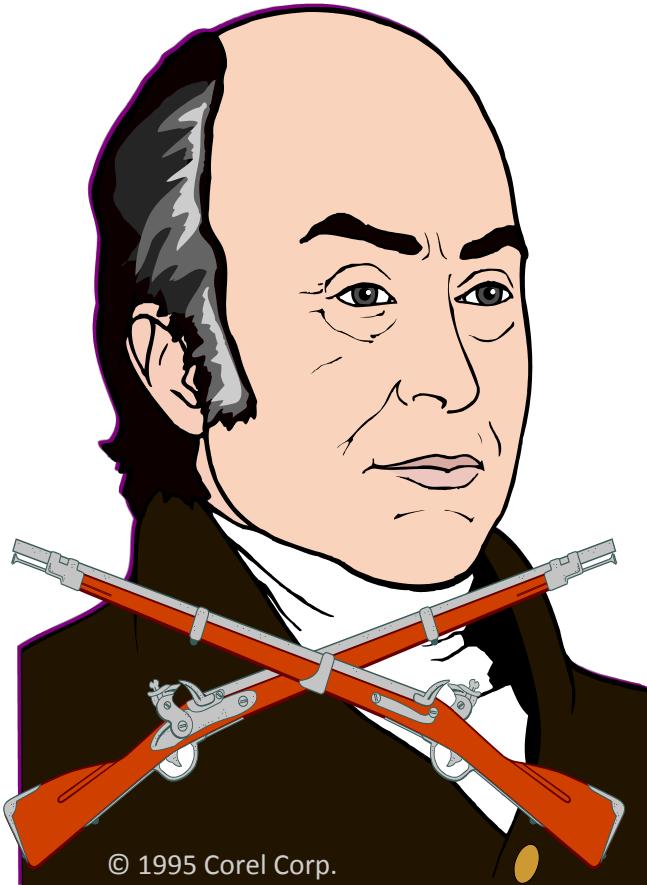


Introduction to Operations Management

Theocharis Papadopoulos

The historic development of operations management?

Eli Whitney

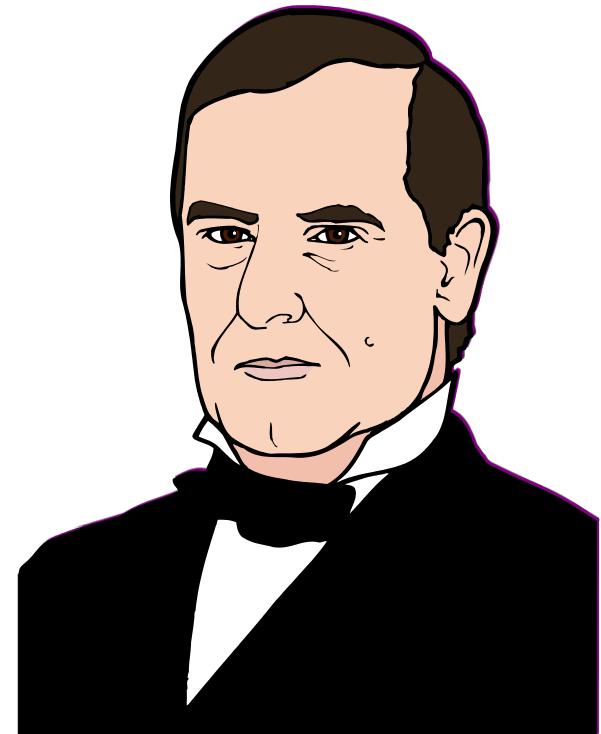


© 1995 Corel Corp.

- ◆ Born 1765; died 1825
- ◆ In 1798, received government contract to make 10,000 muskets
- ◆ Showed that machine tools could make standardized parts to exact specifications
 - ◆ Musket parts could be used in any musket

Frederick W. Taylor

- ◆ Born 1856; died 1915
- ◆ Known as 'father of scientific management'
- ◆ In 1881, as chief engineer for Midvale Steel, studied how tasks were done
 - ◆ Began first motion & time studies
- ◆ Created efficiency principles



Taylor: Management Should Take More Responsibility for

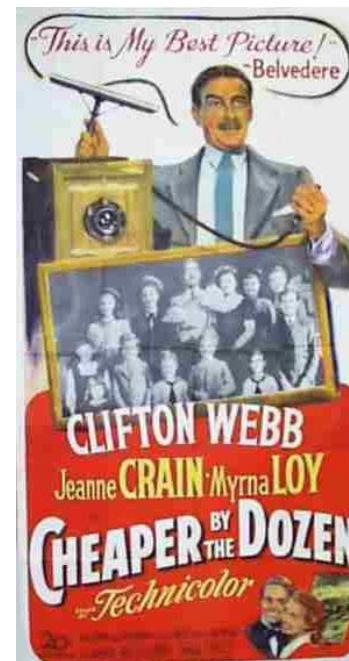
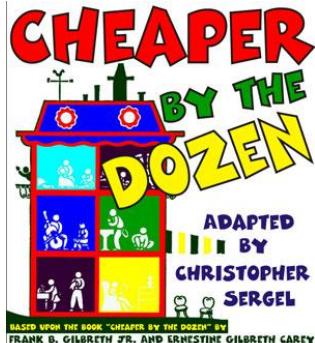
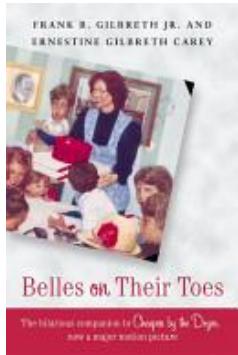
- Matching employees to right job
- Providing the proper training
- Providing proper work methods and tools
- Establishing legitimate incentives for work to be accomplished

Frank & Lillian Gilbreth

- ◆ Frank (1868-1924); Lillian (1878-1972)
- ◆ Husband-and-wife engineering team
- ◆ Further developed work measurement methods
- ◆ Applied efficiency methods to their home & 12 children!
- ◆ (Book & Movie: “Cheaper by the Dozen,” book: “Bells on Their Toes”)

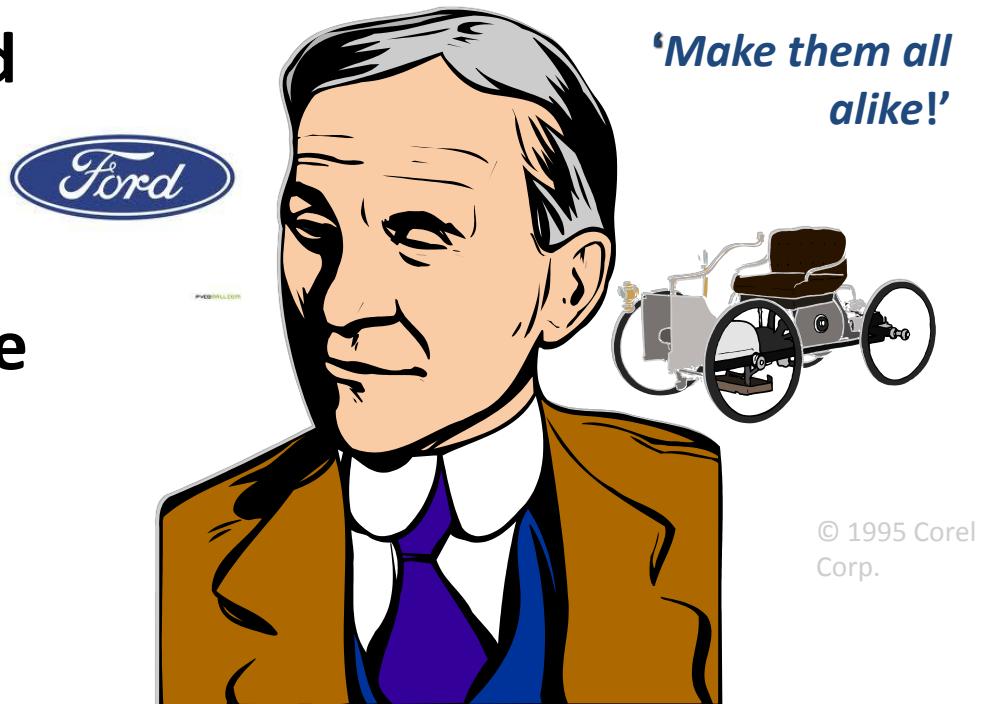


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Henry Ford

- ◆ Born 1863; died 1947
- ◆ In 1903, created Ford Motor Company
- ◆ In 1913, first used moving assembly line to make Model T
 - ◆ Unfinished product moved by conveyor past work station
- ◆ Paid workers very well for 1911 (\$5/day!)

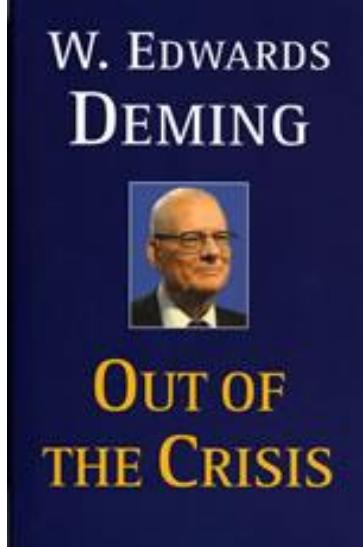


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W. Edwards Deming



- ◆ Born 1900; died 1993
- ◆ Engineer & physicist
- ◆ Credited with teaching Japan quality control methods in post-WW2
- ◆ Used statistics to analyze process
- ◆ His methods involve workers in decisions



What is operations management?

Key operations questions

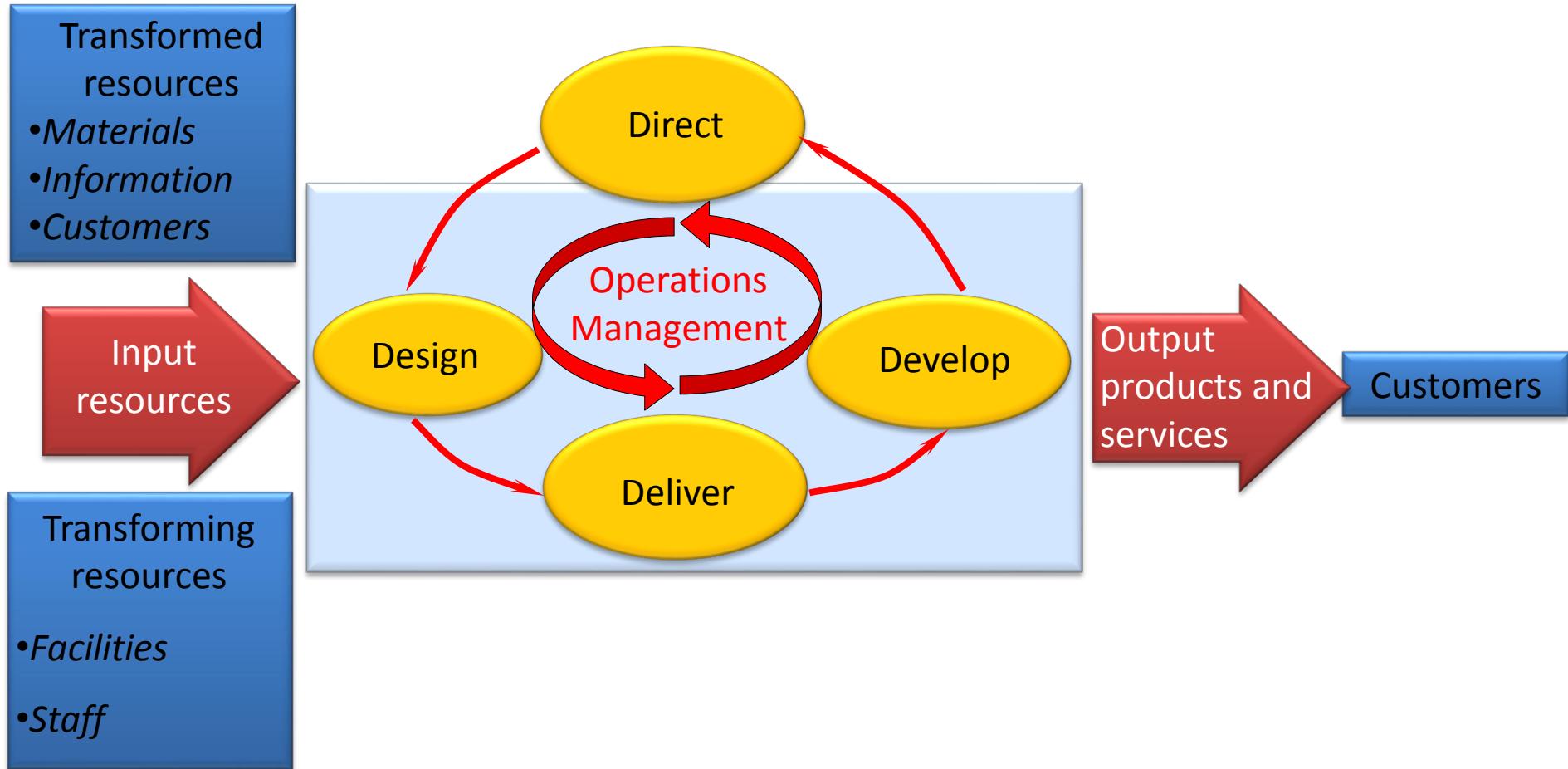
- ❑ What is operations management?
- ❑ Why is operations management important in all types of organization?
- ❑ What is the input-transformation-output process?
- ❑ What is the process hierarchy?
- ❑ How do operations processes have different characteristics?
- ❑ What are the activities of operations management?

Operations management defined



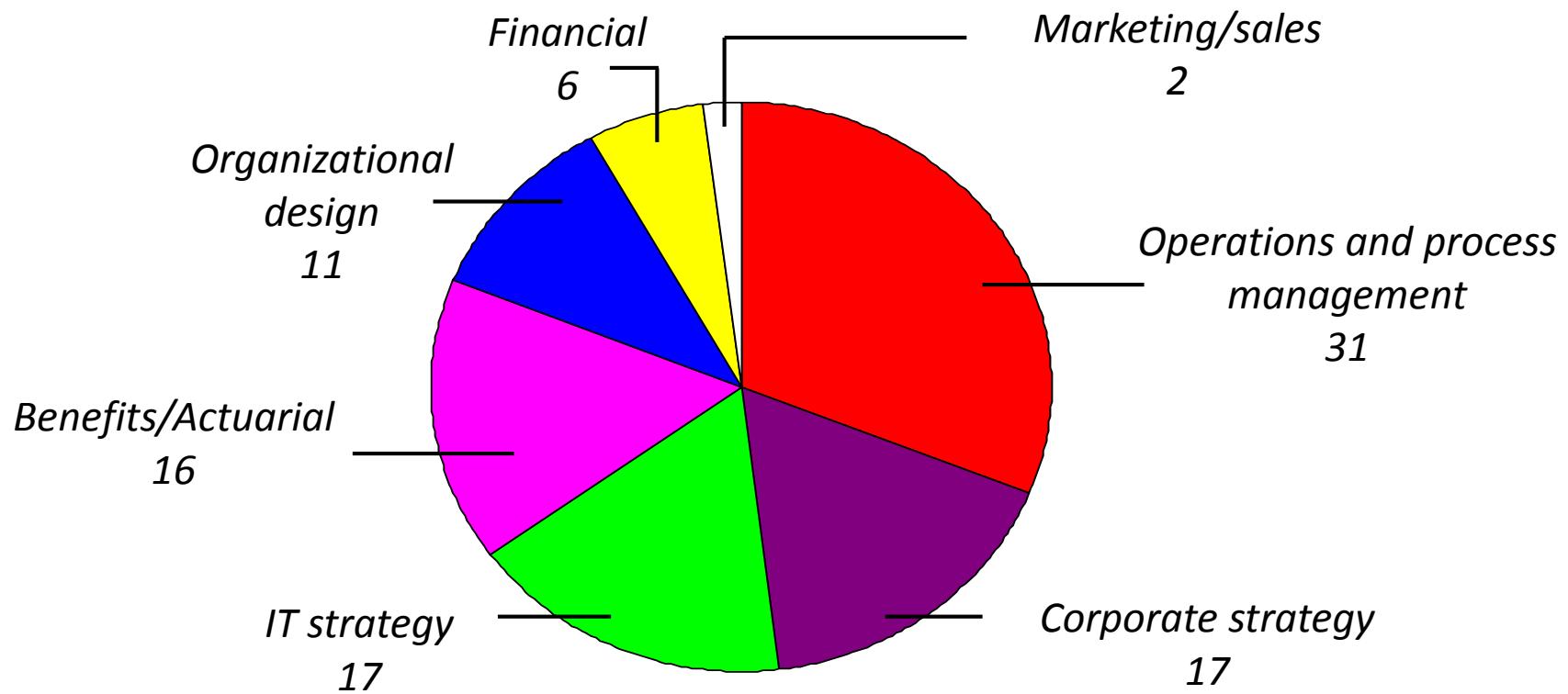
Operations management is the activity of managing the resources which are devoted to the production and delivery of products and services.

Slack et al's model of operations management



Operations management is fashionable!

The consultancy services market - % of world revenues of 40 largest consultancy firms



Operations management at..... IKEA

Design elegant products which can be flat-packed efficiently

Design a store layout which gives smooth and effective flow

Ensure that the jobs of all staff encourage their contribution to business success

Site stores of an appropriate size in the most effective locations

Continually examine and improve operations practice

Maintain cleanliness and safety of storage area

Arrange for fast replenishment of products

Monitor and enhance quality of service to customers



They are all *operations*

Back office operation in
a bank

Kitchen unit
manufacturing
operation

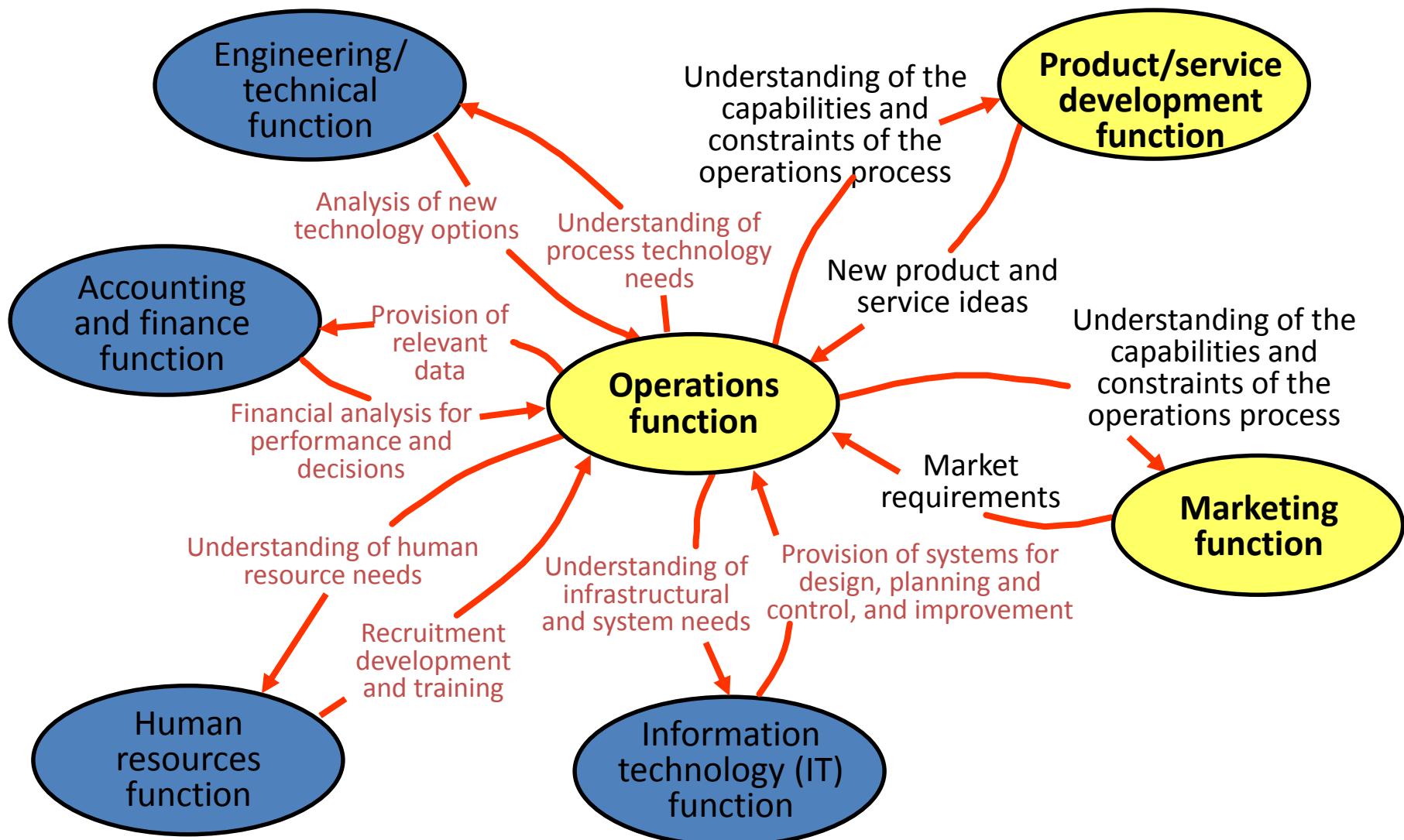
Retail operation

Take-out / restaurant
operation

Operations are everywhere

- The best way to start understanding the nature of “*Operations*” is to look around you
- Everything you can see around you (except the flesh and blood) has been *produced* by an *operation*
- Every service you consumed today (radio station, bus service, lecture, etc.) has also been *produced* by an *operation*
- Operations Managers *create* everything you buy, sit on, wear, eat, throw at people, and throw away

Interfunctional relationships between operations and other functions

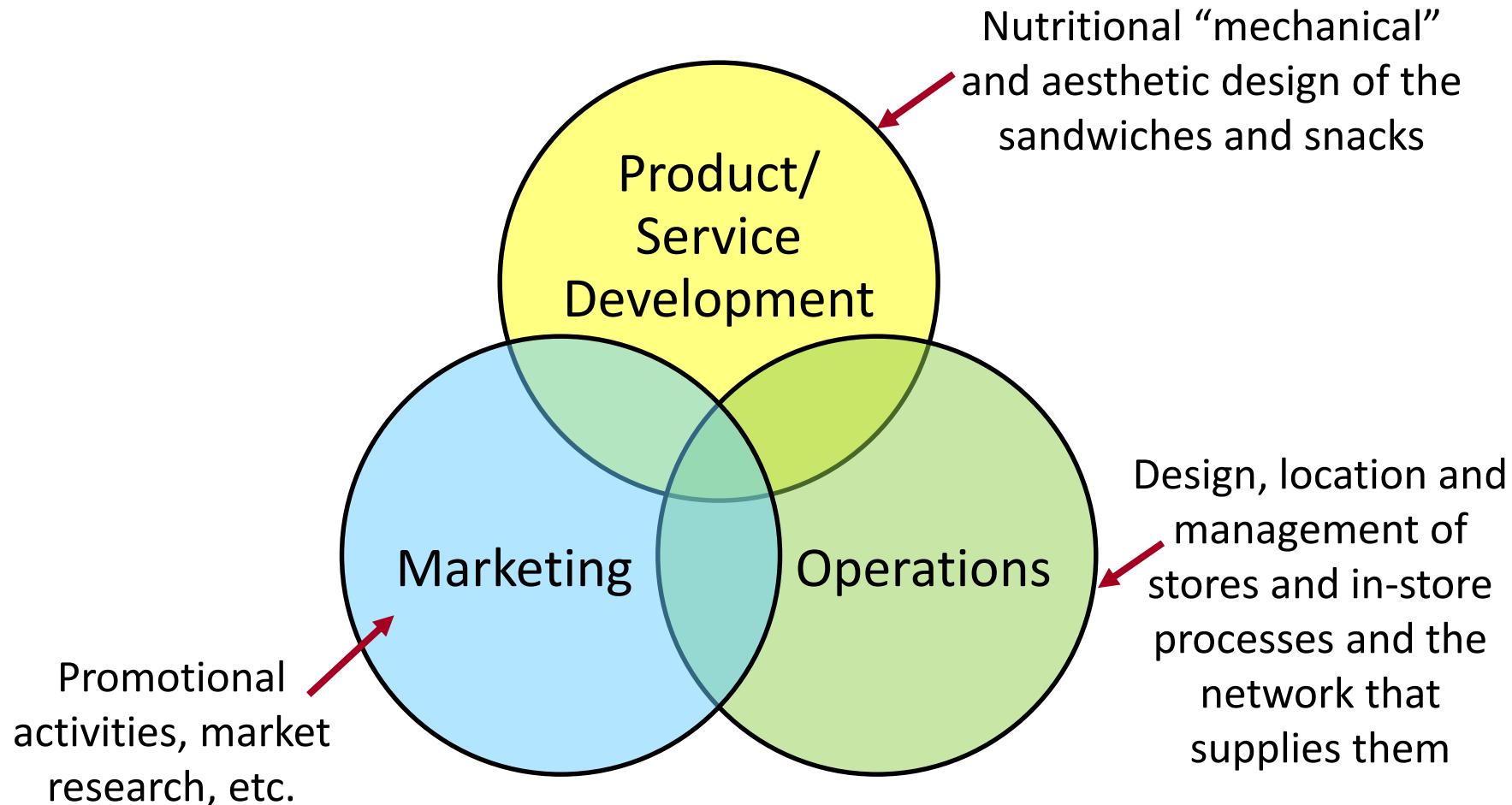


Prêt à Manger

- “High-end” sandwich and snack retailer
- Use only “wholesome” ingredients
- All shops have own kitchens which makes fresh sandwiches every day
- Fresh ingredients delivered early every morning
- Same staff who serve you at lunch made the sandwiches that morning
- *“We don’t work nights, we wear jeans, we party...”*



The three basic functions at Prêt à Manger



Operations management in all types of organization

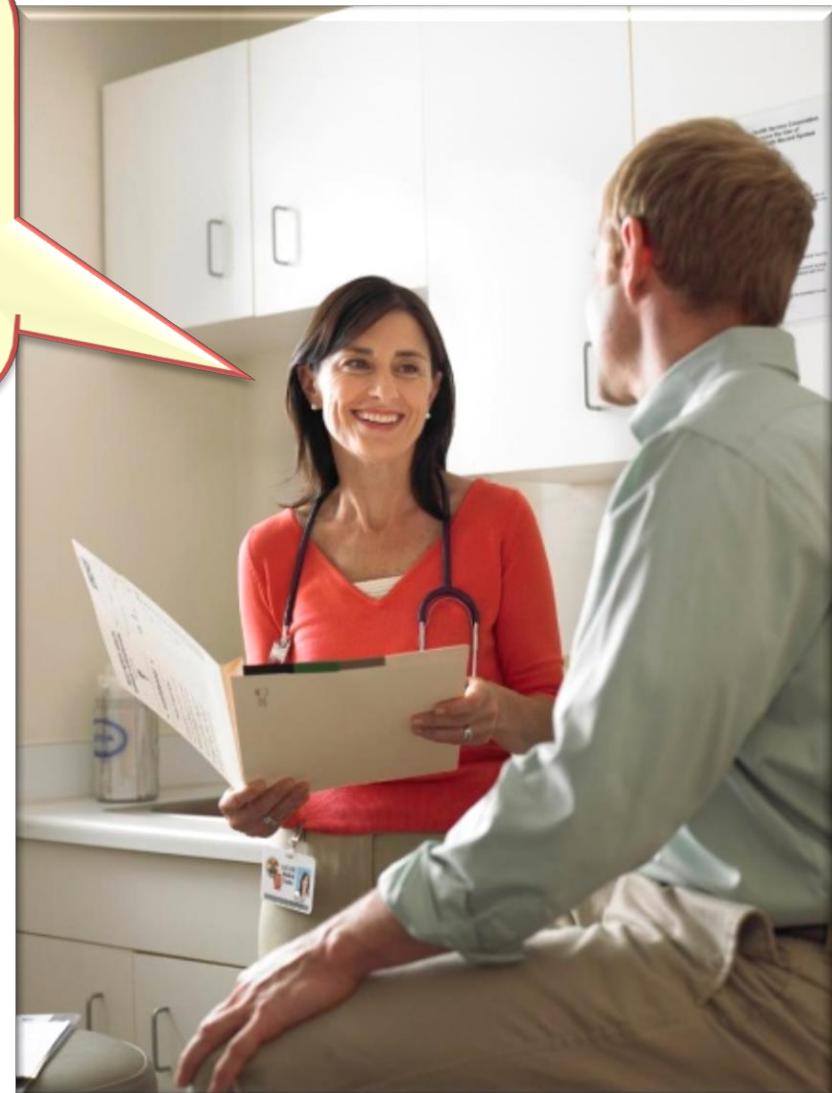
Automobile assembly factory - *Operations management uses machines to efficiently assemble products that satisfy current customer demands*



Operations management in all types of organization

Physician (General practitioner) -

Operations management uses knowledge to effectively diagnose conditions in order to treat real and perceived patient concerns



Operations management in all types of organization



Management consultant - Operations management uses people to effectively create the services that will address current and potential client needs

Operations management in all types of organization



Disaster relief charity -
Operations management uses ours and our partners' resources to speedily provide the supplies and services that relieve community suffering

Operations management in all types of organization

Advertising agency - Operations

management uses our staff's knowledge and experience to creatively present ideas that delight clients and address their real needs



Operations management uses.....

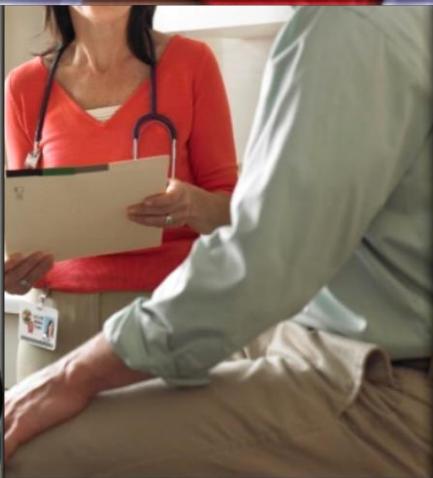
machines



knowledge



people



ours
pa
res

our
know
exp



ideas that delight
clients and address
their real needs

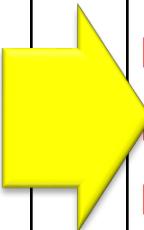
Operations management is changing

The business environment is changing, for example.....

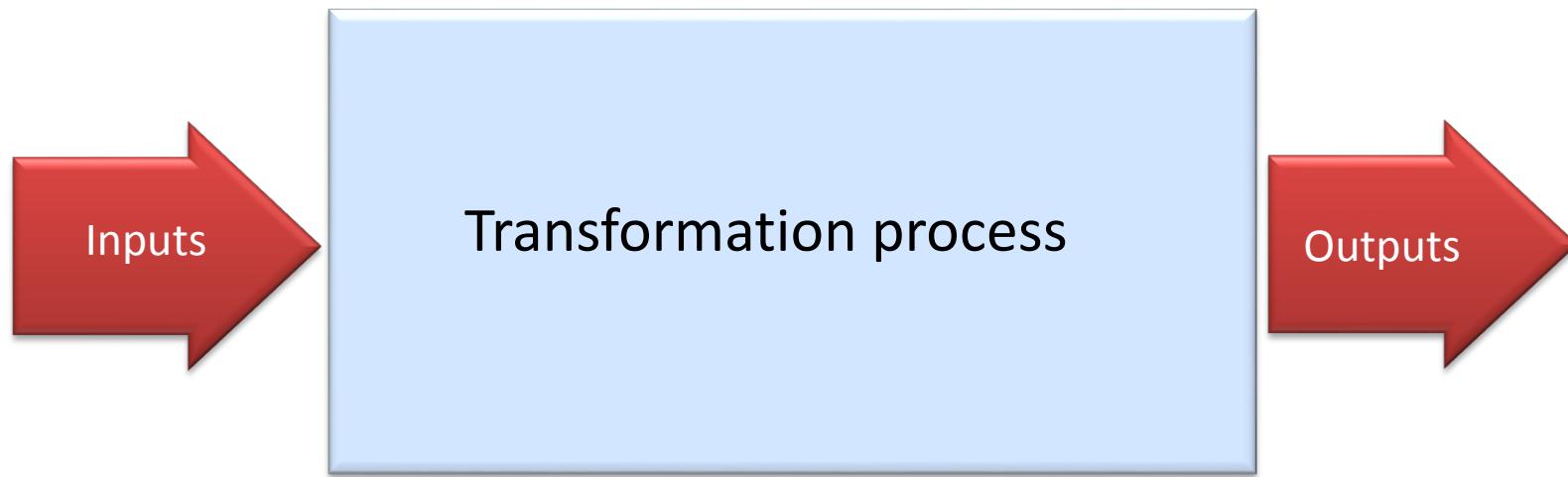
- Increased cost-based competition
- Higher quality expectations
- Demands for better service
- More choice and variety
- Rapidly developing technologies
- Frequent new product/service introduction
- Increased ethical sensitivity
- Environmental impacts are more transparent
- More legal regulation
- Greater security awareness

Prompting operations responses, for example.....

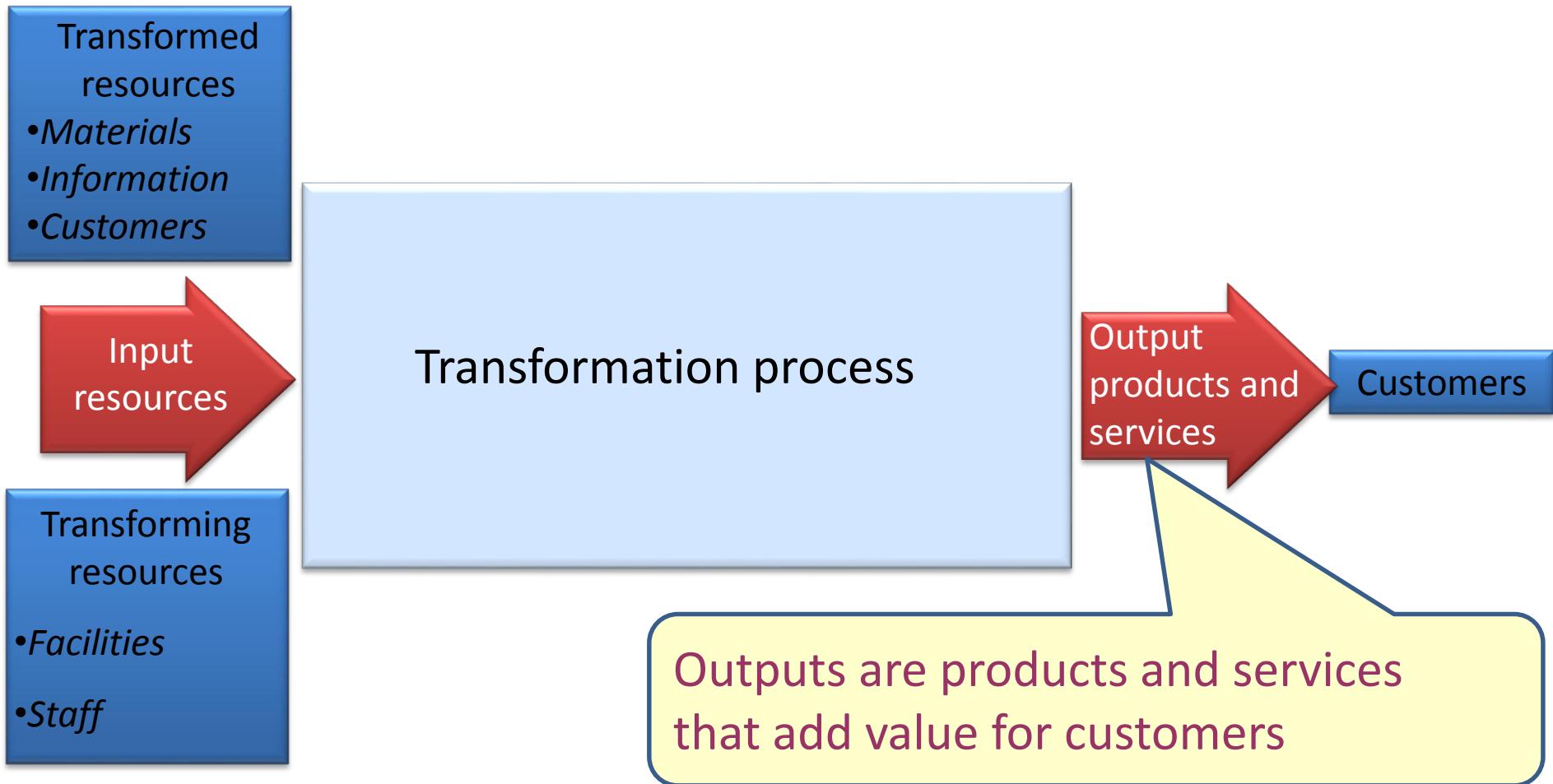
- Globalization of operations networking
- Information-based technologies
- Internet-based integration of operations activities
- Supply chain management
- Customer relationship management
- Flexible working patterns
- Mass customization
- Fast time-to-market methods
- Lean process design
- Environmentally sensitive design
- Supplier ‘partnership’ and development
- Failure analysis
- Business recovery planning



All operations are input-transformation-output processes



Operations input resources and outputs



Inputs and outputs at Prêt a Manger

Transformed
resources

- Ingredients
- Packaging
- Customers

Input
resources

➤ Transforming
resources

- Equipment
- Fittings
- Staff



Served and
satisfied
customers

Customers

Most operations produce products and services

Crude oil production

Aluminium smelting

Specialist machine tool production

Restaurant

Information systems provider

Management consultancy

Psychotherapy clinic

Acme whistles

Prêt a manger

IKEA

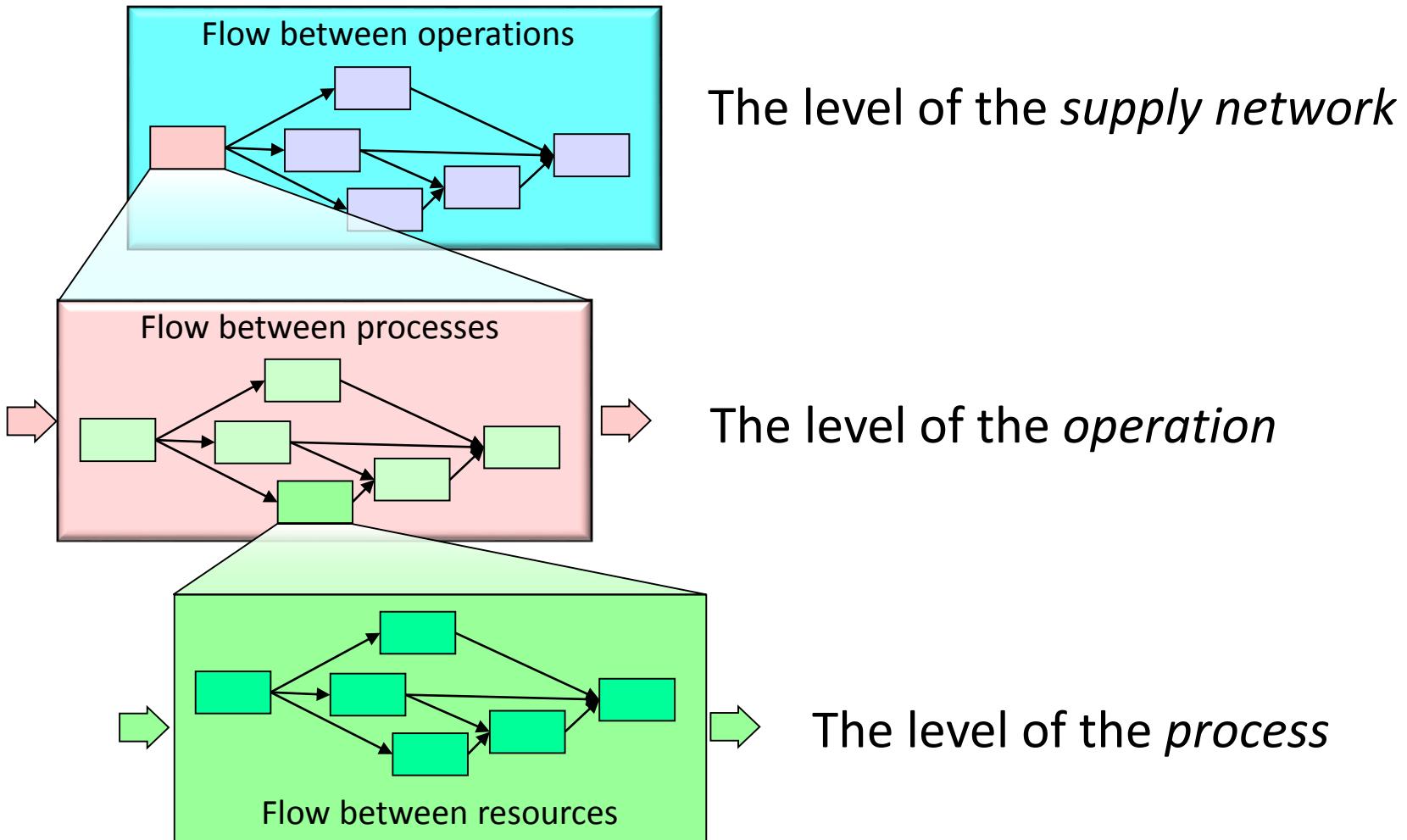
Mwagusi Safari Lodge

Pure products – Outputs that are exclusively tangible

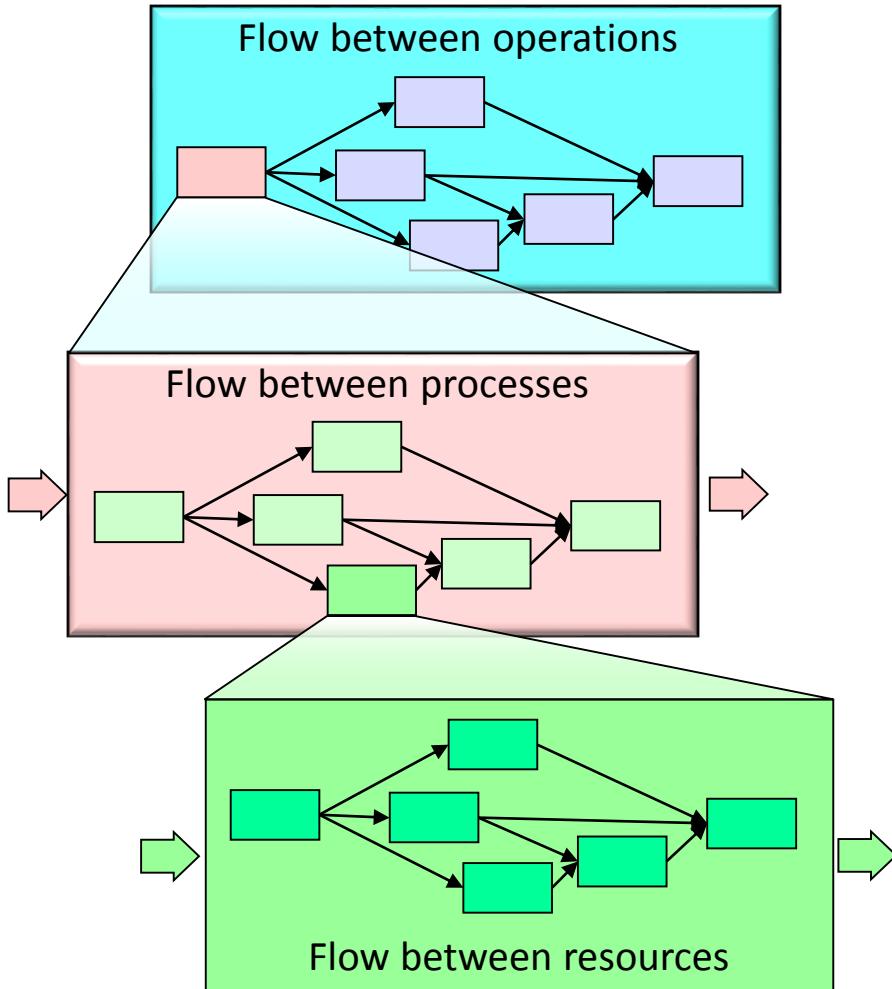
Mixture of products and services – Outputs that are a mixture of the tangible and intangible

Pure services – Outputs that are exclusively intangible

Operations can be analyzed at three levels



Operations can be analyzed at three levels

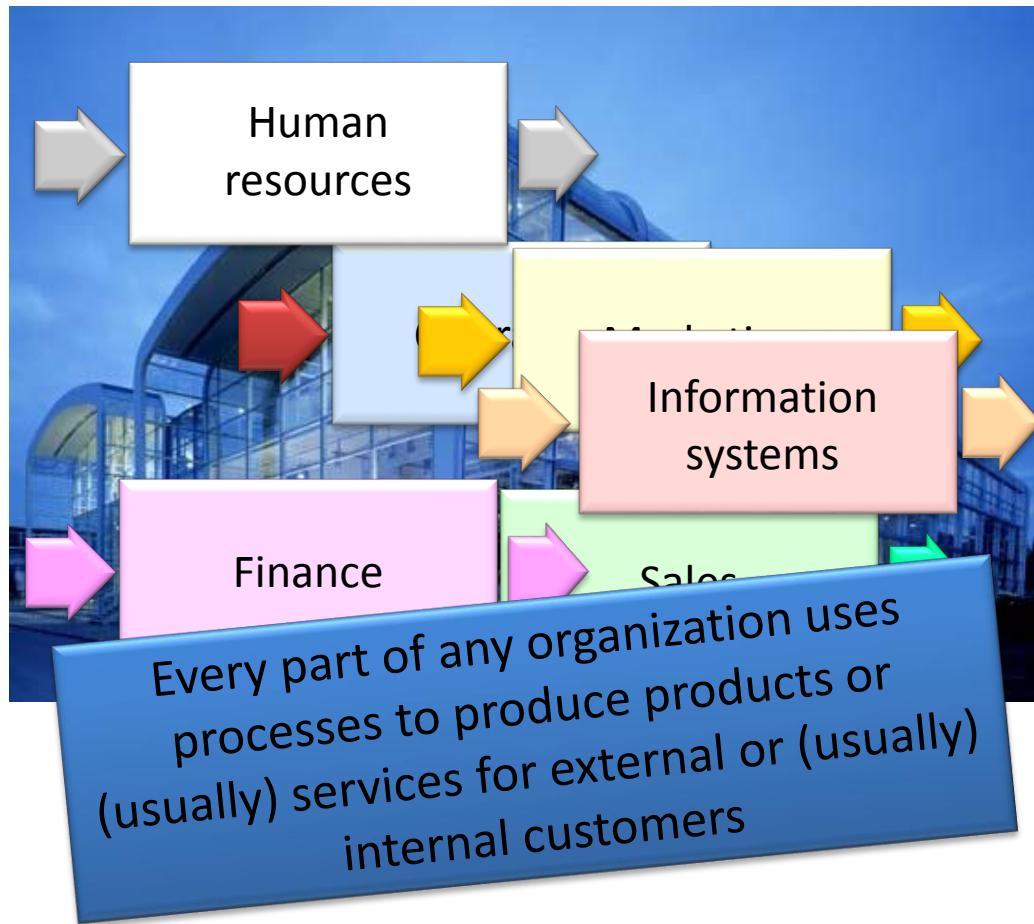


Operations management is concerned with the flow of transformed resources between operations, processes, where....

