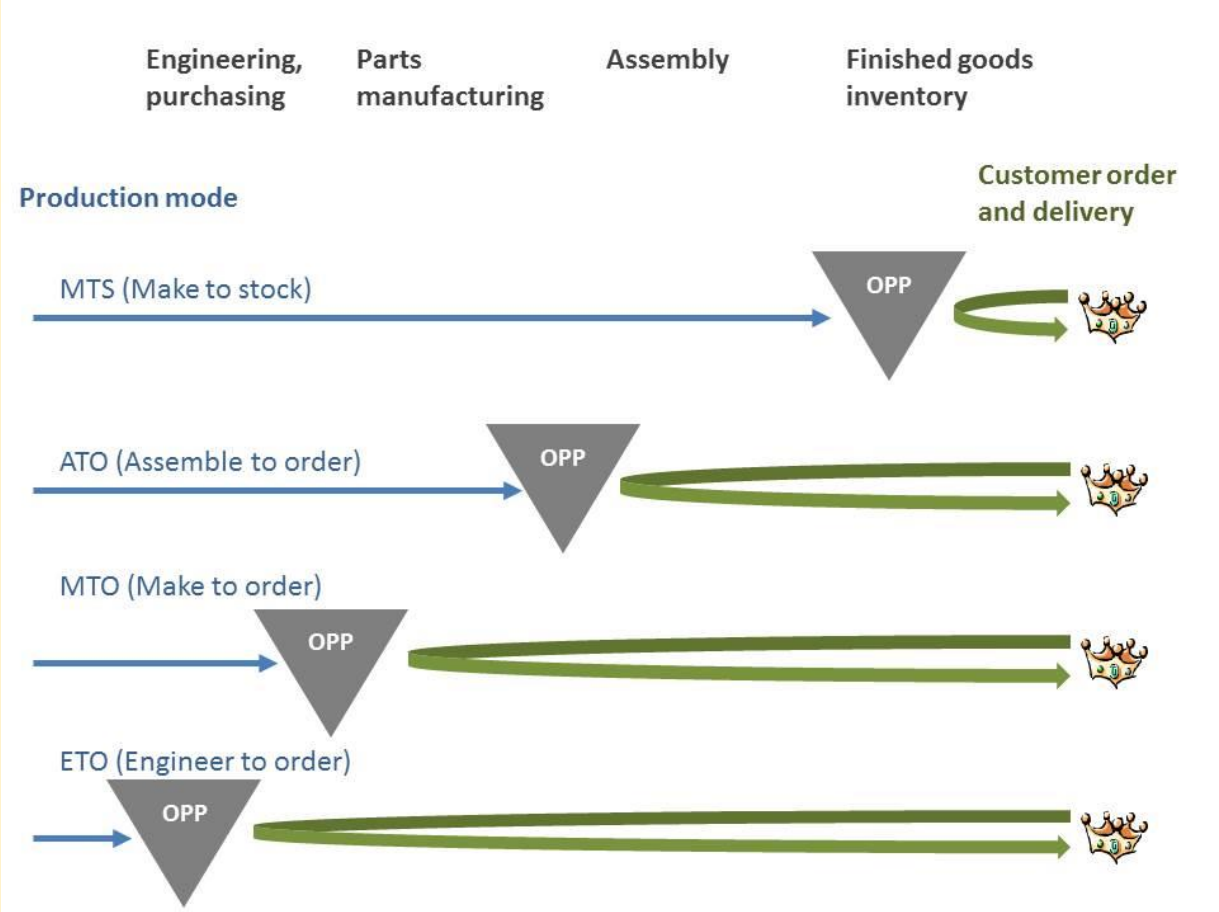
- The de-coupling point can be defined as that point in the supply chain where the business ceases to be ‘forecast-driven’ and becomes ‘demand-driven’.
- In other words, up until this point all actions are planned ahead against a forecast, e.g. production volumes, inventory levels and so on.
- After that point, actions are triggered by the ‘pull’ of market demand
- Therefore, seek to identify ways in which the **demand penetration point can be pushed as far as possible upstream**

Pushing the Demand Penetration Point Upstream



Source: Christopher (2016)

Manufacturing Strategy and OPP



What is a good location for the Order penetration point (OPP)?

- **Very short delivery time** requirements from the customer usually lead to OPP close to the customer
- **Large amount of variants** and **low predictability** of future demand would imply an Order penetration point further away from the customer (i.e. upstream)as it would be financially unfeasible to hold finished goods inventories in such a situation
- **High volume consumer products** would be more likely to be in make-to-stock mode, while customer-specific industrial equipment would likely be engineered to order i.e. the OPP is even further upstream

Multiple Order Penetration Points

- Companies typically may also have several different locations for Order penetration point
- This depends on:
  - the demand for the product
  - amount of variants
  - possibilities for holding inventories
  - criticality of short delivery time
- The different OPP locations are visible to sales and customers in practice through different delivery classes

Example

- Equipment manufacturer sells its products in three different delivery classes.
- The high volume runner products have been modularized, which makes it possible to assemble these standard products to order.
- Delivery time is typically two weeks: when the customer order arrives, the product is assembled from standard modules which are available in buffer stocks, it is tested, packed and sent to the customer.
- In order to get this short delivery time the product has to consist of limited amount of pre-defined modules and no special materials are allowed.
- There is also a maximum order size: even if the order would consist of standard modules, it will be made to order if the order amount exceeds the agreed limits for this delivery class. The module amounts kept in buffer reflect these maximum order sizes.

Responsive Supply Chain

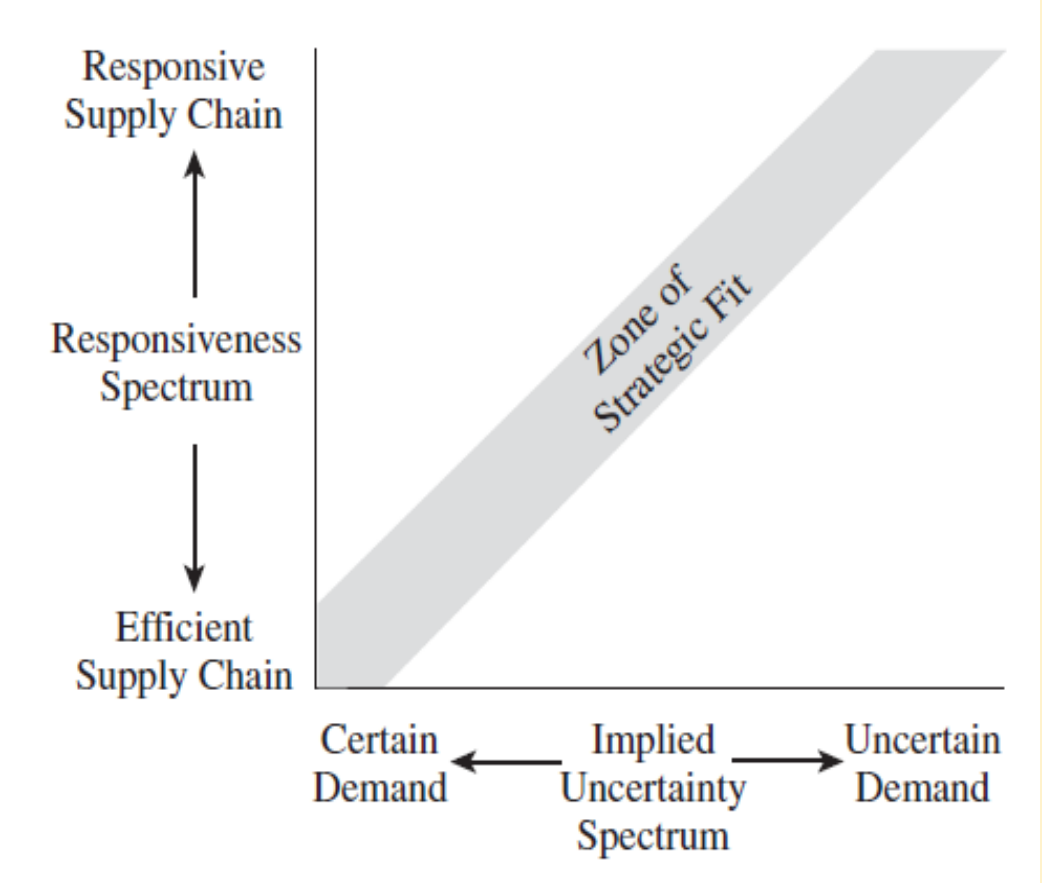
WHY?

- If we can have a clearer view of real demand in the final marketplace, rather than the distorted picture which more typically is the case
- If we can respond more rapidly then a more effective matching of supply and demand can be achieved
- **Move from a forecast-driven to a demand-driven mentality**
- The end result of which is **better customer service at lower cost**

Finding the Zone of Strategic Fit

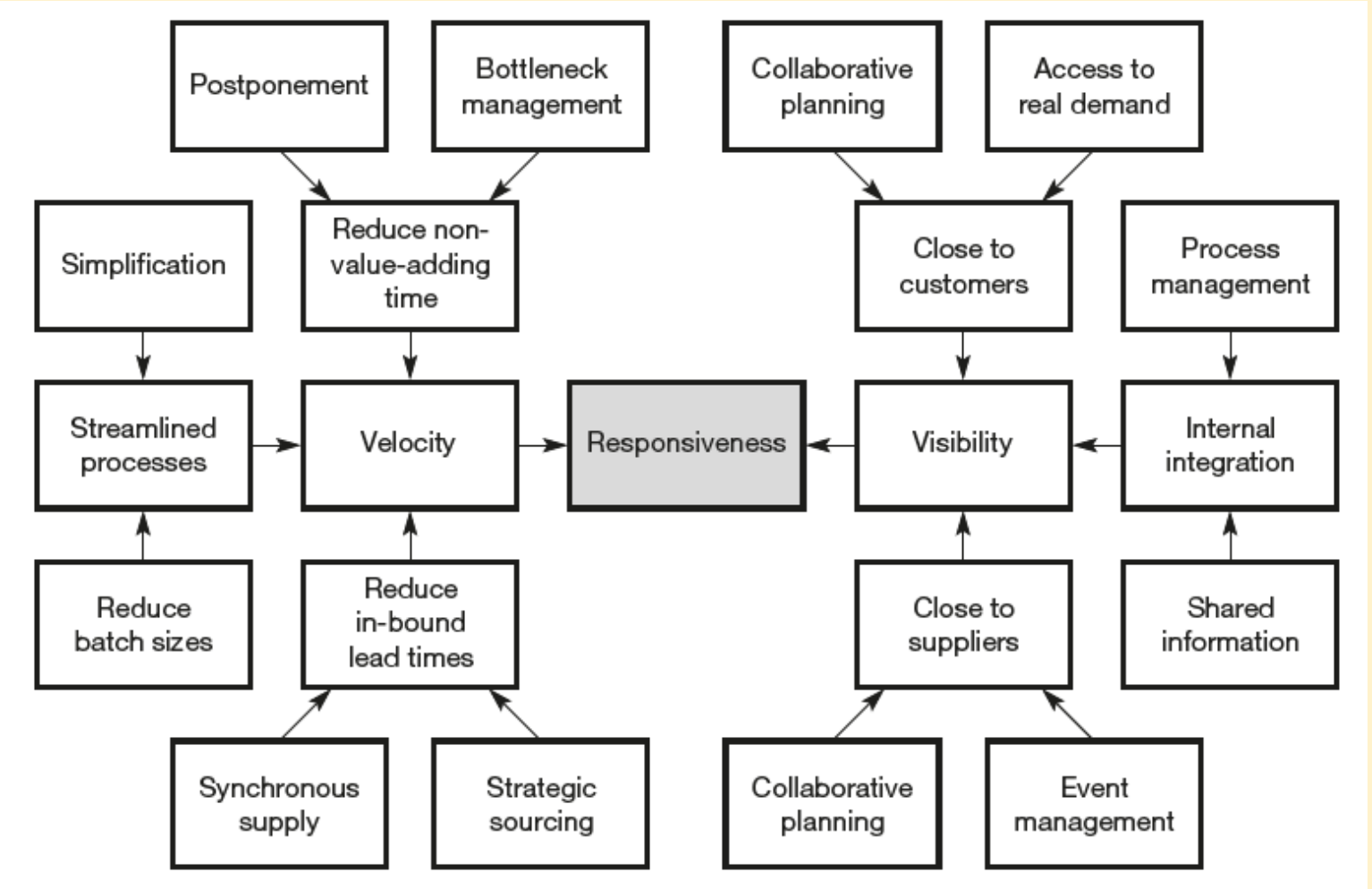
- It follows that increasing implied uncertainty from customers and supply sources is best served by increasing responsiveness from the supply chain.

- So **Find ways to make it possible to react to demand within the customer's order cycle**



Chopra and Meindl (2013, p. 28)

Velocity and visibility drive responsiveness

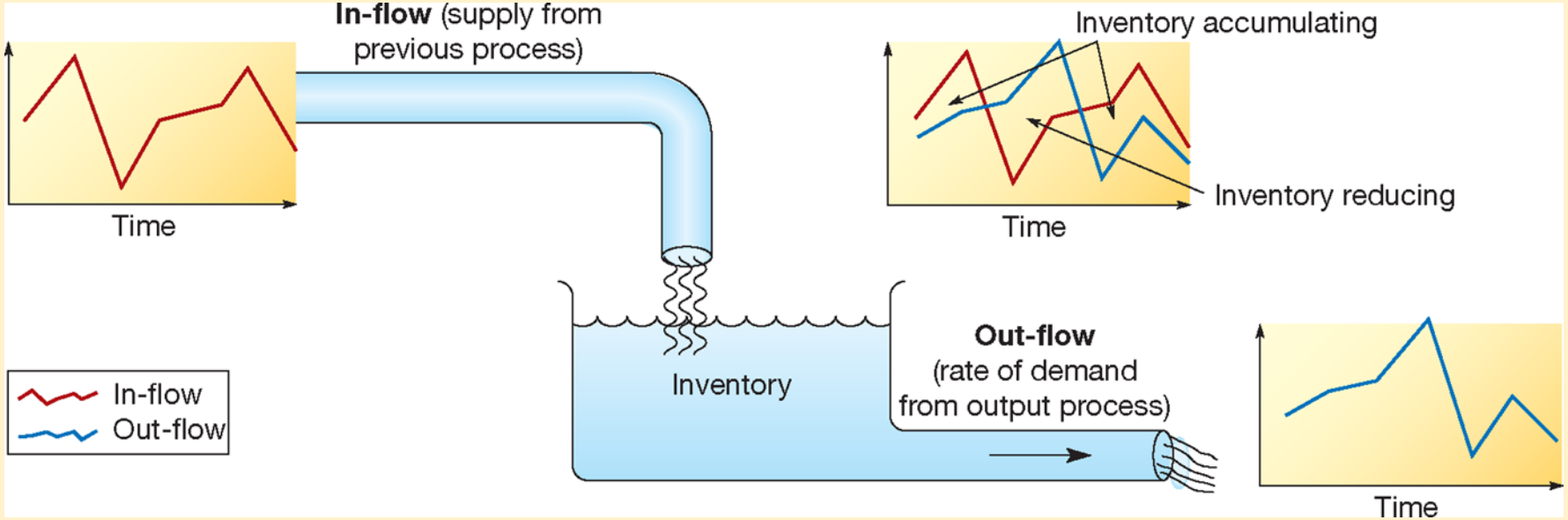


Source: Christopher (2016)