External operations interact with internal processes to form the external supply network

Processes form an internal “supply network” and become each others customers and suppliers

All functions use processes to provide service



Differences within sectors are often greater than the differences between sector

Financial services

An account management centre at a large retail bank

Financial analyst advising a client at an investment bank

Furniture manufacturing

Mass production of kitchen units

Craft production of reproduction 'antique' furniture

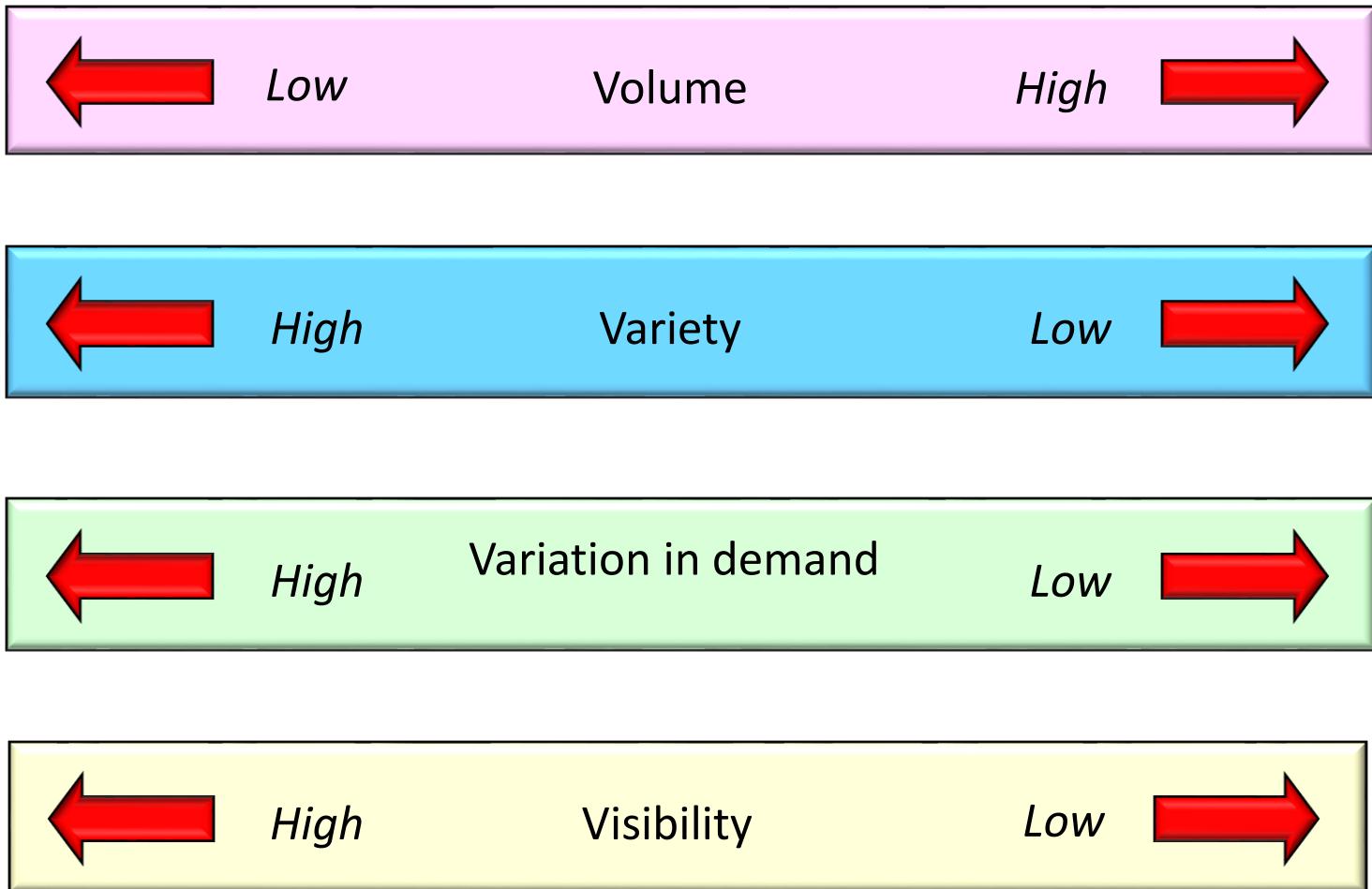
Hotels

Value-for-money hotel

Lobby of an international luxury hotel

A typology of operations and processes

The 4 vs.....



A typology of operations and processes

The implications of high and low Volume in operations and processes.....

Implications

- Low repetition
- Each staff member performs more of each task
- Less systemization
- High unit costs

Implications

- High repeatability
- Specialization
- Capital intensive
- Low unit costs



A typology of operations and processes

The implications of high and low Variety in operations and processes.....



A typology of operations and processes

The implications of high and low Variation in operations and processes.....



A typology of operations and processes

The implications of high and low Visibility in operations and processes.....

Implications

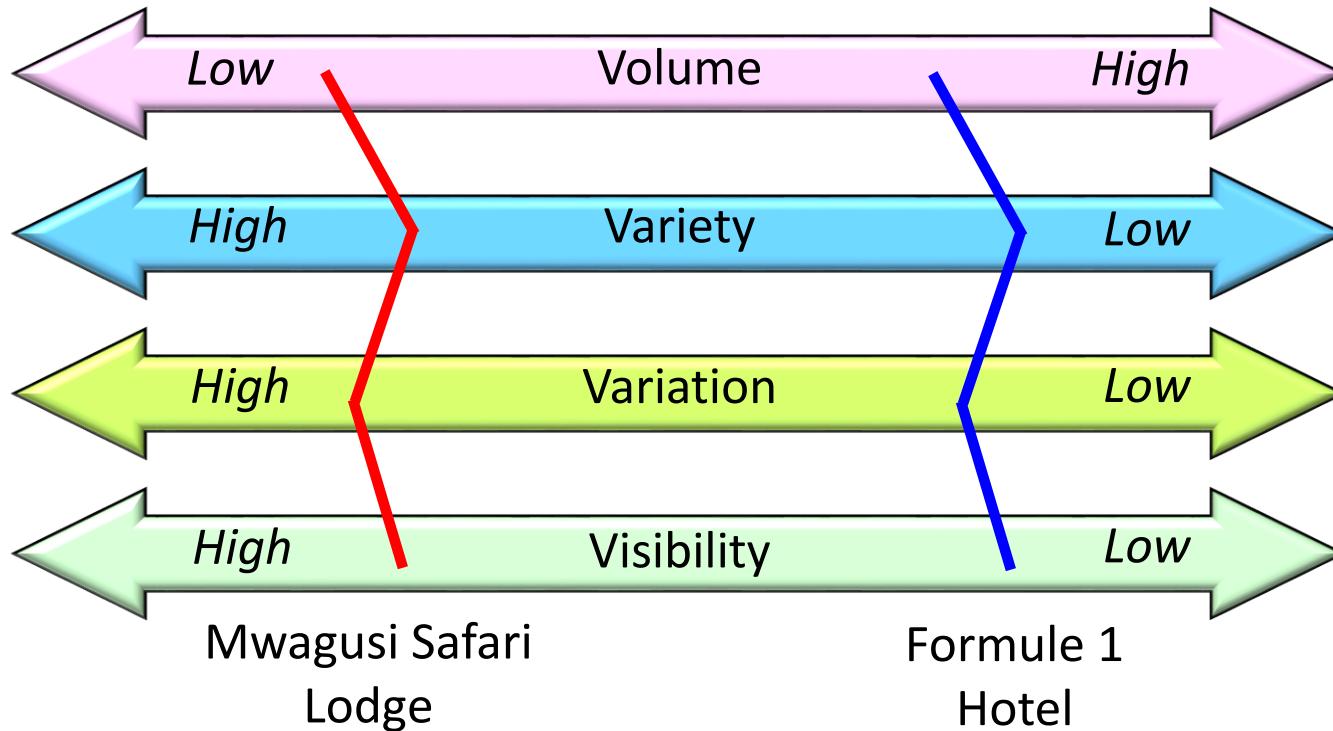
- Short waiting tolerance
- Satisfaction governed by customer perception
- Customer contact skills needed
- Received variety is high
- High unit costs

Implications

- Time lag between production and consumption
- Standardization
- Low contact skills
- High staff utilization
- Centralization
- Low unit costs

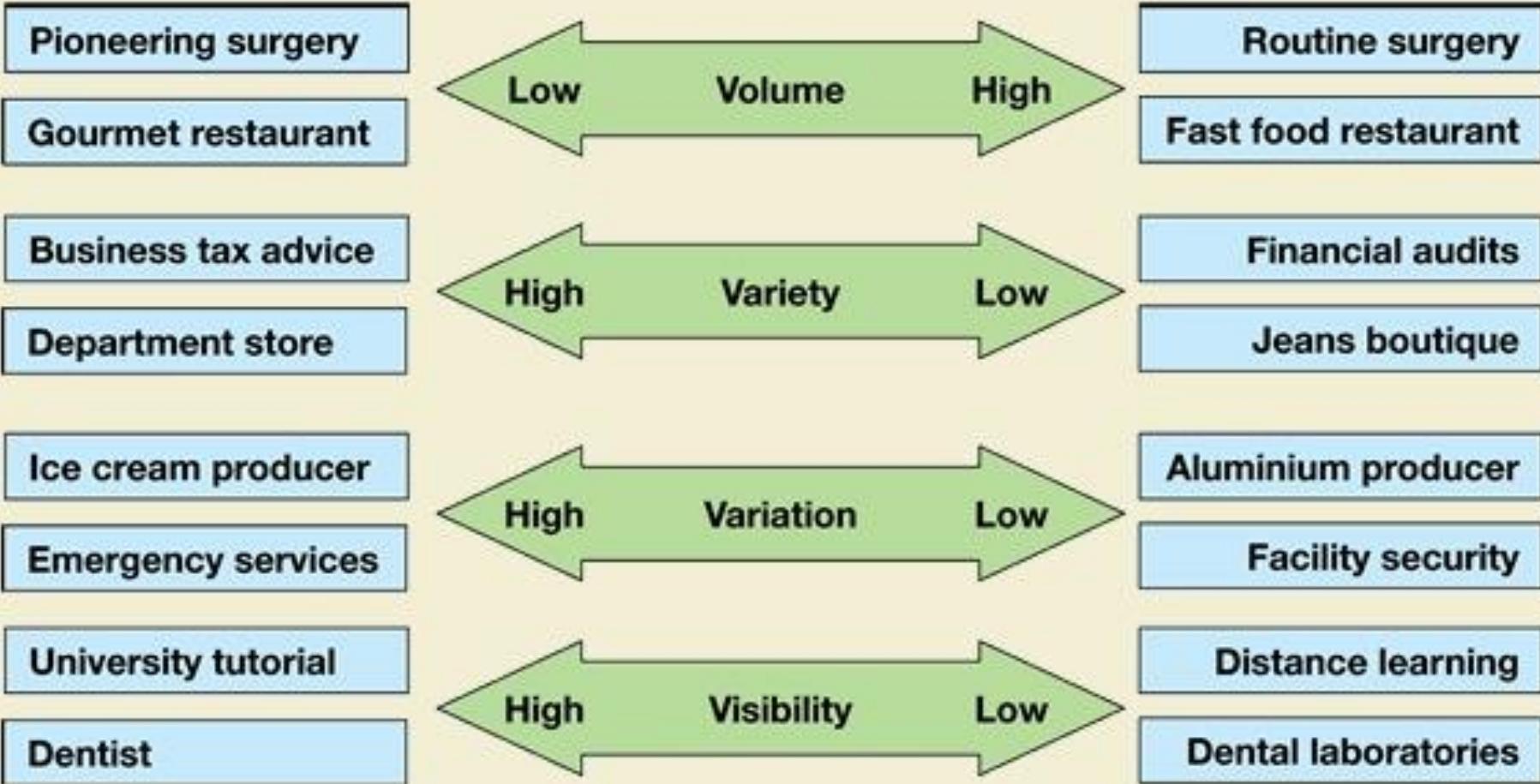


A 4 Vs profile of two operations



- Important to understand how different operations are positioned on the 4 V's.
- Is their position where they want to be?
- Do they understand the strategic implications?

4 Vs Examples



4 Vs Example - Sales



Large account sales process.

80 transactions per month, average value

€58,000

Every customer has negotiated a complex set of discounts, terms of trade, etc.

Because there are few customers needing individual attention, sales activity can fluctuate significantly

Customers expect the sales team to visit them.

Small account sales process.

1,500 transactions per month, average value €2,300

All customers accept standard discounts, terms of trade, etc.

Sales activity fluctuates, but smaller customers encouraged to place orders early.

Customers all use internet or call centre to place orders.



Operations Management

MGT355



Operations strategy



Key operations questions

- ❑ *What is strategy and operations strategy?*
- ❑ *What is the difference between a ‘top-down’ and a ‘bottom-up’ view of operations strategy?*
- ❑ *What is the difference between a ‘market requirements’ and an ‘operations resources’ view of operations strategy?*



Operations strategy at Flextronics and Ryanair



For each of these companies.....

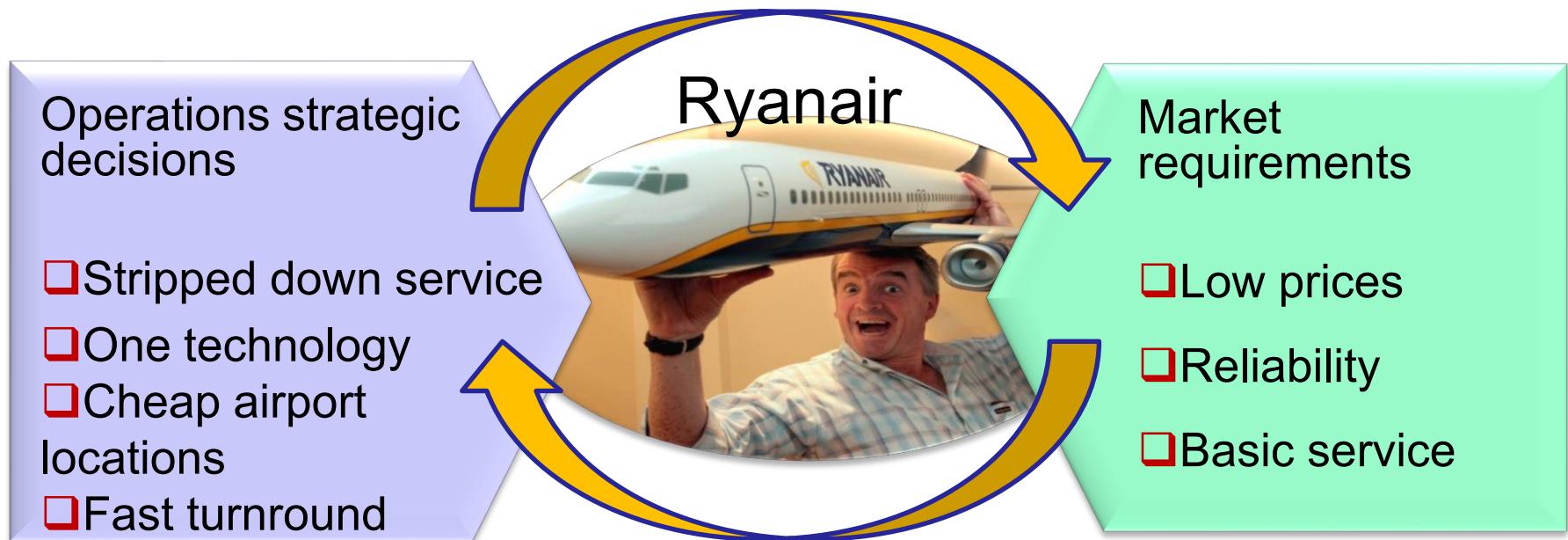
1. What do they have to be good at to compete in their markets?
2. How do their operations help them to achieve this?



Operations strategy at Flextronics



Operations strategy at Ryanair



What is strategy?

- ❑ Setting broad objectives that direct an enterprise towards its overall goal
- ❑ Planning the path (in general rather than specific terms) that will achieve these goals
- ❑ Stressing long-term rather than short-term objectives
- ❑ Dealing with the total picture rather than stressing individual activities
- ❑ Being detached from, and above, the confusion and distractions of day-to-day activities.



Strategic decisions



Strategic decisions are those decisions which: are widespread in their effect on the organization to which the strategy refers, define the position of the organization relative to its environment, and move the organization closer to its long-term goals.

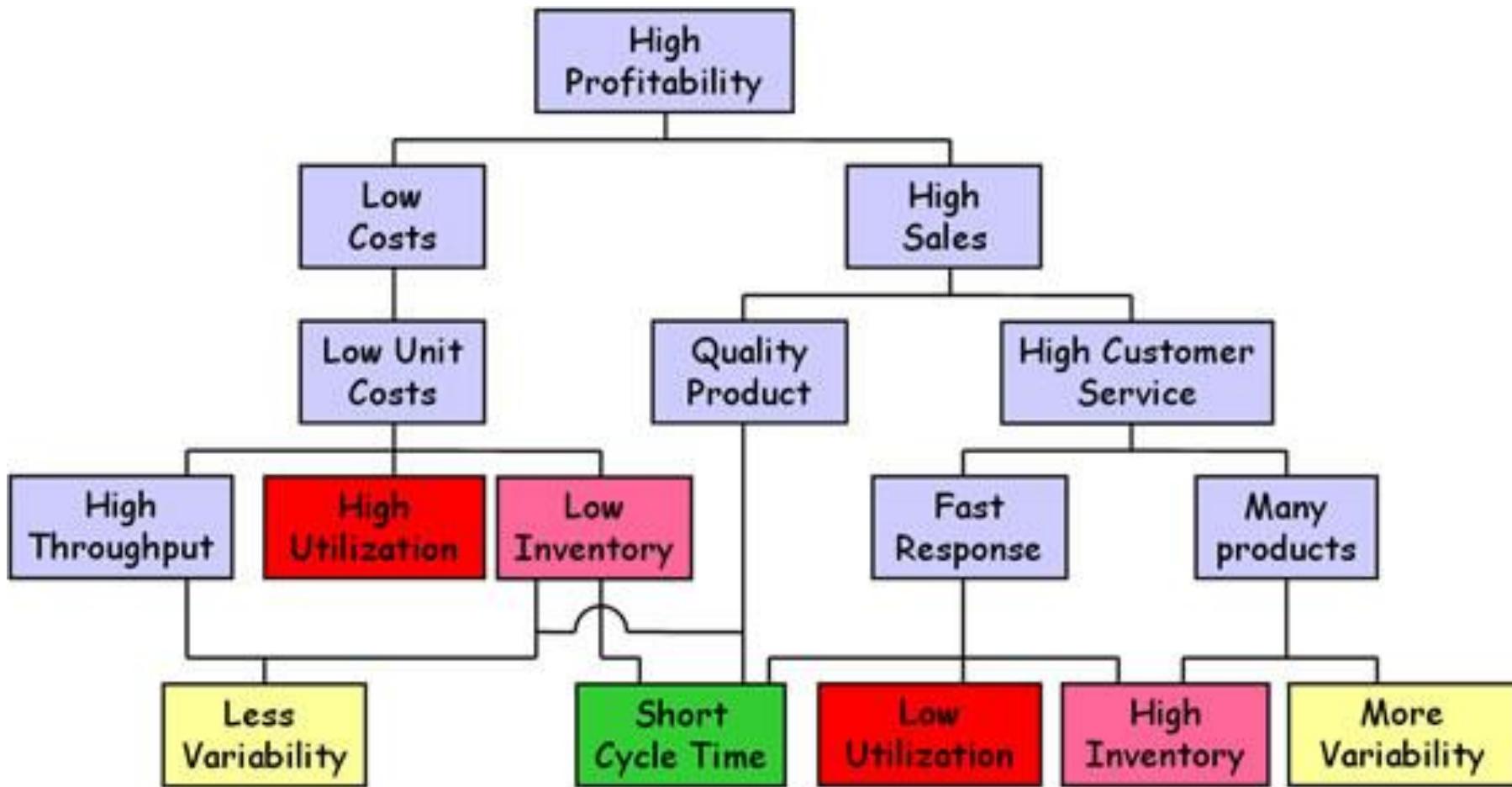


Porter's Generic Strategies

Target Scope	Advantage	
	Low Cost	Product Uniqueness
Broad (Industry Wide)	Cost Leadership Strategy	Differentiation Strategy
Narrow (Market Segment)	Focus Strategy (low cost)	Focus Strategy (differentiation)



Strategy and Operations



'Operations' is not the same as '*operational*'

- 'Operations' are the resources that create products and services.
- 'Operational' is the opposite of strategic, meaning day-to-day and detailed.
- So, one can examine both the operational *and* the strategic aspects of operations.



How is operations strategy different to operations management?

The time scale is longer...

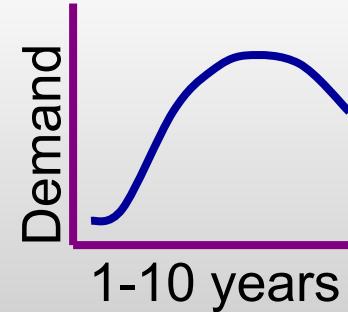
Operations management

Short-term
for example,
capacity decisions

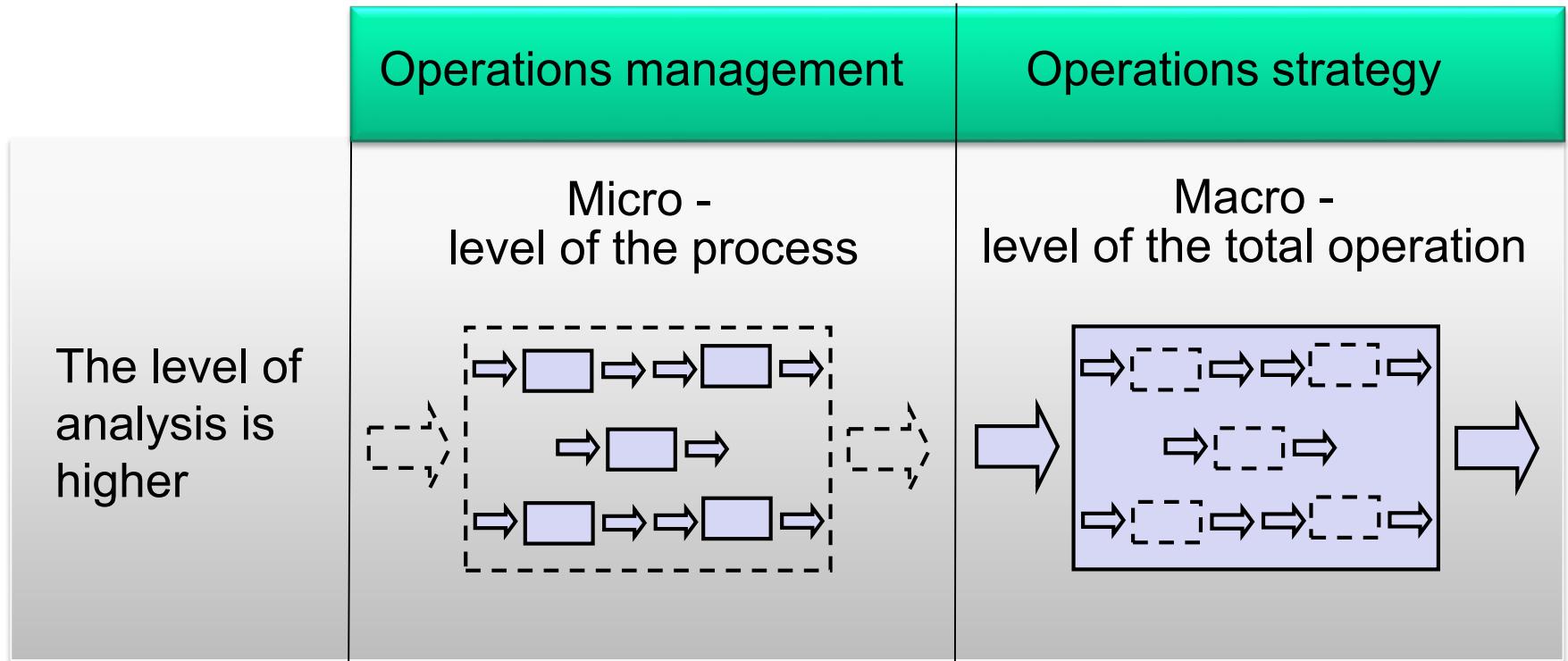


Operations strategy

Long-term
for example,
capacity decisions



How is operations strategy different to operations management?



How is operations strategy different to operations management?

	Operations management	Operations strategy
The level of aggregation is higher	<p>Detailed</p> <p>For example.....</p> <p><i>“Can we give tax services to the small business market in Antwerp?”</i></p>	<p>Aggregated</p> <p>For example.....</p> <p><i>“What is our overall business advice capability compared with other capabilities?”</i></p>

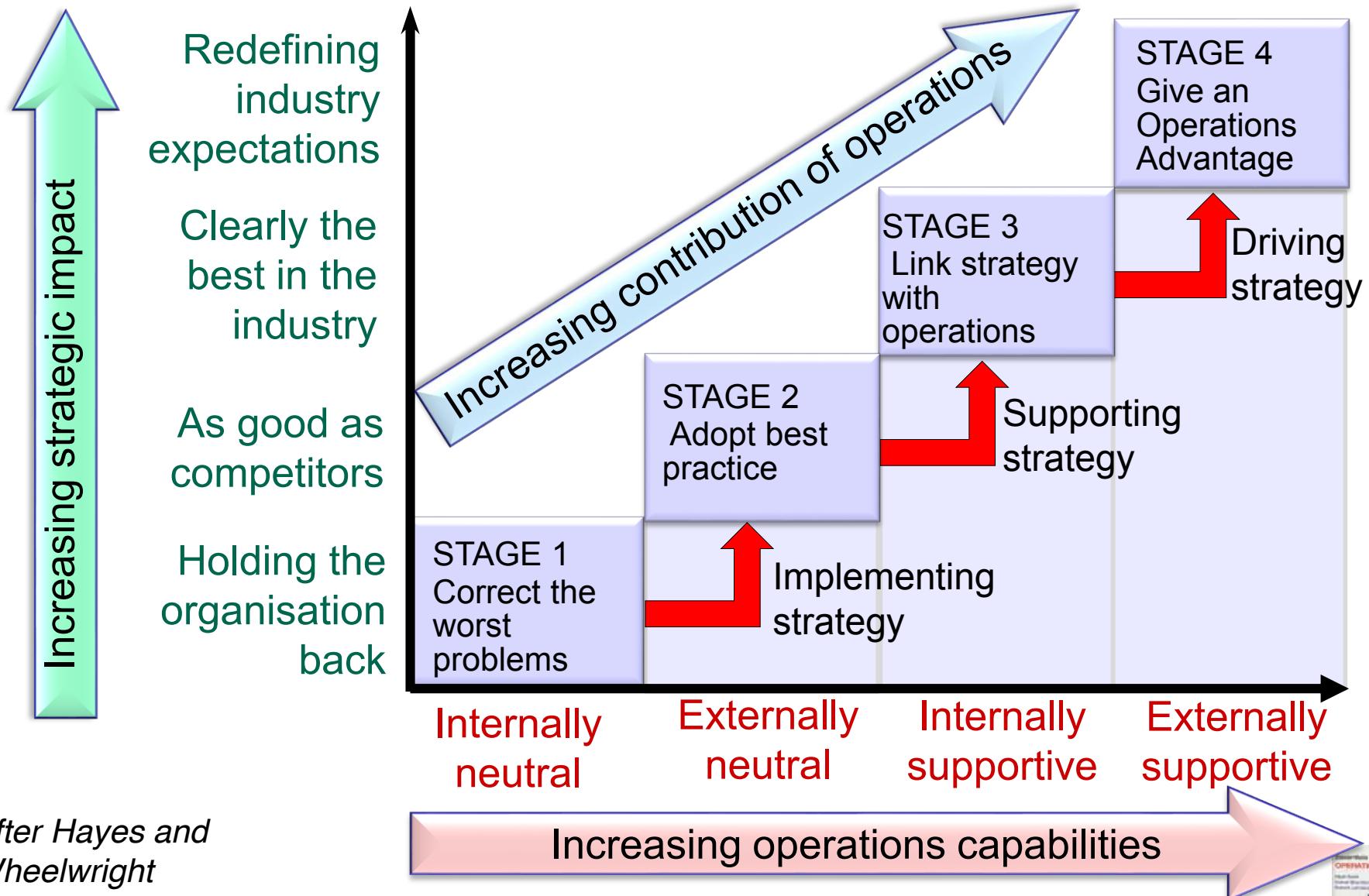


How is operations strategy different to operations management?

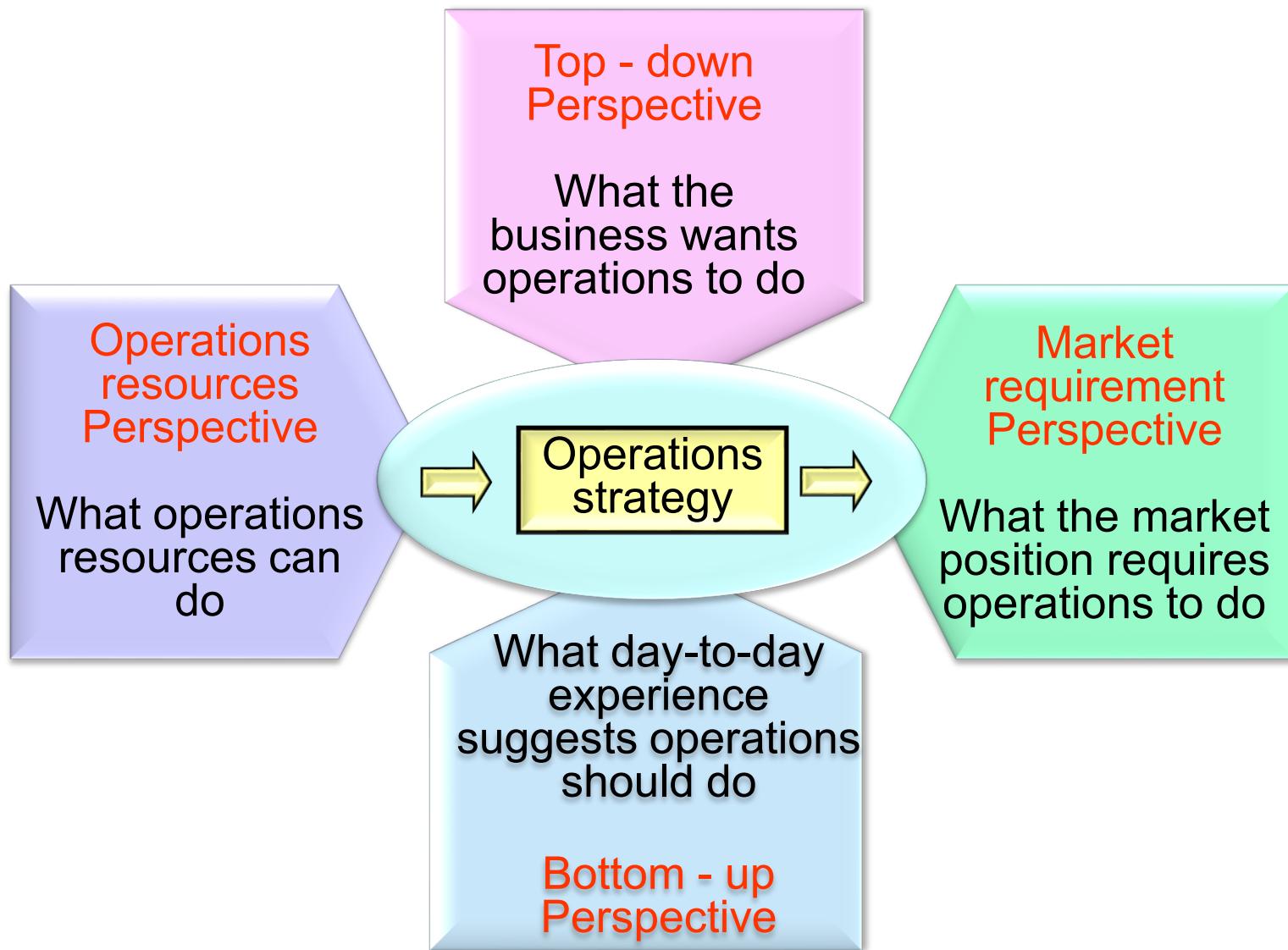
	Operations management	Operations strategy
The level of abstraction is higher	<p>Concrete</p> <p>For example</p> <p><i>“How do we improve our purchasing procedures?”</i></p>	<p>Philosophical</p> <p>For example</p> <p><i>“Should we develop strategic alliances with suppliers?”</i></p>



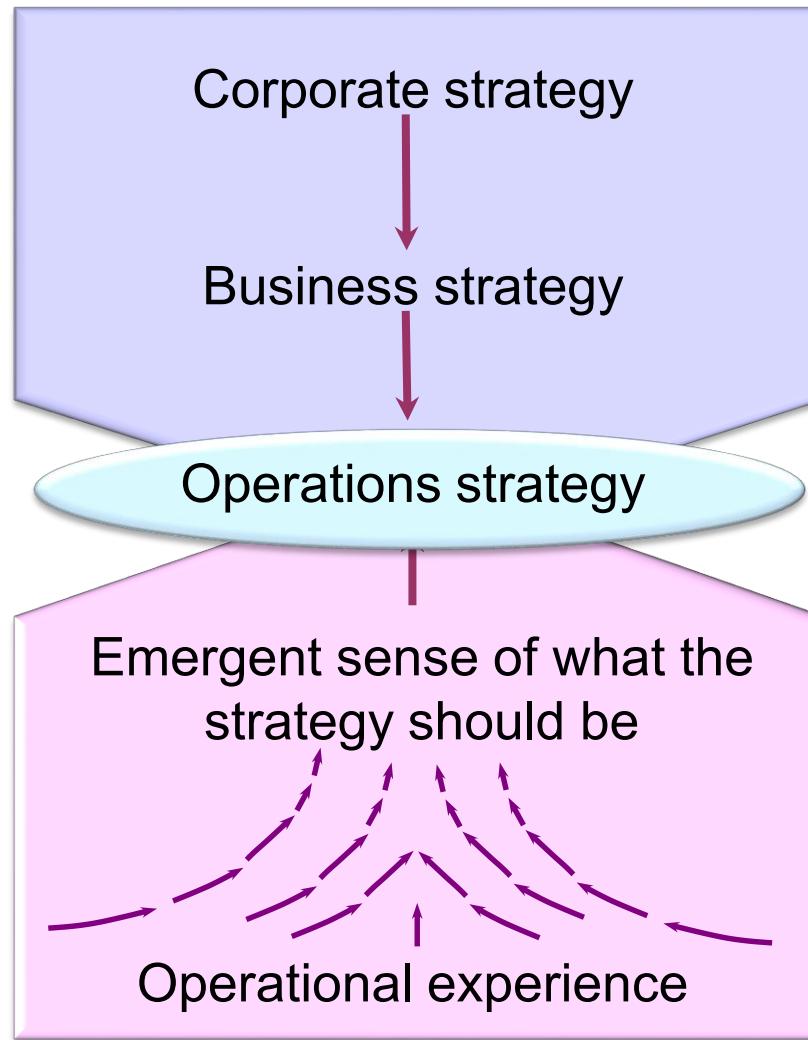
The 4 stage model of operations contribution



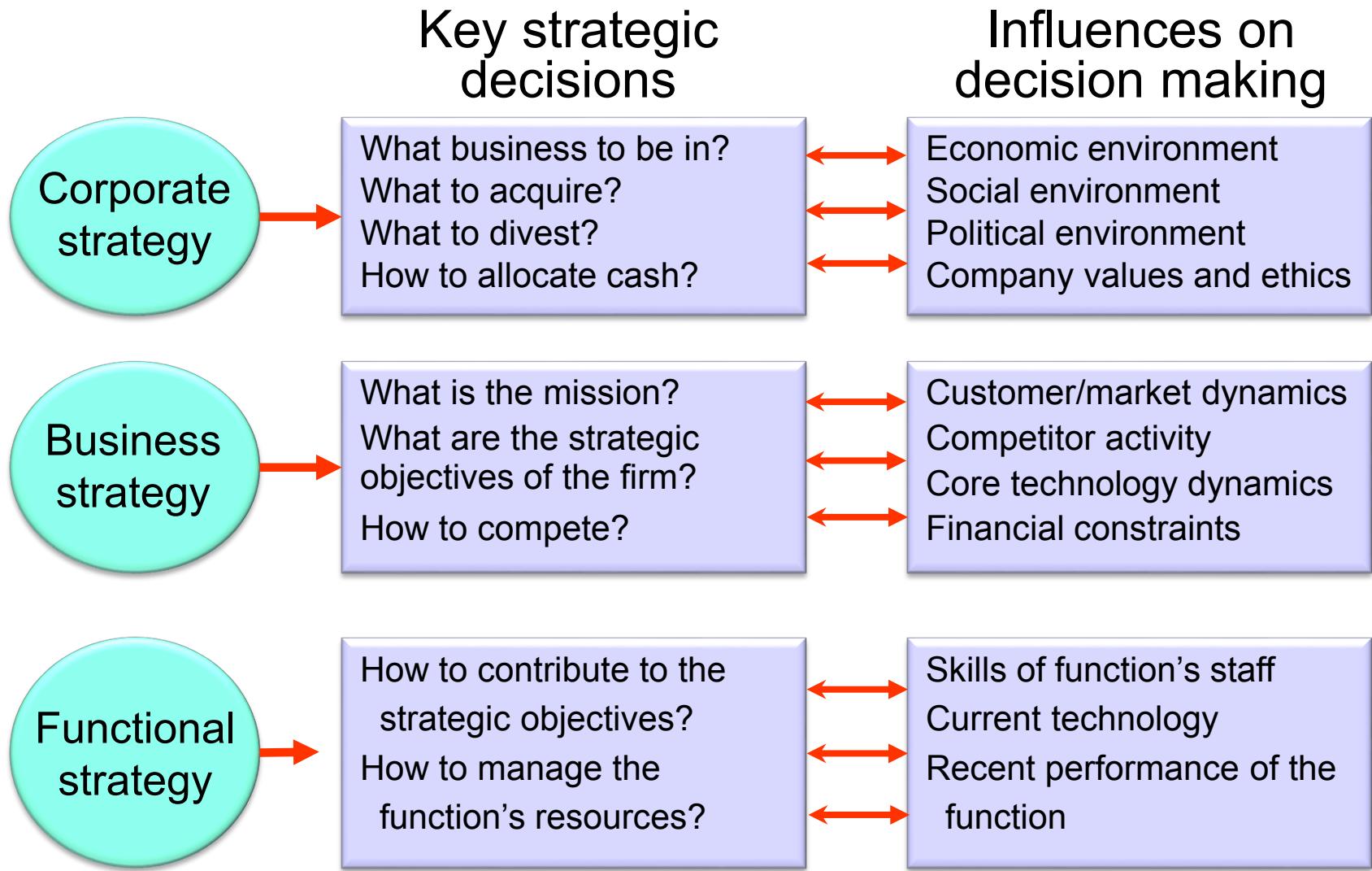
The four perspectives on operations strategy



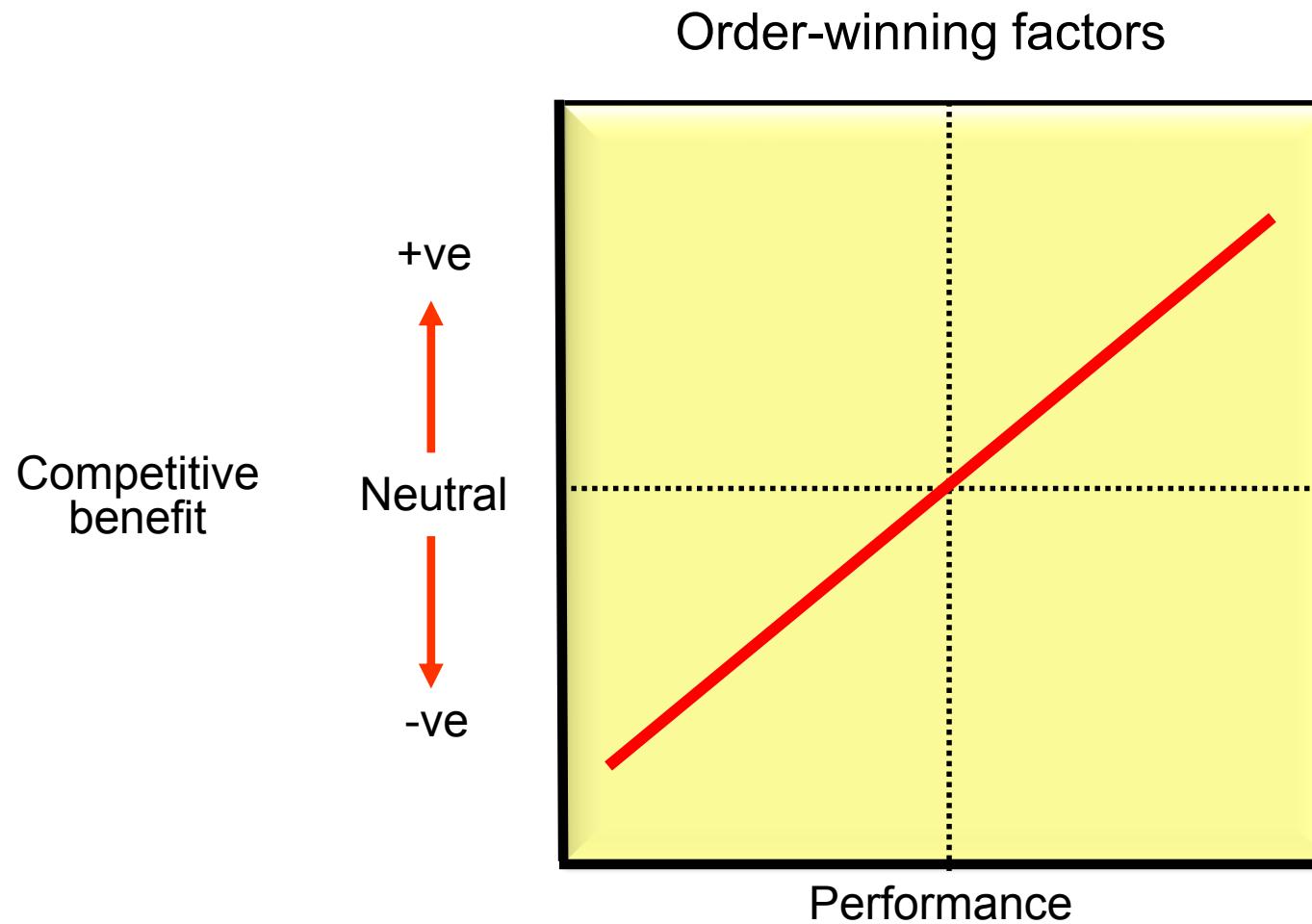
Top-down and bottom-up perspectives of strategy



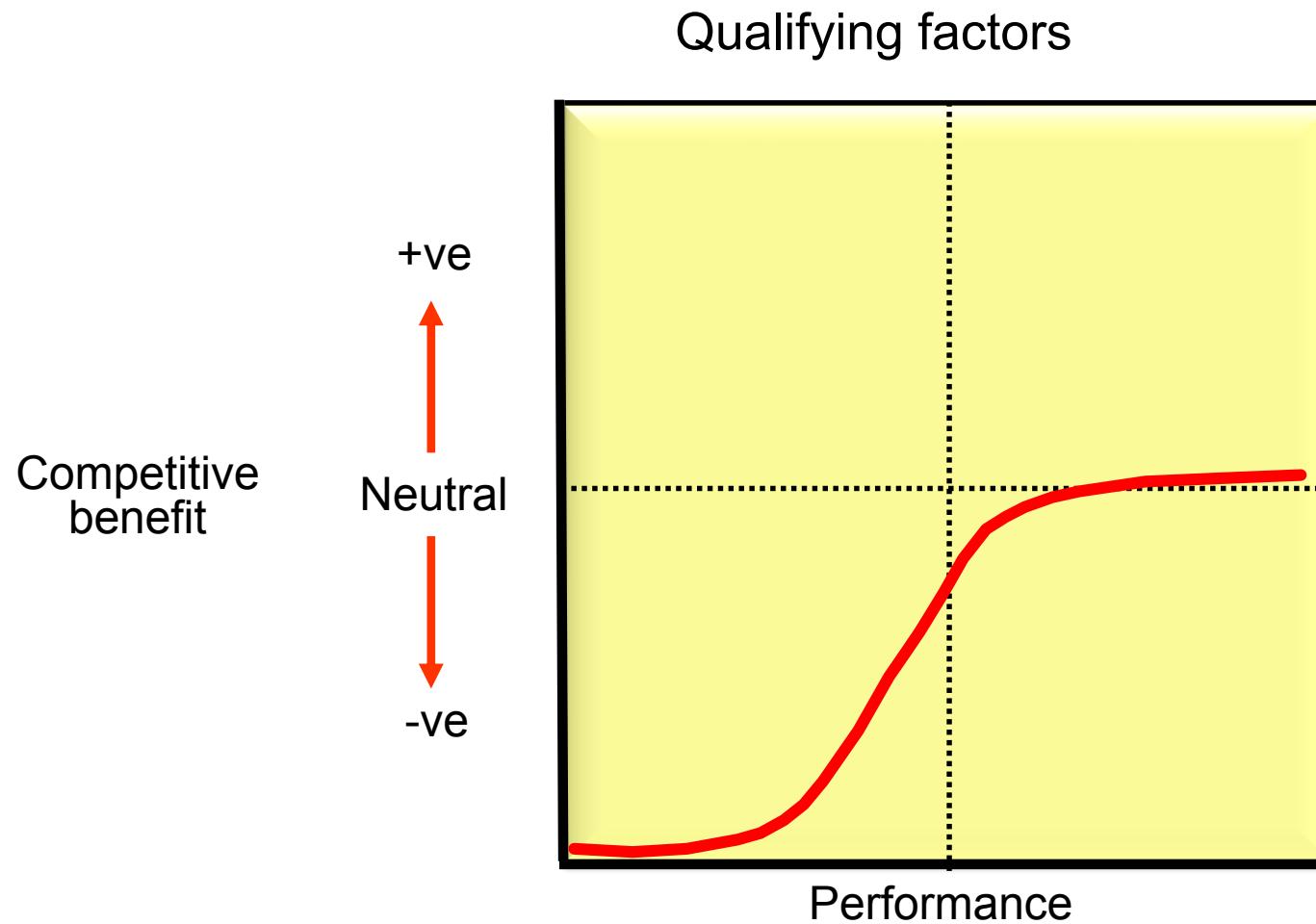
The strategy hierarchy



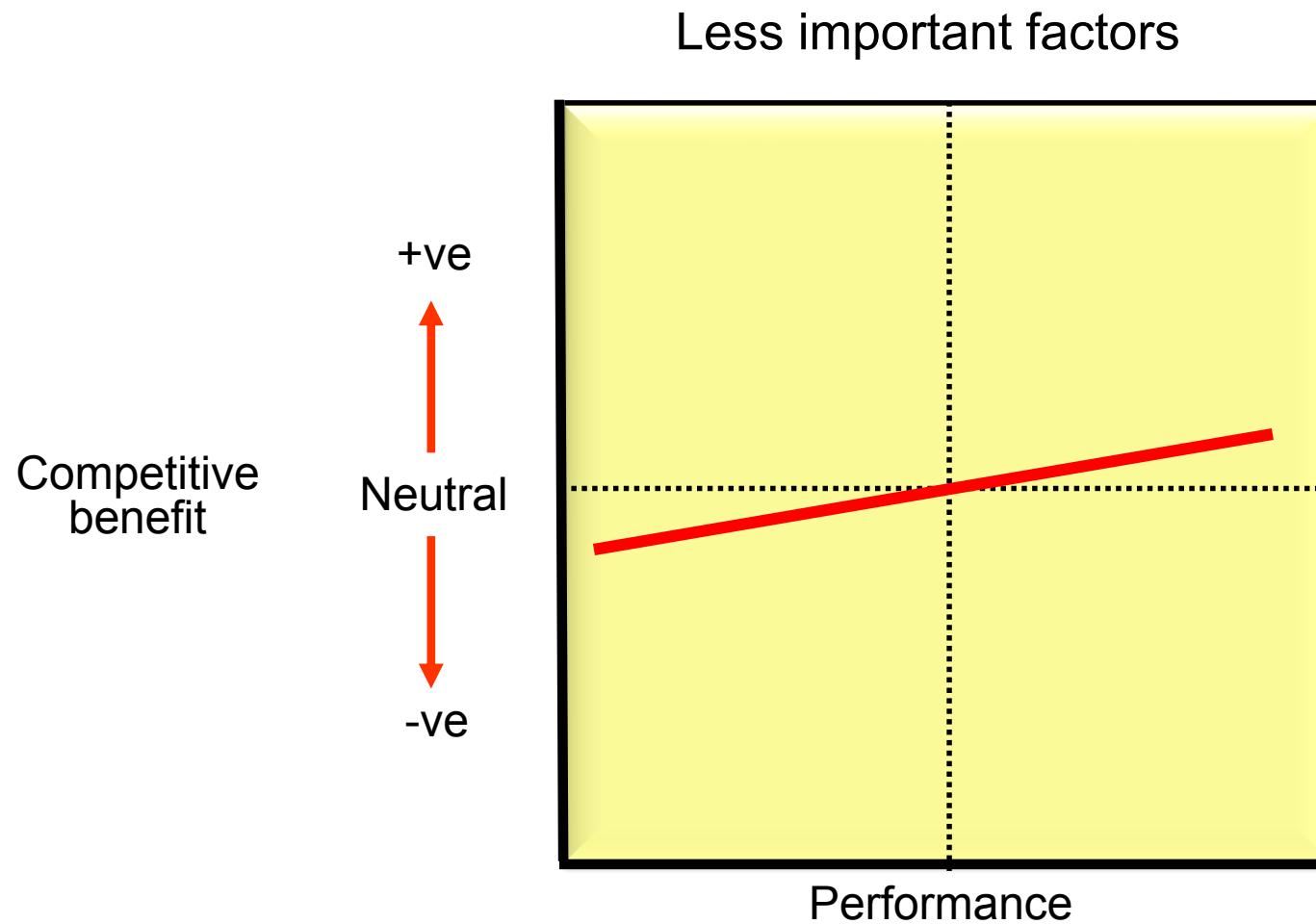
Order-winning, qualifying and less important competitive factors



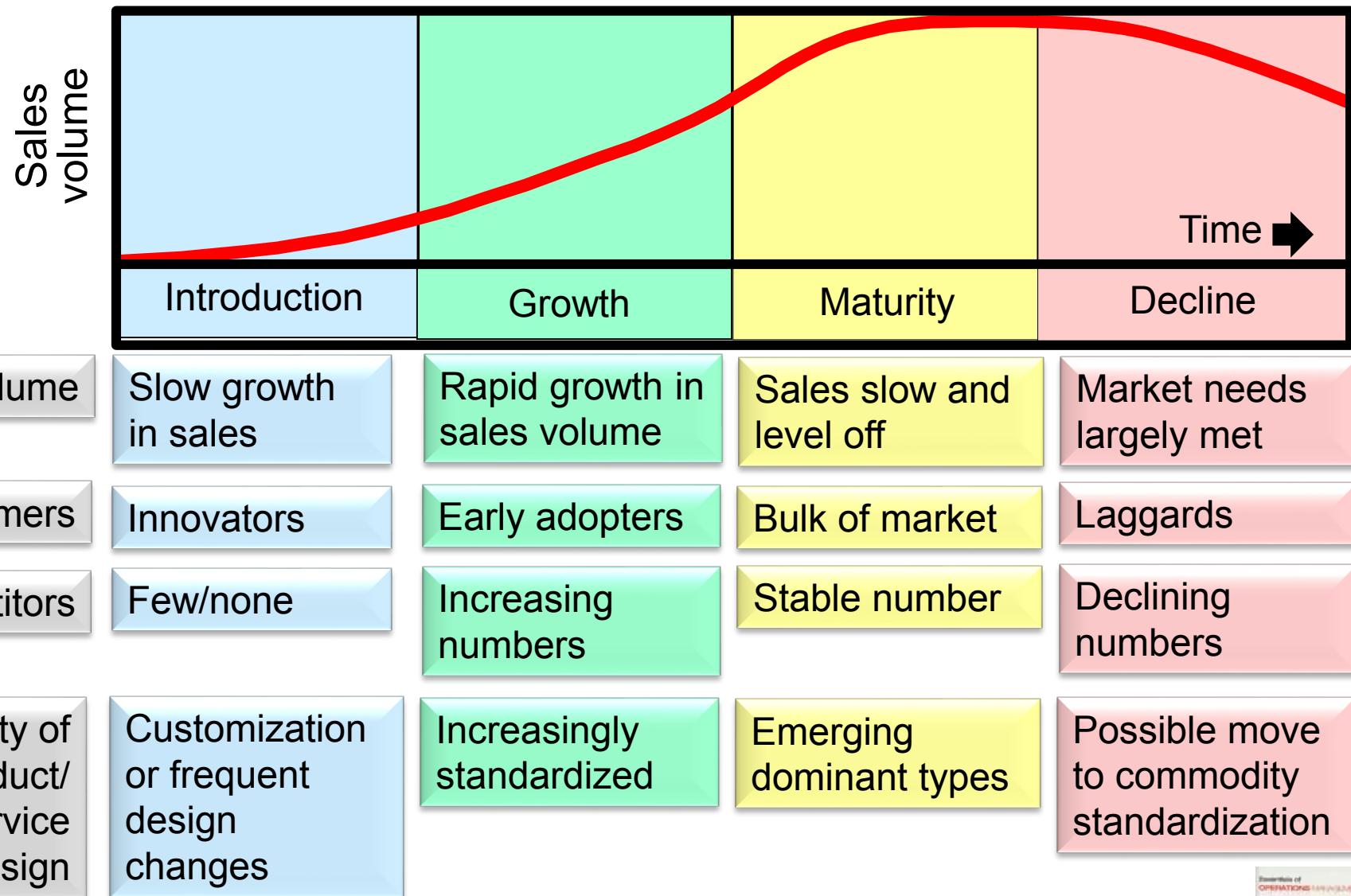
Order-winning, qualifying and less important competitive factors



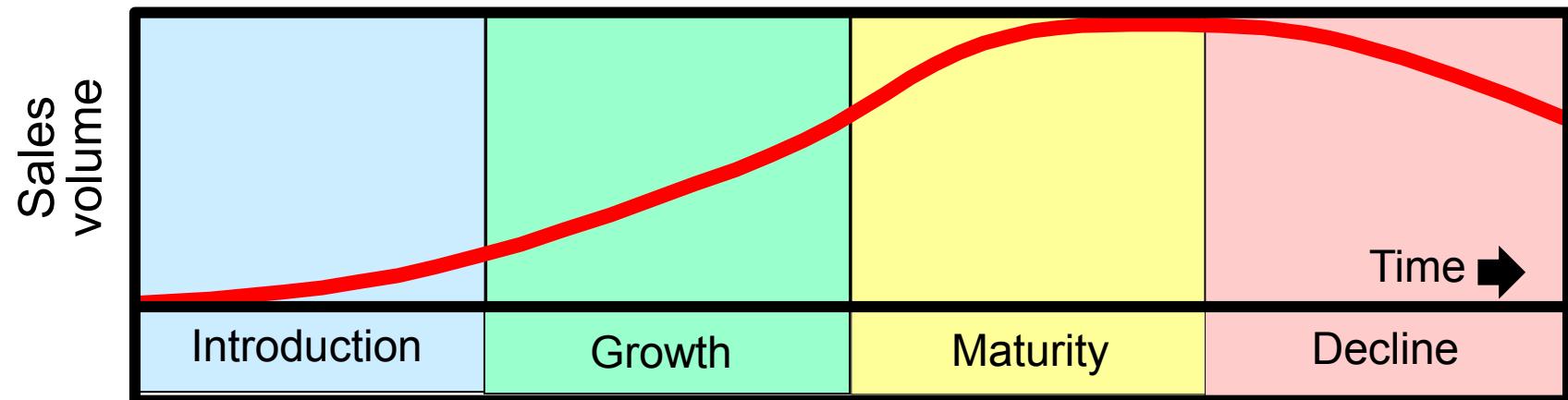
Order-winning, qualifying and less important competitive factors



The effects of the product / service life cycle



The effects of the product / service life cycle



Likely order winners

Product/
service
characteristics

Availability
Quality

Low price
Dependable
supply

Low price

Likely
qualifiers

Quality
Range

Price
Range

Quality
Range

Dependable
supply

Dominant
performance
objectives

Flexibility
Quality

Speed
Dependability
Quality

Cost
Dependability

Cost



Different competitive factors imply different performance objectives

Competitive factors
If the customers value these ...

Performance objectives
Then, the operations will need to excel at these ...

Low price



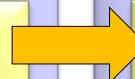
Cost

High quality



Quality

Fast delivery



Speed

Reliable delivery



Dependability

Innovative products and services



Flexibility (products/services)

Wide range of products and services



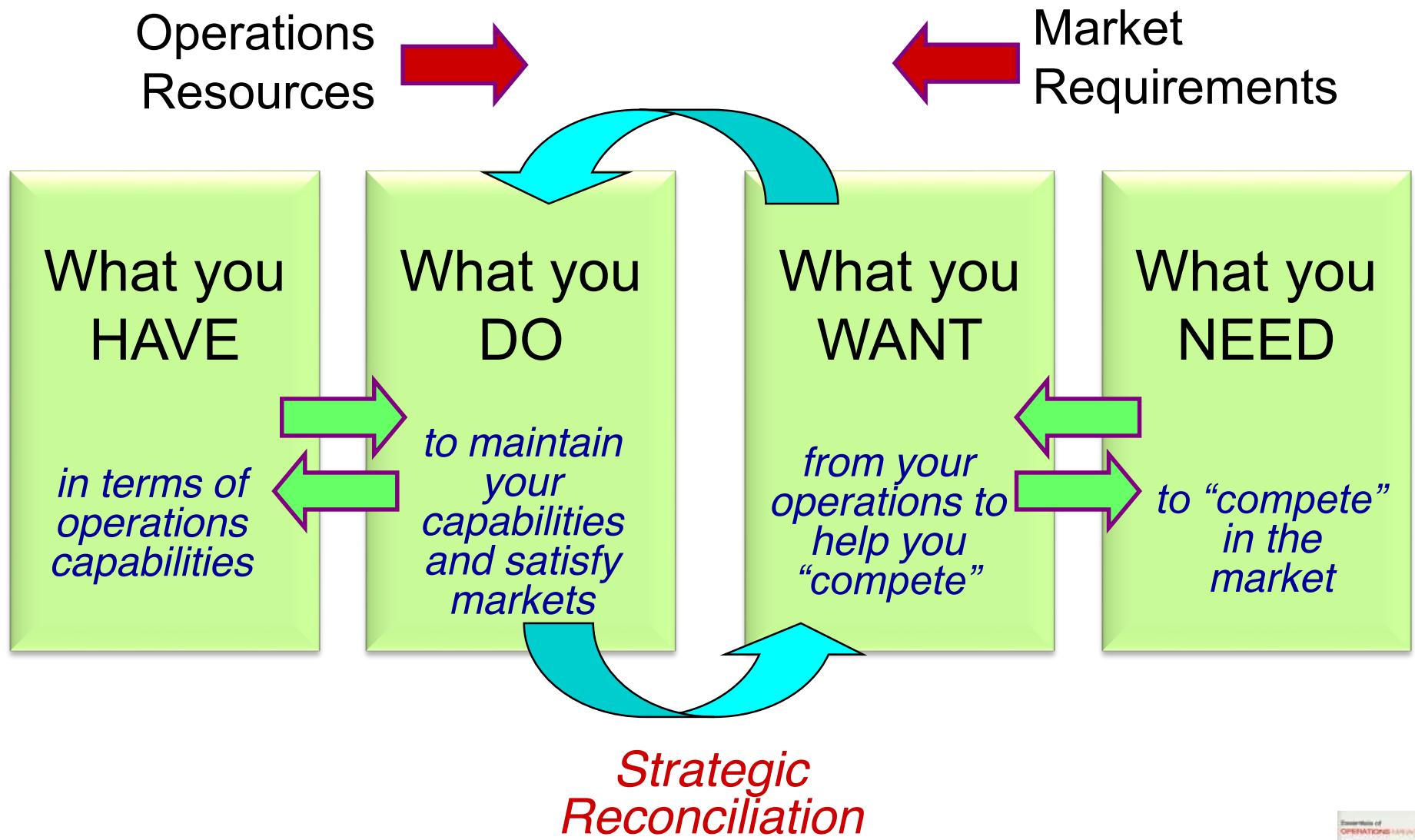
Flexibility (mix)

The ability to change the timing or quantity of products and services



Flexibility (volume and/or delivery)







Operations Management

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Social, environmental and economic performance

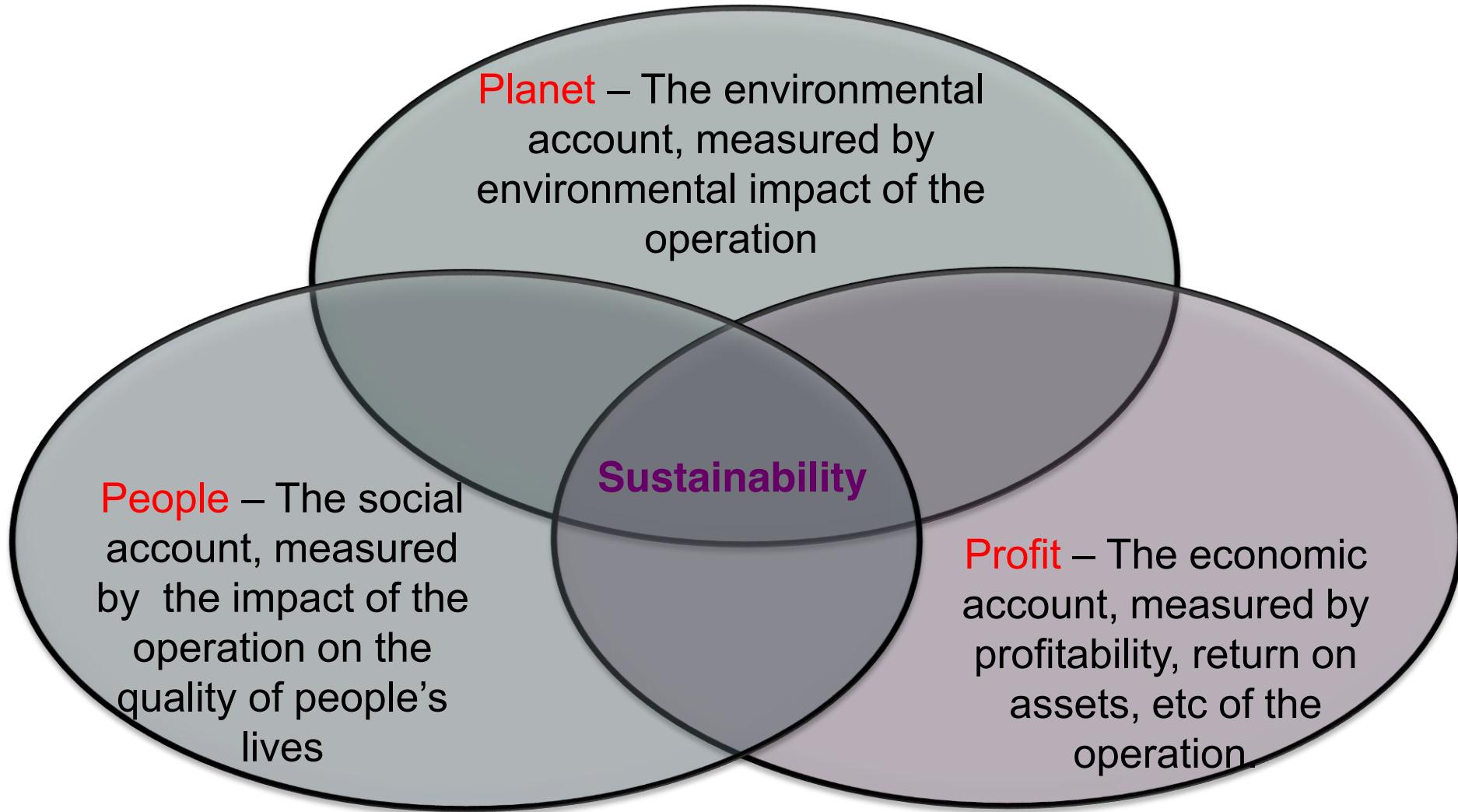


Key operations questions

- ❑ *Why is operations performance important in any organization?*
- ❑ *How should the operations function judge itself?*
- ❑ *What does top management expect from the operations function?*
- ❑ *What are the performance objectives of operations and what are the internal and external benefits which derive from excelling in each of them?*
- ❑ *How do operations performance objectives trade off against each other?*



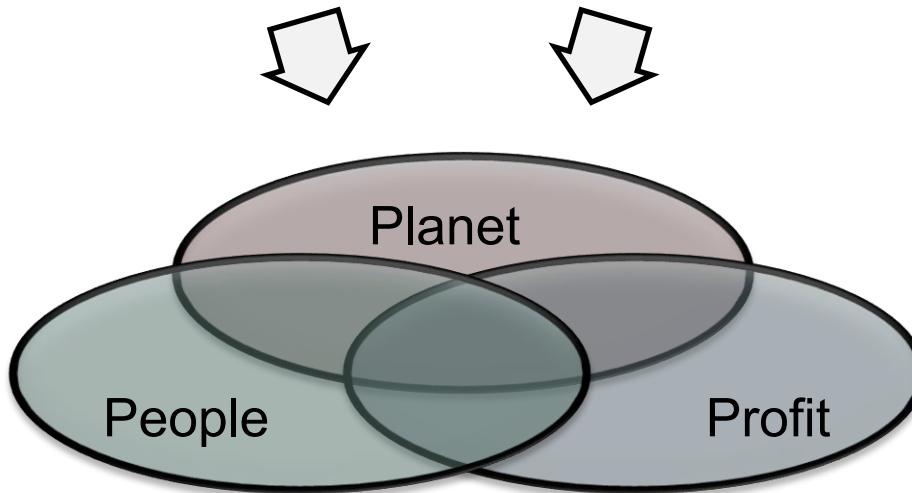
The triple bottom line



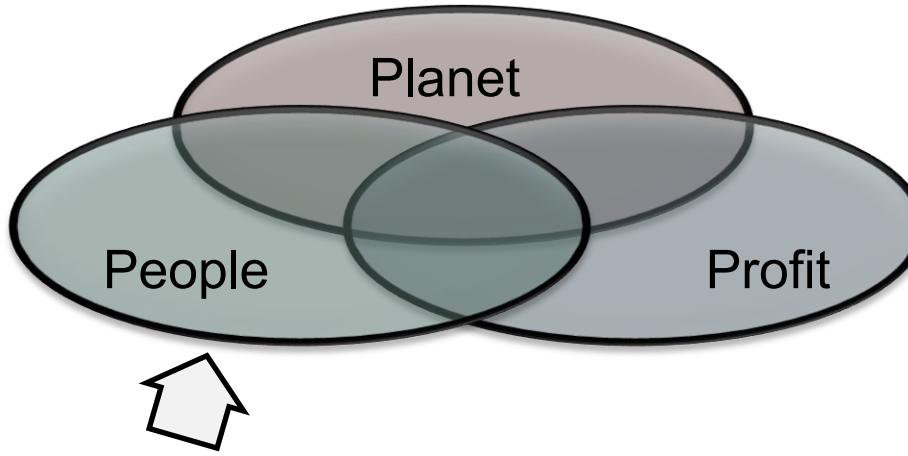
Some ways in which operations can impact each element of the triple bottom line - Planet

- Recyclability of materials, energy consumption, waste material generation
- Reducing transport-related energy
- Noise pollution, fume and emission pollution

- Obsolescence and wastage
- Environmental impact of process failures
- Recovery to minimize impact of failures



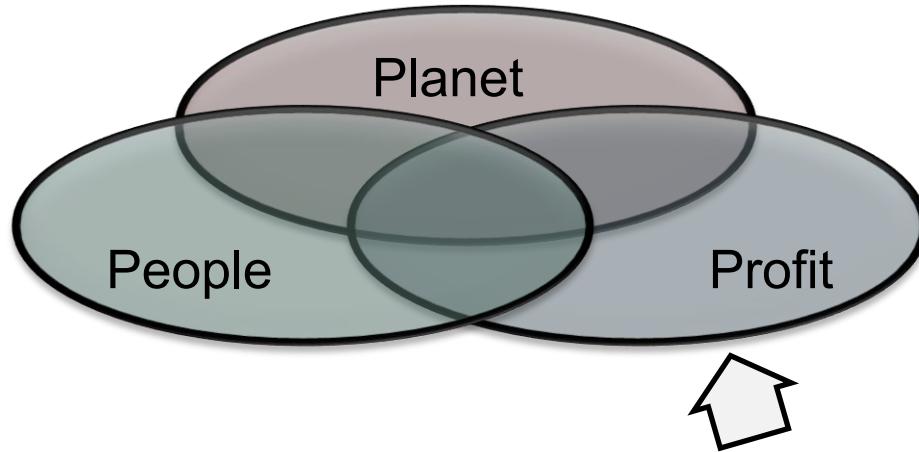
Some ways in which operations can impact each element of the triple bottom line – People



- Customer safety from products and services
- Employment impact of an operation's location
- Employment implications of outsourcing
- Repetitive or alienating work
- Staff safety and workplace stress
- Non-exploitation of developing country suppliers



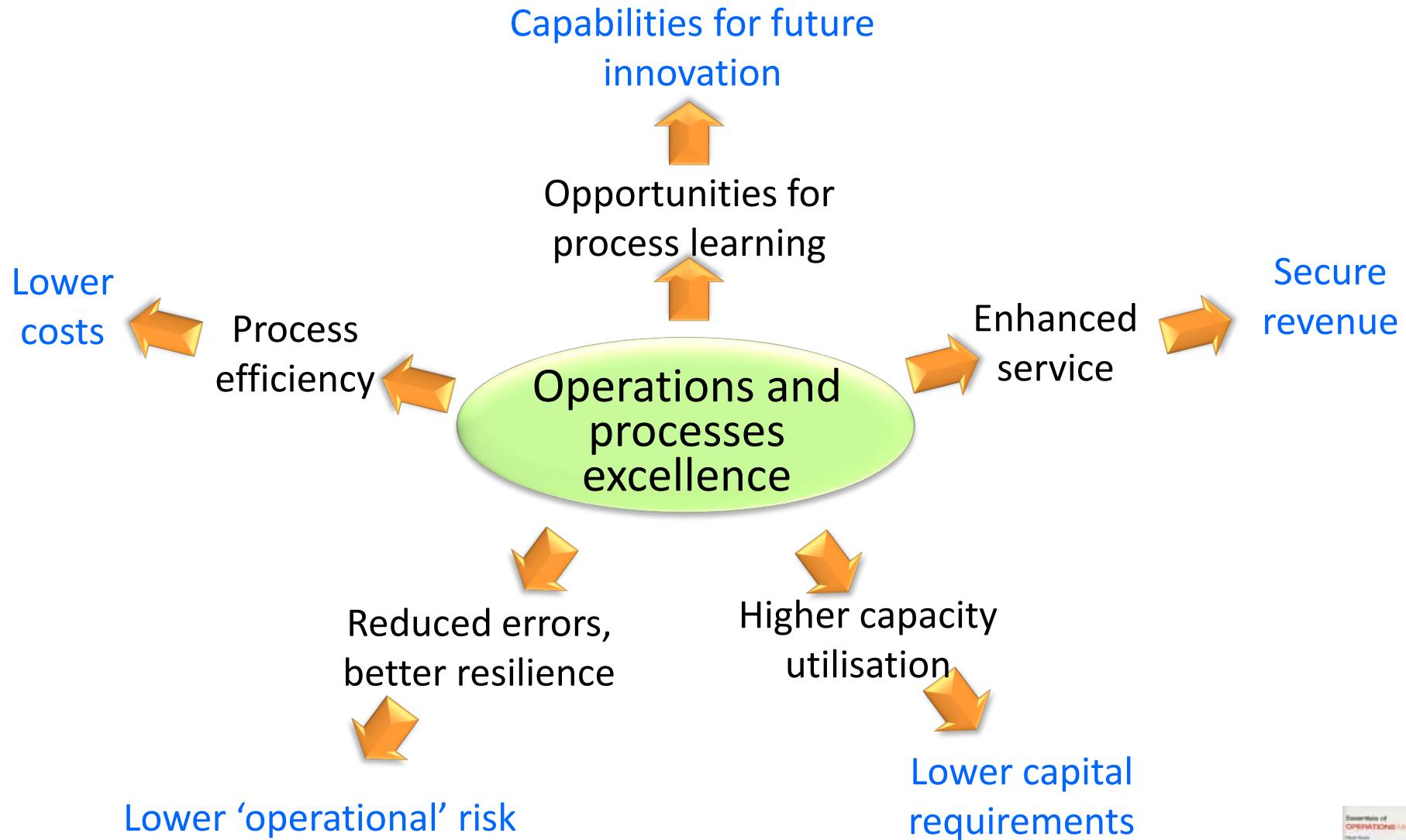
Some ways in which operations can impact each element of the triple bottom line - Profit



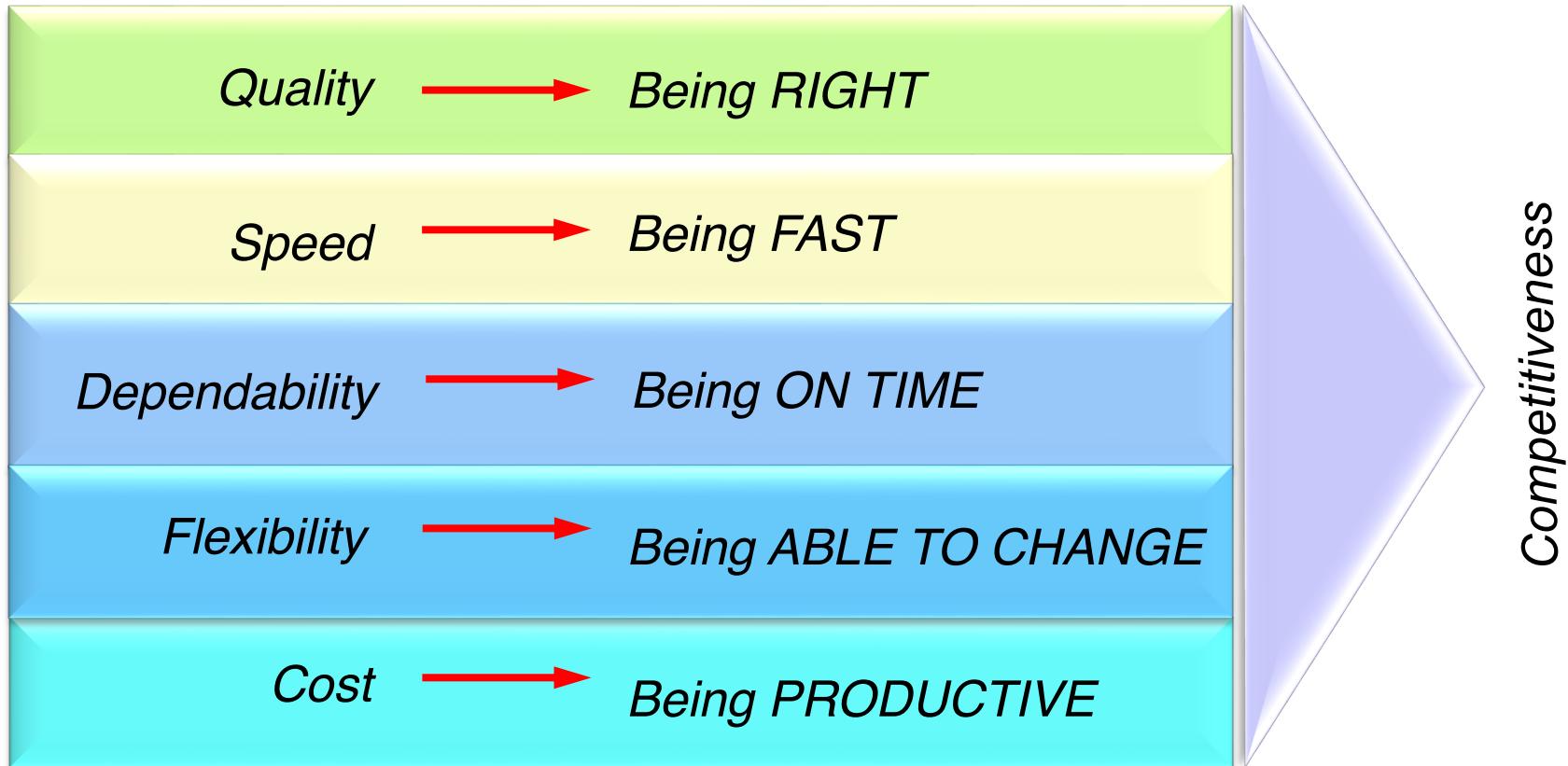
- Cost of producing products and services
- Revenue from the effects of quality, speed, dependability, and flexibility
- Effectiveness of investment in operations resources
- Risk and resilience of supply
- Building capabilities for the future



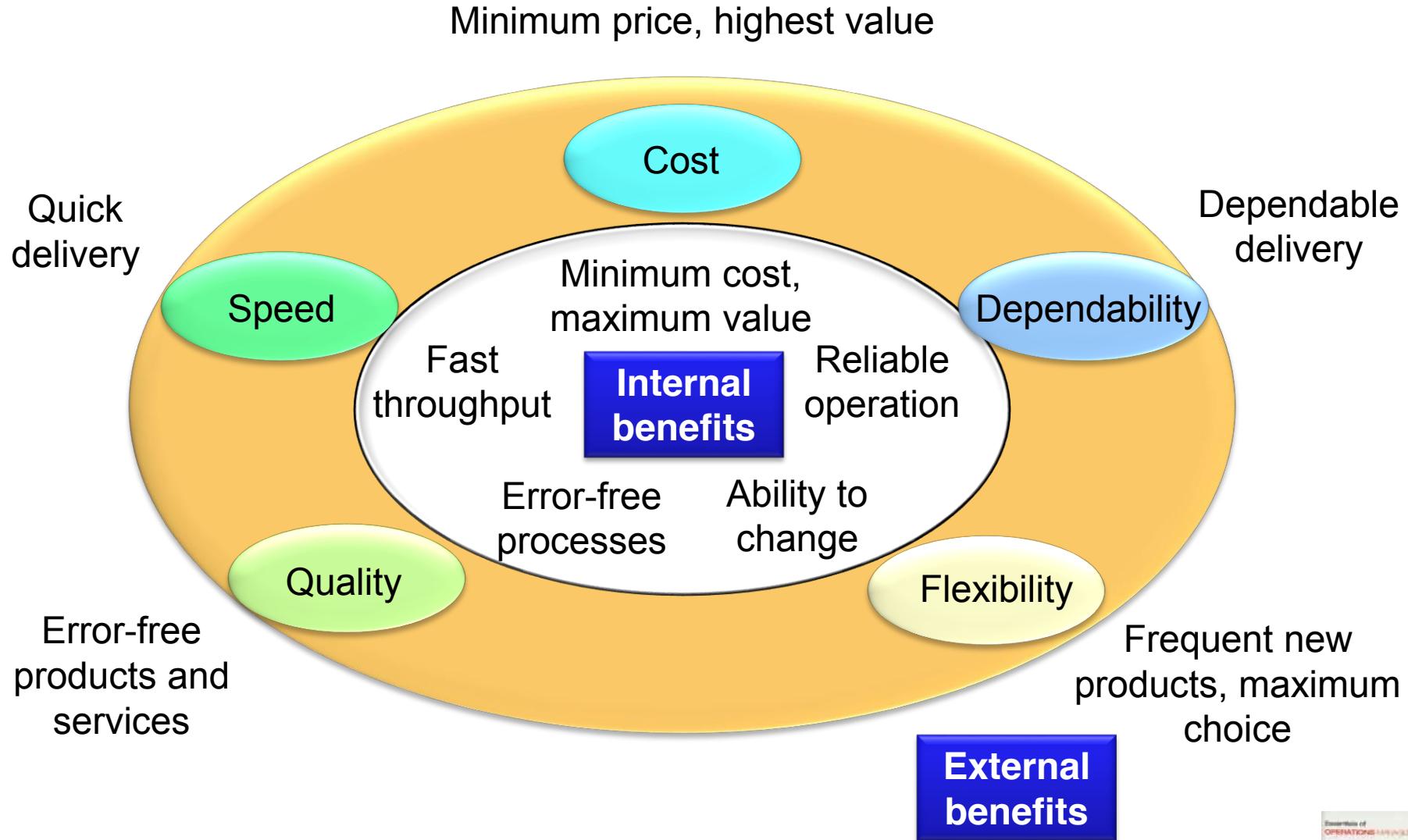
Operations and process management contribution to strategy



The five competitive objectives



The benefits of excelling at the five objectives



What does Quality mean in.....

.... a Hospital ?

- Patients receive the most appropriate treatment
- Treatment is carried out in the correct manner
- Patients are consulted and kept informed
- Staff are courteous, friendly and helpful



What does Quality mean in.....

.... an automobile plant?



- All assembly is to specification
- Product is reliable
- All parts are made to specification
- The product is attractive and blemish-free



What does Quality mean in.....

.... a bus company?

- The buses are clean and tidy
- The buses are quiet and fume-free
- The timetable is accurate and user-friendly
- Staff are courteous, friendly and helpful



What does Quality mean in.....

.... a supermarket?



- The store is clean and tidy
- Décor is appropriate and attractive
- Goods are in good condition
- Staff are courteous, friendly and helpful



Two common meanings of “Quality”

Quality as the *specification* of
a product or service

e.g. Lower Hurst Farm
produces organic meat raised
exclusively on its own farm

Quality as the *conformance*
with which the product or
service is produced

e.g. Quick service restaurants
like McDonalds may buy less
expensive meat, but its
conformance must be high



External and internal benefits of conformance quality

Irrespective of a product or service's specification quality, producing it so it conforms to its specification consistently brings benefits to any operation

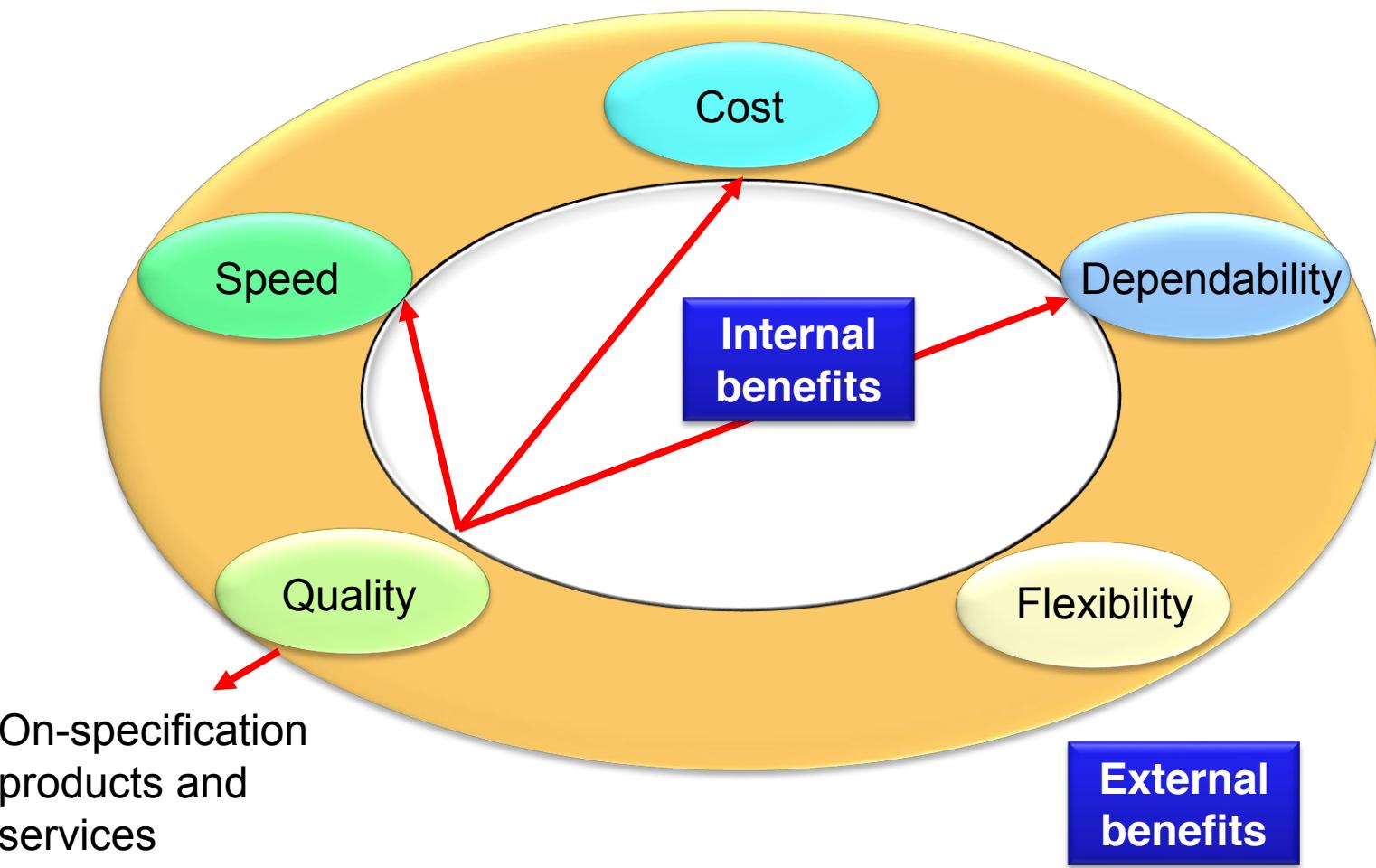
Externally -- it enhances the product or service in the market, or at least avoids customer complaints

Internally -- it brings other benefits to the operation

- It prevents errors slowing down throughput speed
- It prevents errors causing internal unreliability and low dependability
- It prevents errors causing wasted time and effort, therefore saving cost



External and internal benefits of conformance quality



What does Speed mean in.....

.... a Hospital ?

- The time between requiring treatment and receiving treatment is kept to a minimum
- The time for test results, X-rays, etc. to be returned is kept to a minimum



What does Speed mean in.....

.... an automobile plant?



- Time between dealers requesting a vehicle of a particular specification and receiving it is minimized
- Time to deliver spares to service centres minimized



What does Speed mean in.....

.... a bus company?

- The time between customer setting out on the journey and reaching his or her destination is kept to a minimum



What does Speed mean in.....

.... a supermarket?



- The time for the total transaction of going to the supermarket, making the purchases and returning minimized
- The immediate availability of goods



External and internal benefits of speed

Speed again has different interpretations externally and internally

Externally – it means the elapsed time between a customer asking for a product or service and getting it (in a satisfactory condition)

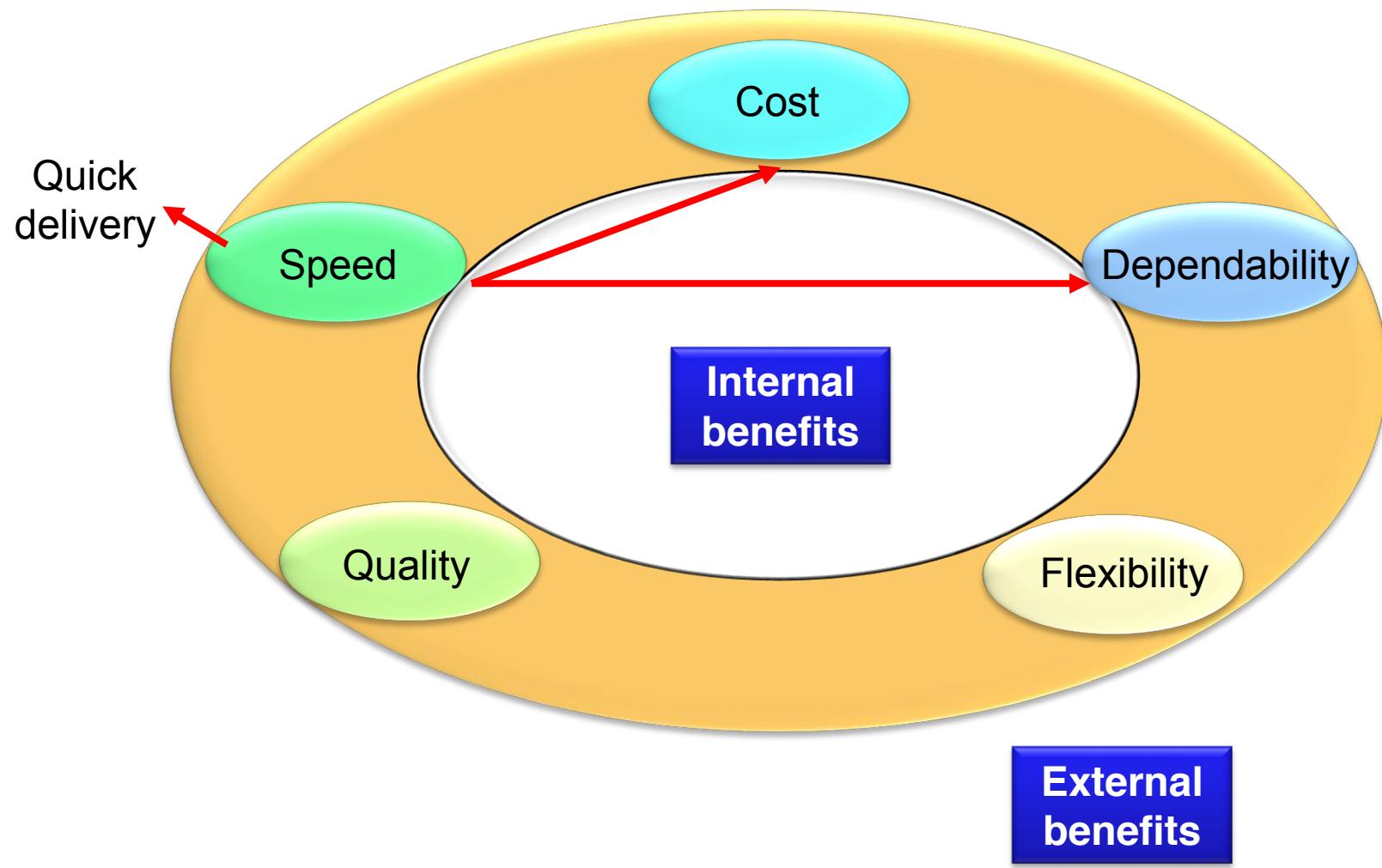
It often enhances the value of the product or service to customers

Internally -- it brings other benefits to the operation

- It helps to overcome internal problems by maintaining dependability
- It reduces the need to manage transformed resources as they pass through the operation, therefore saving cost



External and internal benefits of speed



What does Dependability mean in.....

.... a Hospital ?

- Proportion of appointments that are cancelled kept to a minimum
- Keeping appointment times
- Test results, X-rays, etc. returned as promised



What does Dependability mean in.....

.... an automobile plant?



- On-time delivery of vehicles to dealers
- On-time delivery of spares to service centres



What does Dependability mean in.....

.... a bus company?

- Keeping to the published timetable at all points on the route
- Constant availability of seats for passengers



What does Dependability mean in.....

.... a supermarket?



- Predictable opening hours
- Proportion of goods out of stock kept to a minimum
- Keeping to reasonable queuing times
- Constant availability of parking



External and internal benefits of Dependability

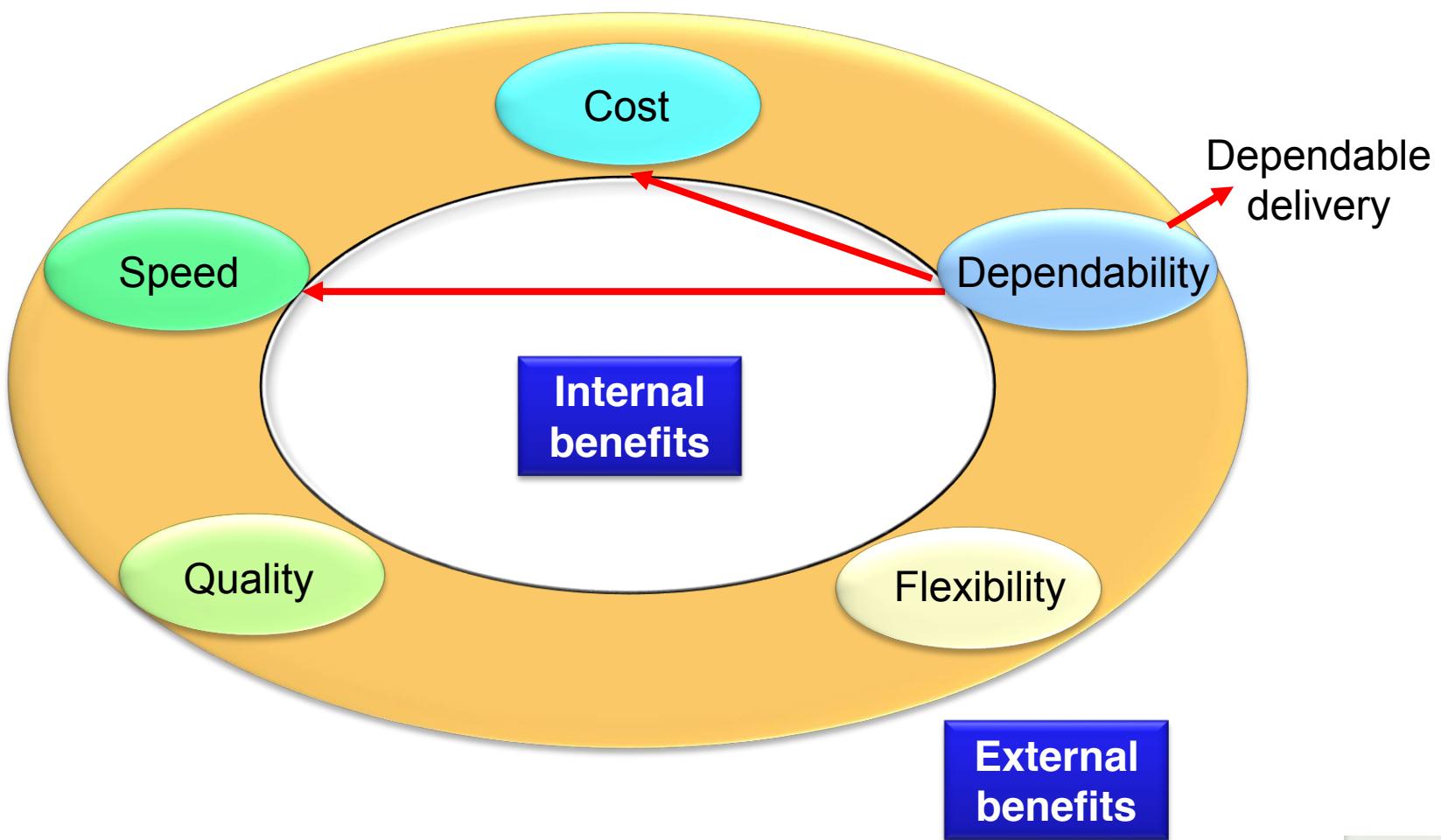
Externally -- it enhances the product or service in the market, or at least avoids customer complaints

Internally -- it brings other benefits to the operation

- It prevents late delivery slowing down throughput speed
- It prevents lateness causing disruption and wasted time and effort, therefore saving cost



External and internal benefits of dependability



Flexibility – What does it mean?