Inventory Management

Inventories are often the result of uneven flows

- If there is a difference between the timing or the rate of supply and demand at any point in a process or network then accumulations will occur



Slack et al 2013

- **IF** supply exceeds the rate of demand,
  - **THEN** inventory increases;
- **IF** demand exceeds the rate of supply,
  - **THEN** inventory decreases

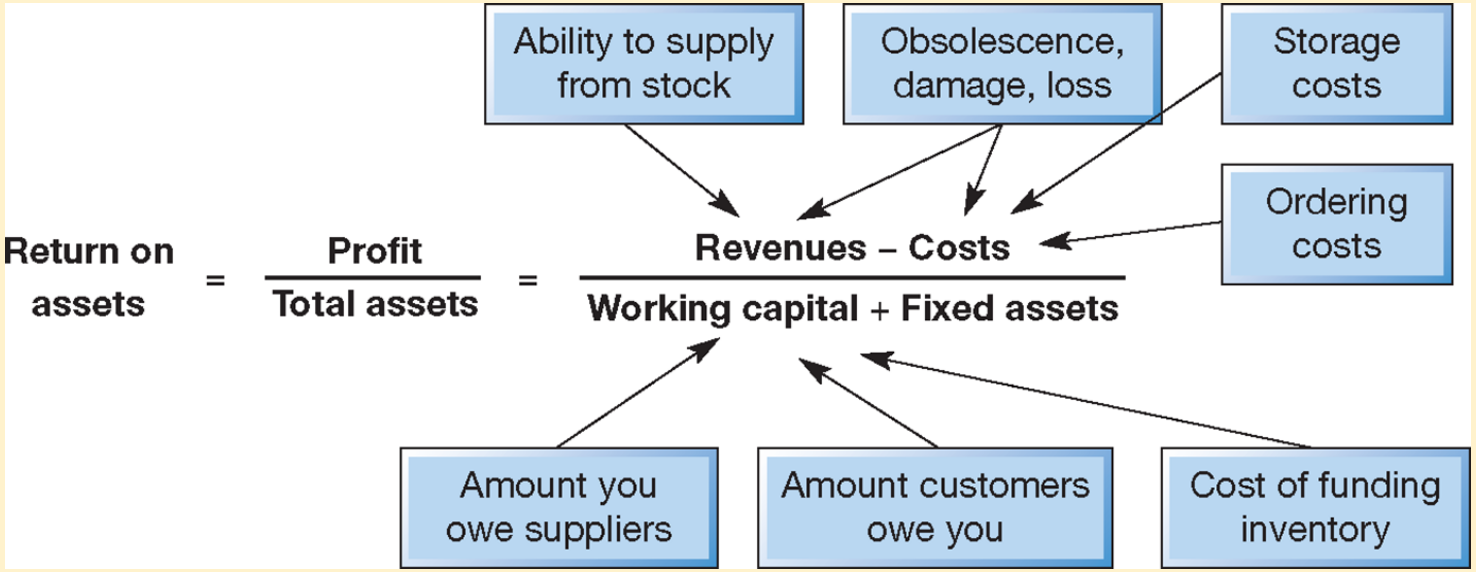
- AIM: Match supply and demand rates, it will also succeed in reducing its inventory levels
- Challenge: Most organizations must cope with unequal supply and demand, at least at some points in their supply chain

Why have inventory?

Reason for holding inventory	*Example*	*How inventory could be reduced*
As an insurance against uncertainty	Safety stocks for when demand or supply is not perfectly predictable	• Improve demand forecasting • Tighten supply, e.g. through service level penalties
To counteract a lack of flexibility	Cycle stock to maintain supply when other products are being made	• Increase flexibility of processes, e.g. by reducing changeover times (see Chapter 11) • Using parallel processes producing output simultaneously (see Chapter 7)
To take advantage of relatively short-term opportunities	Suppliers offer 'time limited' special low-cost offers	• Persuade suppliers to adopt 'everyday low prices' (see Chapter 13)
To anticipate future demands	Build up stocks in low demand periods for use in high demand periods	• Increase volume flexibility by moving towards a 'chase demand' plan (see Chapter 11)
To reduce overall costs	Purchasing a batch of products in order to save delivery and administration costs	• Reduce administration costs through purchasing process efficiency gains • Investigate alternative delivery channels that reduce transport costs
To fill the processing 'pipeline'	Items being delivered to customer	• Reduce process time between customer request and dispatch of items • Reduce throughput time in the downstream supply chain (see Chapter 13)

Reducing physical inventory

- The objective is to reduce the overall level (and/or cost) of inventory whilst maintaining an acceptable level of customer service.



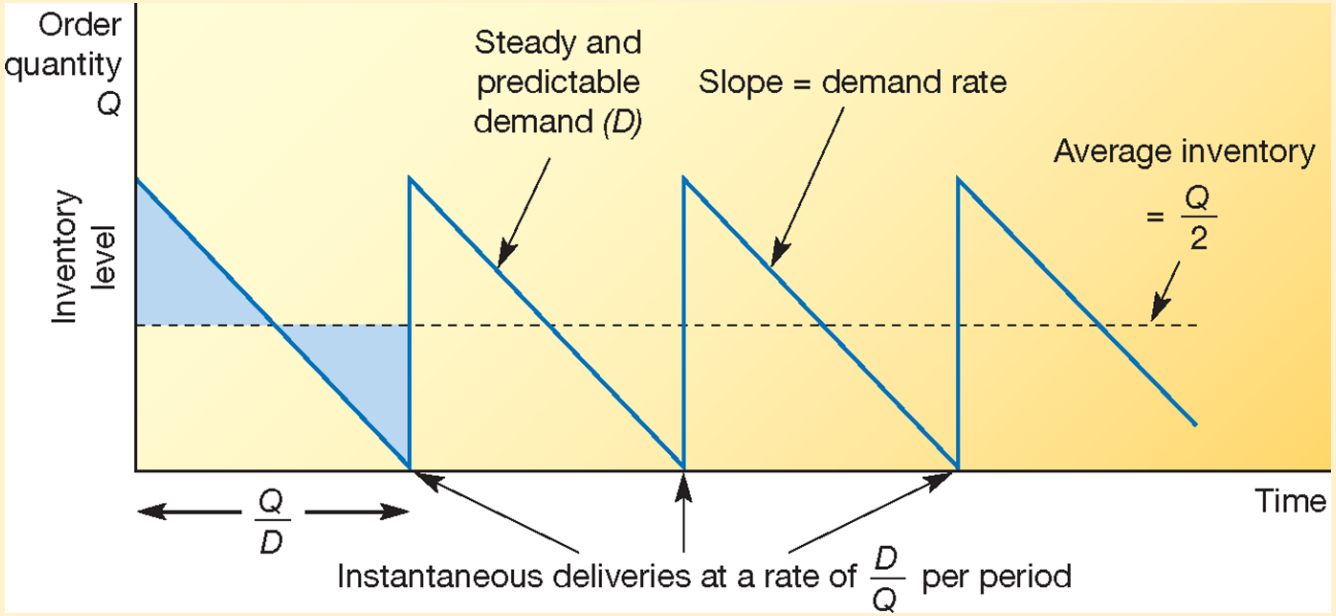
How Much to Order- Volume Decision

- In making this decision we are balancing two sets of costs:

1. the costs associated with ordering
2. the costs associated with holding the stocks

Inventory profiles chart the variation in inventory level

- Every time an order is placed, **Q** items are ordered
- Demand for the item is then steady and perfectly predictable at a rate of **D** units per period
- When demand has depleted the stock of the items entirely, another order of Q items instantaneously arrives, and so on



The economic order quantity (EOQ)

- The most common approach to deciding how much of any particular item to order when stock needs replenishing is called the economic order quantity (EOQ) approach.