Flexibility has several distinct meanings but is always associated with an operation's *ability to change*

Change what ?

- The products and services it brings to the market – *Product/service flexibility*
- The mix of products and services it produces at any one time – *Mix flexibility*
- The volume of products and services it produces – *Volume flexibility*
- The delivery time of its products and services – *Delivery flexibility*



What does Flexibility mean in.....

.... a Hospital ?

- Introducing new treatments
- A wide range of treatments
- The ability to adjust the number of patients treated
- The ability to reschedule appointments



What does Flexibility mean in.....

.... an automobile plant?



- The introduction of new models
- A wide range of options
- The ability to adjust the number of vehicles manufactured
- The ability to reschedule manufacturing priorities



What does Flexibility mean in.....

.... a bus company?

- The introduction of new routes and excursions
- A large number of locations served
- The ability to adjust the frequency of services
- The ability to reschedule trips



What does Flexibility mean in.....

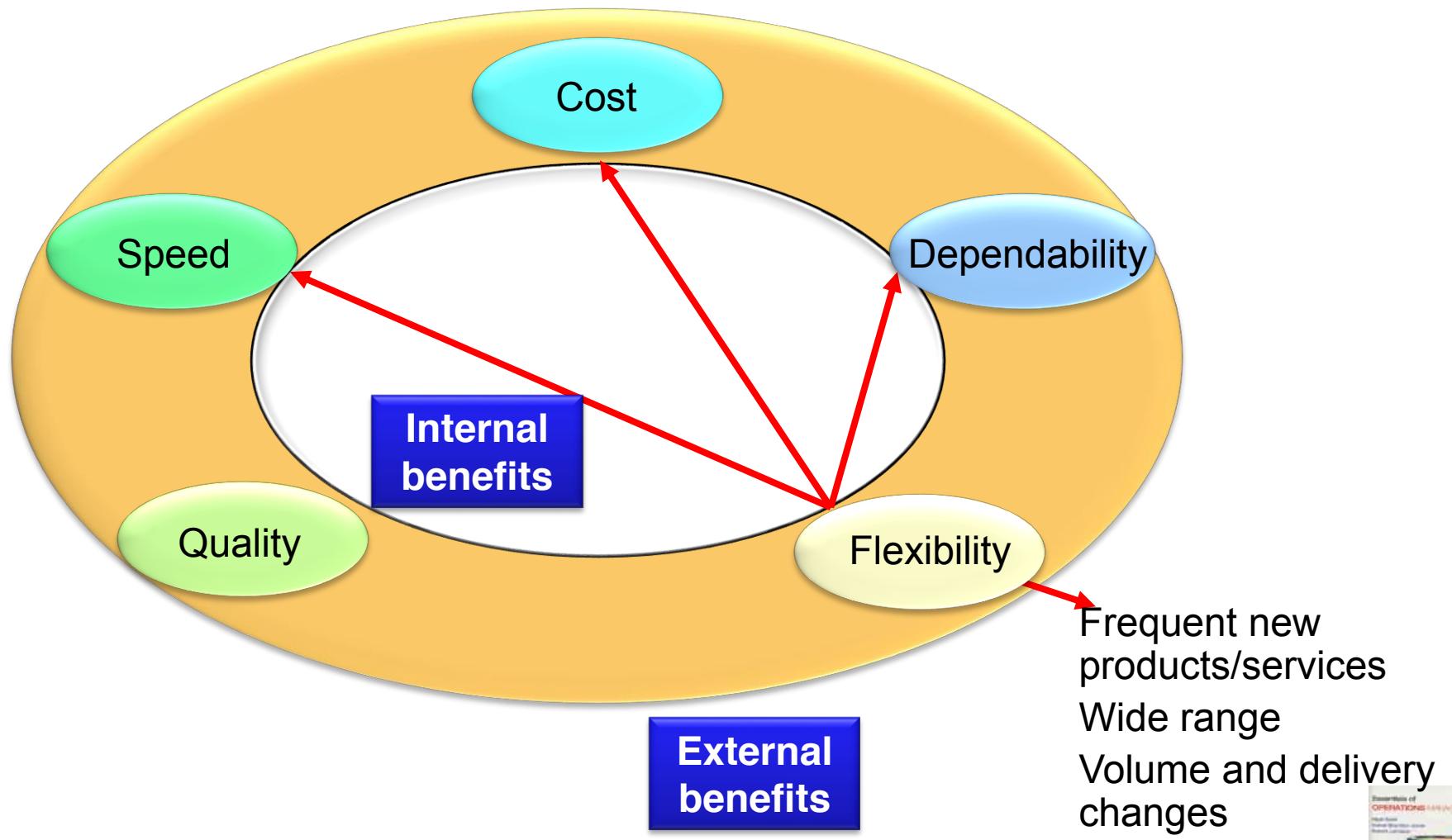
.... a supermarket?



- The introduction of new goods
- A wide range of goods stocked
- The ability to adjust the number of customers served
- The ability to get out-of-stock items



External and internal benefits of flexibility



Cost

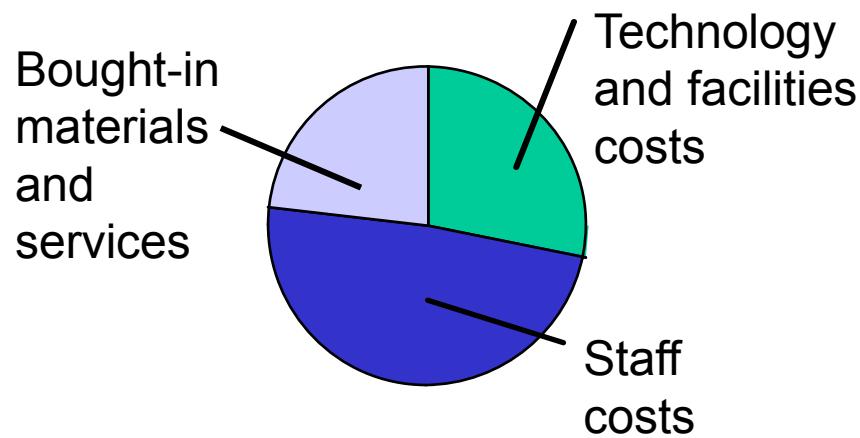
The cost of producing products and services is obviously influenced by many factors such as input costs, but two important sets are.....

- The 4 V's volume
 - variety
 - variation
 - visibility
- The internal performance of the operation at
 - quality
 - speed
 - dependability
 - flexibility



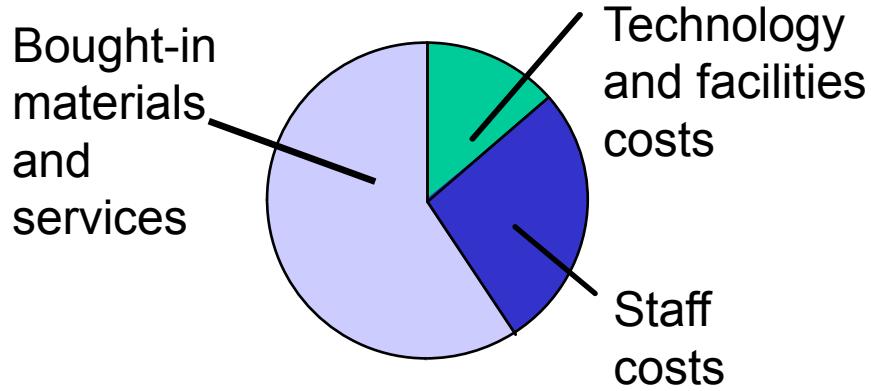
What does Cost mean in.....

.... a Hospital ?



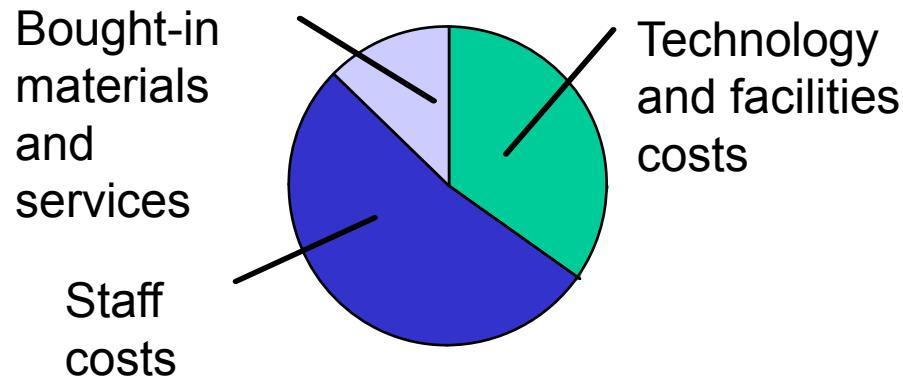
What does Cost mean in.....

.... an automobile plant?



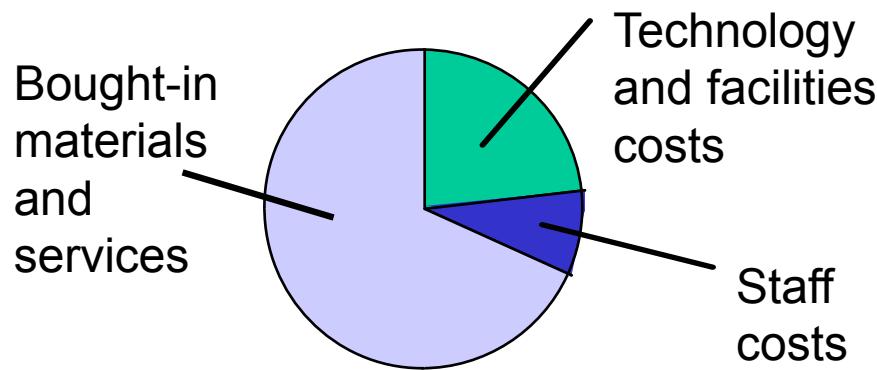
What does Cost mean in.....

.... a bus company?

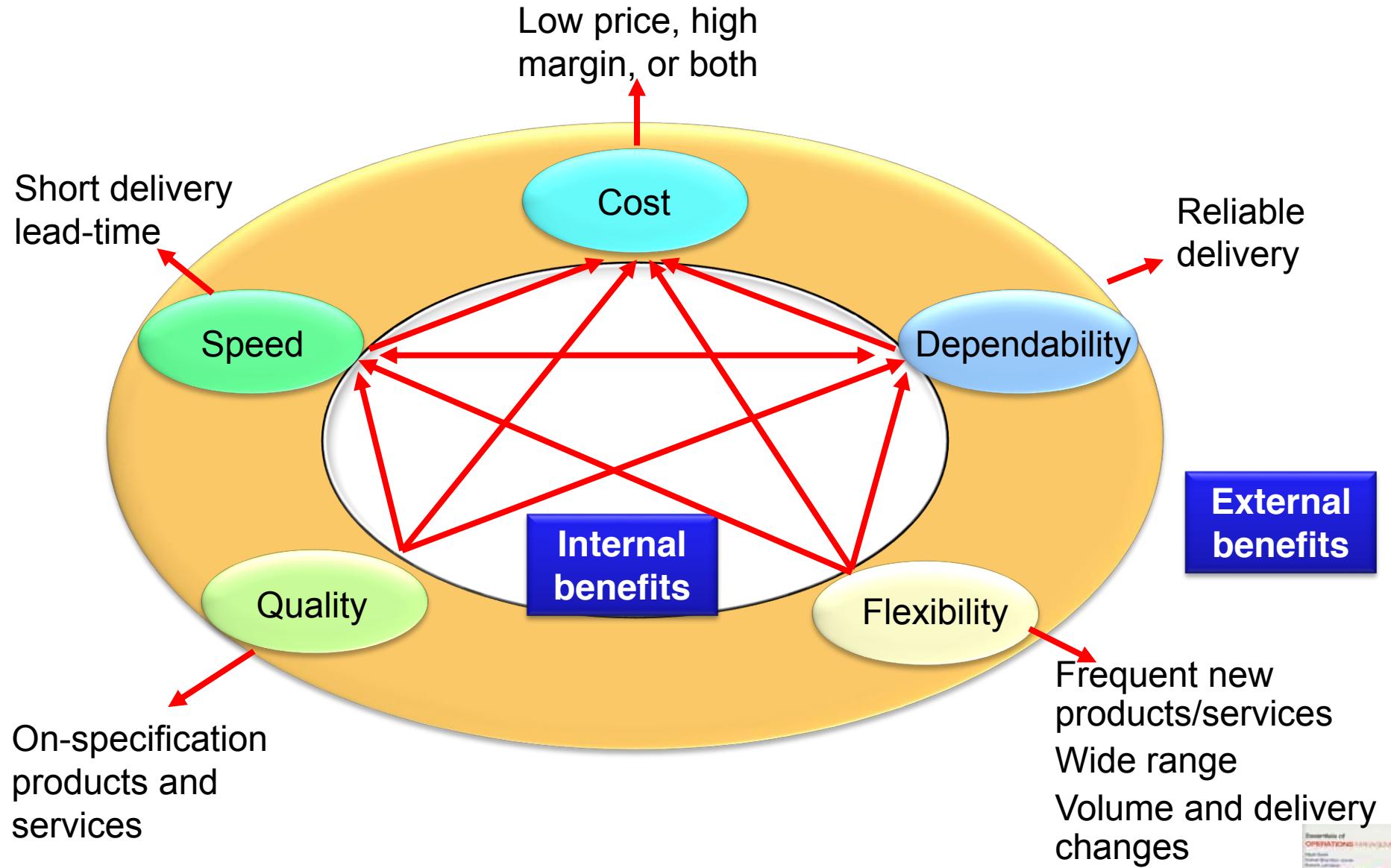


What does Cost mean in.....

.... a supermarket?

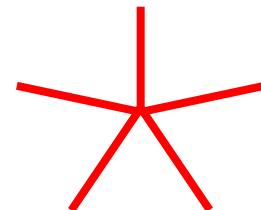


External and internal benefits of performance objectives

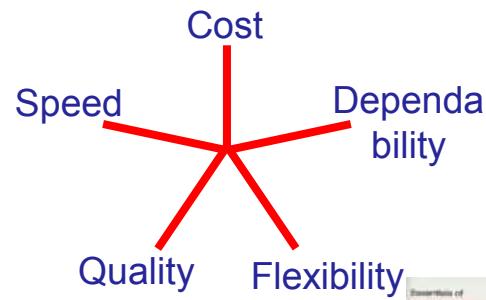


Polar diagrams

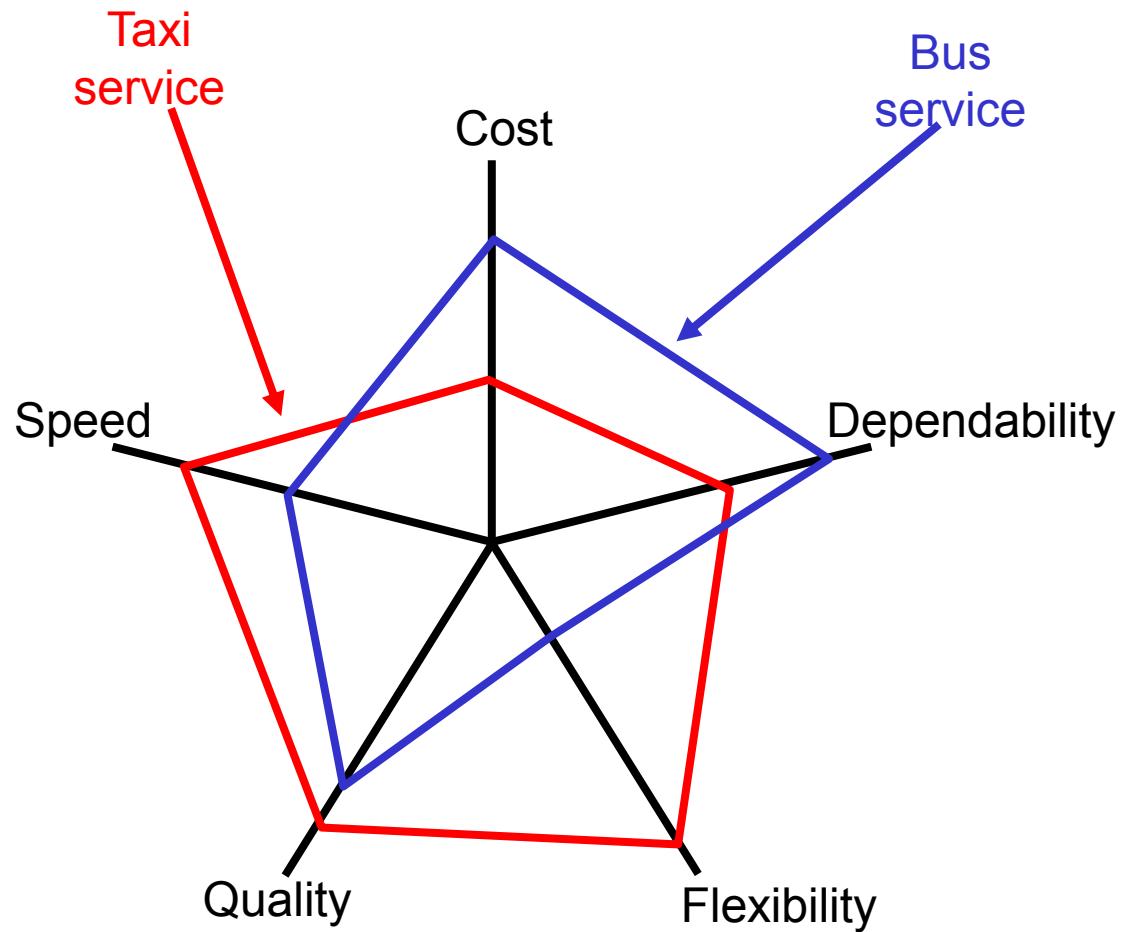
- Polar diagrams are used to indicate the relative importance of each performance objective to an operation or process



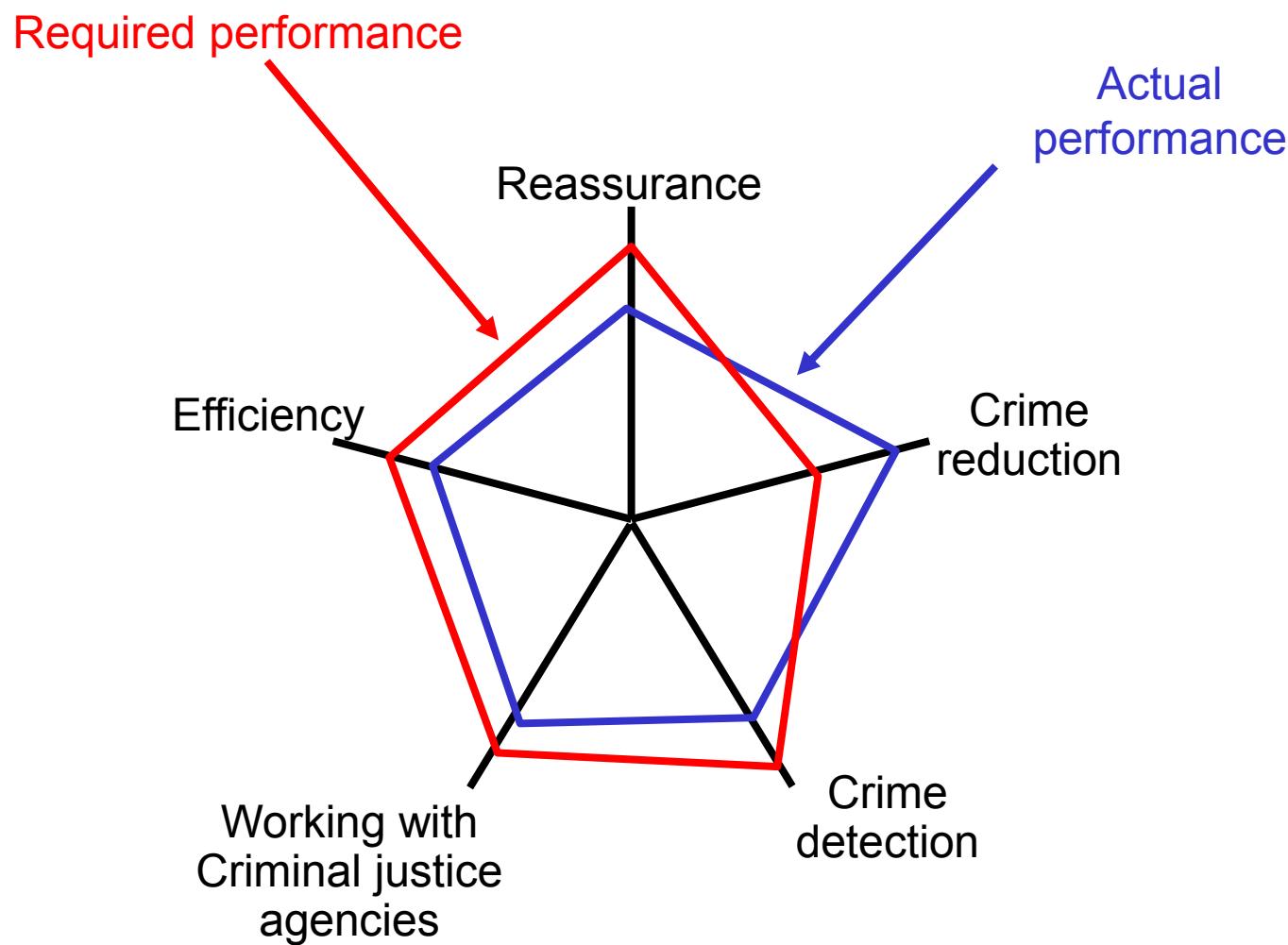
- They can also be used to indicate the difference between different products and services produced by an operation or process



Polar diagrams for a taxi service versus a bus service



Polar diagrams for a proposed police performance method



Trade-offs

- “*Do you want it good, or do you want it Tuesday?*”
- “*No such thing as a free lunch.*”
- “*You can't have an aircraft which flies at the speed of sound, carries 400 passengers and lands on an aircraft carrier. Operations are just the same.*” (Skinner)
- “*Trade-offs in operations are the way we are willing to sacrifice one performance objective to achieve excellence in another.*”





Operations Management

MGT355



The design of services and products and processes

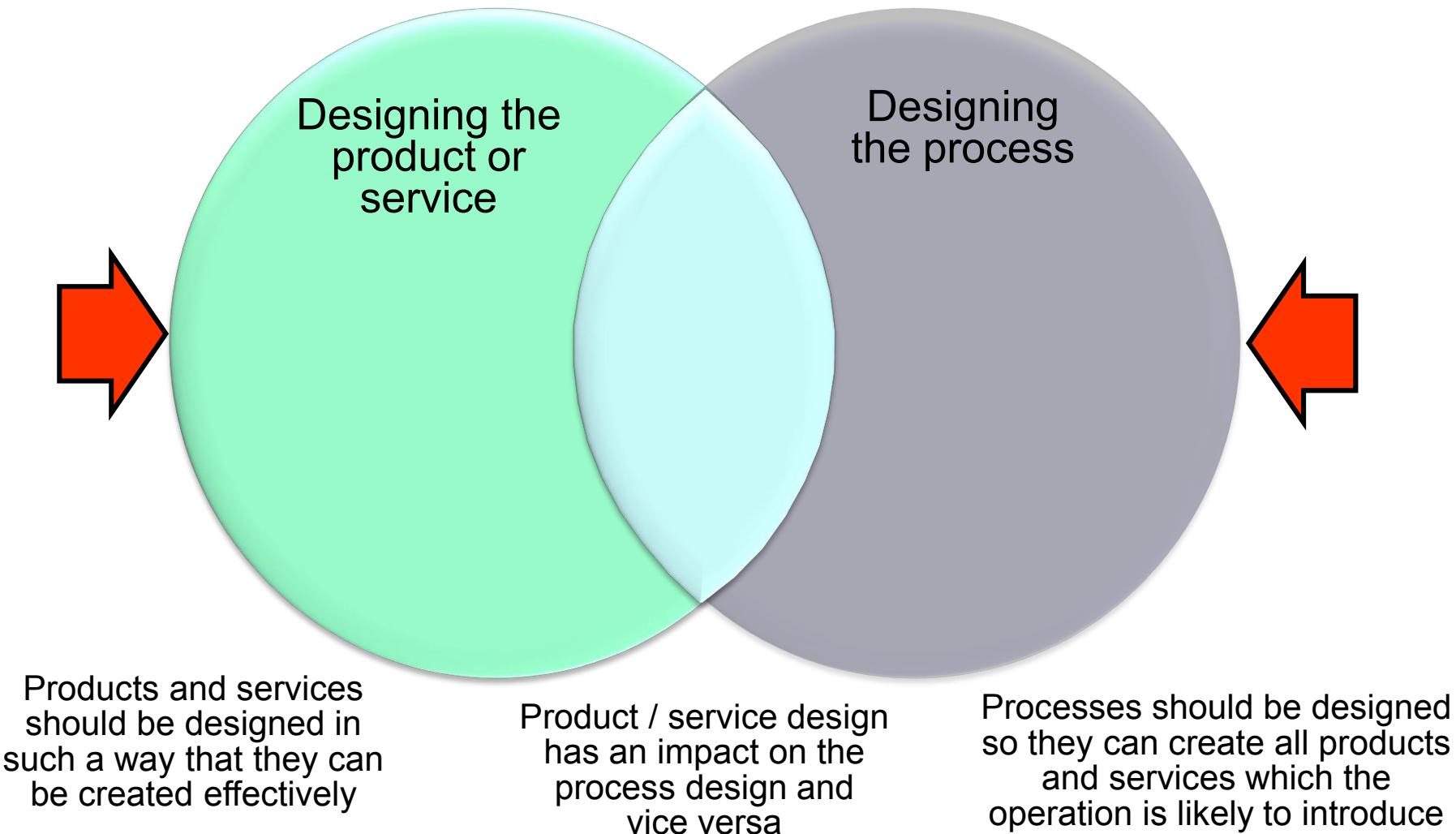


Key operations questions

- ❑ ***Why is good product and service design important?***
- ❑ ***What are the stages in product and service design?***
- ❑ ***Why should product and service design and process design be considered interactively?***
- ❑ ***How should interactive design be managed?***



The design of products/services and processes are interrelated and should be treated together



Why is design so important?

UK Design Council Survey.....

- Design helps businesses connect strongly with their customers
- 90% of businesses growing rapidly say design is significant to them, only 26% of static companies say the same.
- Design reduces costs by making processes more efficient. It can also reduce the time to market for new products and services.
- Almost 70 per cent of companies seeing design as integral have developed new products and services in the last three years, compared to only a third of businesses overall.
- Companies who were ‘effective users of design’ had financial performances 200% better than average.



What is designed in a product or service?

A concept



the understanding of the nature, use and value of the service or product;

A package



The group of 'component' products and services that provide those benefits defined in the concept;

A process



the way in which the component products and services will be created and delivered.

Example – Spangler, Hoover and Dyson

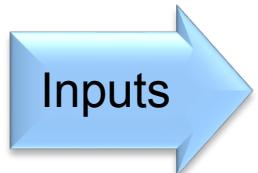
- What was Spangler's mistake?
- What do you think makes 'good design' in markets such as domestic appliances?
- Why do you think two major vacuum cleaner manufacturers rejected Dyson's ideas?
- How did design make Dyson a success?



The product and service design activity is a process in itself

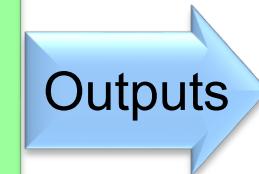
Transformed resources,
eg.

- Technical information
- Market information
- Time information



The product / service design process whose performance is measured by its

- Quality
- Speed
- Dependability
- Flexibility and
- Cost



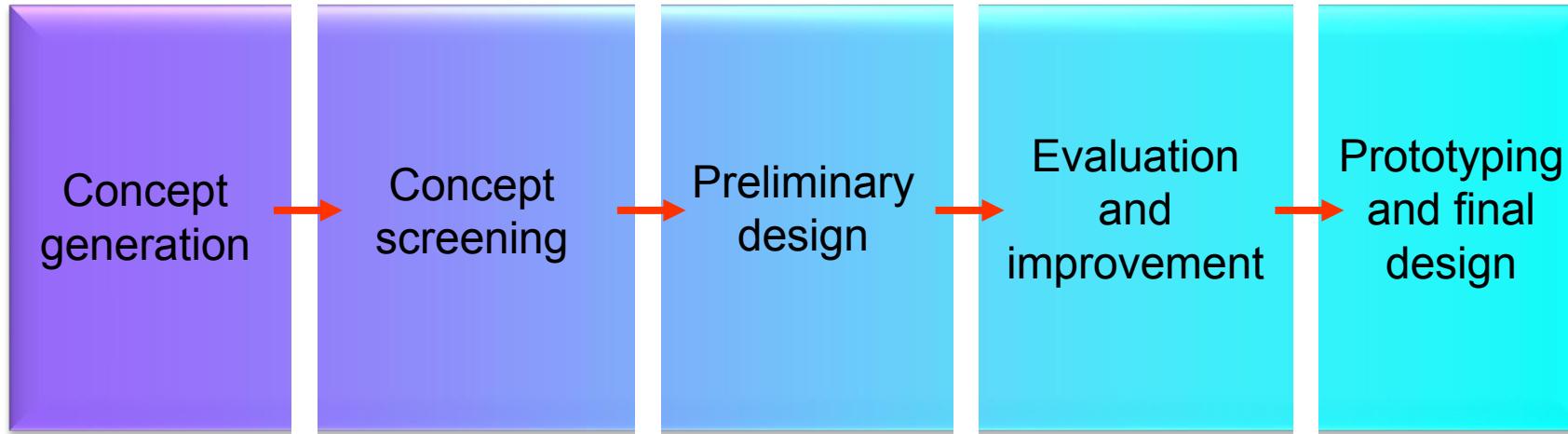
Fully specified products and services

Transforming resources,
eg.

- Test and design equipment
- Design and technical staff



The stages of product / service design



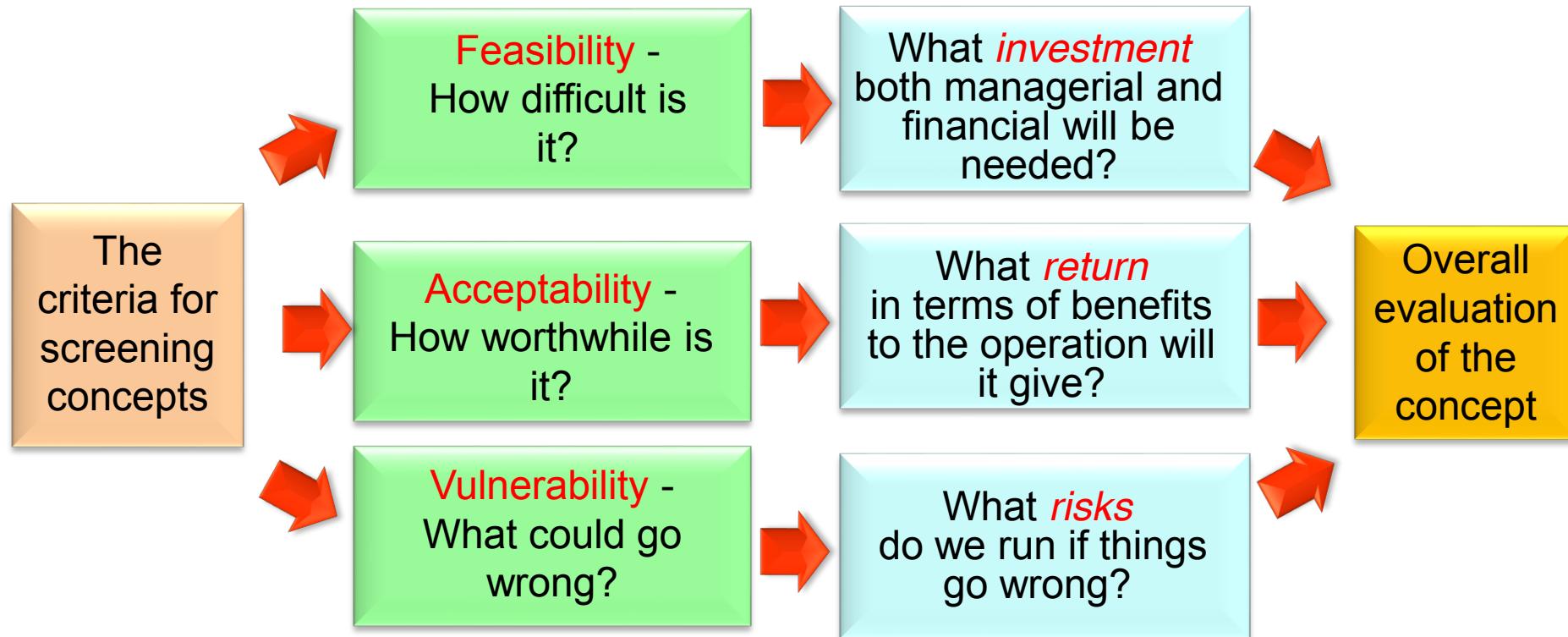
Concept generation.....

- Ideas from customers formally through Marketing activities
- Listening to customers - on a day-to-day basis.
- Ideas from competitor activity – For example reverse engineering
- Ideas from staff – Especially those who meet customers every day.
- Ideas from research and development

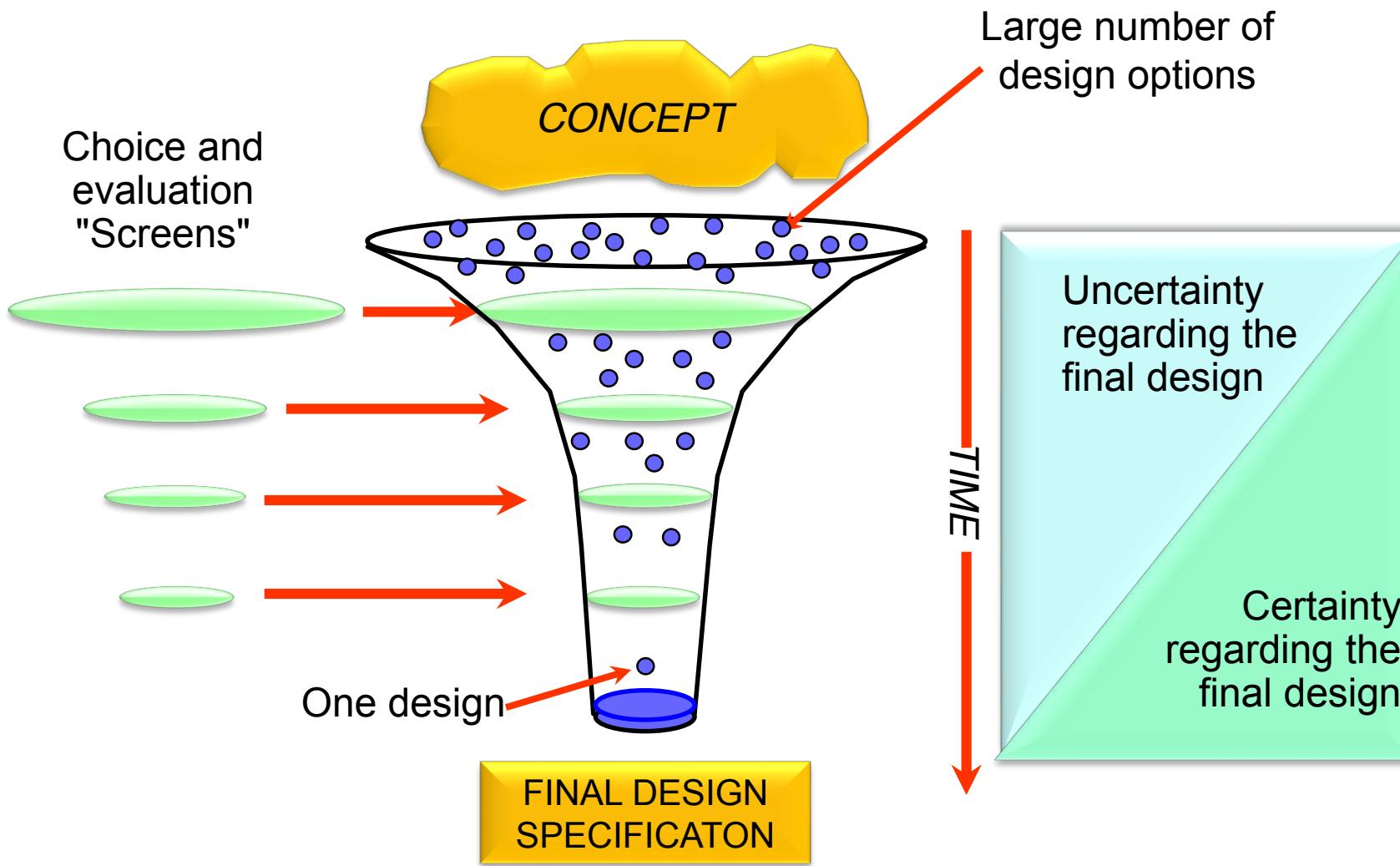


Concept screening.....

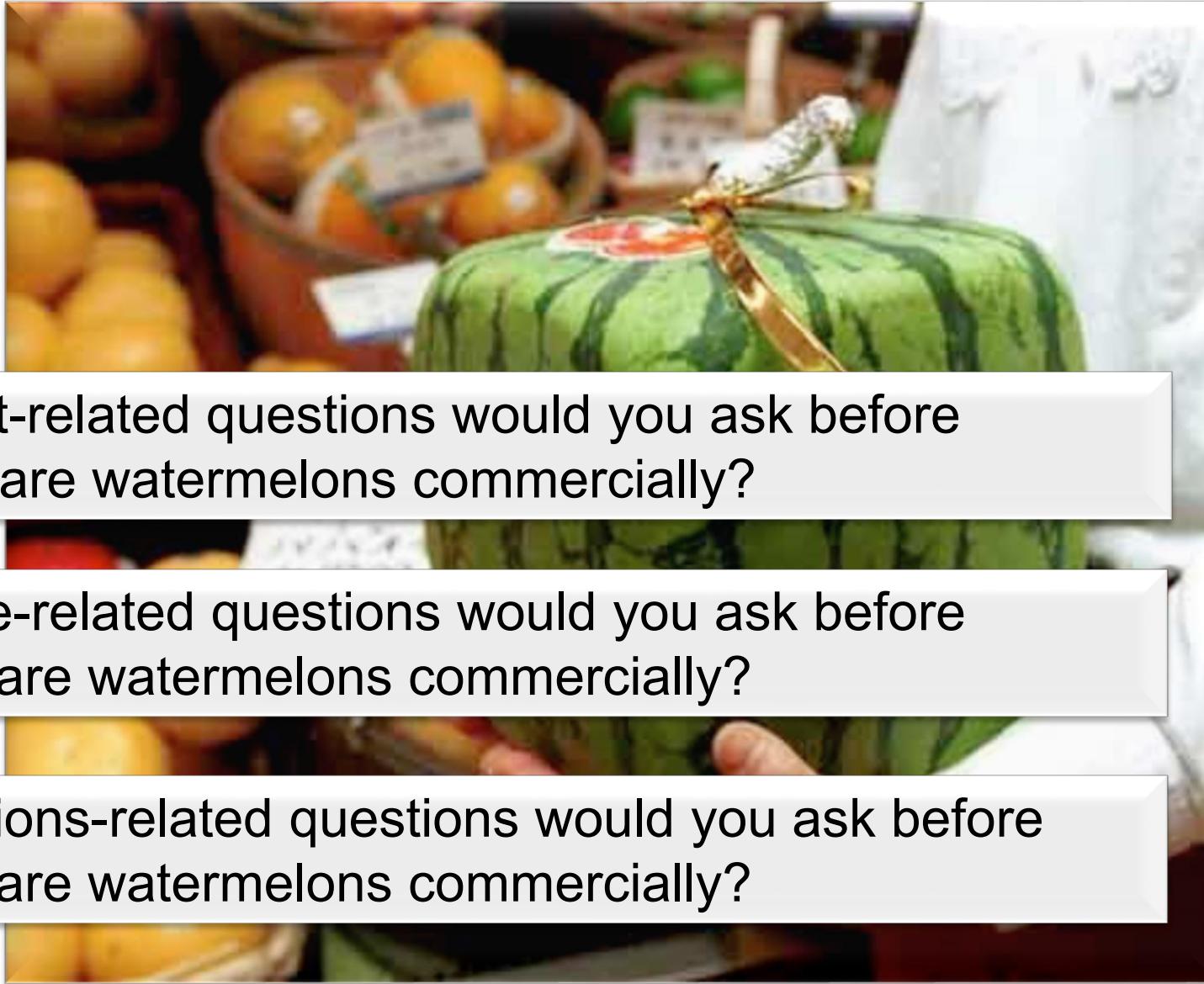
Broad categories of evaluation criteria for assessing concepts



Design involves progressively reducing the number of possibilities until the final design is reached

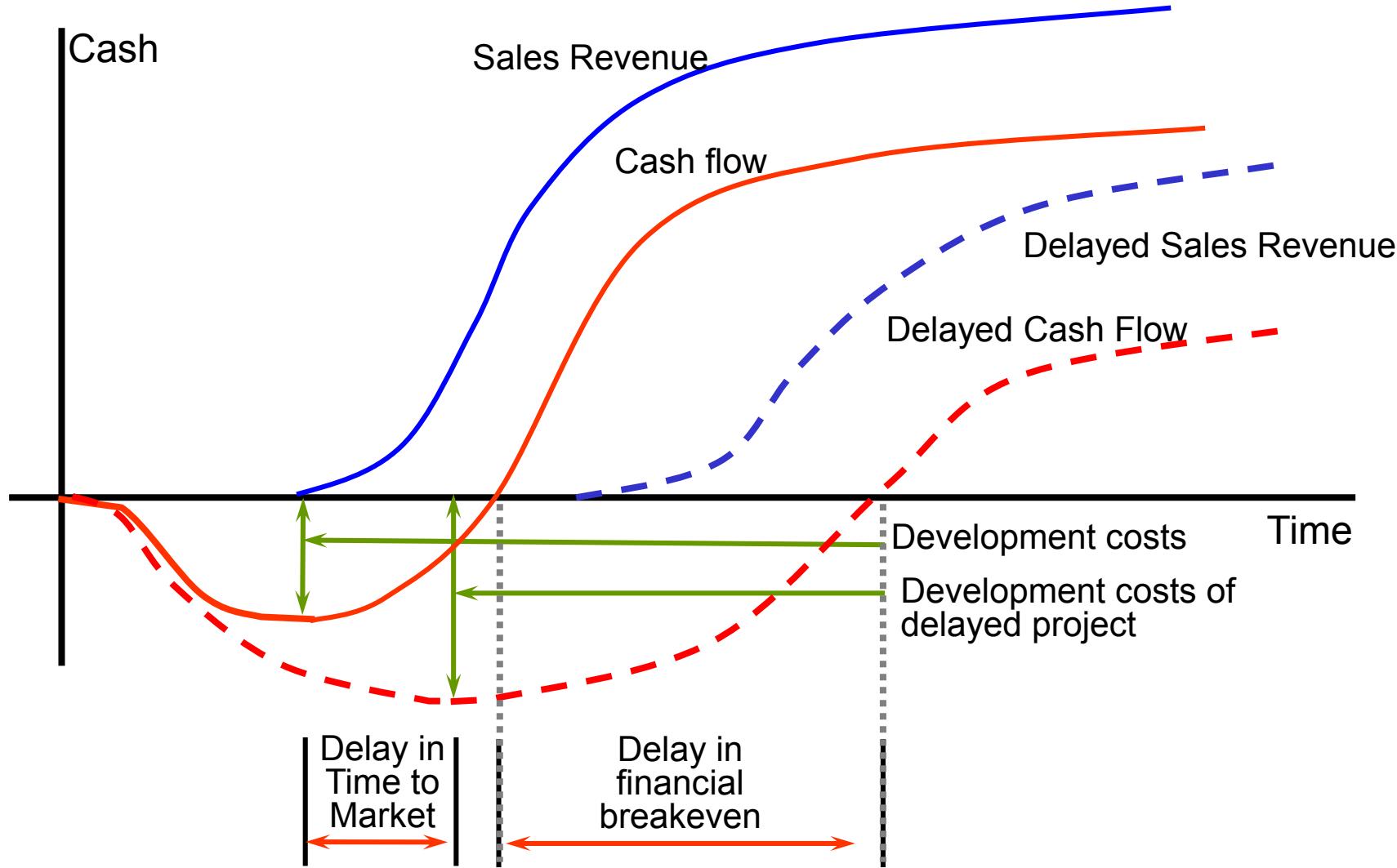


Example – Square watermelons



- What market-related questions would you ask before producing square watermelons commercially?
- What finance-related questions would you ask before producing square watermelons commercially?
- What operations-related questions would you ask before producing square watermelons commercially?

A delays in the ‘Time to Market’ disproportionately delays the financial breakeven point





Operations Management

MGT355

Location, layout and flow



Key operations questions

- ❑ *Where should operations be located?*
- ❑ *What is 'layout' and what are the basic types used in operations?*
- ❑ *What type of layout should an operation choose?*
- ❑ *How should items be positioned in a workplace?*



Location

The aim of the location decision is to achieve an appropriate balance between three related objectives:

- The **spatially variable costs** of the operations (spatially variable = something changes with geographical location)
- The service the operation is able to provide to its customers
- The revenue potential of the operations



Supply-side and demand-side factors in location decisions

Supply Side

- Labour costs
- Land costs
- Energy costs
- Transportation costs
- Community factors
 - Local tax rates
 - Governance assistance
 - Political stability
 - Language
 - Availability of support services
 - Labour relations
 - Environmental restrictions

Demand-side

- Labour skills
- The suitability of the site itself
- Image of the location
- Convenience for customers



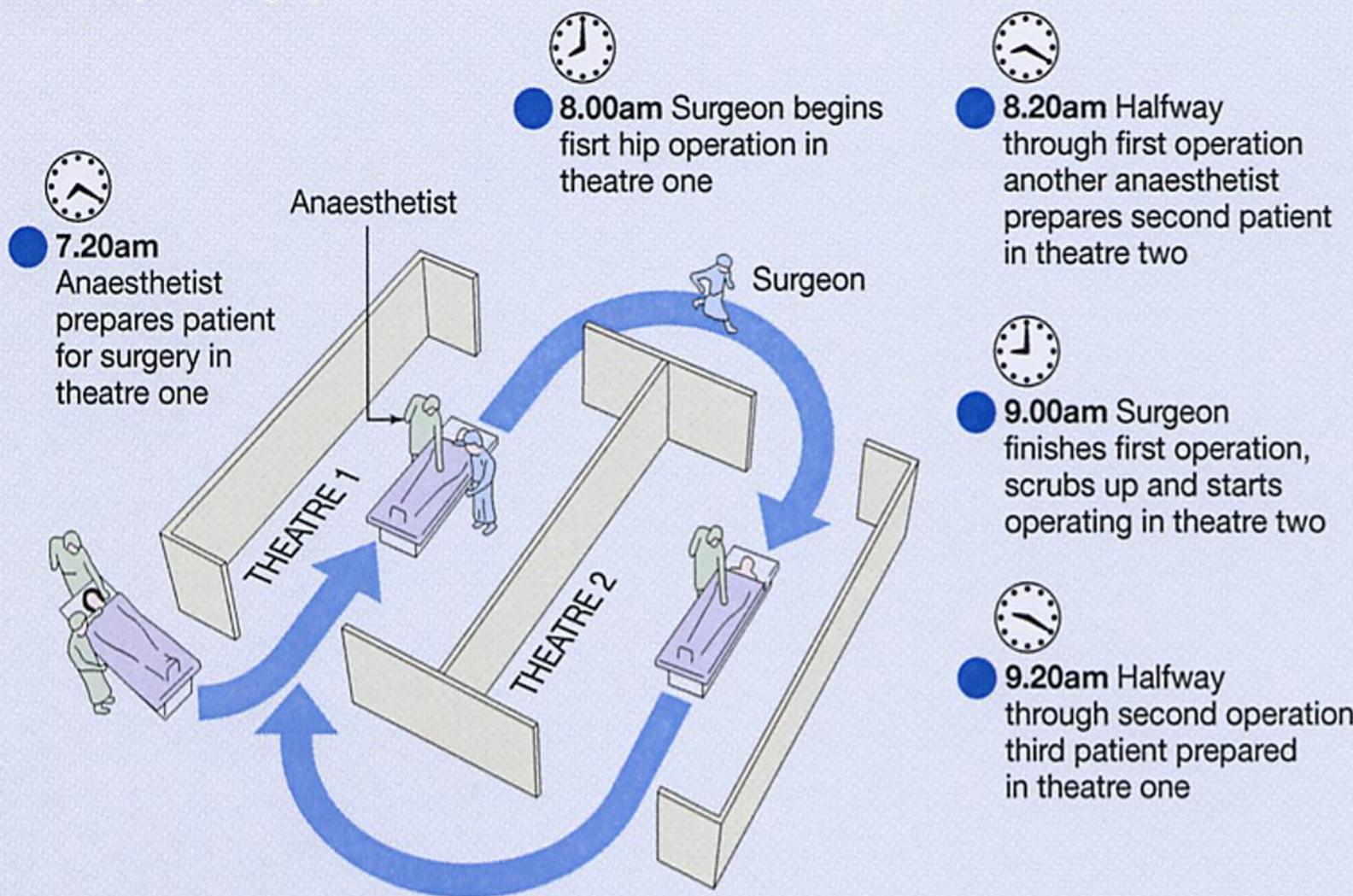
What makes a good layout?

- Inherent safety
- Length of flow
- Clarity of flow
- Staff conditions
- Management coordination
- Accessibility
- Use of space
- Long-term flexibility



An innovative layout in a surgery improves its efficiency

Assembly line surgery



Product flow in Cadbury's

Flow of chocolate in Cadbury's factory



Flow of customers in Cadbury World



Both Cadbury's chocolate factory and its 'Cadbury World' visitor attraction use 'product' layout. But what will be different about the layouts and why?



The basic layout types

- Fixed-position layout
- Functional layout
- Cell layout
- Line layout



Fixed-position layout

- The transformed resources do not move between the transforming resources.
- Instead of materials, informations or customers flowing through an operation, the recipient of the processing is stationary and the transforming resources move as necessary.



Advantages and disadvantages of Fixed position layout

Fixed position layout	
Advantages	Very high product and mix flexibility Product/customer not moved High variety of tasks for staff
Disadvantages	Very high unit costs Scheduling space and activities can be difficult

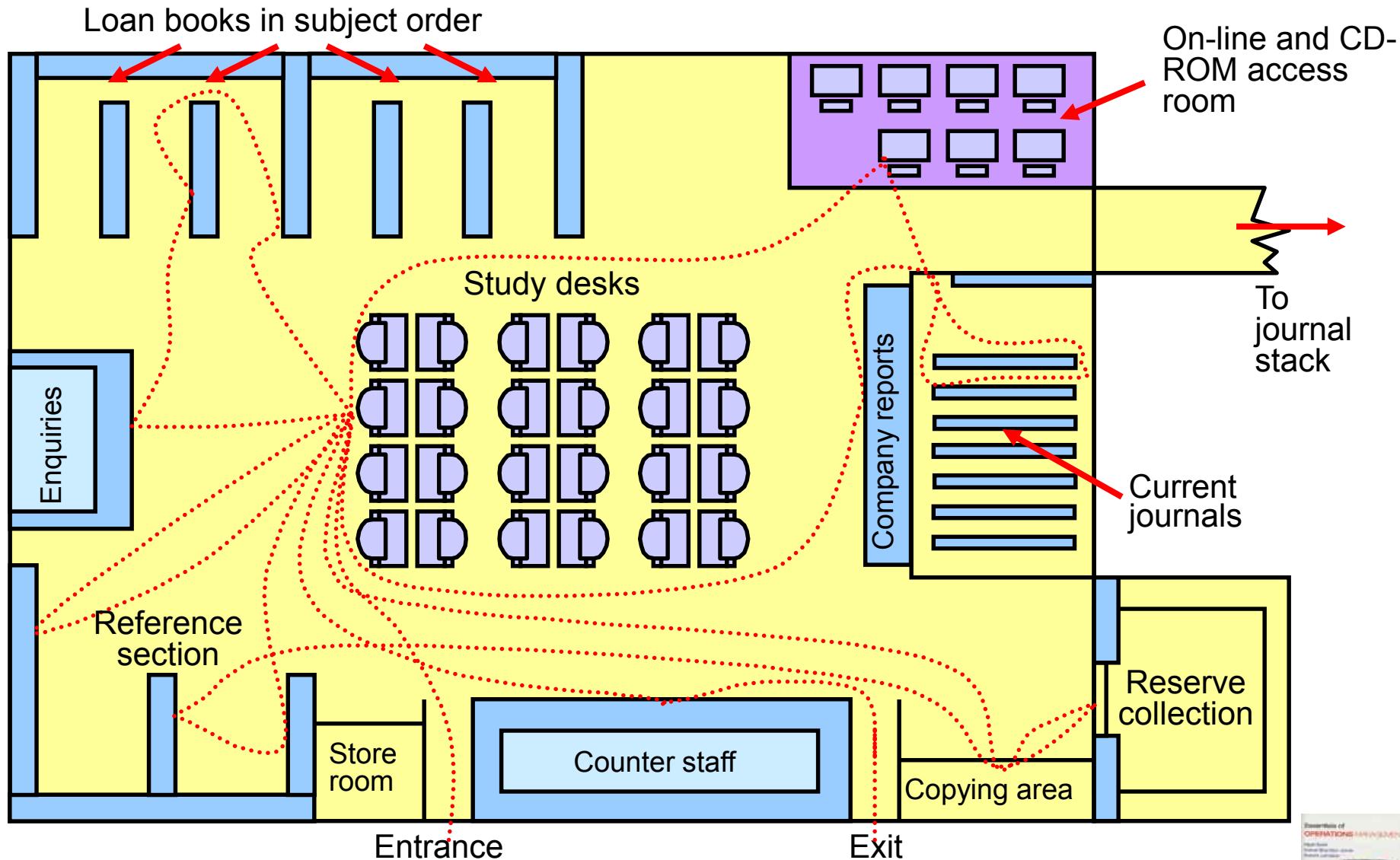


Functional layout

- It conforms to the needs and convenience of the functions performed by the transforming resources within the process.
- Similar resources or processes are located together.
- The combinatorial complexity of functional layouts makes optimal solutions difficult to achieve in practice.



Functional layout in a library - the path of one customer



Advantages and disadvantages of Functional layout

Functional layout	
Advantages	High product and mix flexibility Relatively robust in the case of disruptions Easy to supervise
Disadvantages	Low utilization Can have very high WIP Complex flow

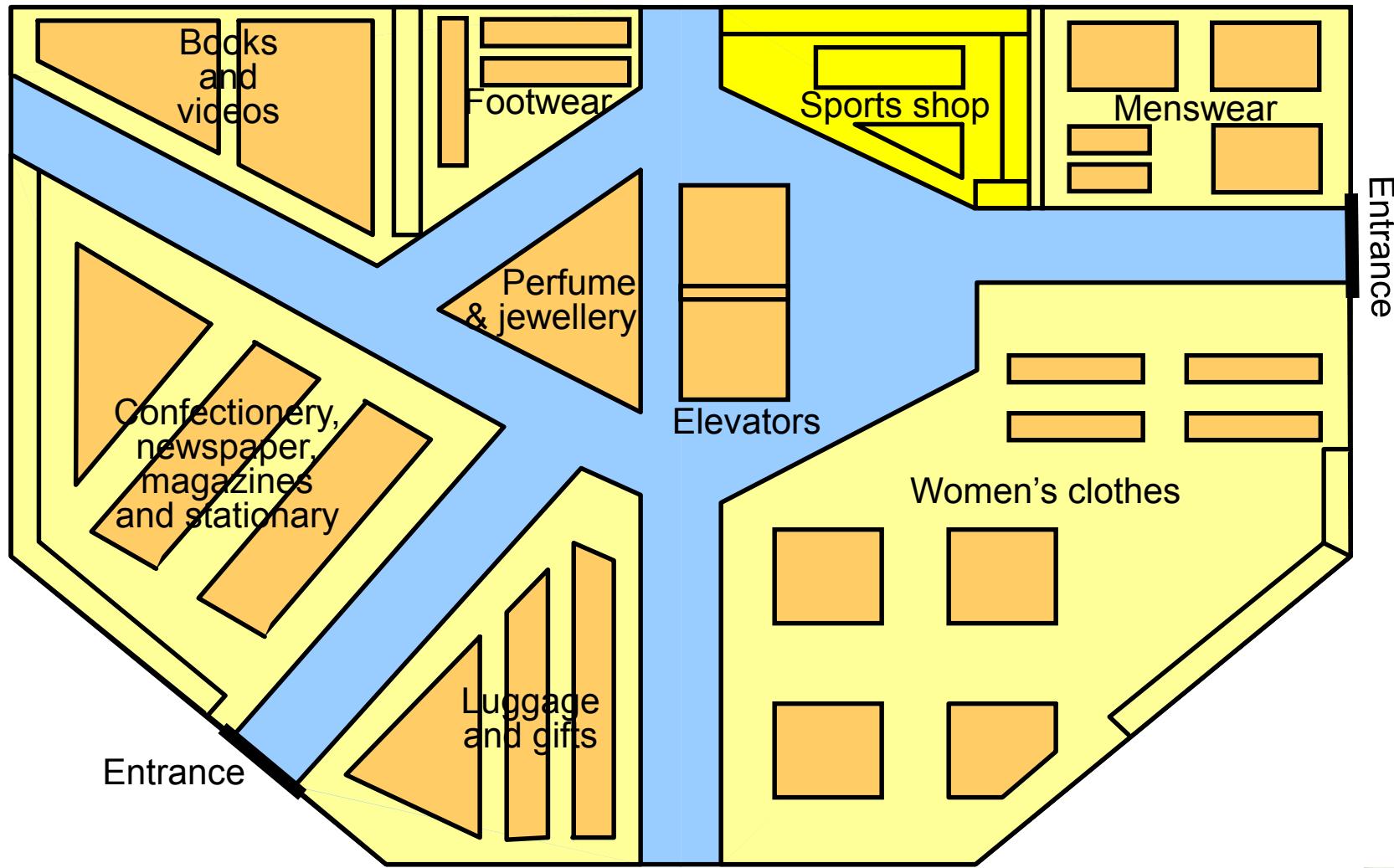


Cell layout

- Transformed resources entering the operation are pre-selected (or pre-select themselves) to move to one part of the operation (cell) in which they meet their immediate processing needs.
- After being processed in the cell, transformed resources may go on to another cell.
- An attempt to bring some order to the complexity of flow which characterizes functional layout.



Department store with sports goods 'shop-within-a-shop'



Advantages and disadvantages of Cell layout

Cell layout	
Advantages	Can give good compromise Fast throughput Group work can result in good motivation
Disadvantages	Can be costly to rearrange existing layout Can need more plant

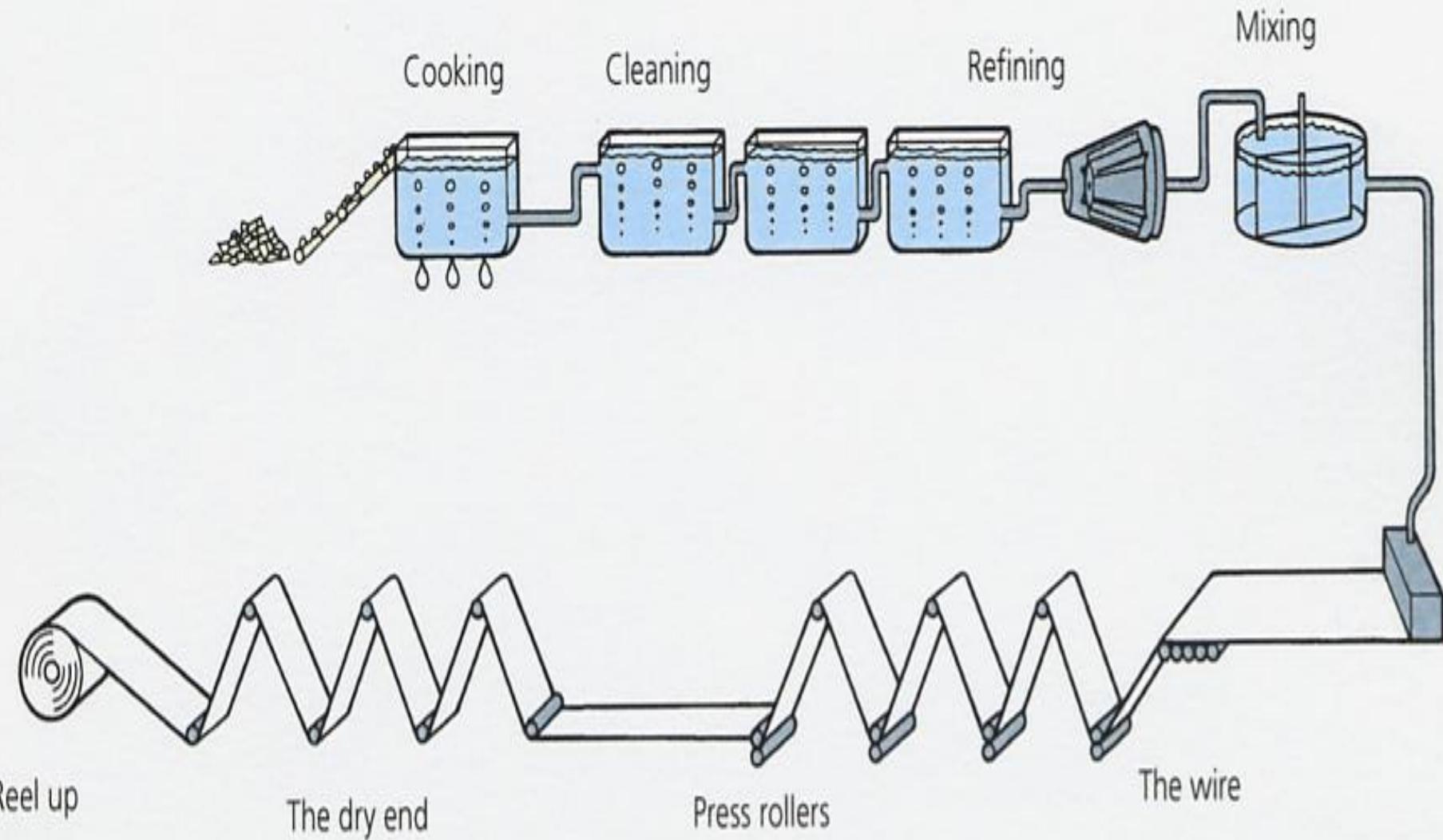


Line layout (product layout)

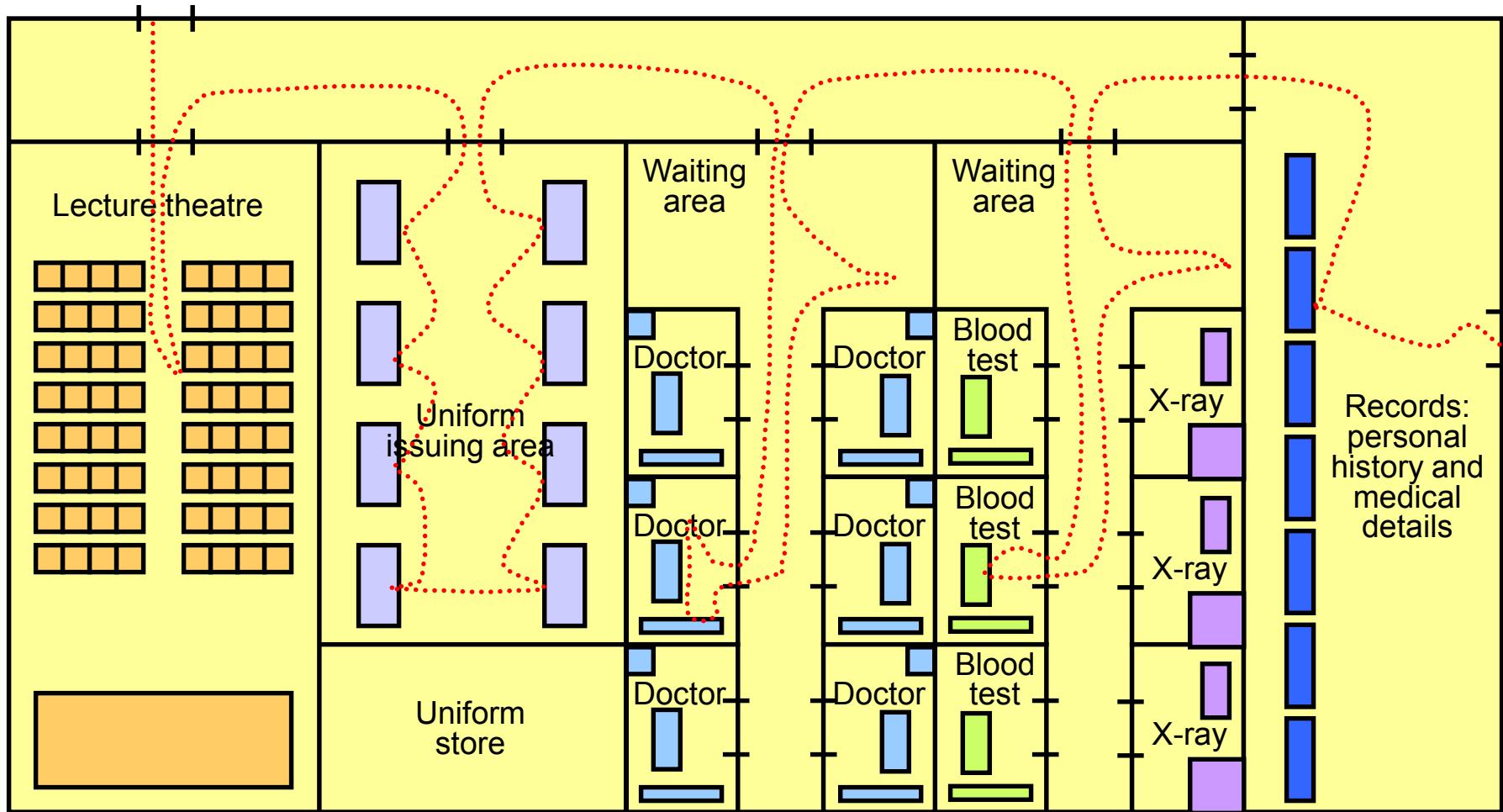
- Locating the transforming resources entirely for the convenience of the transformed resources.
- Customers, products or pieces of information follow a prearranged route in which the sequence of activities that are required matches the sequence in which processes have been located.
- The transformed resources “flow” as in a “line” through the process.
- Flow is predictable and therefore relatively easy to control.



A product layout in a paper manufacturing operation



An army induction centre which uses product layout



Advantages and disadvantages of Product layout

Product layout	
Advantages	Low unit costs for high volume Opportunities for specialization of equipment
Disadvantages	Can have low mix flexibility Not very robust in the case of disruptions Work can be very repetitive

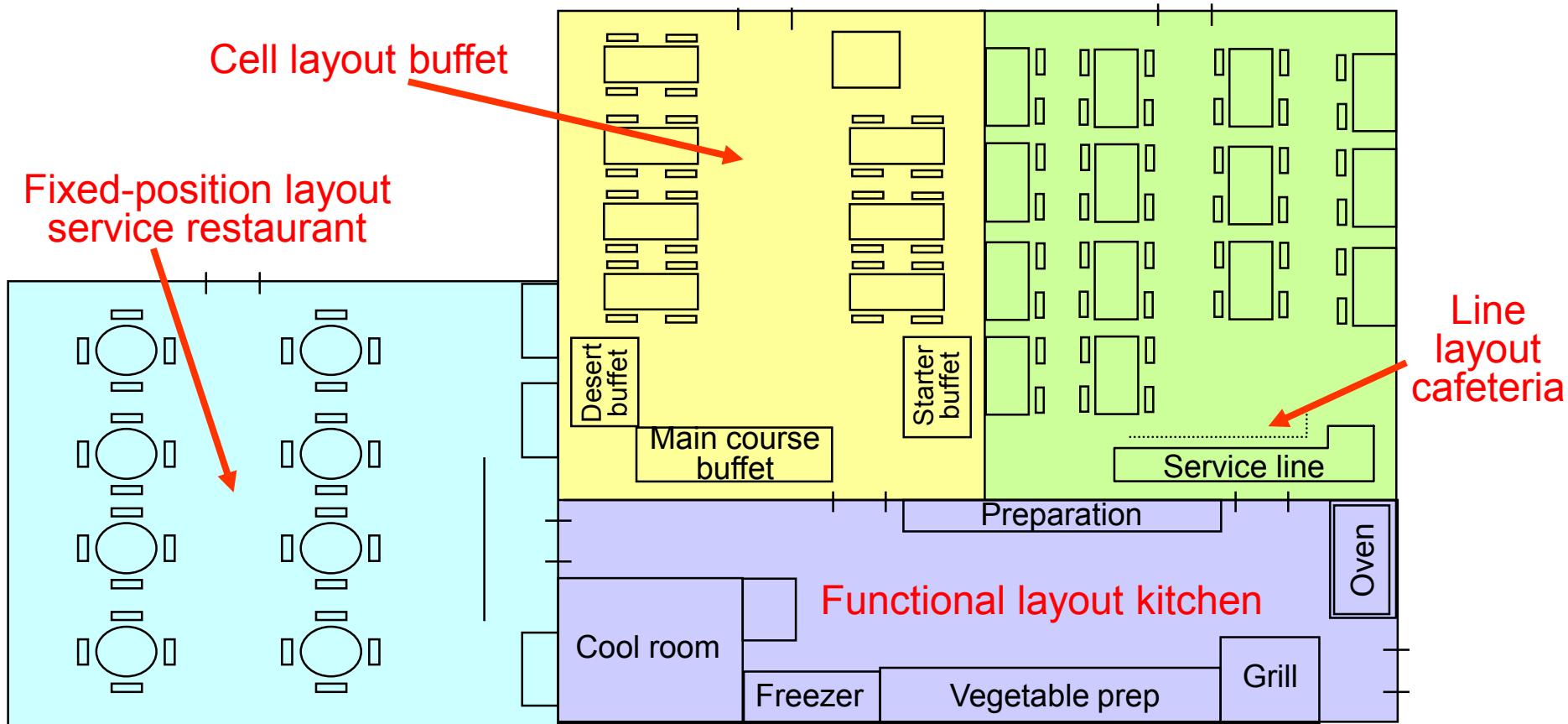


Mixed layouts

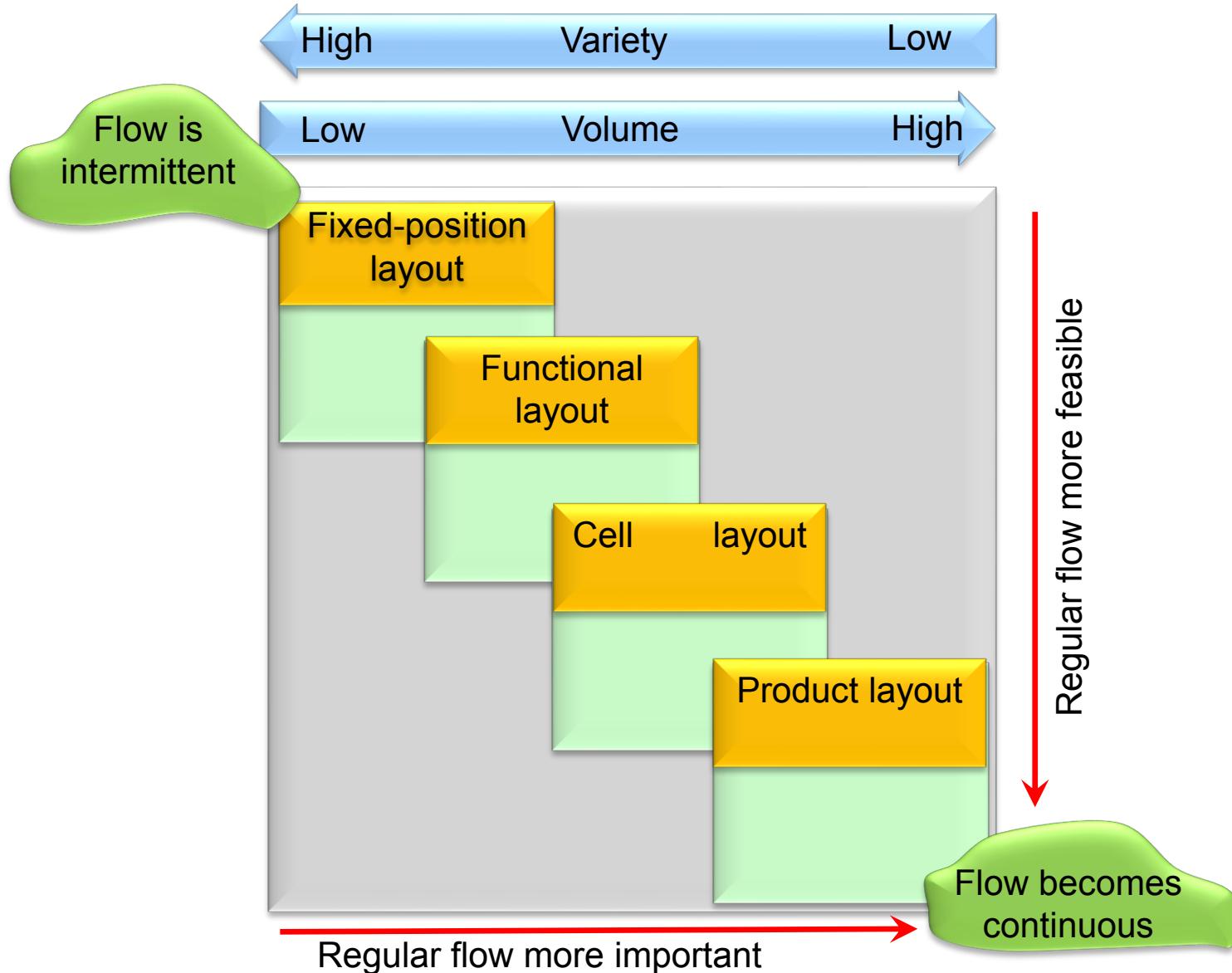
- Hybrid layouts which combine elements of some or all of the basic layout types.
- Use the “pure” basic layout types in different parts of the operation.



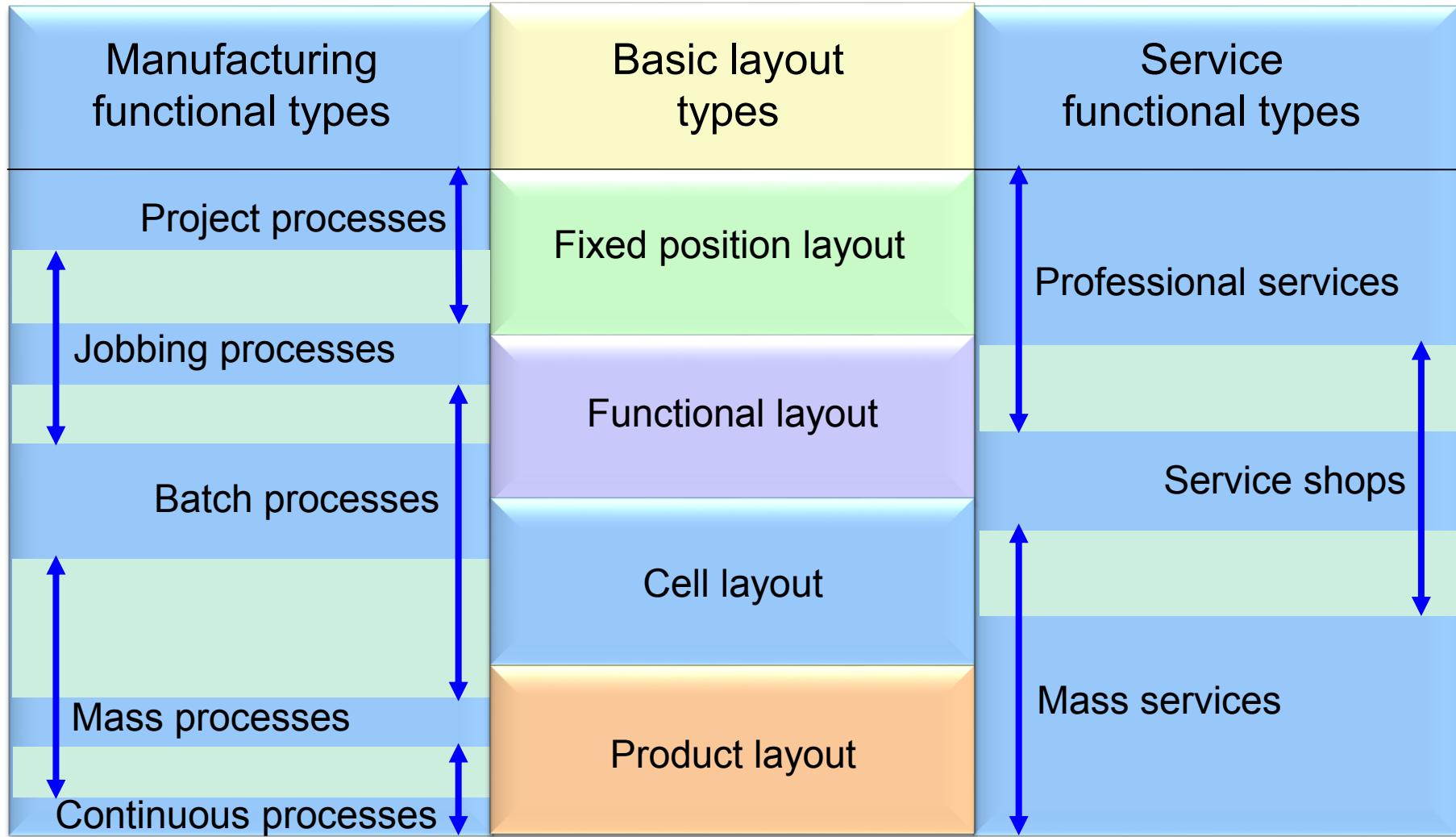
A restaurant complex with all four basic layout types



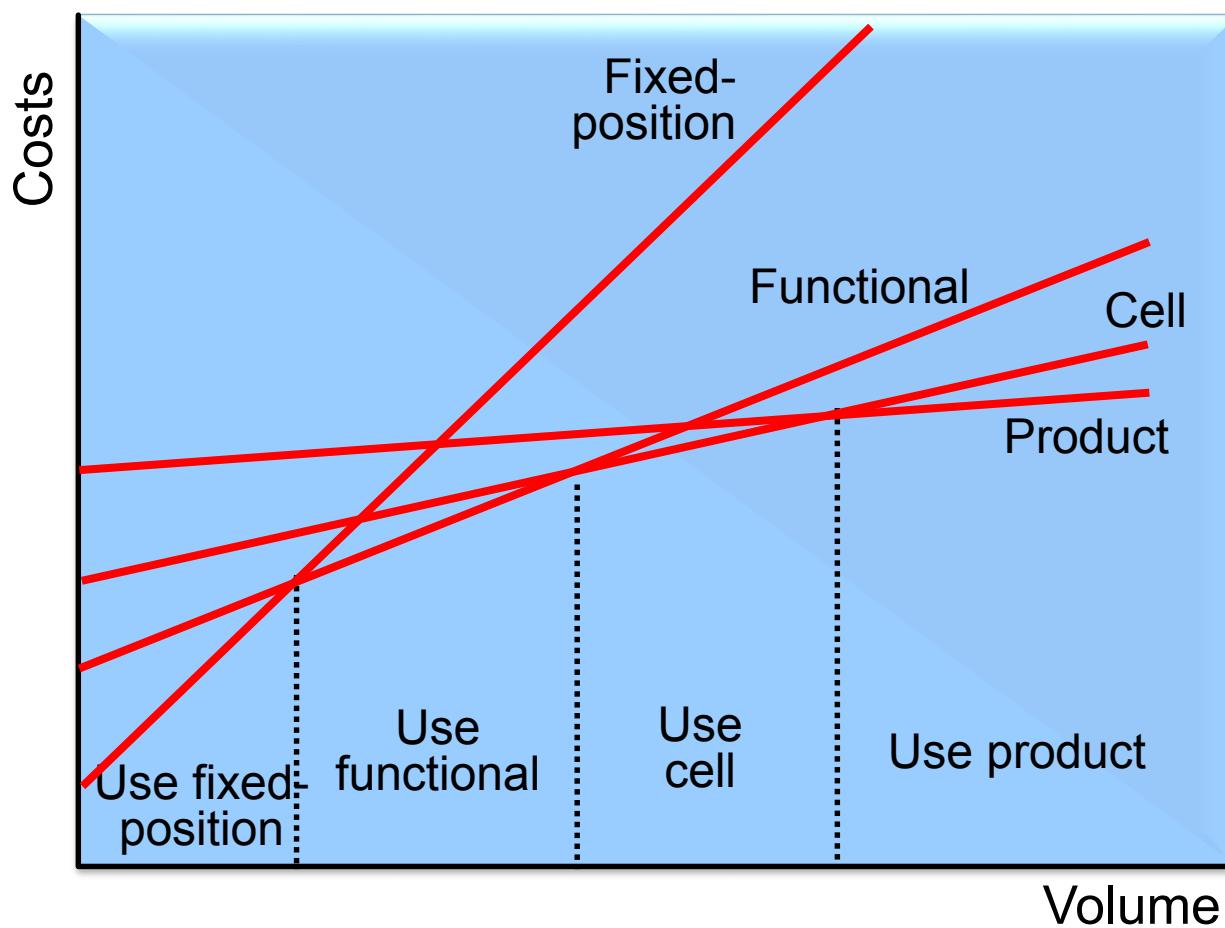
Volume and variety characteristics of layout types



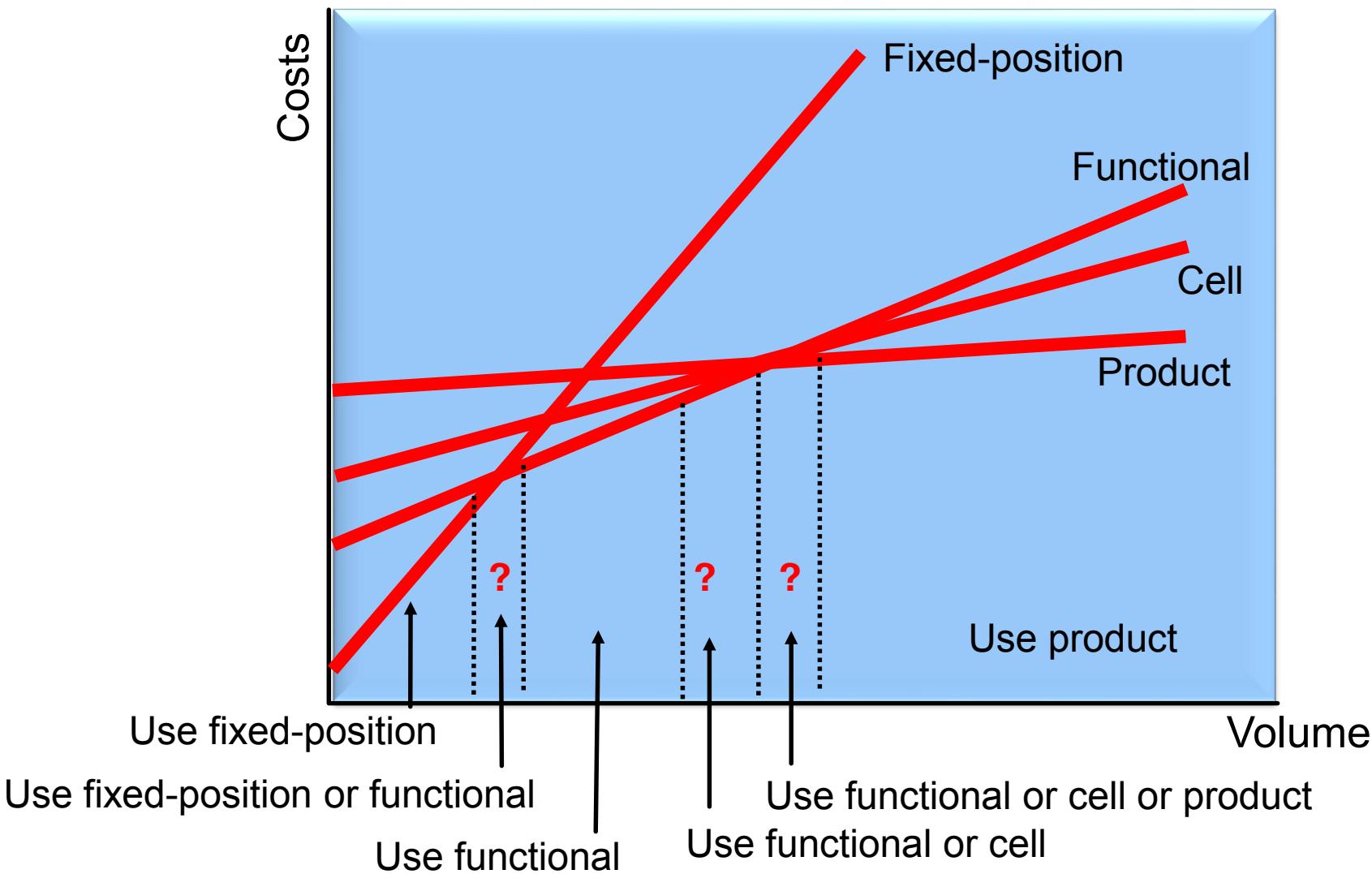
The relationship between functional and layout types



Basic layout types have different fixed and variable costs that seem to determine which one to use.

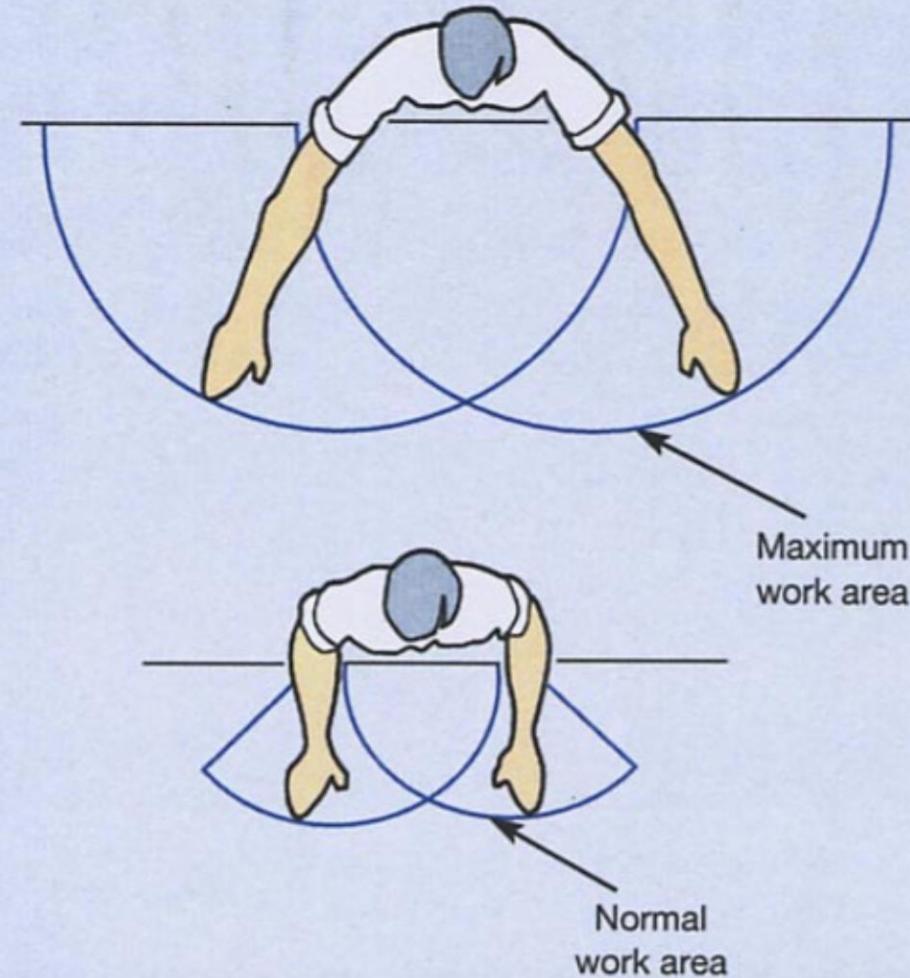
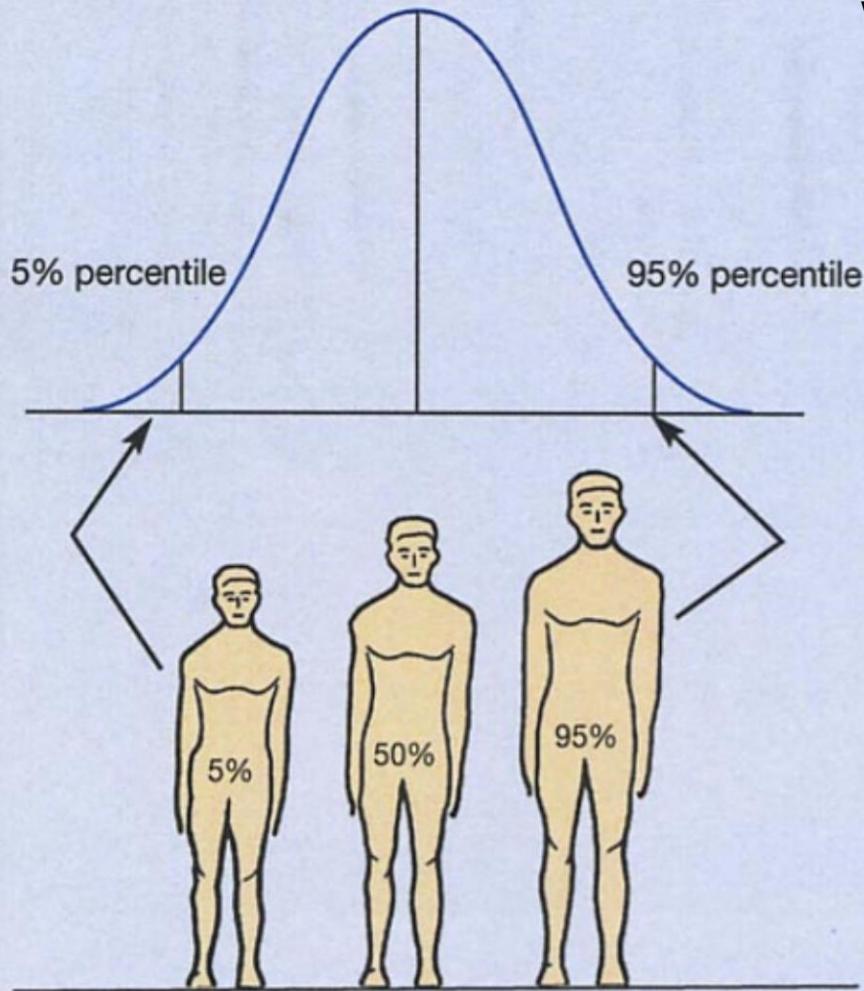


But uncertainty about exact fixed and variable costs means the decision can rarely be made on cost alone



Workplace layout

Using anthropometric data, ergonomics can guide how people interface with their workplace



Workplace layout

Ergonomics in the office environment

Forearms approximately horizontal

Seat back adjustability

Good lumbar support

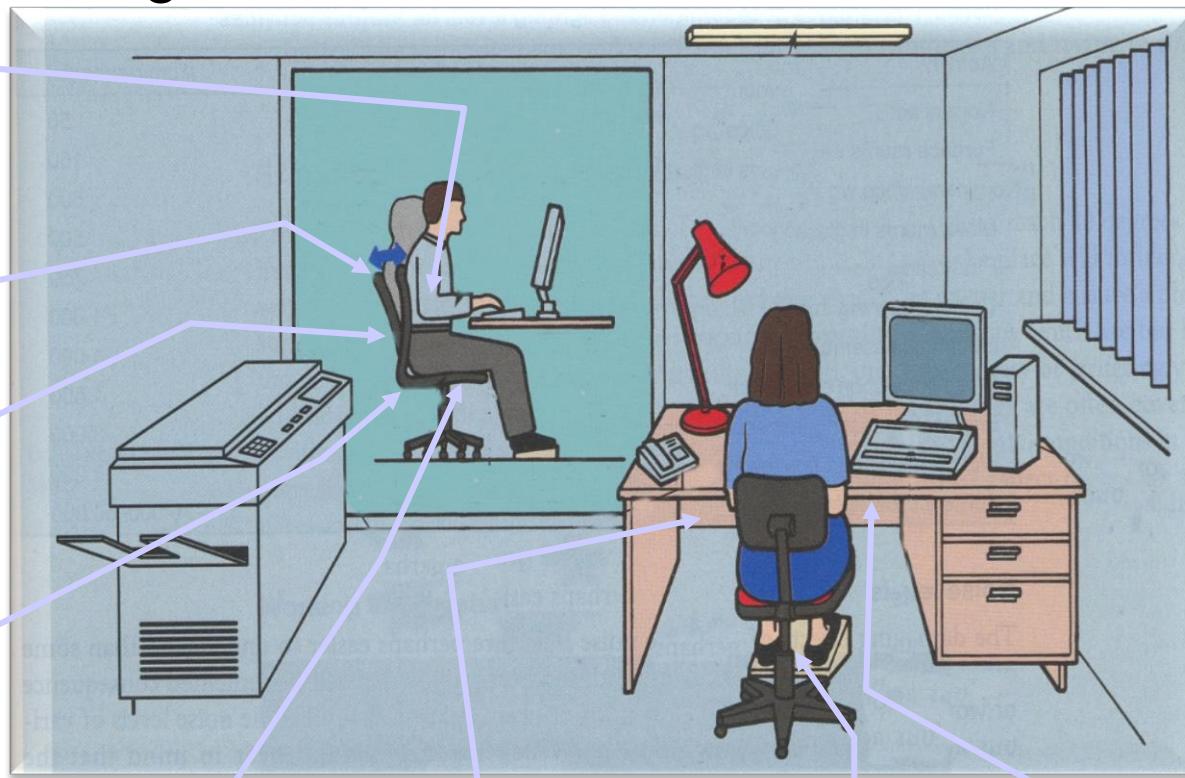
Seat height adjustability

No excess pressure on underside of thighs and backs of knees

Leg room and clearance to allow postural changes

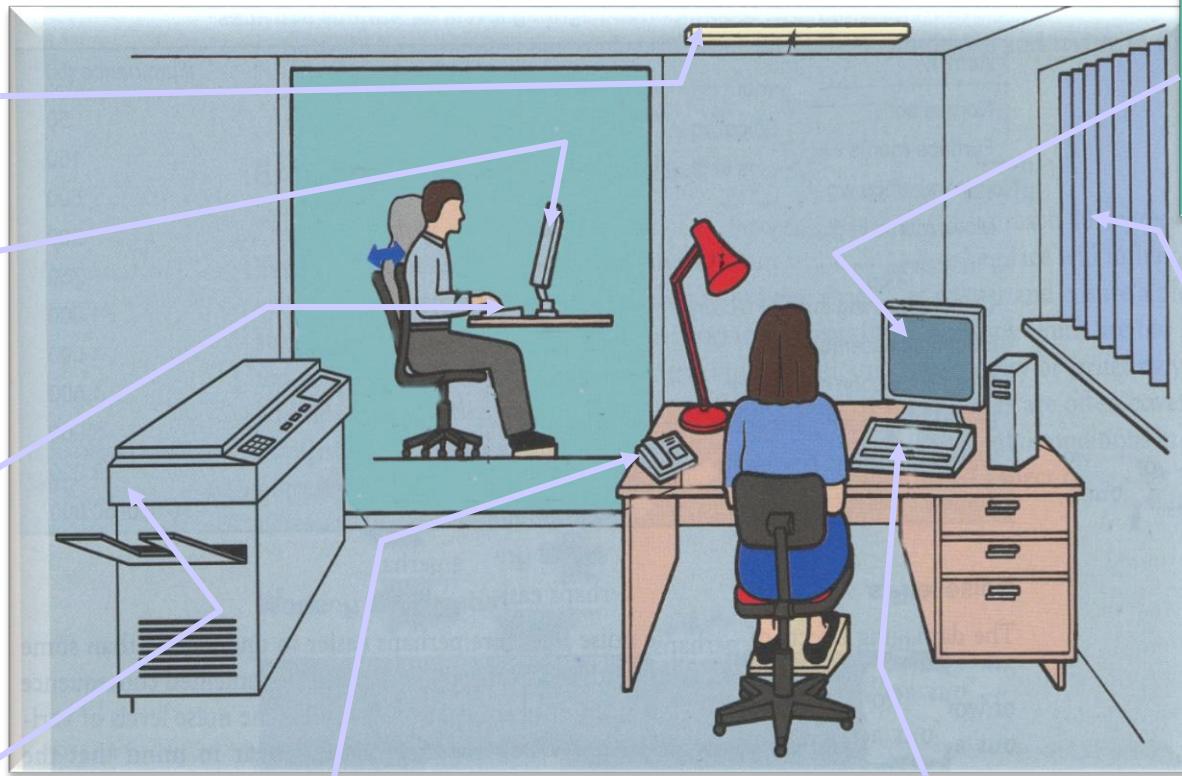
Foot support if needed

Space for postural change, no obstacles under desk



Workplace layout

Ergonomics in the office environment



Adequate lighting

Adequate contrast,
no glare or
distracting
reflections

Keyboard
usable,
adjustable,
detachable,
legible

Distracting
noise
minimized

Work surfaces:
allow flexible
arrangements,
spacious, glare free

Software appropriate to
task, adapted to user, no
undisclosed monitoring

Screen: stable
image,
adjustable,
readable
glare/
reflection free

Window
covering





Operations Management

MGT355

Supply network management



What is supply chain management?