- This approach attempts to find the best balance between the advantages and disadvantages of holding stock

The Total Cost of stocking the item

- Information Needed:
  - The total cost of holding one unit in stock for a period of time (C_h)
  - The total costs of placing an order (C_o)

$$\text{Holding costs} = \text{holding cost/unit} \times \text{average inventory} = C_h \times \frac{Q}{2}$$

$$\text{Ordering costs} = \text{ordering cost} \times \text{number of orders per period} = C_o \times \frac{D}{Q}$$

$$\text{So, total cost, } C_t = \frac{C_h Q}{2} + \frac{C_o D}{Q}$$

Costs of adoption of plans with different order quantities

Demand (D) = 1,000 units per year *Order costs (C_o) = £20 per order*			*Holding costs (C_h) = £1 per item per year*		
Order quantity (Q)	*Holding costs ($0.5Q \times C_h$)*	+	*Order costs ($(D/Q) \times C_o$)*	=	*Total costs*
50	25		$20 \times 20 = 400$		425
100	50		$10 \times 20 = 200$		250
150	75		$6.7 \times 20 = 134$		209
200	100		$5 \times 20 = 100$		200*
250	125		$4 \times 20 = 80$		205
300	150		$3.3 \times 20 = 66$		216
350	175		$2.9 \times 20 = 58$		233
400	200		$2.5 \times 20 = 50$		250

- As we would expect with low values of Q, holding costs are low but the costs of placing orders are high because orders have to be placed very frequently.
- As Q increases, the holding costs increase but the costs of placing orders decrease.
- Initially the decrease in ordering costs is greater than the increase in holding costs and the total cost falls.
- After a point, however, the decrease in ordering costs slows, whereas the increase in holding costs remains constant and the total cost starts to increase.

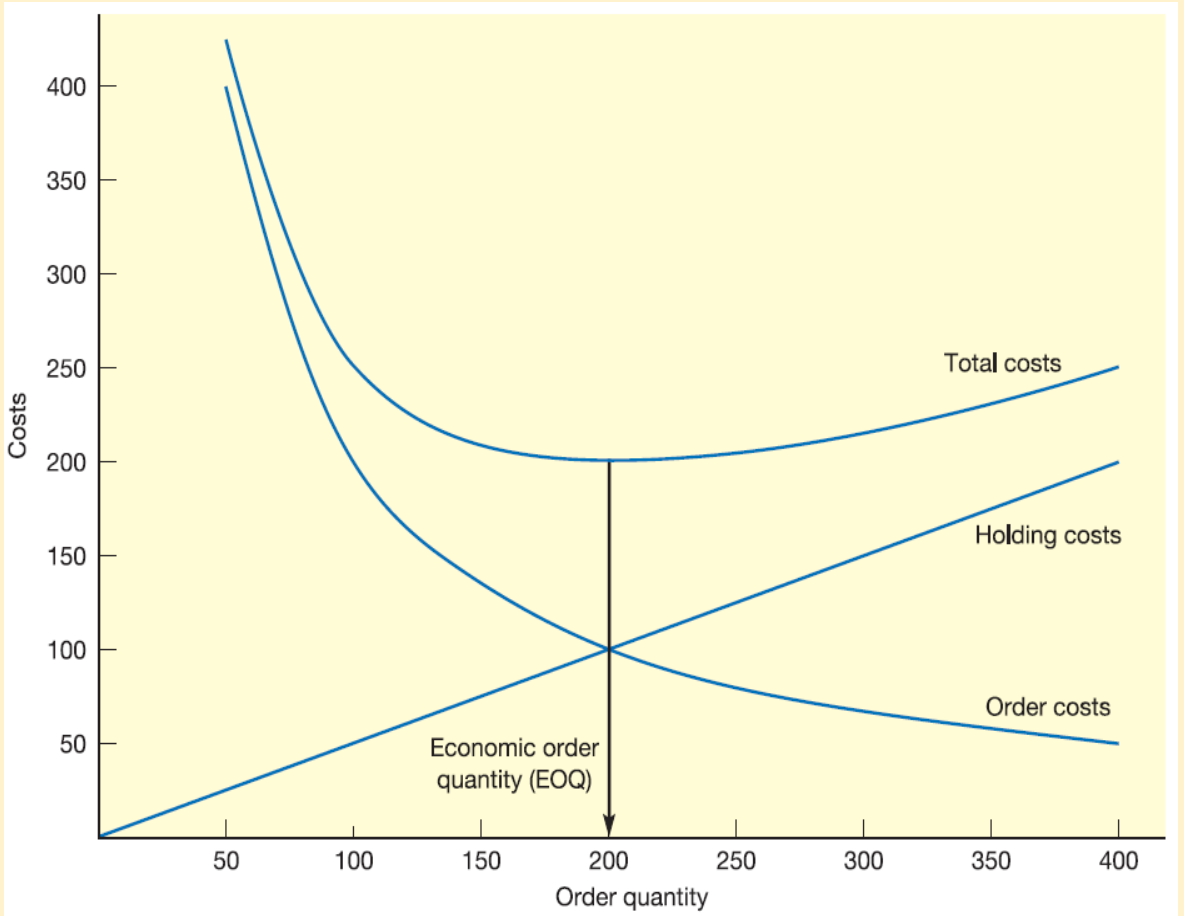
EOQ

$$Q_o = \text{EOQ} = \sqrt{\frac{2C_oD}{C_h}}$$

When using the EOQ:

$$\text{Time between orders} = \frac{\text{EOQ}}{D}$$

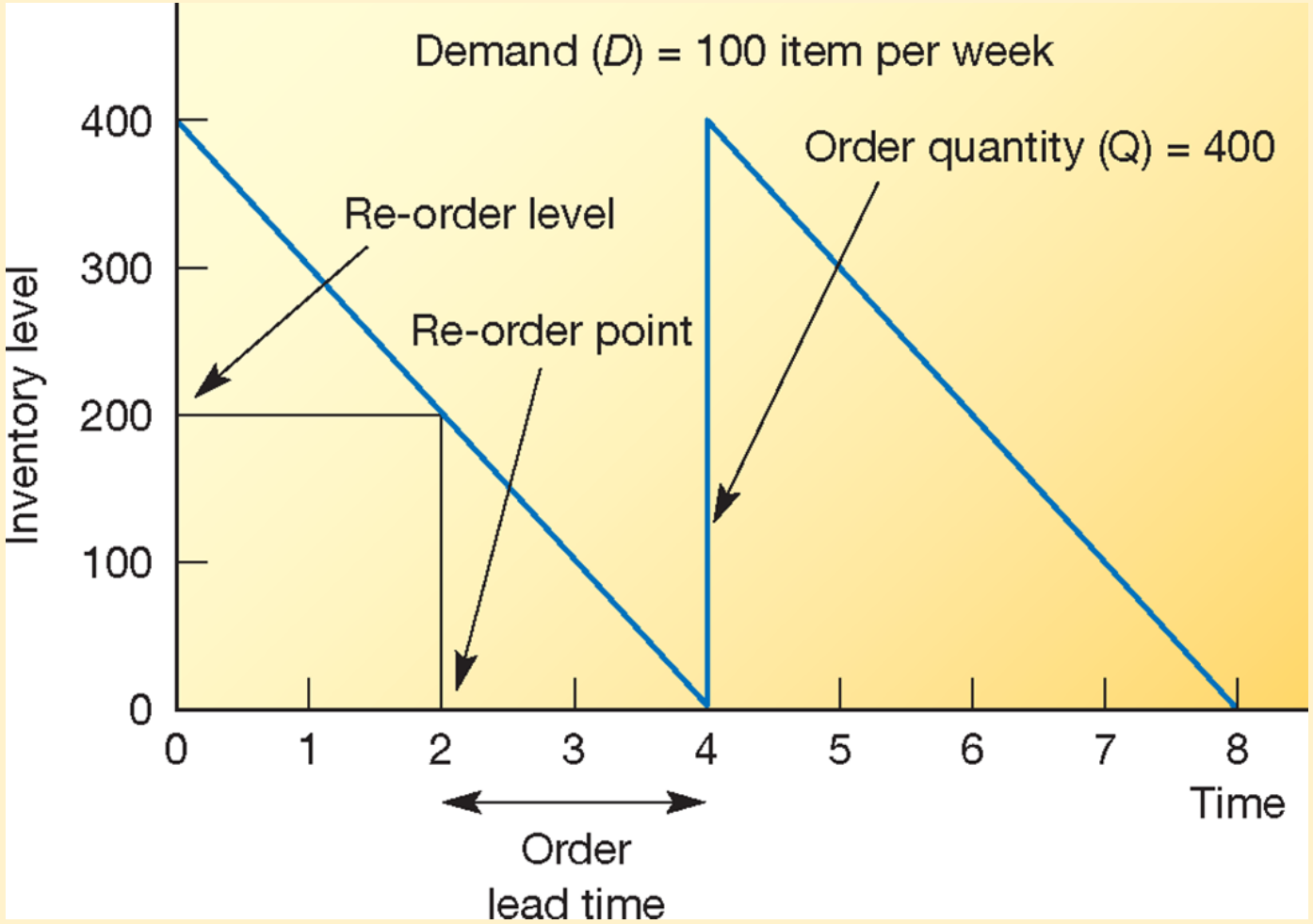
$$\text{Order frequency} = \frac{D}{\text{EOQ}} \text{ per period}$$



When to Place an Order- Timing Decision

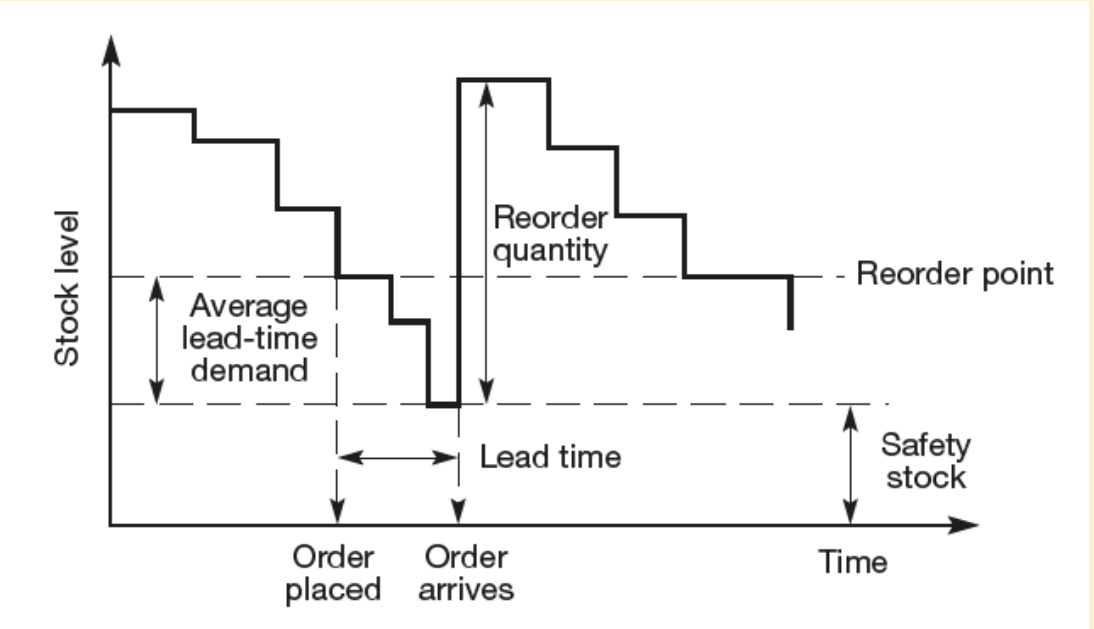
- If replenishment orders do not arrive instantaneously, but have a lag between the order being placed and it arriving in the inventory,
- Then we need to calculate the Reorder Point level
- So the Re-order point (ROP) is the point at which stock will fall to zero minus the order lead time
- Re-order level (ROL) the level of inventory when a replenishment order needs to be placed

Re-order level (ROL) and re-order point (ROP) are derived from the order lead time and demand rate



The reorder point method of stock control

- A reorder point or **reorder level** is predetermined
- Based upon the expected length of the **replenishment lead-time**
- The amount to be ordered may be based upon **the economic order quantity** (EOQ)
- To balance the cost of holding inventory against the costs of placing replenishment orders.



Source: Christopher (2016)

The Bullwhip Effect

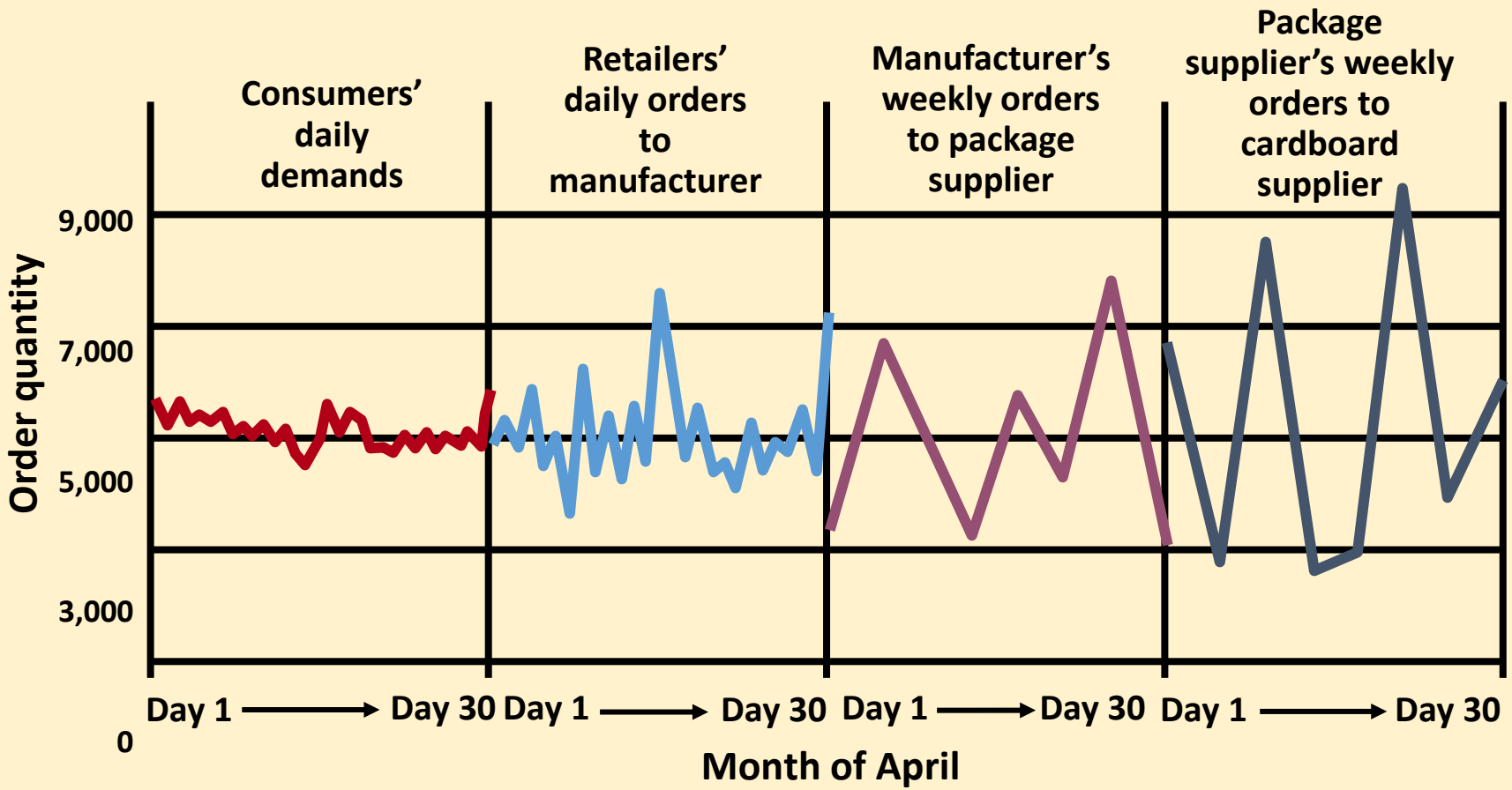
https://www.youtube.com/watch?v=JgLkDbiwTX0