'Supply chain management is the management of the interconnection of organizations that relate to each other through upstream and downstream linkages between the processes that produce value to the ultimate consumer in the form of products and services'.



Why consider the whole supply network?

- It helps an understanding of competitiveness
- It helps identify significant links in the network
- It helps focus on long-term issues
- It helps focus on cost

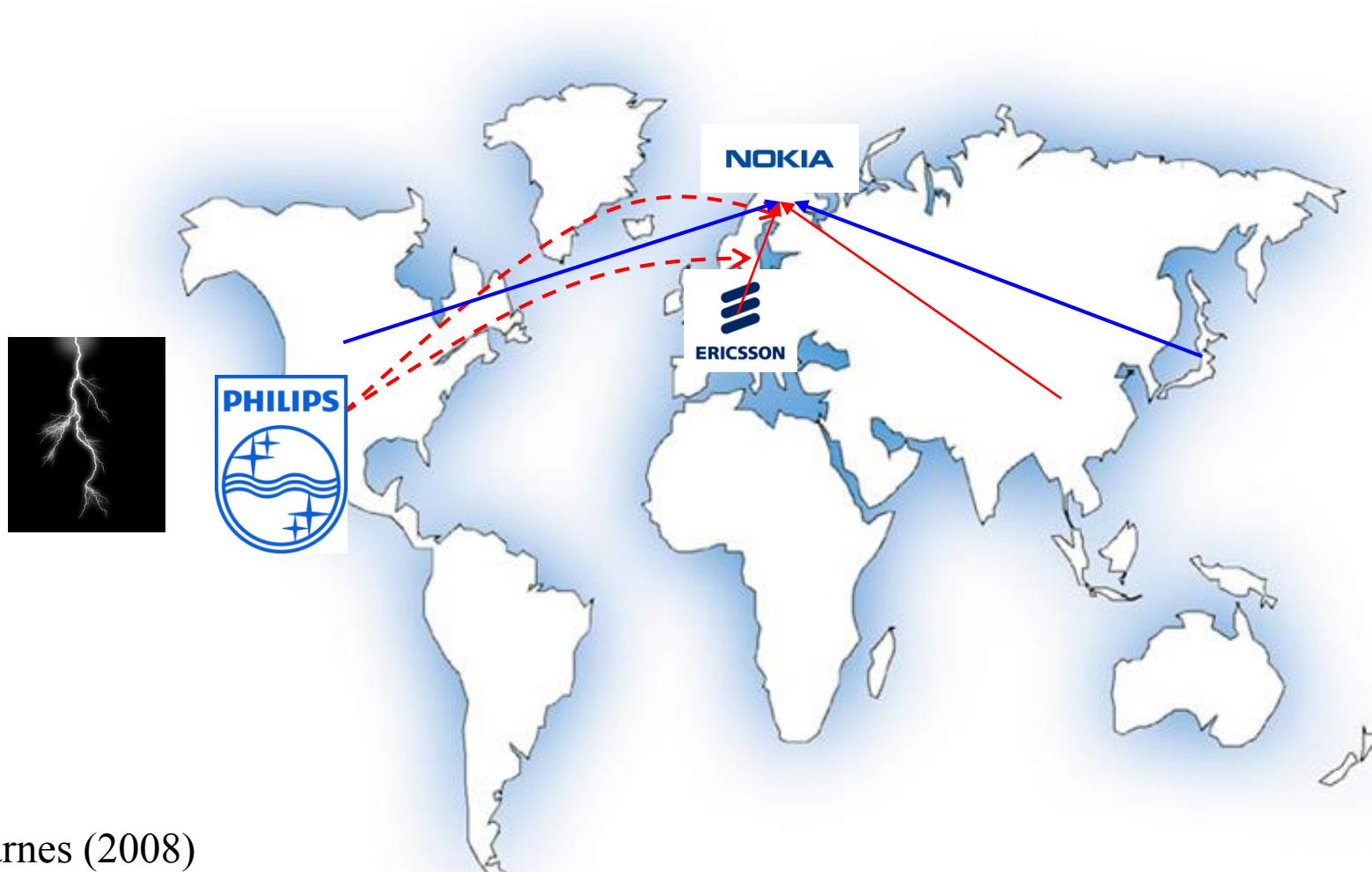


Performance objectives

- Quality
- Speed
- Dependability
- Flexibility (agility)
- Cost



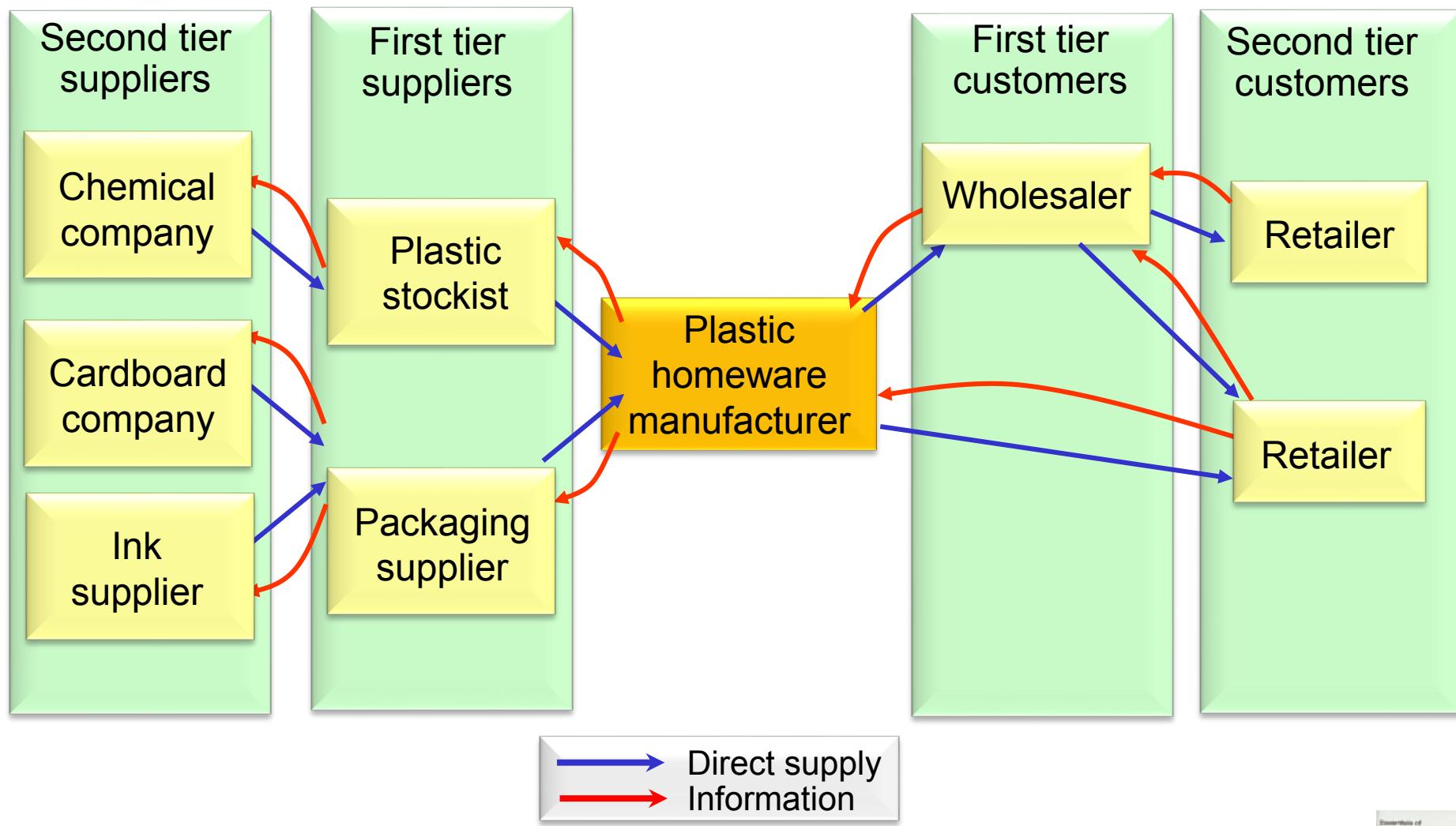
Relationship with suppliers



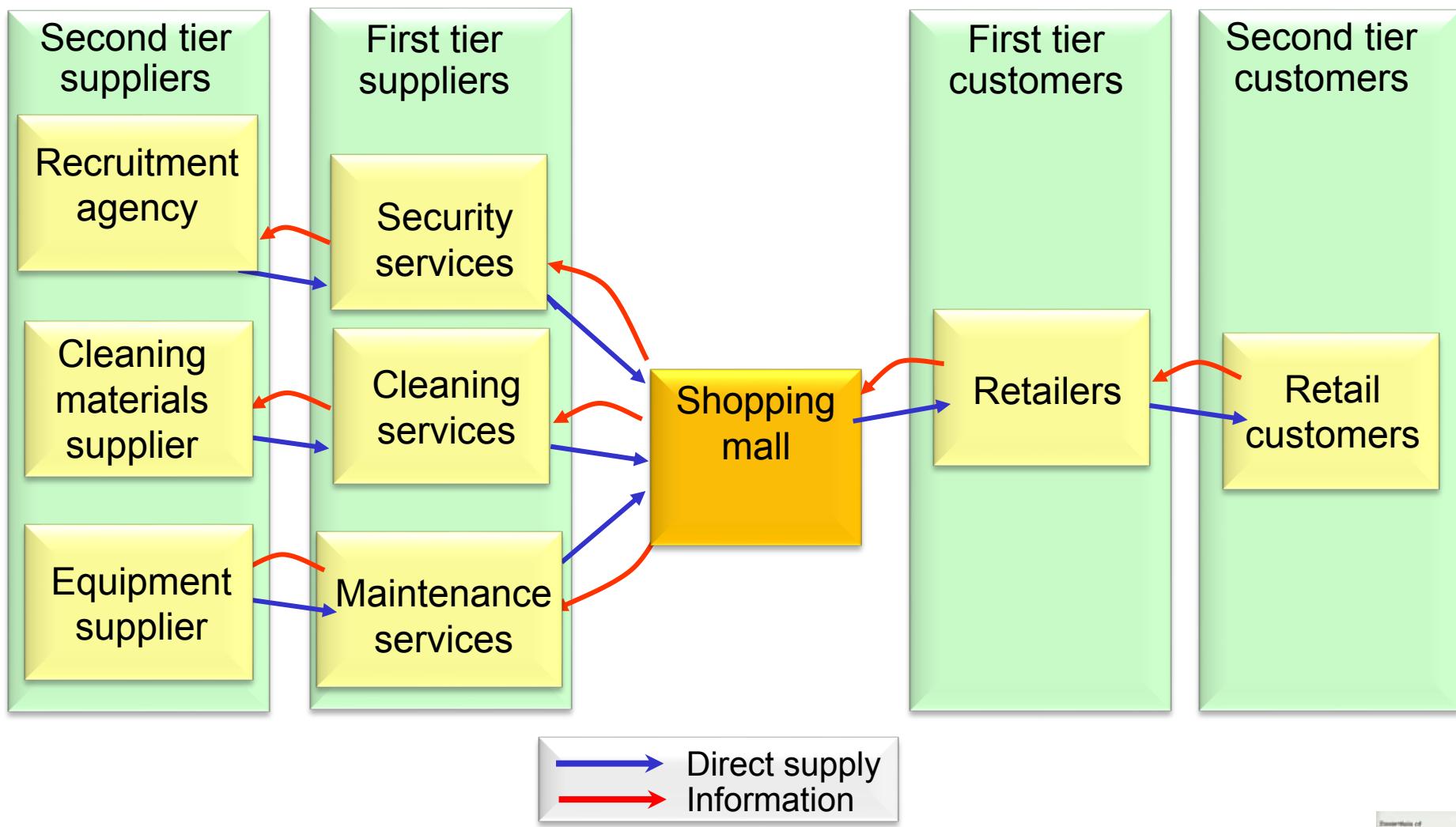
Barnes (2008)



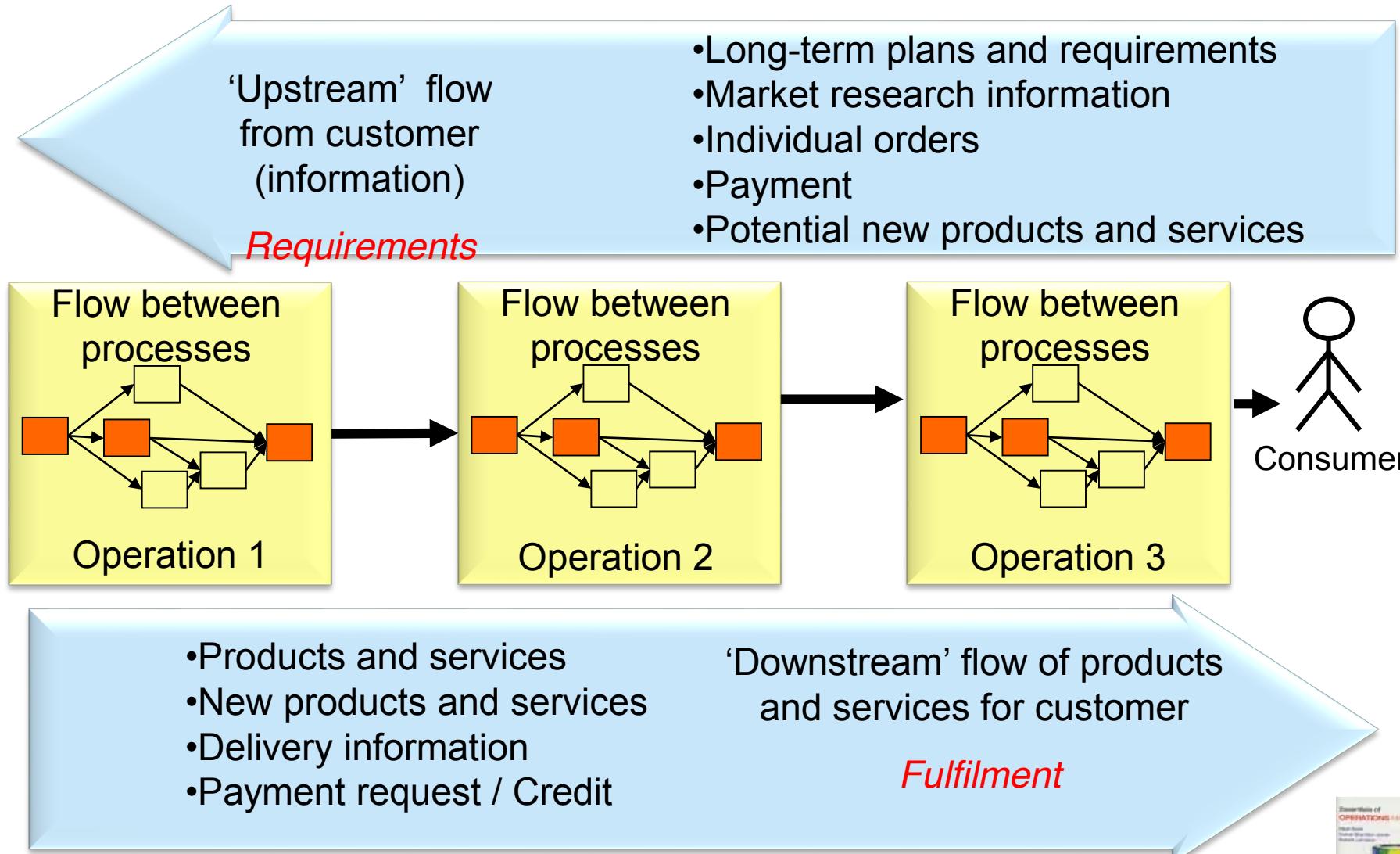
Operations network for a plastic homeware company



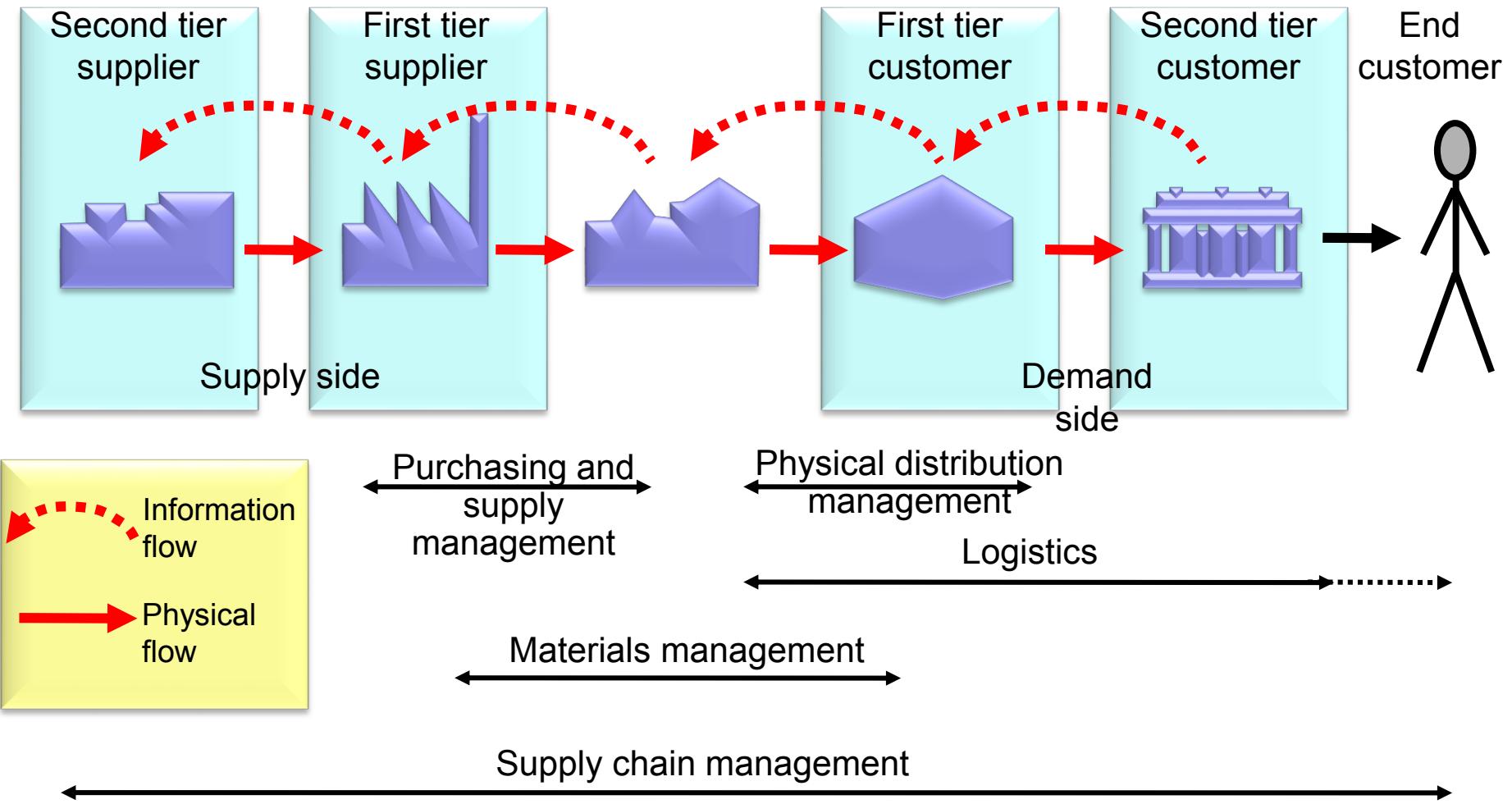
Operations network for a shopping mall



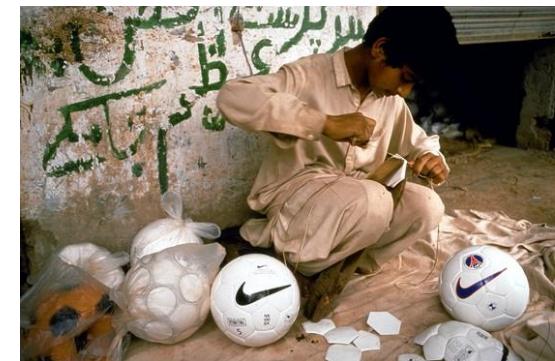
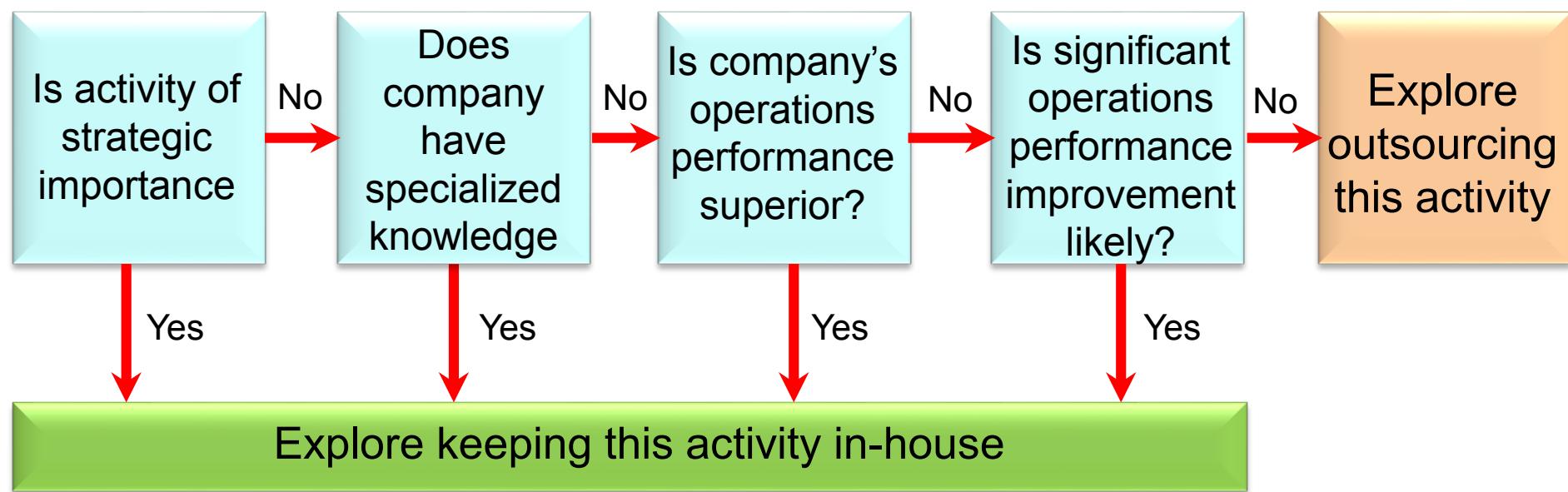
Supply chains management is concerned with the flow of information and the flow of products and services



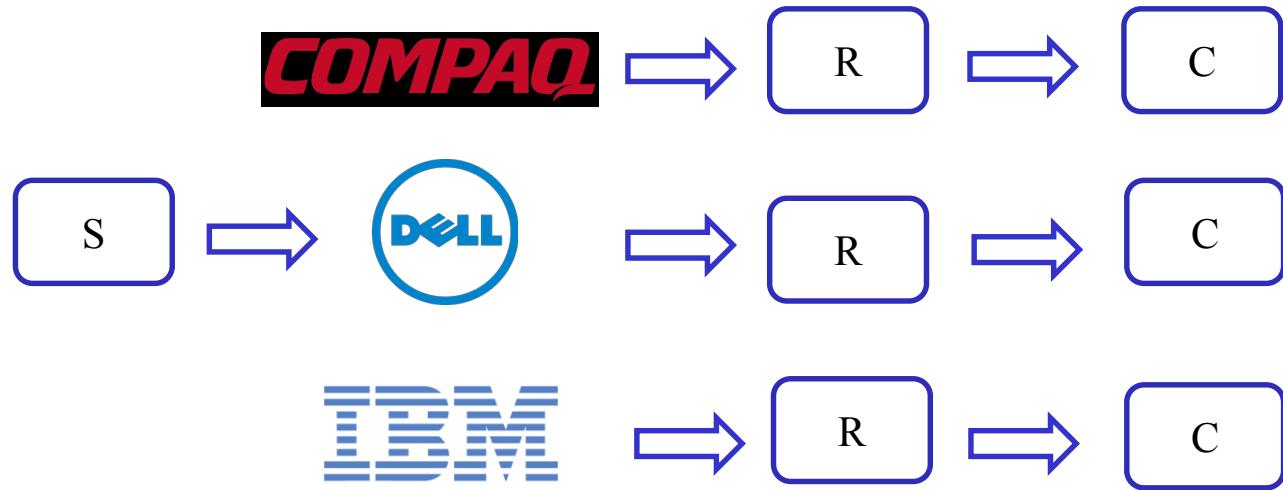
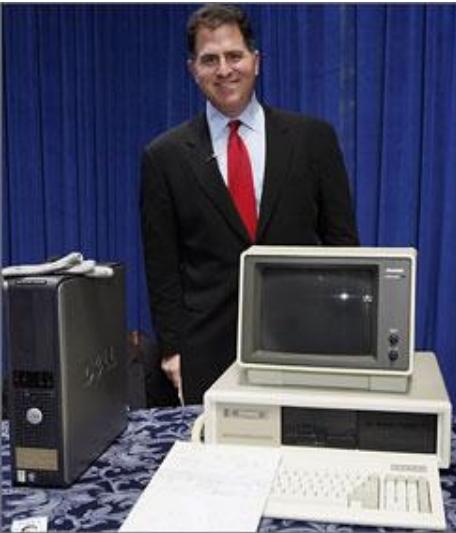
Supply chain planning and control



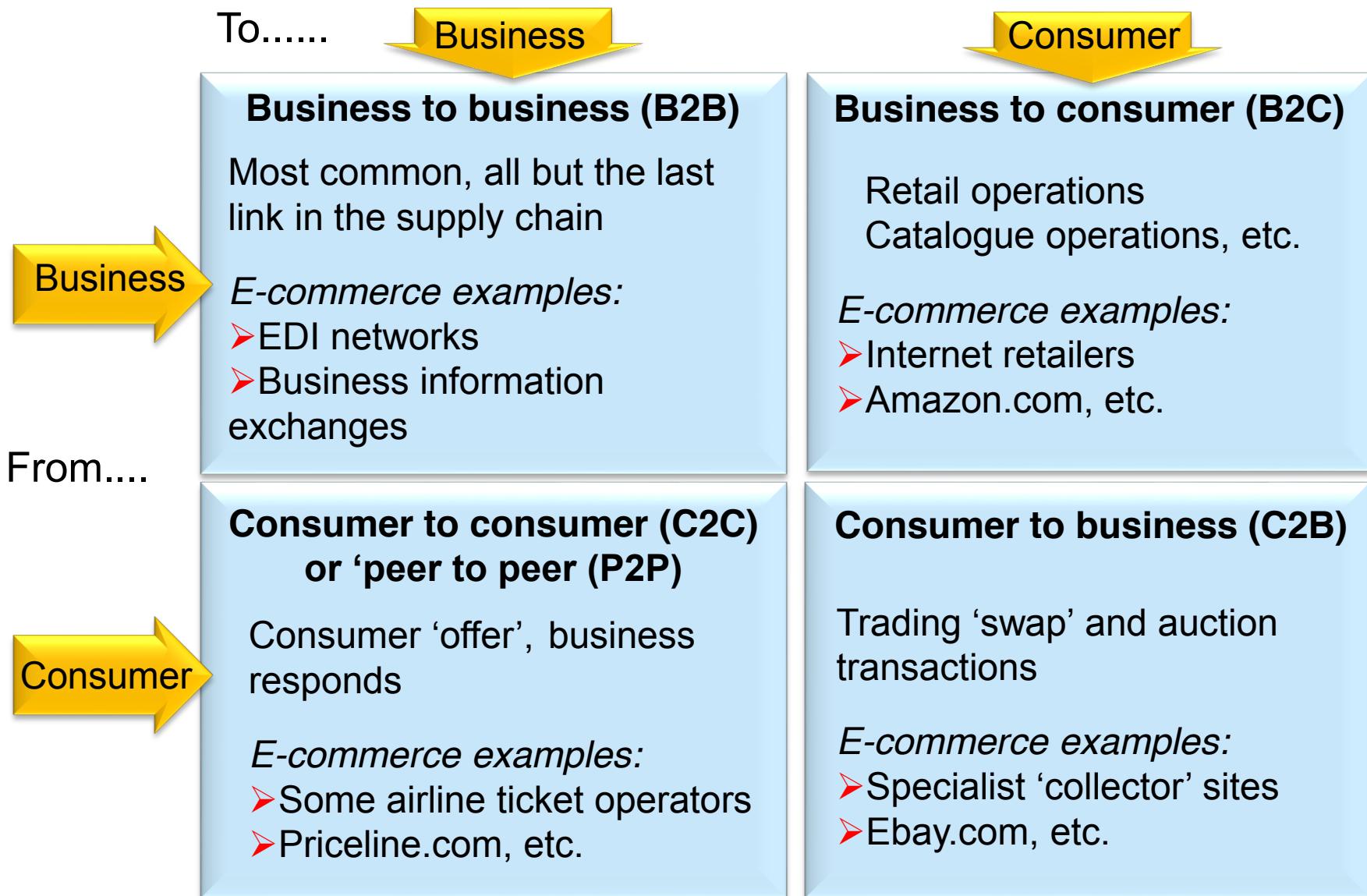
The decision logic of outsourcing



Even the best models do not work for ever!



Supply chain relationships



Factors for rating alternative suppliers

Short-term ability to supply	Longer-term ability to supply
• Range of products or services provided	• Potential for innovation
• Quality of products or services	• Ease of doing business
• Responsiveness	• Willingness to share risk
• Dependability of supply	• Long-term commitment to supply
• Delivery and volume flexibility	• Ability to transfer knowledge as well as products and services
• Total cost of being supplied	• Technical capability
• Ability to supply in the required quantity	• Operations capability
	• Financial capability
	• Managerial capability



Weighted supplier selection criteria for a hotel chain

Factor	Weight	Supplier A score	Supplier B score
Cost performance	10	8 (8x10=80)	5 (5x10=50)
Quality record	10	7 (7x10=70)	9 (9x10=90)
Delivery speed promised	7	5 (5x7=35)	5 (5x7=35)
Delivery speed achieved	7	4 (4x7=28)	8 (8x7=56)
Dependability record	8	6 (6x8=48)	8 (8x8=64)
Range provided	5	8 (8x5=40)	5 (5x5=25)
Innovation capability	4	6 (6x4=24)	9 (9x4=36)
Total weighted score		325	356



The bullwhip effect

PERIOD	3rd LEVEL SUPPLIER		2nd LEVEL SUPPLIER		1st LEVEL SUPPLIER		ORIGINAL EQUIPMENT MFG.		DEMAND
	Prodn.	Stock	Prodn.	Stock	Prodn.	Stock	Prodn.	Stock	
1	100	100 100	100	100 100	100	100 100	100	100 100	100
2	20	100 60	60	100 80	80	100 90	90	100 95	95
3	180	60 120	120	80 100	100	90 95	95	95 95	95
4	60	120 90	90	100 95	95	95 95	95	95 95	95
5	100	90 95	95	95 95	95	95 95	95	95 95	95
6	95	95 95	95	95 95	95	95 95	95	95 95	95

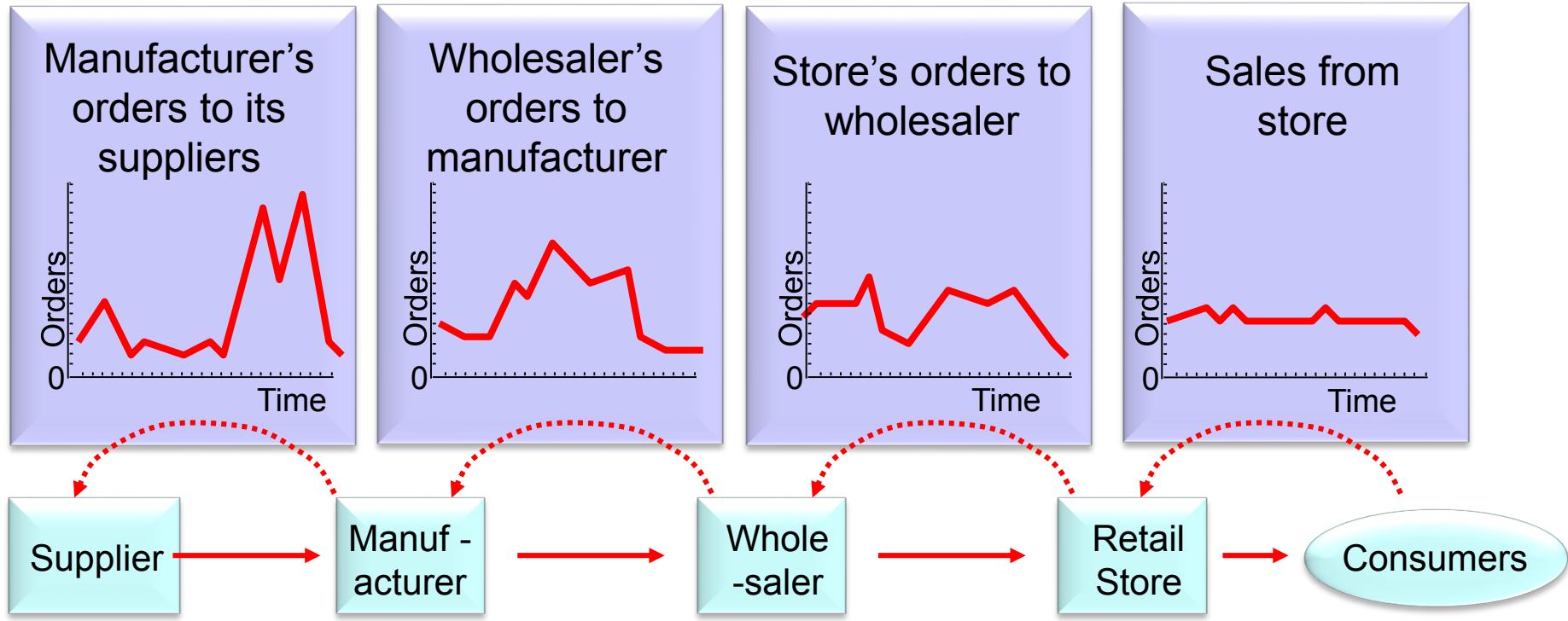


The bullwhip effect

PERIOD	3rd LEVEL SUPPLIER		2nd LEVEL SUPPLIER		1st LEVEL SUPPLIER		ORIGINAL EQUIPMENT MFG.		DEMAND
	Prodn.	Stock	Prodn.	Stock	Prodn.	Stock	Prodn.	Stock	
1	100	100	100	100	100	100	100	100	100
2									95
3									105
4									95
5									105
6									95



The bullwhip effect

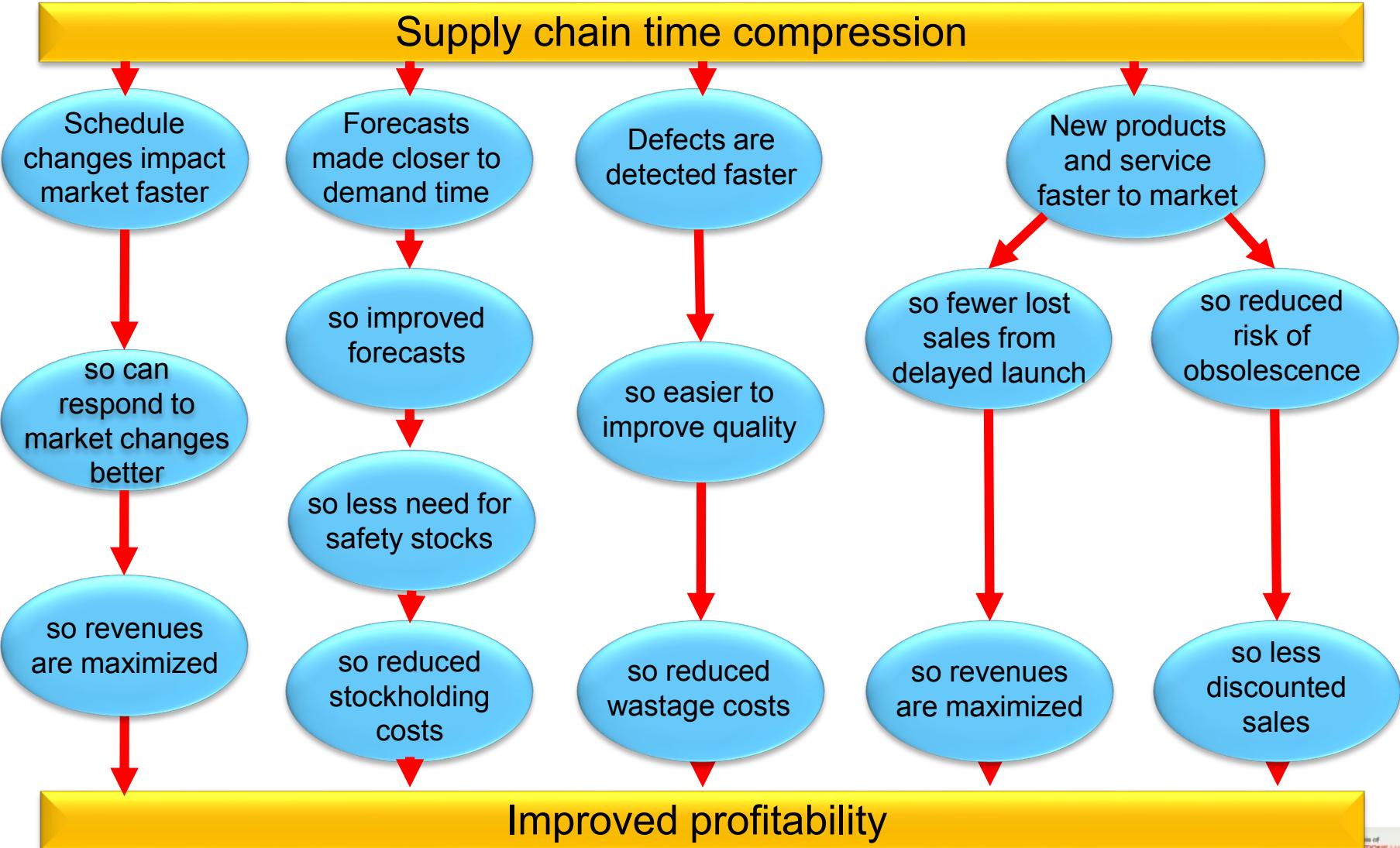


Methods for coping with the bullwhip effect

- **Reducing uncertainty.** This can be accomplished by centralizing demand information.
- **Reducing variability.** This can be accomplished by using a technique made popular by *WalMart* and then *Home Depot* called *everyday low pricing* (EDLP). EDLP eliminates price promotions as well as the shifts in demand that accompany them.
- **Reducing lead time.** Order times can be reduced by using EDI (electronic data interchange).
- **Strategic partnerships.** The use of strategic partnerships can change how information is shared and how inventory is managed within the supply chain. These will be discussed later.



The effects of supply chain compression





Operations Management

MGT355

Capacity management



What is capacity?

- ❖ Capacity 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

<i>Operation</i>	<i>Input measure of capacity</i>	<i>Output measure of capacity</i>
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

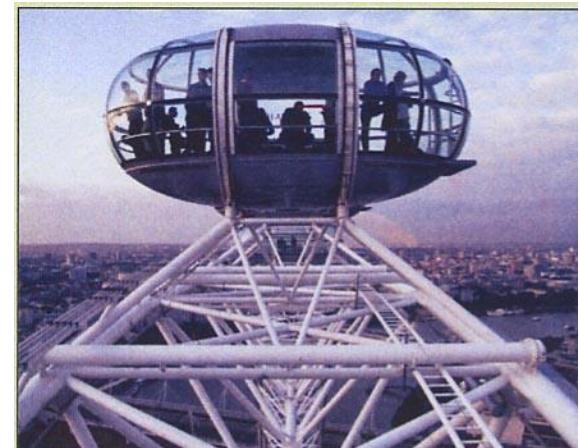
Note: The most commonly used measure is shown in bold.