Definition (Lee et al., 1997)

- Caused by:
  - **Demand distortion-** the phenomenon where orders to the supplier tend to have larger variance than sales to the buyer
- Results in:
  - **Variance amplification-** the distortion propagates upstream in an amplified form

A simplified example of the bullwhip effect

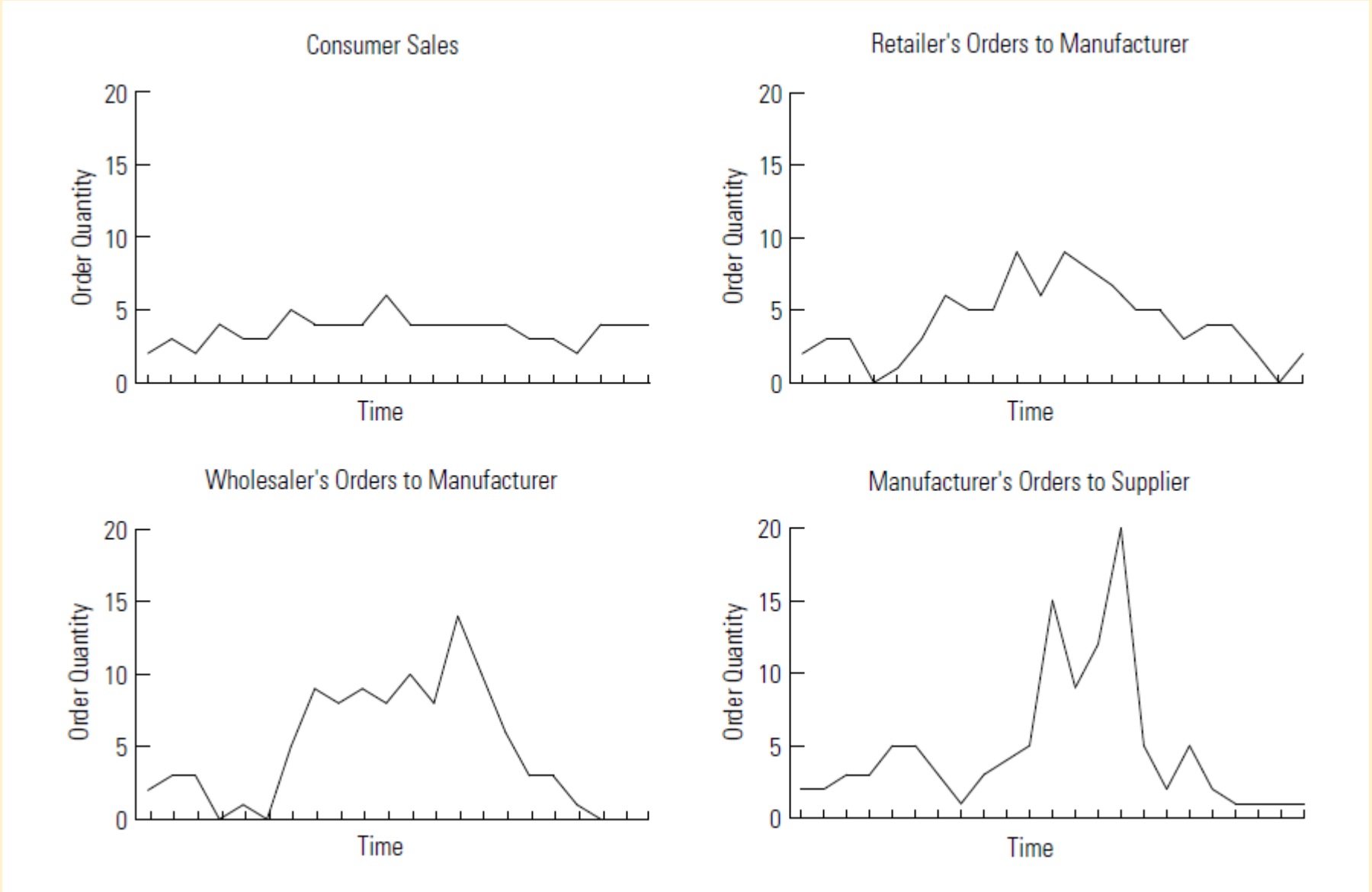
- A retailer typically keeps 100 six-packs of one soda brand in stock.
- If it normally sells 20 six-packs a day, it would order that replacement amount from the distributor.
- But one day, the retailer sells 70 six-packs and assumes customers will start buying more product, and responds by ordering 100 six-packs to meet this higher forecasted demand
- The distributor may then respond by ordering double, or 200 six-packs, from the manufacturer to ensure they do not run out.
- The manufacturer then produces 250 six-packs to be on the safe side.
- In the end, the increased demand has been amplified up the supply chain **from to 100 six-packs at the customer level to 250** at the manufacturer.



The Bullwhip Effect

Krajewski et al (2016)

Increasing Variability of Orders up the Supply Chain

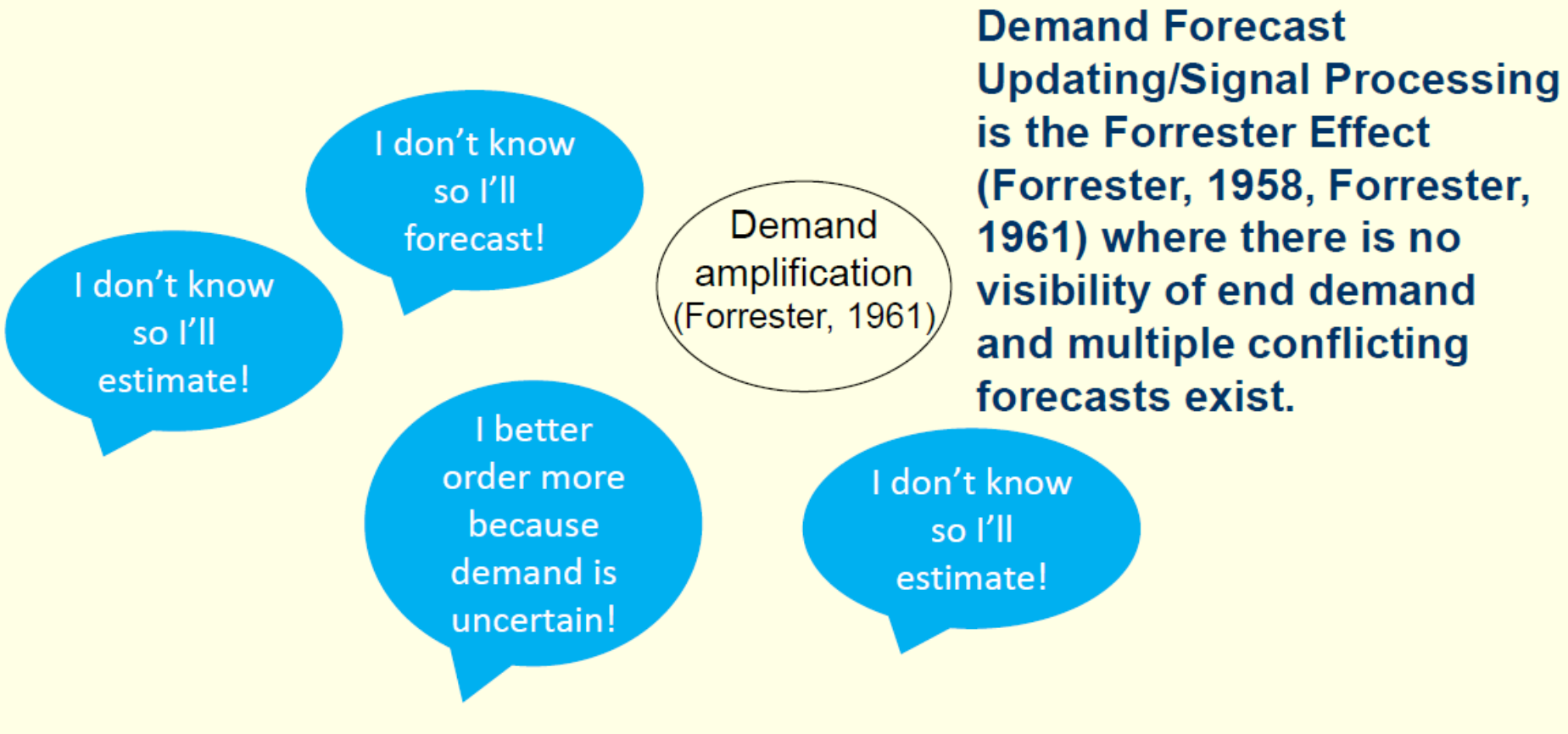


Lee et al. (1997)