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

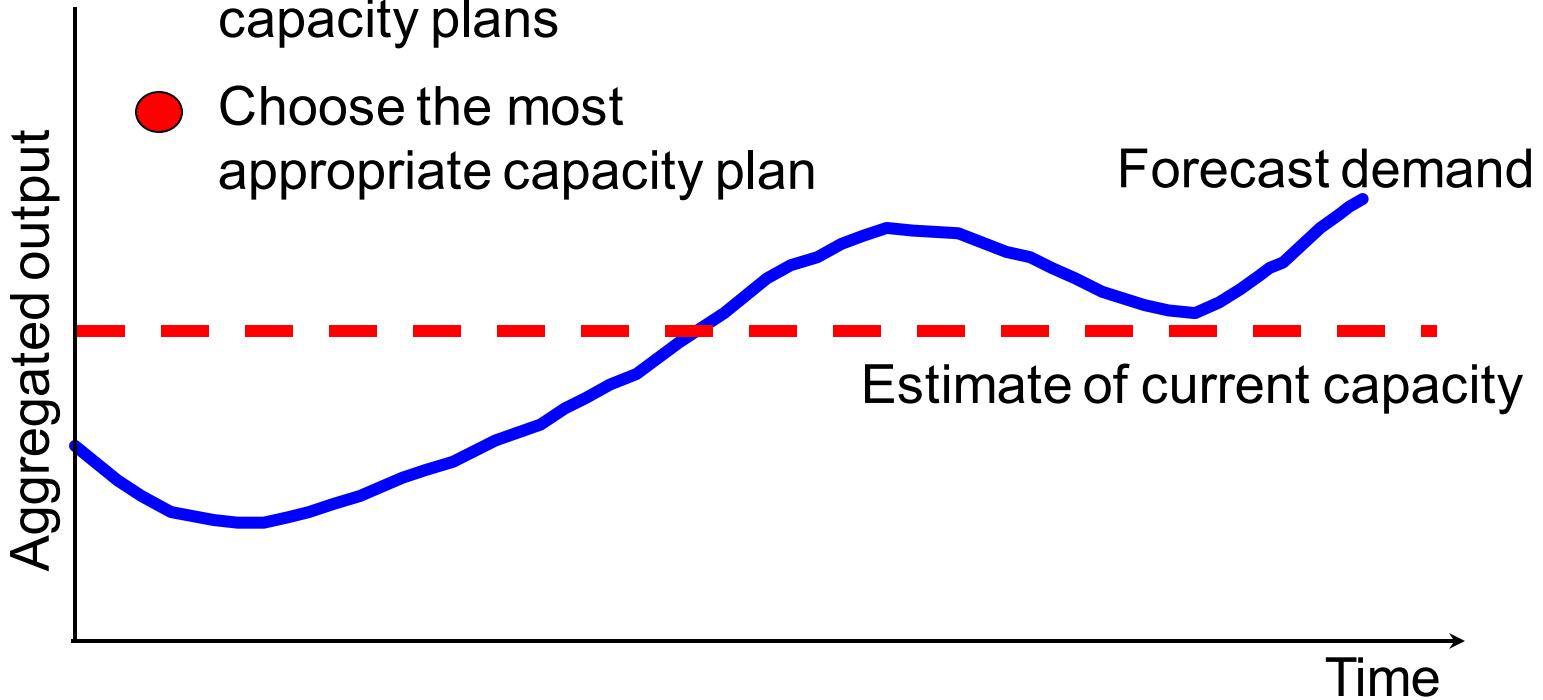


Objectives of capacity planning and control

- Measure aggregate capacity and demand

- Identify the alternative capacity plans

- Choose the most appropriate capacity plan

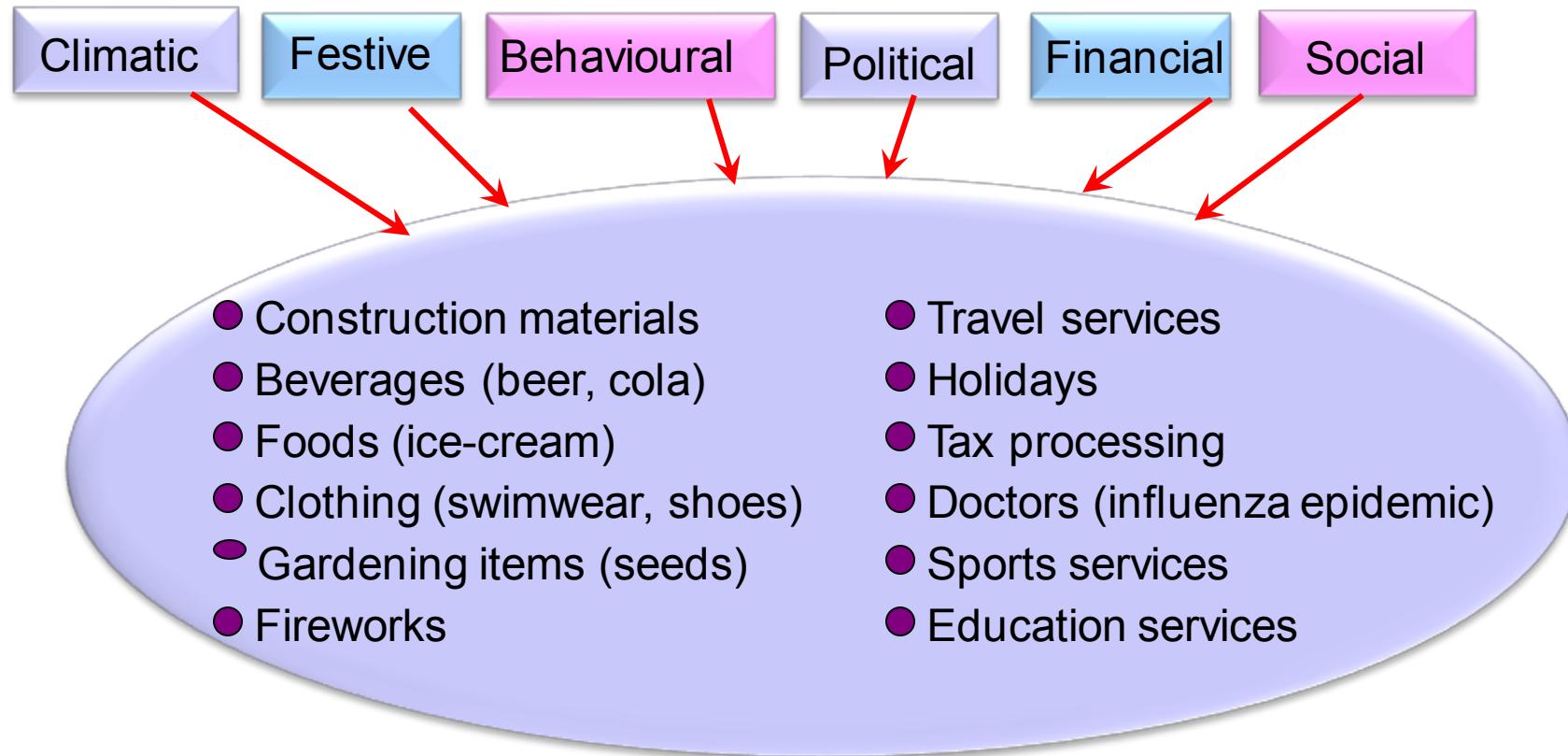


The nature of aggregate capacity

- 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.



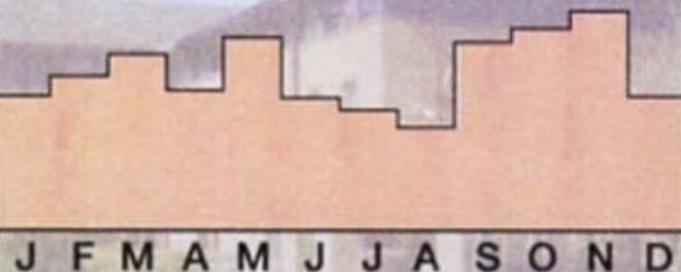
Causes of seasonality



Demand fluctuations in four operations

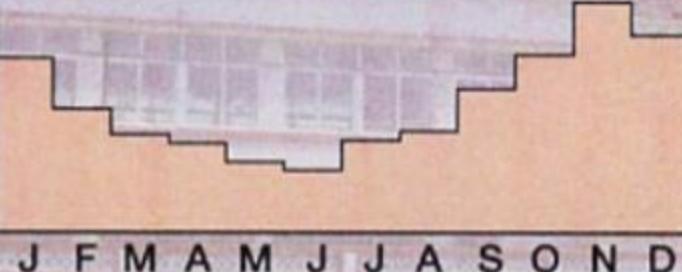
Hotel

Room nights sold



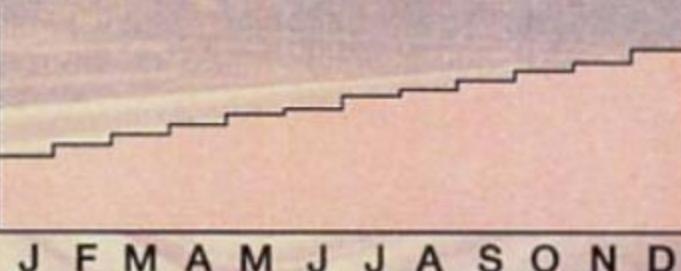
Woollen knitwear factory

Units per month



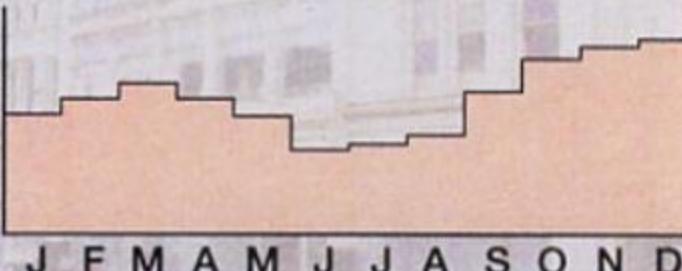
Aluminium producer

Tonnes per month



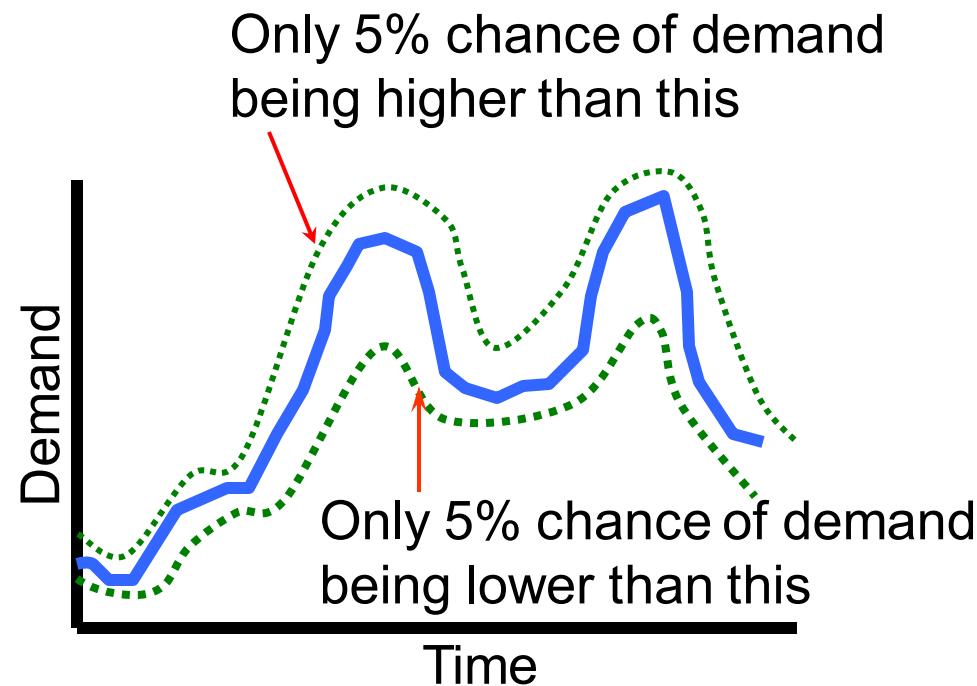
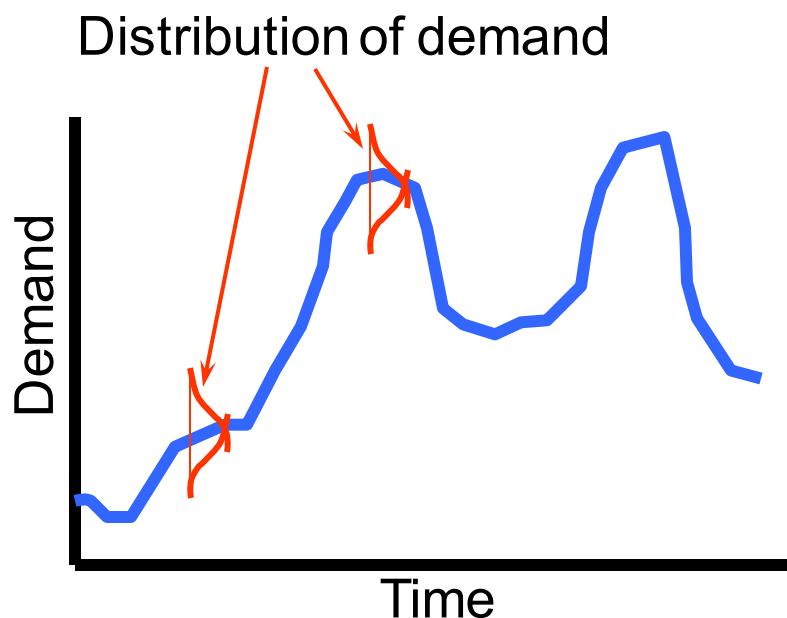
Retail store

Revenue per month



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**

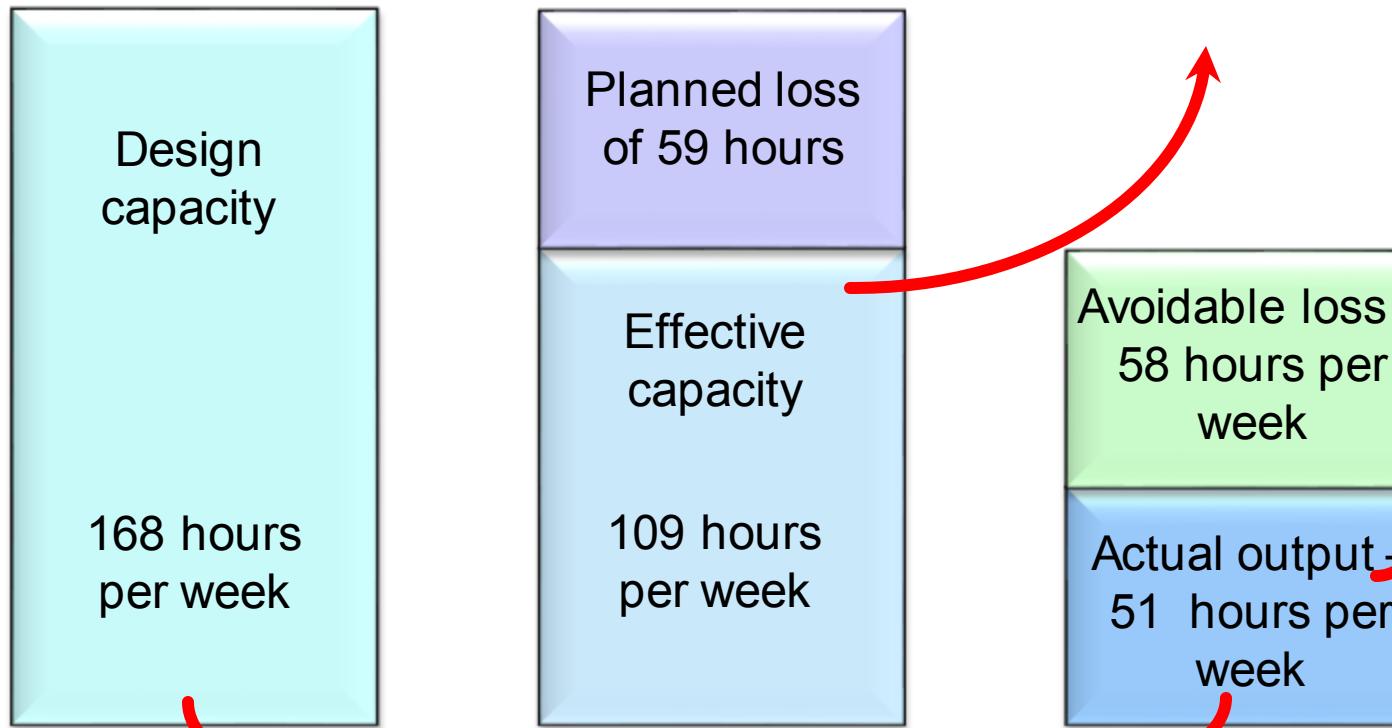
(Barnes, 2008)



How capacity is measured

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

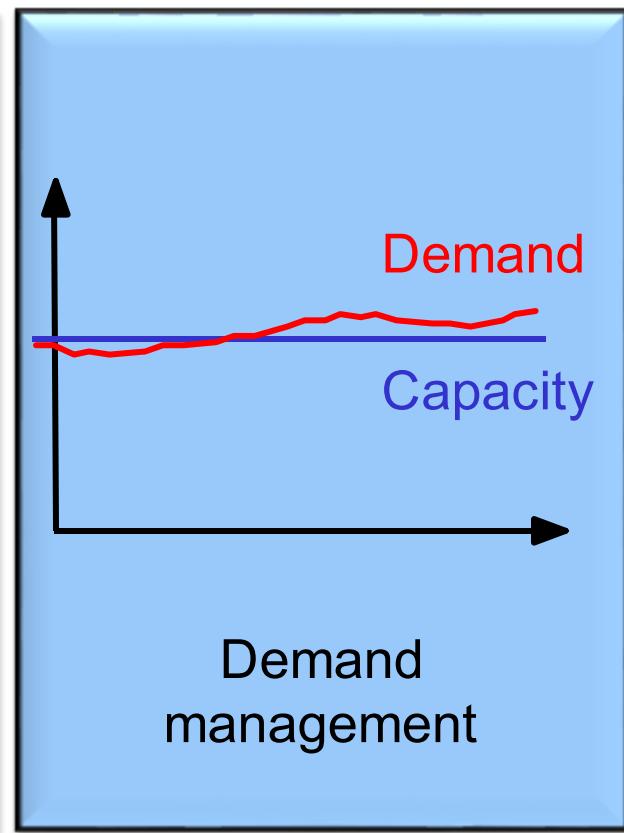
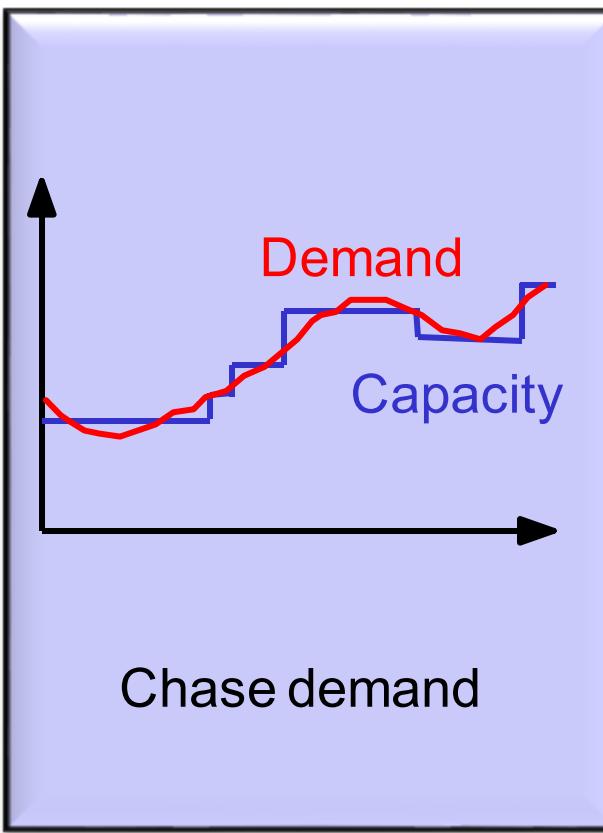
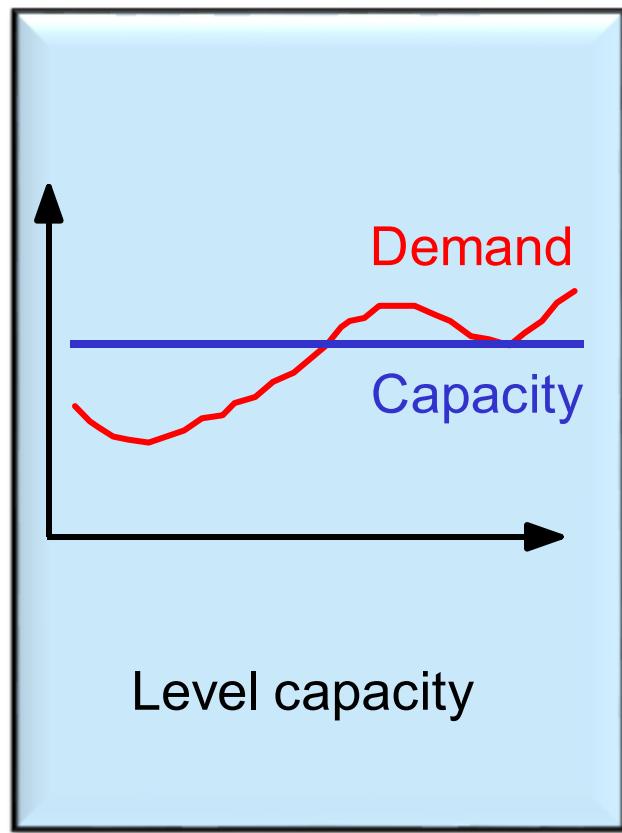
$$\text{Efficiency} = \frac{\text{Actual output}}{\text{Effective capacity}}$$



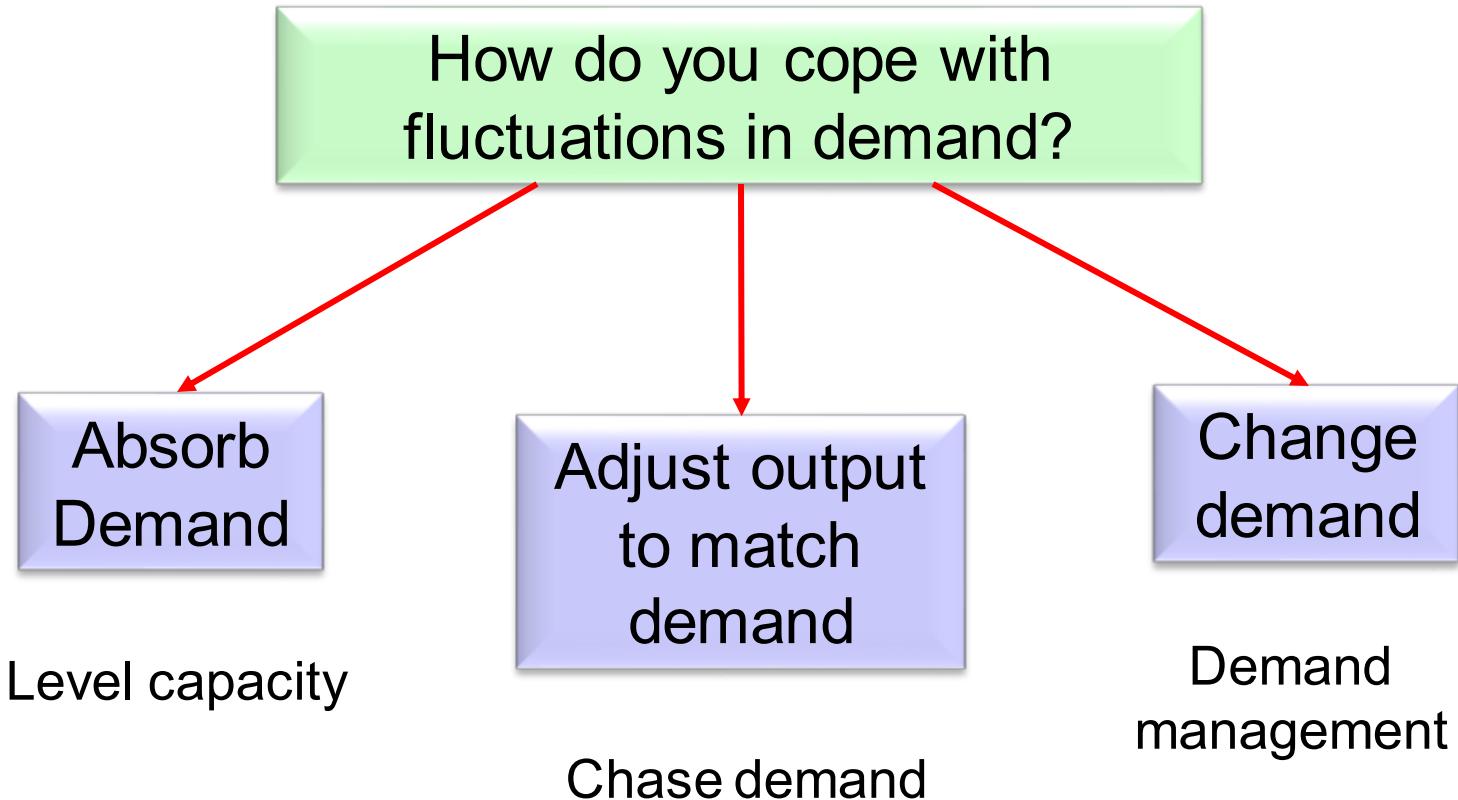
$$\text{Utilization} = \frac{\text{Actual output}}{\text{Design capacity}}$$



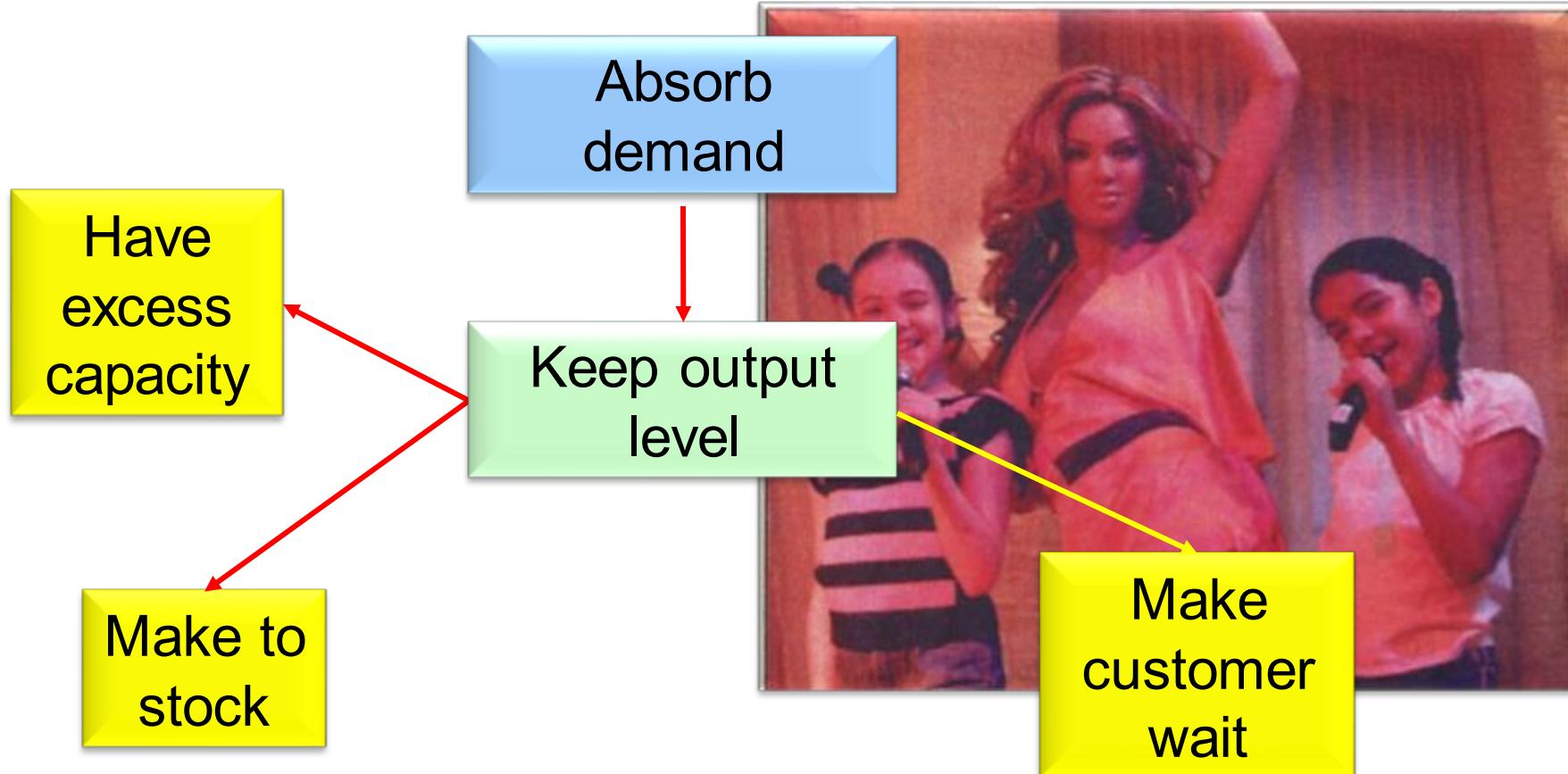
Ways of reconciling capacity and demand



Ways of reconciling capacity and demand



Absorb demand



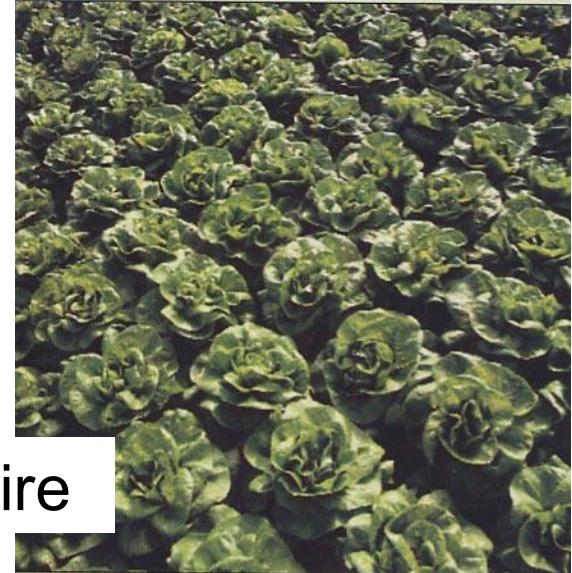
- Part finished
- Finished goods, or
- Customer Inventory

- 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

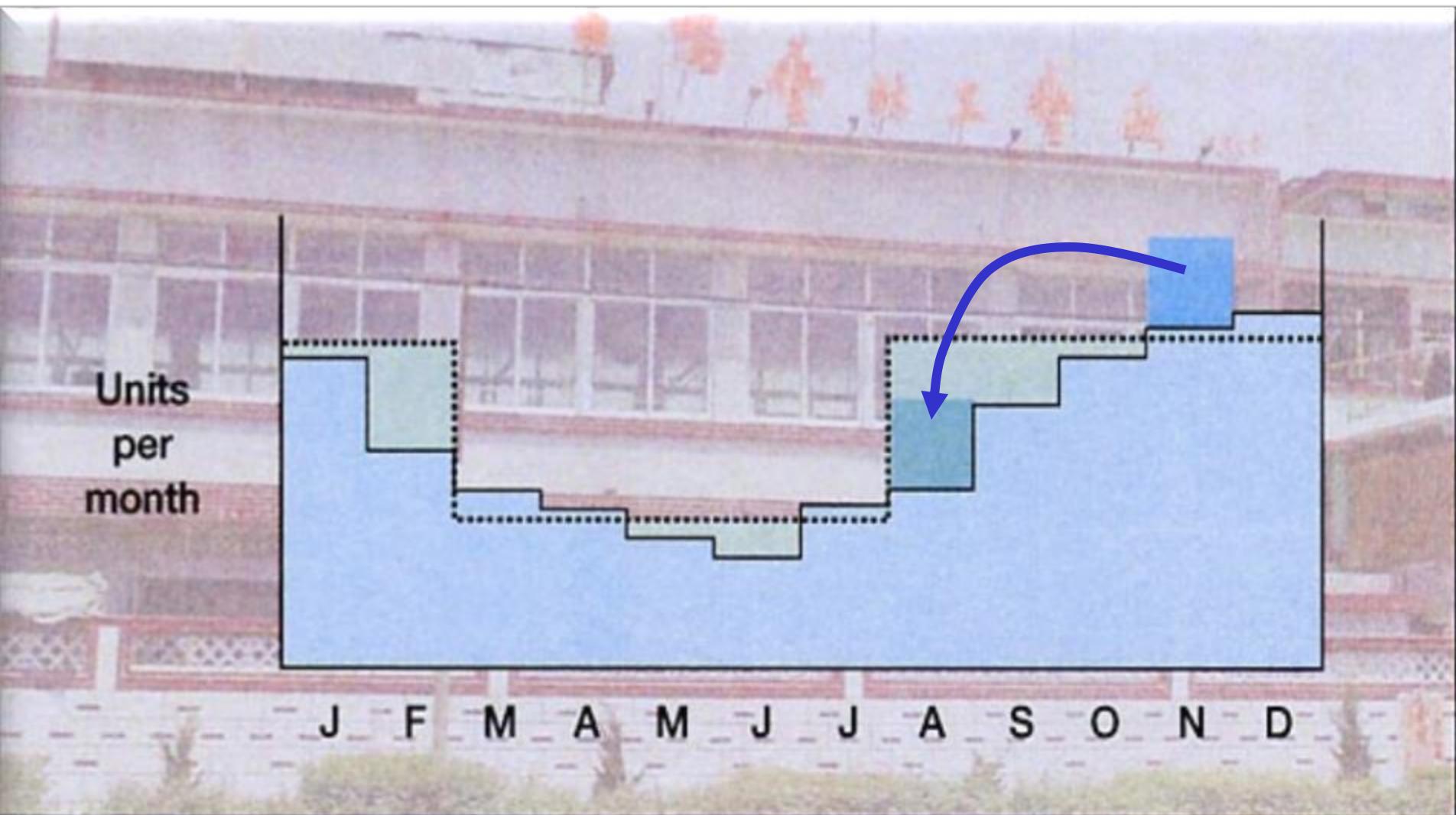
Change demand

Change
demand

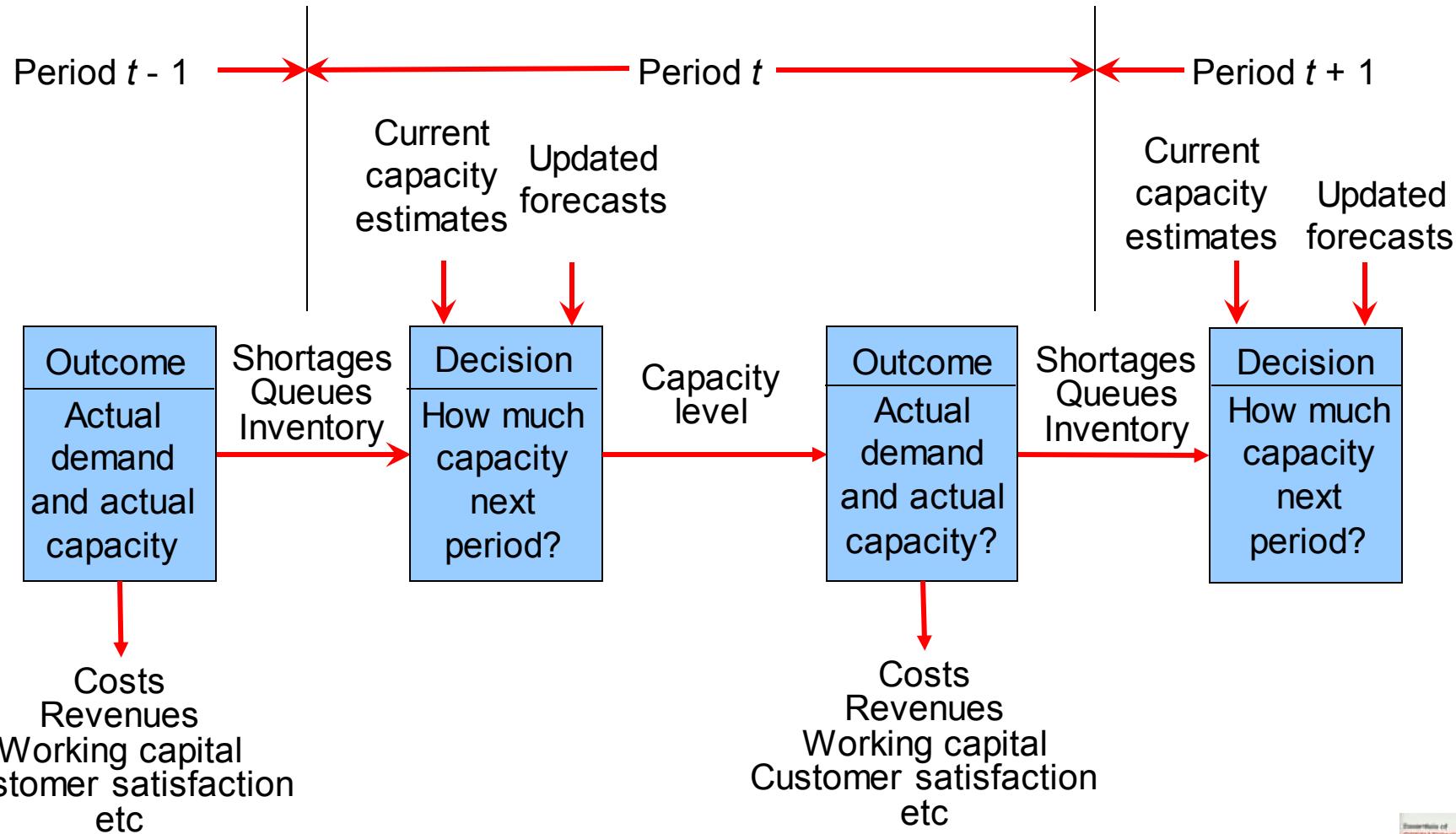
- Change pattern of demand
- Develop alternative products and/or services



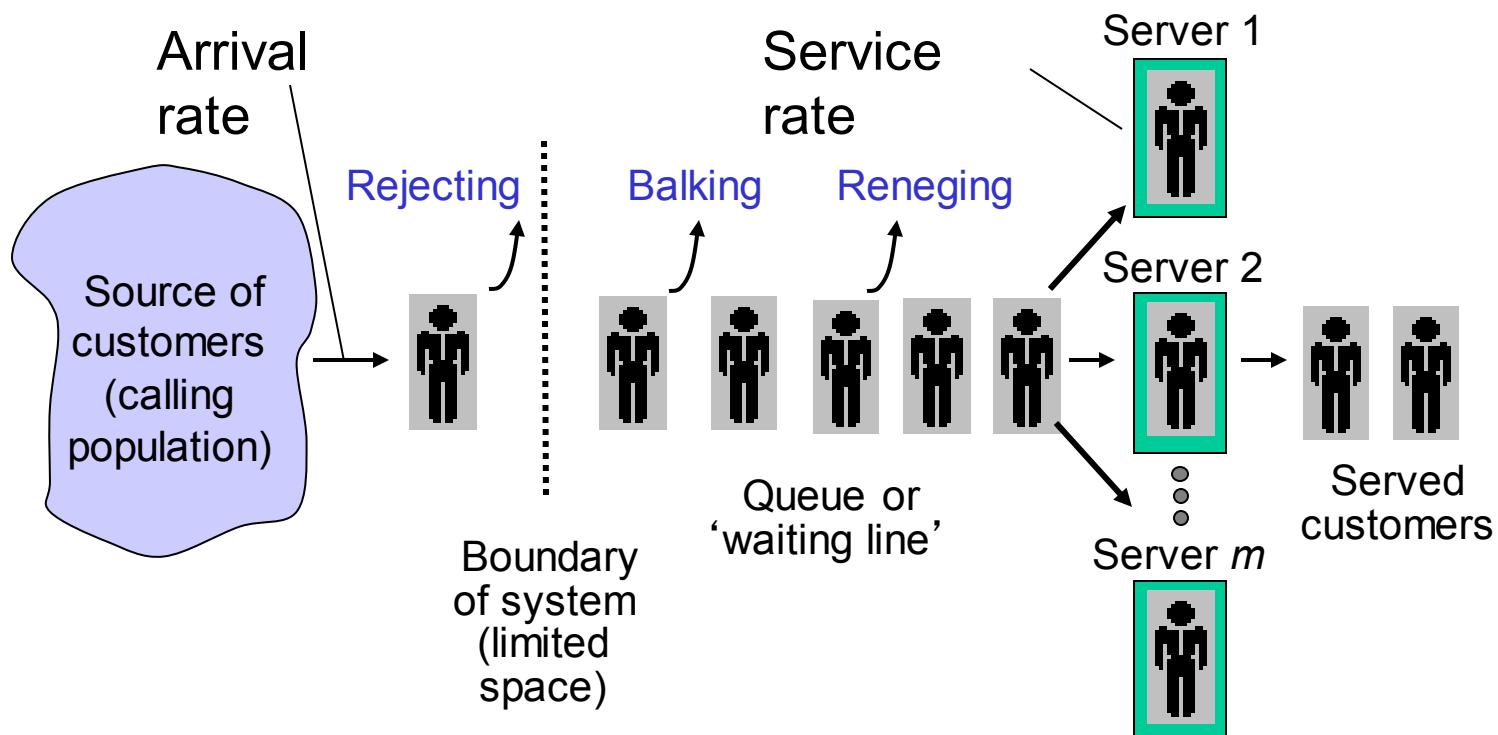
Moving a peak in demand can make capacity planning easier



Capacity planning and control as a dynamic sequence of decisions



Queuing – the range of behaviours





Operations Management

MGT355

Inventory management

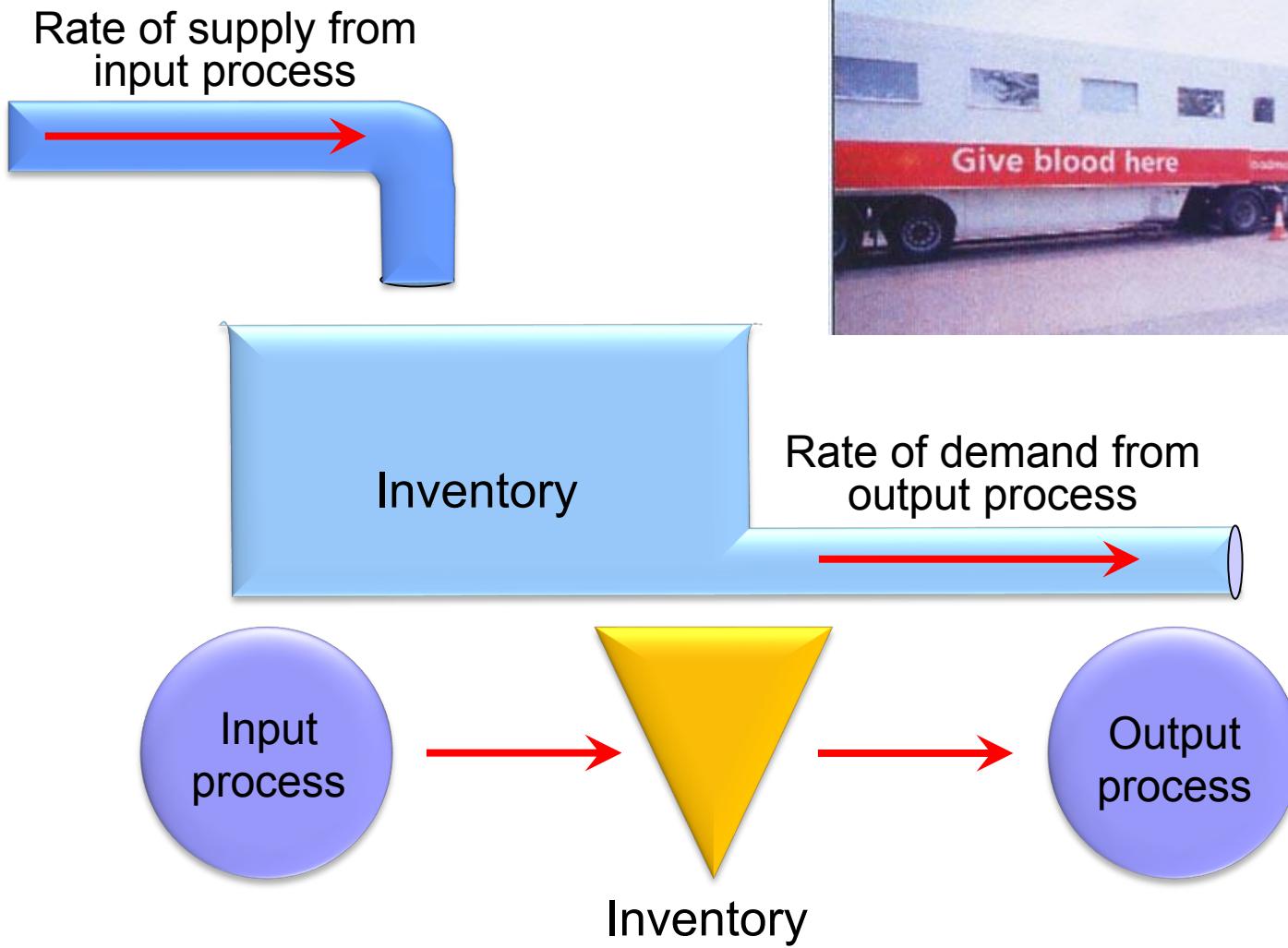


A definition

- **Inventory or stock** is defined as the *stored accumulation of resources in a transformation system*.
- Usually the term refers only to *transformed resources*.