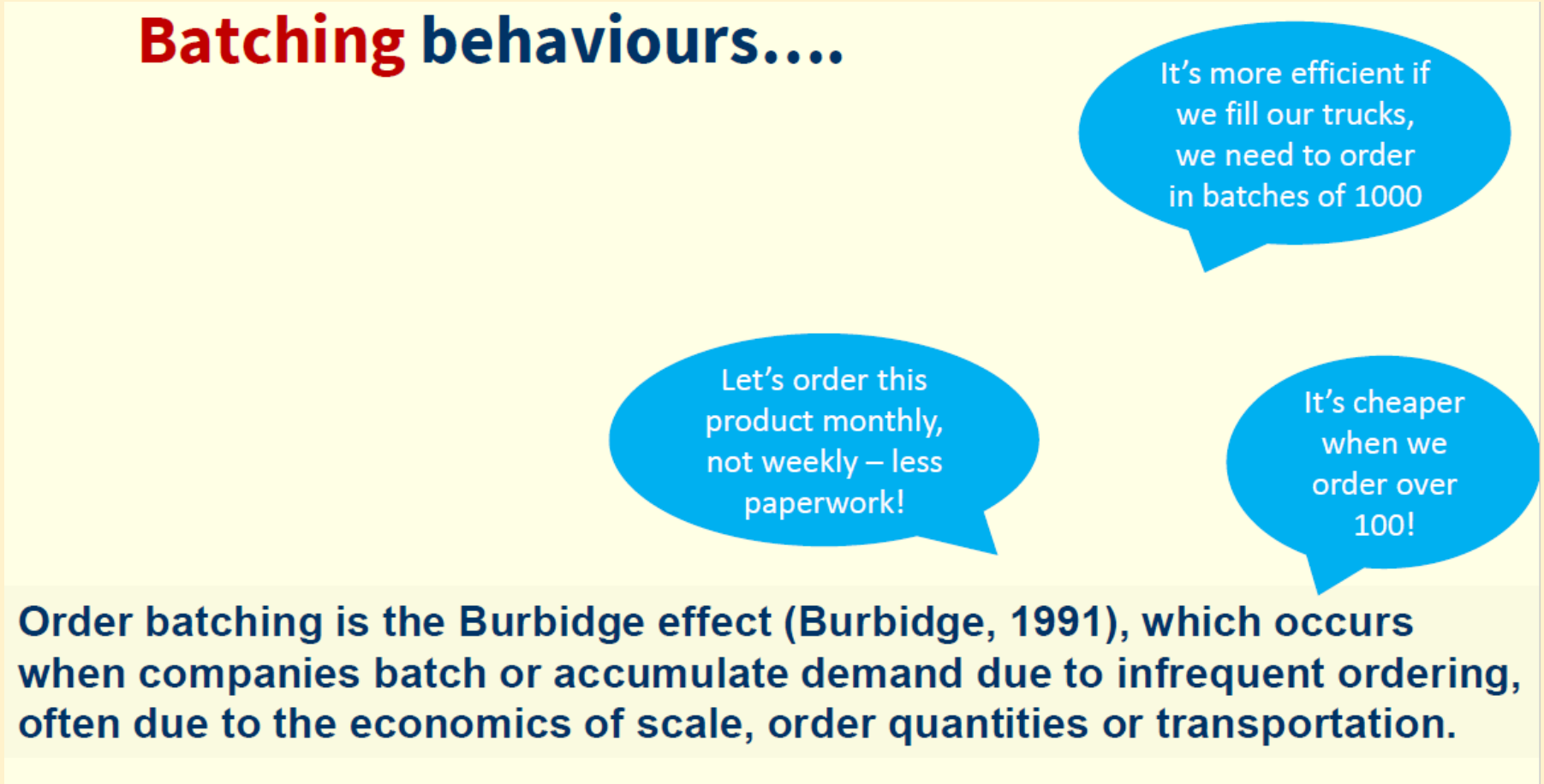
Causes of Bullwhip Effect

1. Demand forecast updating
2. Order batching
3. Price fluctuation
4. Rationing and shortage gaming

Demand Forecast Updating/Signal Processing



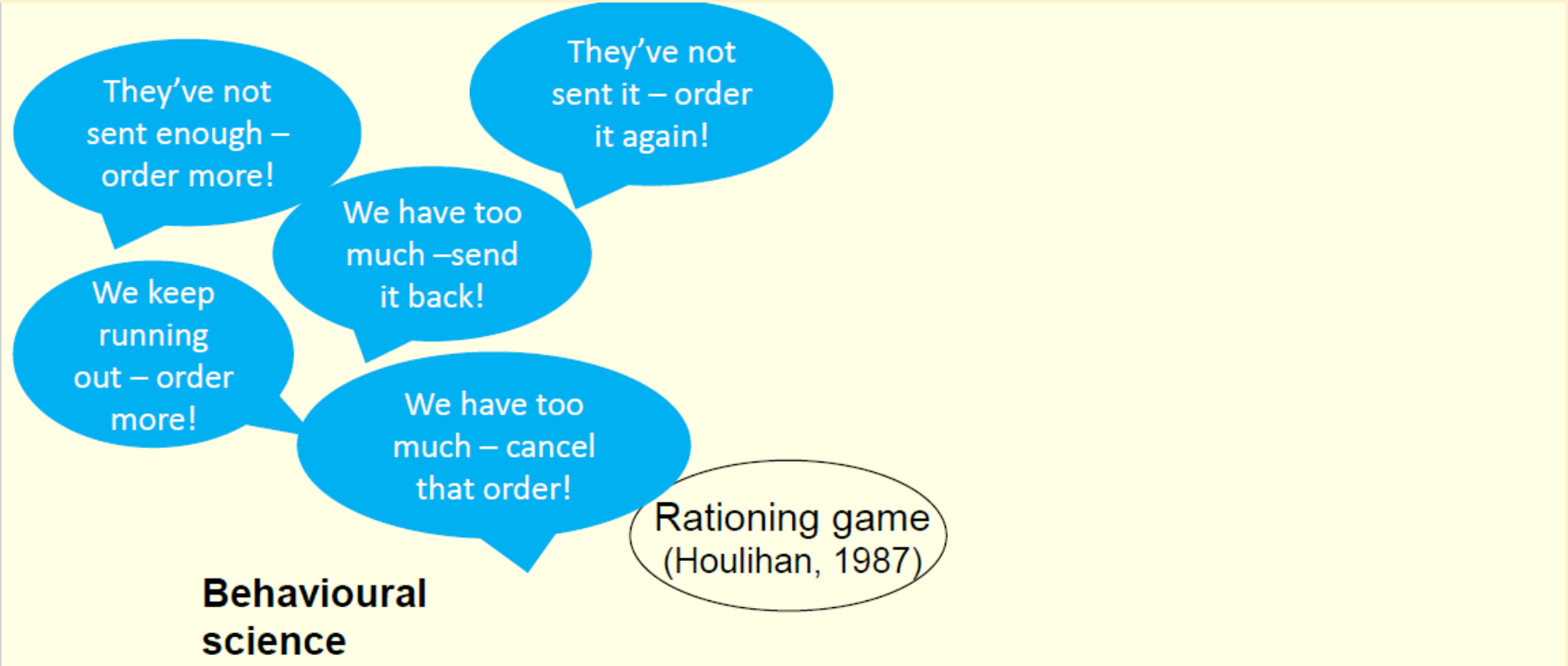
Order Batching



Price Fluctuations

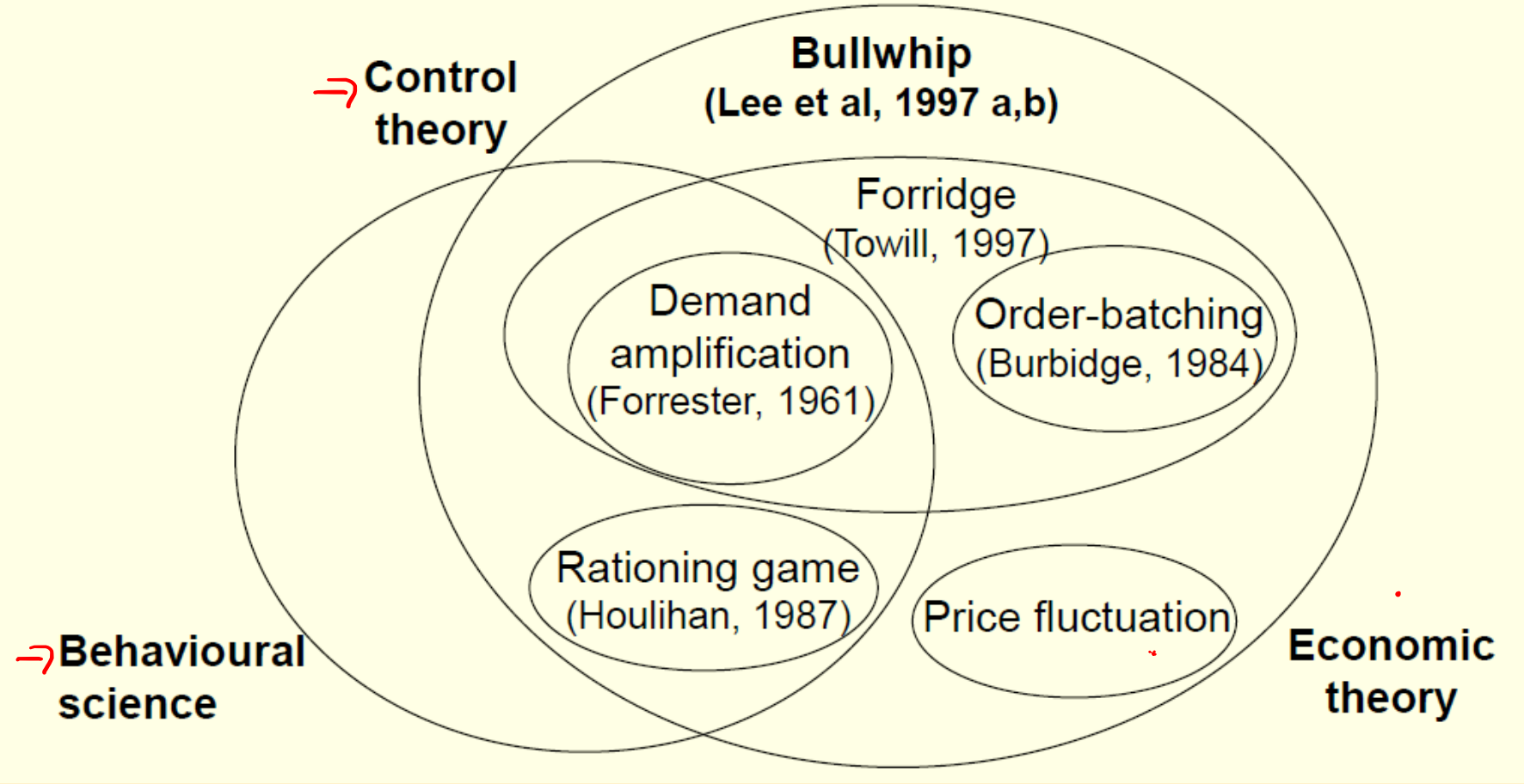
Price fluctuation causes manufacturers and distributors to "forward buy" usually due to an attractive price offer. The result is the consumer buys in bulk and then stops buying until their inventory is depleted; Holweg (2002) links this to economic theory.

Rationing and Short Gaming



Rationing and Shortage Gaming is the Houlihan effect (1987) which occurs when demand exceeds supply so customers get less than they ordered. Therefore they then over order to compensate for the rationing and then orders will disappear or be cancelled due to an overreaction in anticipation by customers.

Summary- What Caused the Bullwhip Effect?



Impact of the Bullwhip Effect

- Leads to **inefficient resource utilization**
- Because planning and managing are difficult
- It is not clear **how a manufacturer should determine production capacity**
- Should it be based on peak demand, which implies that most of the time the manufacturer has expensive resources sitting idle,
- Or should it be based on average demand, which requires extra — and expensive — capacity during periods of peak demand?
- Similarly, it is not clear how to plan transportation capacity — based on peak demand or average demand.
- Thus, in a push-based supply chain, **we often find increased transportation costs, high inventory levels, and high manufacturing costs**, due to the need for emergency production changeovers