Inventory is created to compensate for the differences in timing between supply and demand



Inventory related costs

- Cost of placing the order
- Price discount costs
- Stock-out costs
- Working capital costs
- Storage costs
- Obsolescence costs
- Operating inefficiency costs
- * Consignment cost



Reasons for keeping inventory

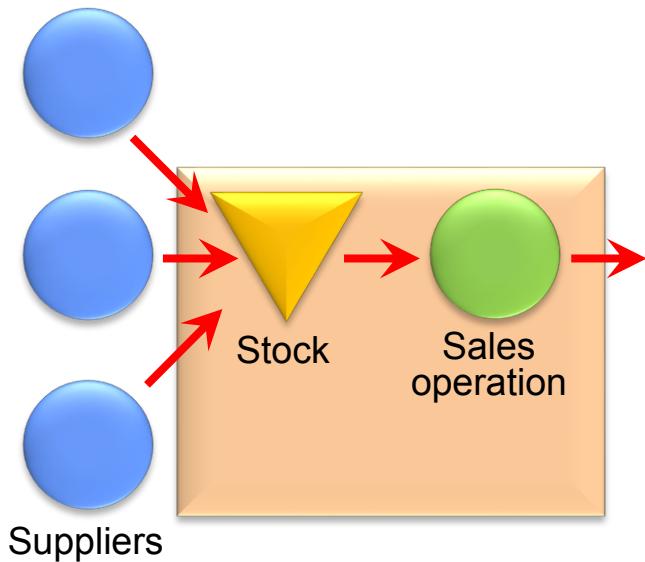
- There are five main reasons for keeping inventory:
 - To cope with random or unexpected interruptions in supply or demand (**buffer inventory or Safety inventory**)
 - To cope with an operation's inability to make all products simultaneously (**cycle inventory**)
 - To allow different stages of processing to operate at different speeds and with different schedules (**de-coupling inventory**)
 - To cope with planned fluctuations in supply or demand (**anticipation inventory**)
 - To cope with transportation delays in the supply network (**pipeline inventory**)

Disadvantages of holding inventory

- Inventory **ties up money**, in the form of working capital, which is therefore unavailable for other uses
- Inventory **incurs storage costs** (leasing space, maintaining appropriate conditions etc.)
- Inventory **may become obsolete** as alternatives become available
- Inventory **can be damaged or deteriorate**
- Inventory **could be lost, or be expensive to retrieve**, as it gets hidden amongst other inventory
- Inventory **might be hazardous to store** (flammable solvents, explosives, chemicals and drugs etc.)
- Inventory **uses space that could be used to add value**
- Inventory **involves administrative and insurance costs**

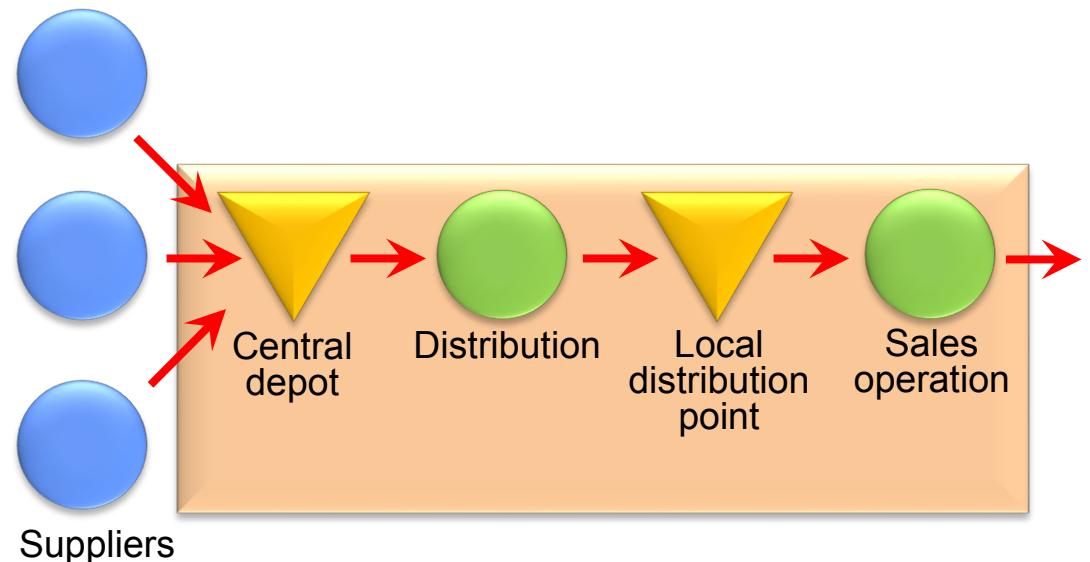
Single-stage and two-stage inventory systems

Single-stage
inventory system



e.g. Local retail store

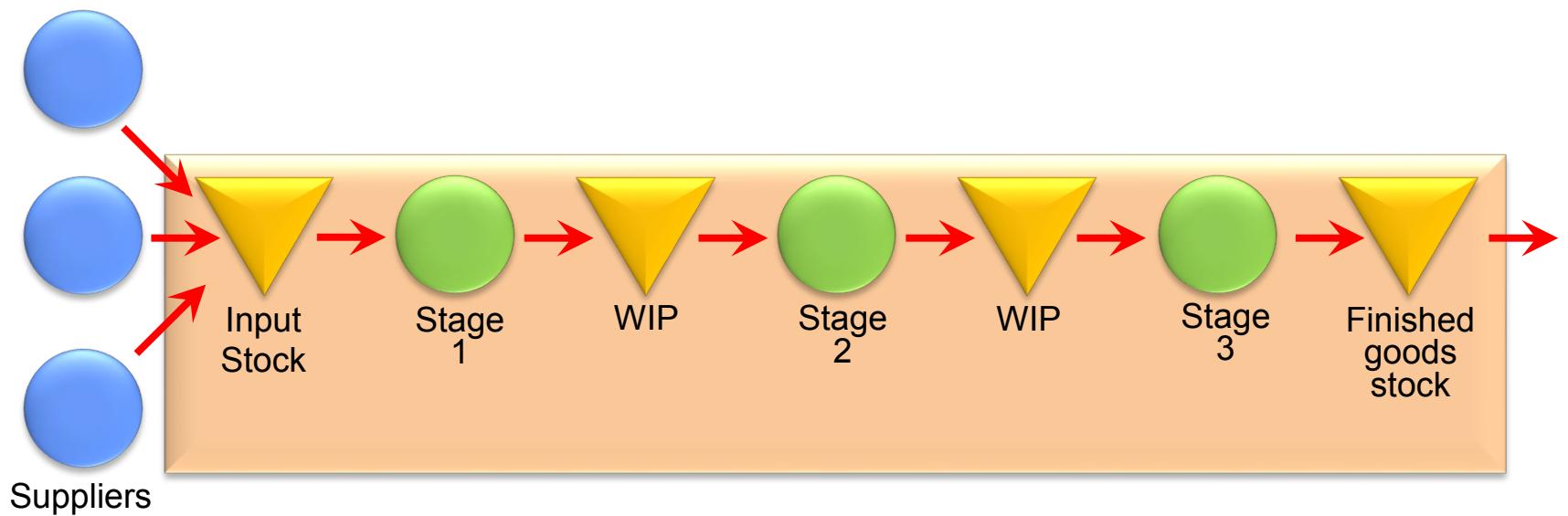
Two-stage inventory
system



e.g. Automotive parts
distributor



A Multi-stage inventory system



e.g. Television manufacturer



Determining the amount of inventory

- The best-known approach to determining the amount of inventory to order is the **Economic Order Quantity (EOQ)** formula. The EOQ can be adapted to different types of inventory profile using different stock behaviour assumptions.
- Another approach for gradual replacement of the inventory is the Economic Batch Quantity (EBQ).

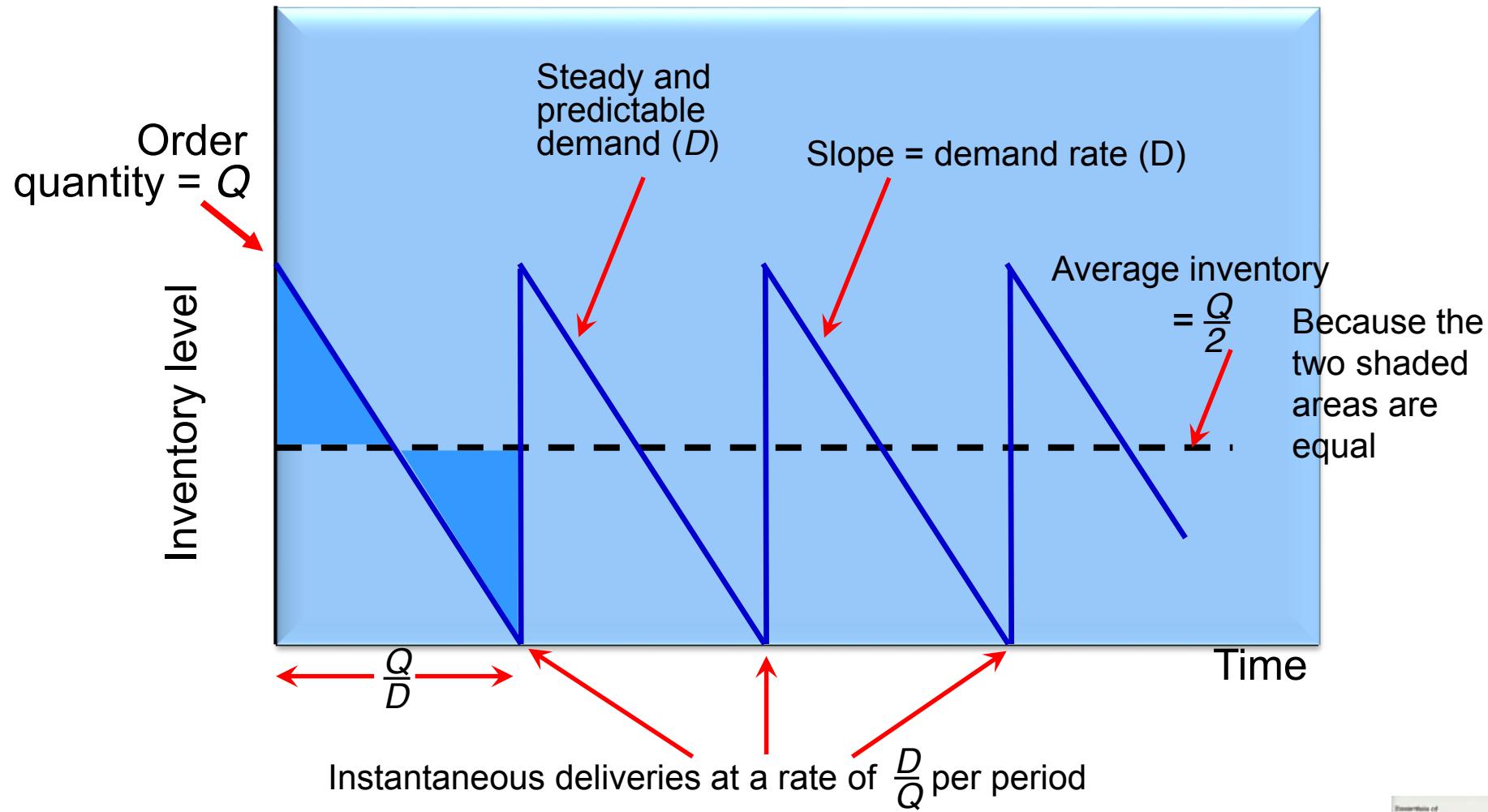


Defining things

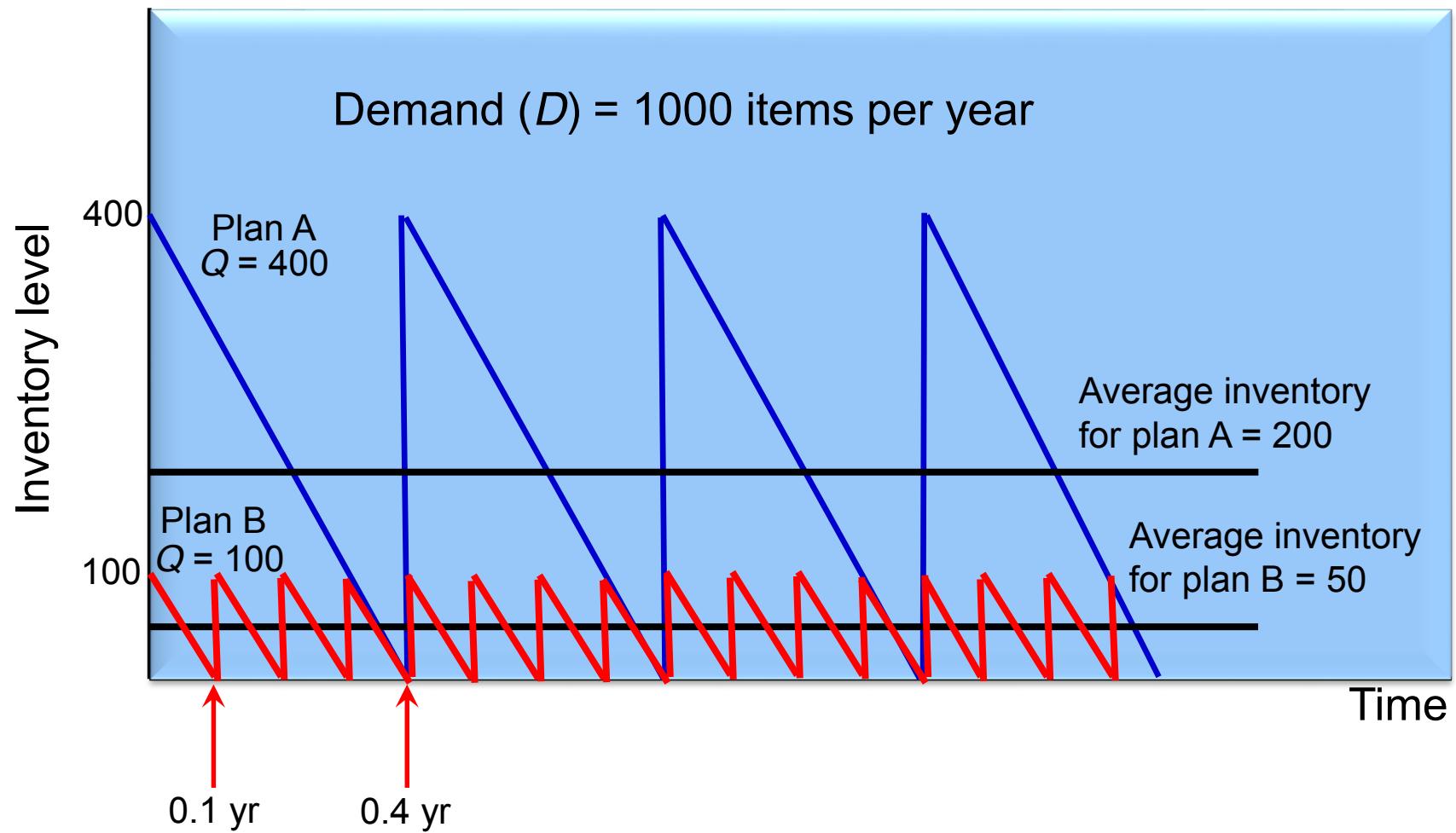
- Order quantity = Q
- Steady and predictable demand = D
- Average inventory = $Q/2$
- Time interval between deliveries = Q/D
- Frequency of deliveries = D/Q



Inventory profiles chart the variation in inventory level



Two alternative inventory plans with different order quantities (Q)



- C_h : Total cost of holding a unit for a period of time
 - Working capital costs
 - Storage costs
 - Obsolescence risk costs
- C_o : The total cost of placing an order
 - Cost of placing the order (eg. Transportation)
 - Price discount costs

- Holding costs = holding cost/unit x average inventory
 $= C_h \times Q/2$
- Ordering costs = ordering cost x number of orders per period
 $= C_o \times D/Q$
- Total costs = Holding costs + Ordering costs
 $C_t = C_h Q/2 + C_o D/Q$

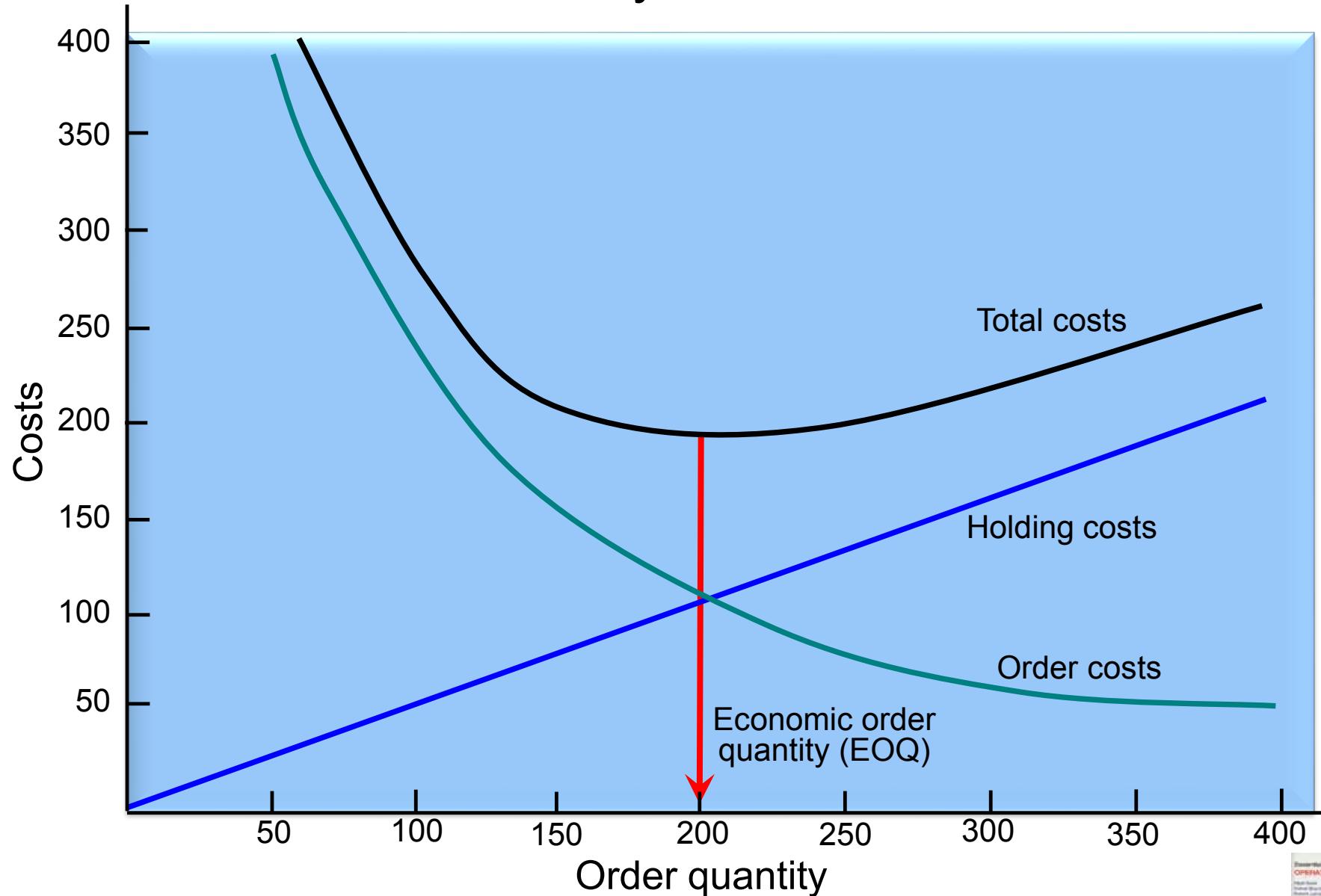


EOQ

- The optimum order quantity that minimizes the total costs is called *Economic Order Quantity (EOQ)*
- For $Q = EOQ$ the holding costs are equal to order costs
- $EOQ = \sqrt{2C_oD/C_h}$



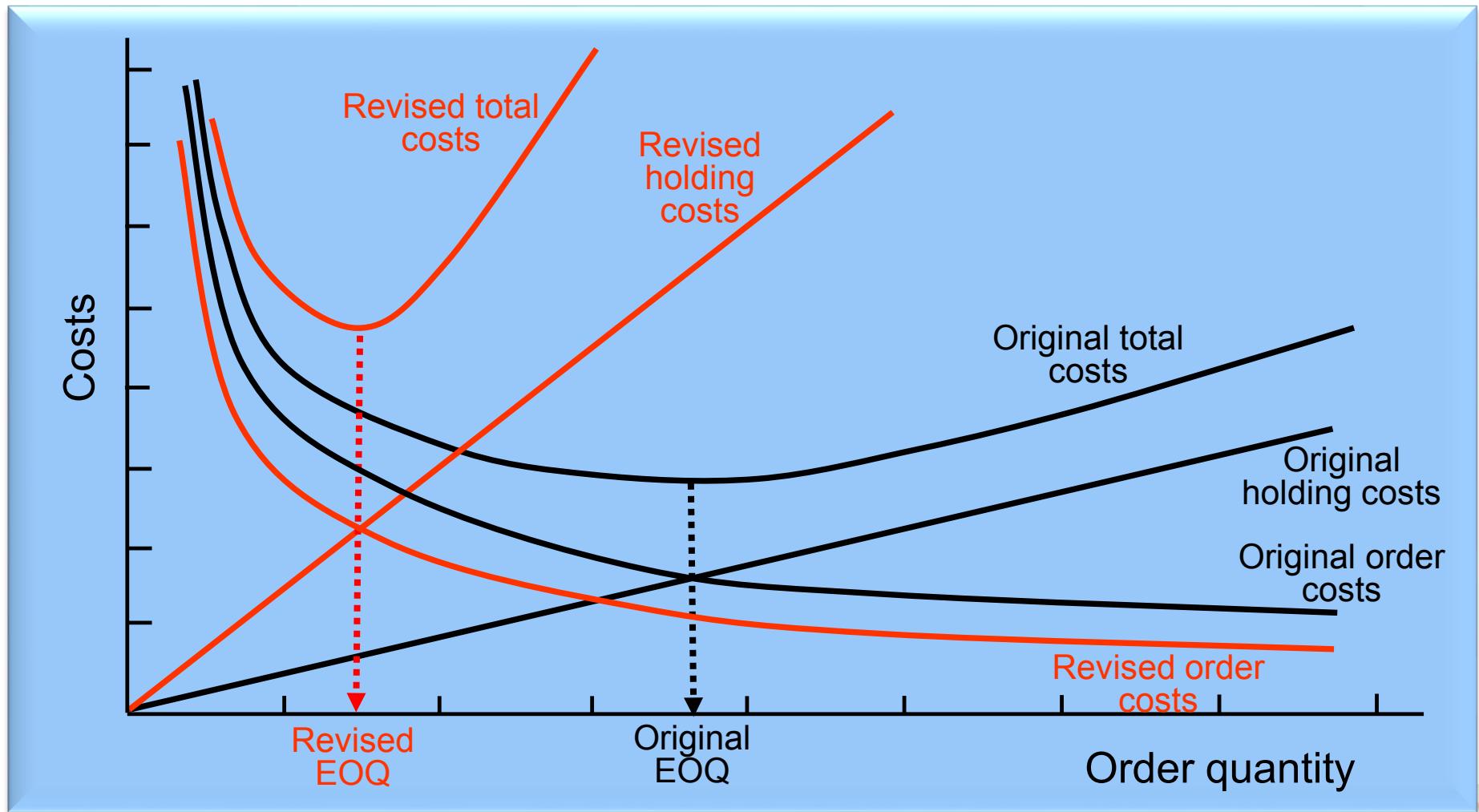
Traditional view of inventory-related costs



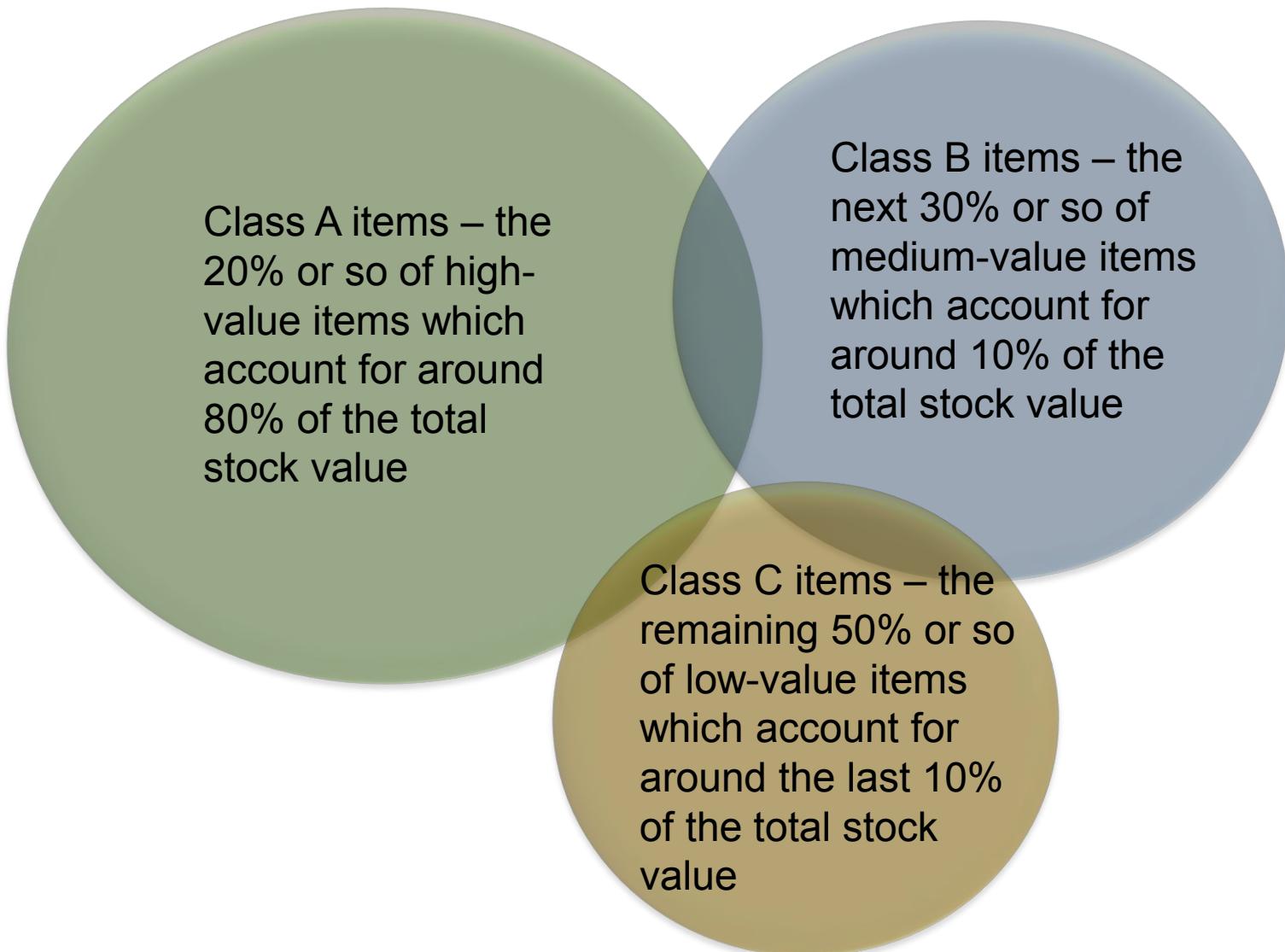
Criticisms to EOQ

- The criticisms fall in four broad categories:
 - The assumptions included in the EOQ models are simplistic
 - The real costs of stock in operations are not as assumed in EOQ models
 - The models are really descriptive, and should not be used as prescriptive devices
 - Cost minimization is not an appropriate objective for inventory management

If the true costs of stock holding are taken into account, and if the cost of ordering (or changeover) is reduced, the economic order quantity (EOQ) is much smaller



ABC classification



Pareto curve for stocked items

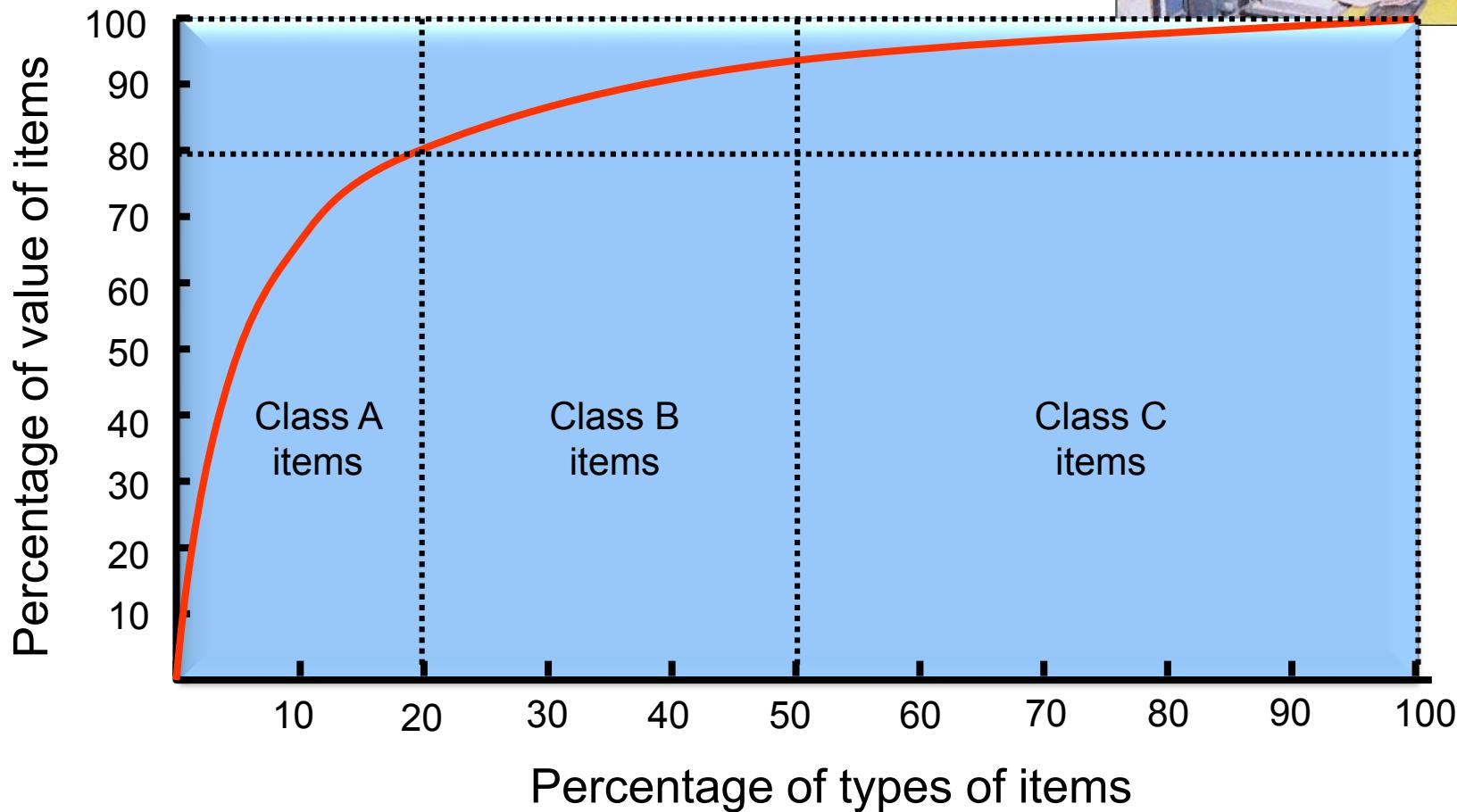
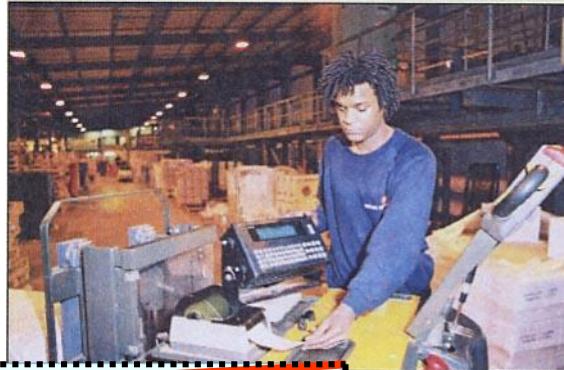


Table 12.5 Warehouse items ranked by usage value

Stock no.	Usage (items/year)	Cost (£/item)	Usage value (£000/year)	% of total value	Cumulative % of total value
A/703	700	2.00	1,400	25.14	25.14
D/012	450	2.75	1,238	22.23	47.37
A/135	1,000	0.90	900	16.16	63.53
C/732	95	8.50	808	14.51	78.04
C/375	520	0.54	281	5.05	83.09
A/500	73	2.30	168	3.02	86.11
D/111	520	0.22	114	2.05	88.16
D/231	170	0.65	111	1.99	90.15
E/781	250	0.34	85	1.53	91.68
A/138	250	0.30	75	1.34	93.02
D/175	400	0.14	56	1.01	94.03
E/001	80	0.63	50	0.89	94.92
C/150	230	0.21	48	0.86	95.78
F/030	400	0.12	48	0.86	96.64
D/703	500	0.09	45	0.81	97.45
D/535	50	0.88	44	0.79	98.24
C/541	70	0.57	40	0.71	98.95
A/260	50	0.64	32	0.57	99.52
B/141	50	0.32	16	0.28	99.80
D/021	20	0.50	10	0.20	100.00
Total			5,569	100.00	

Critical commentary on Pareto/ABC classification

- Many managers point out that the Pareto law is often misquoted.
- It is not that 80% of SKUs (stock-keeping units) account for only 20% of the value, it is that slow moving items, although only accounting for 20% of sales account for 80% of inventory usage, as they require a large part of the total investment in stock.



Critical commentary on Pareto/ABC classification (cont.)

- If errors in forecasting or ordering result in excess stock of “A class” fast moving items, it is relatively unimportant as the excess stock can be sold quickly.
- A items can be left to look after themselves, B and even more C items need controlling.





Operations Management

MGT355

Lean synchronization



Lean operations

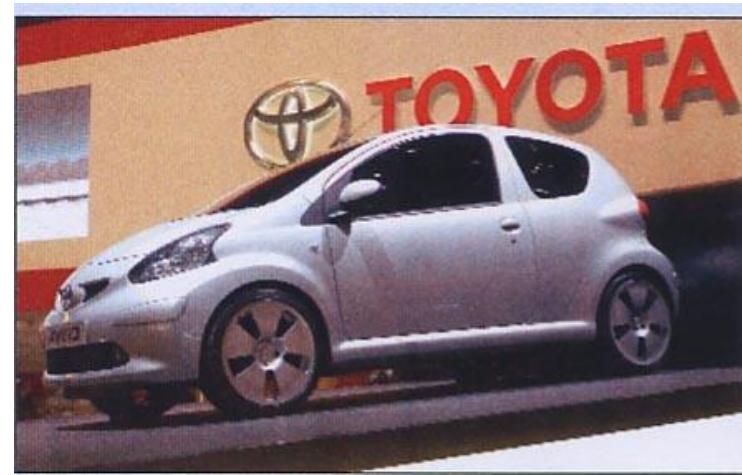
*'The key principle of **lean operations** is relatively straightforward to understand, it means moving towards the elimination of all waste in order to develop an operation that is faster, more dependable, produces higher quality products and services and, above all, operates at low cost'.*



Lean operations

Synonyms

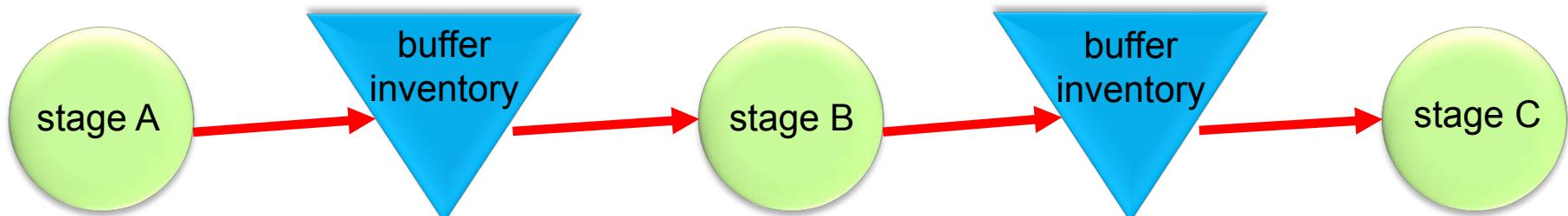
- continuous flow manufacture
- high value-added manufacture
- stockless production
- low-inventory production
- fast-throughput manufacturing
- lean manufacturing
- Toyota production system
- short cycle time manufacturing



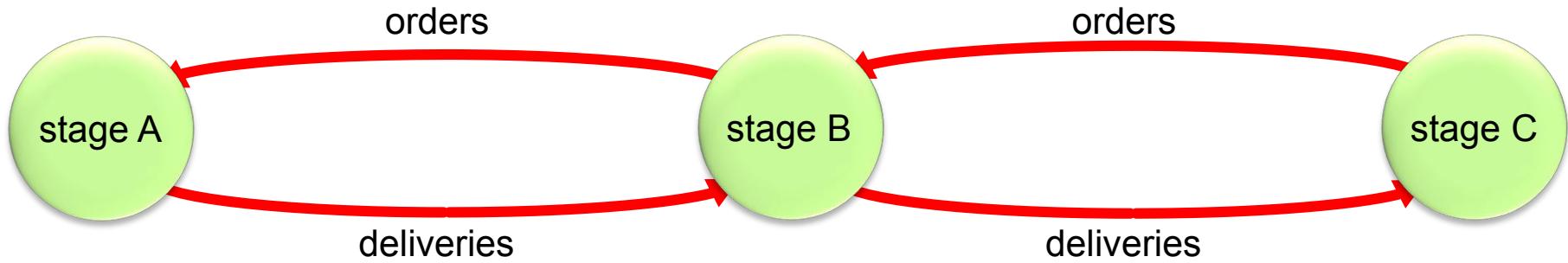
Lean operations

JIT material flow

Traditional approach:

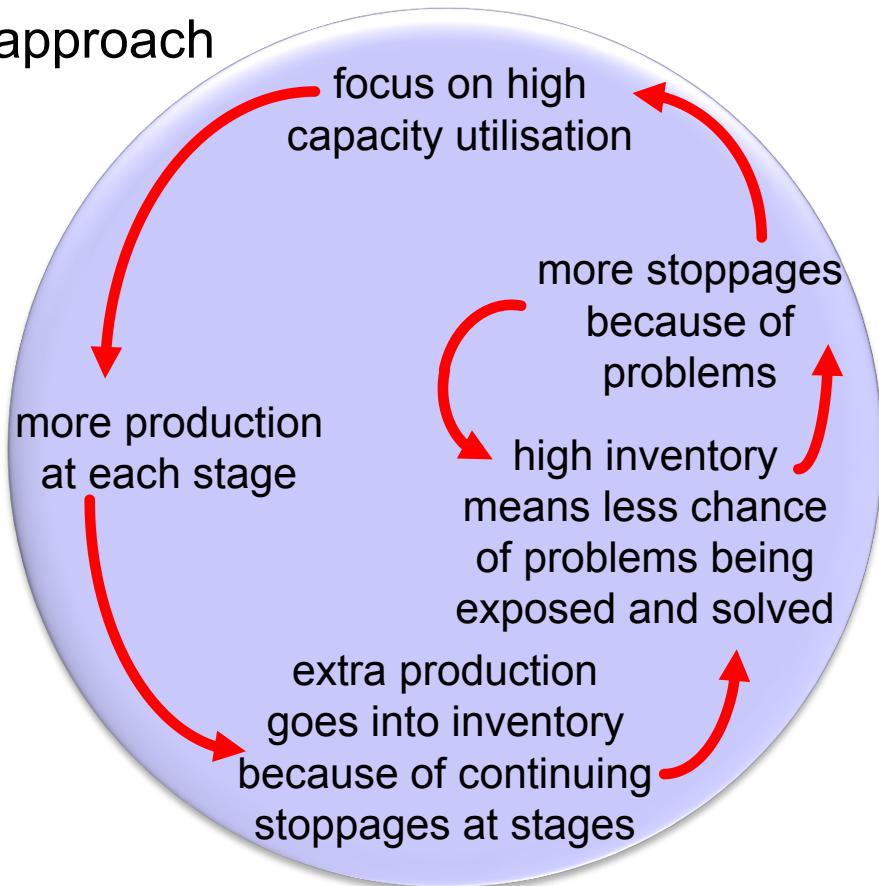


JIT approach:

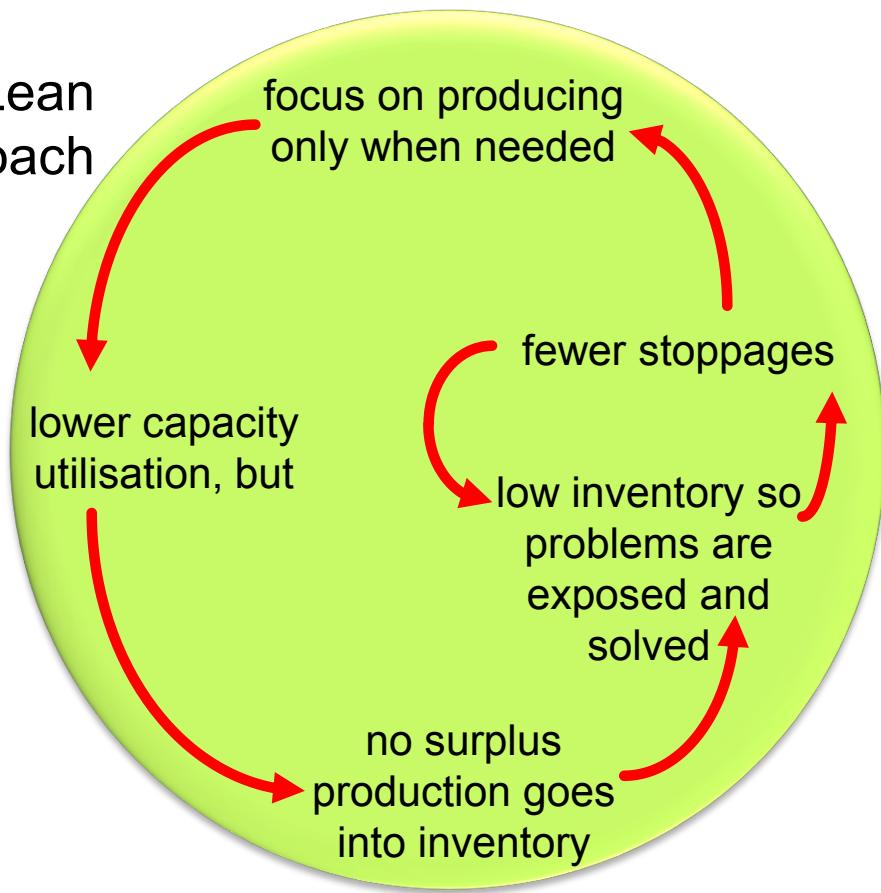


Lean operations

Traditional approach



Lean approach



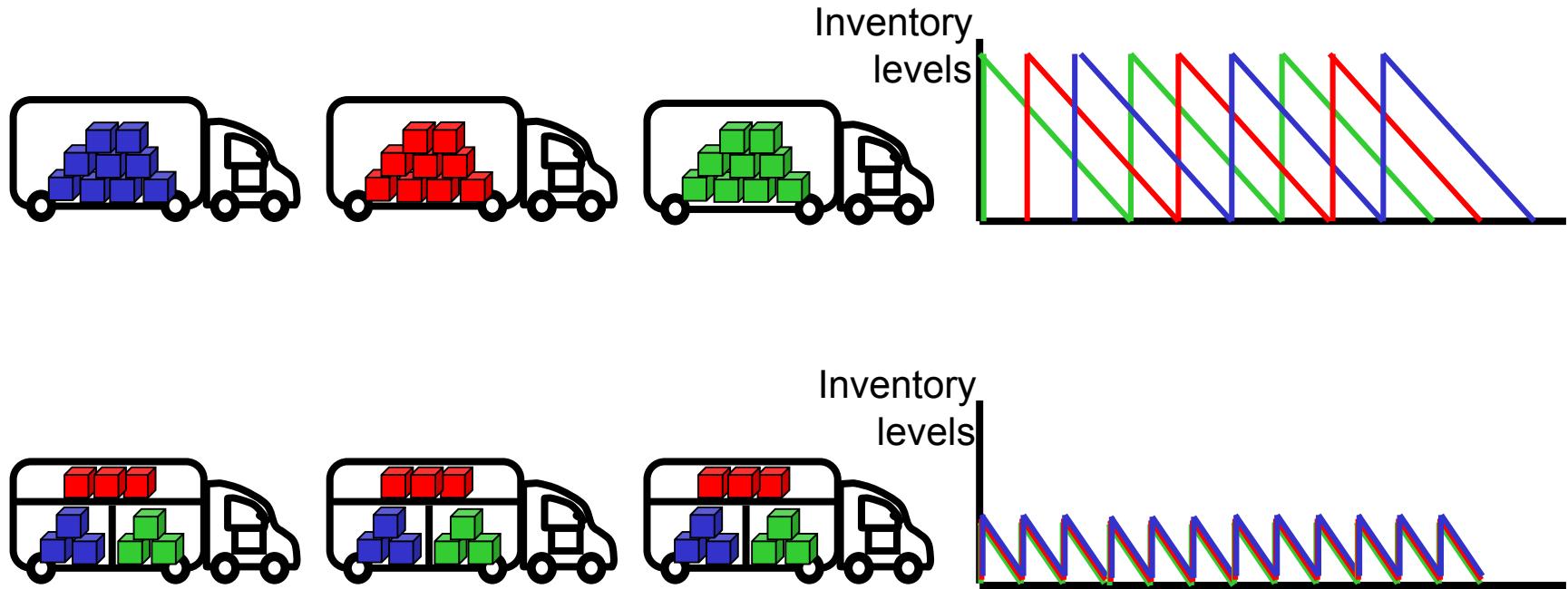
Inventories of materials. Information or customers have similar characteristics

	Inventory		
	Of material (Queue of material)	Of information (Queue of information)	Of customers (Queue of people)
Cost	Ties up working capital	Less current information and so worth less	Wastes customer's time
Space	Needs storage space	Needs memory capacity	Need waiting area
Quality	Defects hidden, possible damage	Defects hidden, possible data corruption	Gives negative perception
Decoupling	Makes stages independent	Makes stages independent	Promotes job specialization / fragmentation
Utilization	Stages kept busy by work in progress	Stages kept busy by work in data queues	Servers kept busy by waiting customers
Coordination	Avoids need for synchronisation	Avoids need for straight through processing	Avoids having to match supply and demand

Source: Adapted from Fitzsimmons, J.A.

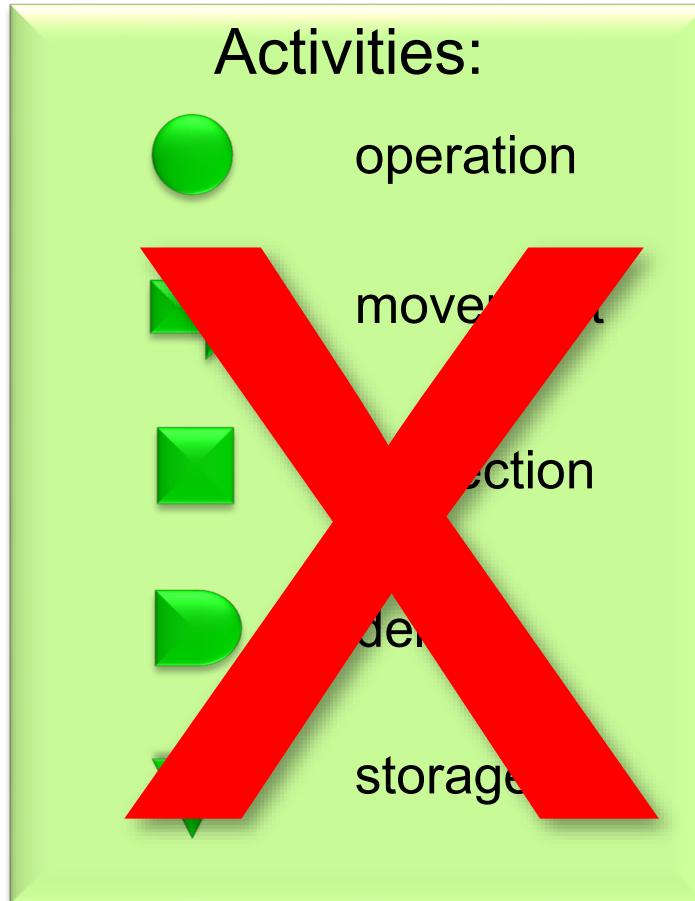


Delivering smaller quantities more often can reduce inventory levels



Waste (muda)

Which of these symbols signify non-value adding activities?



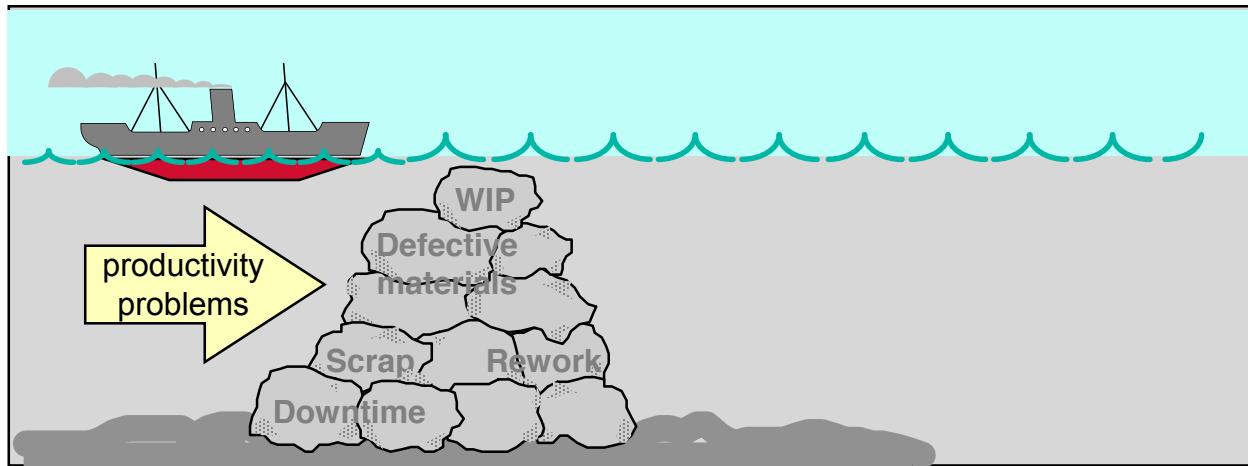
Types of waste:

- over production
- waiting time
- transport
- process
- inventory
- motion
- defective goods

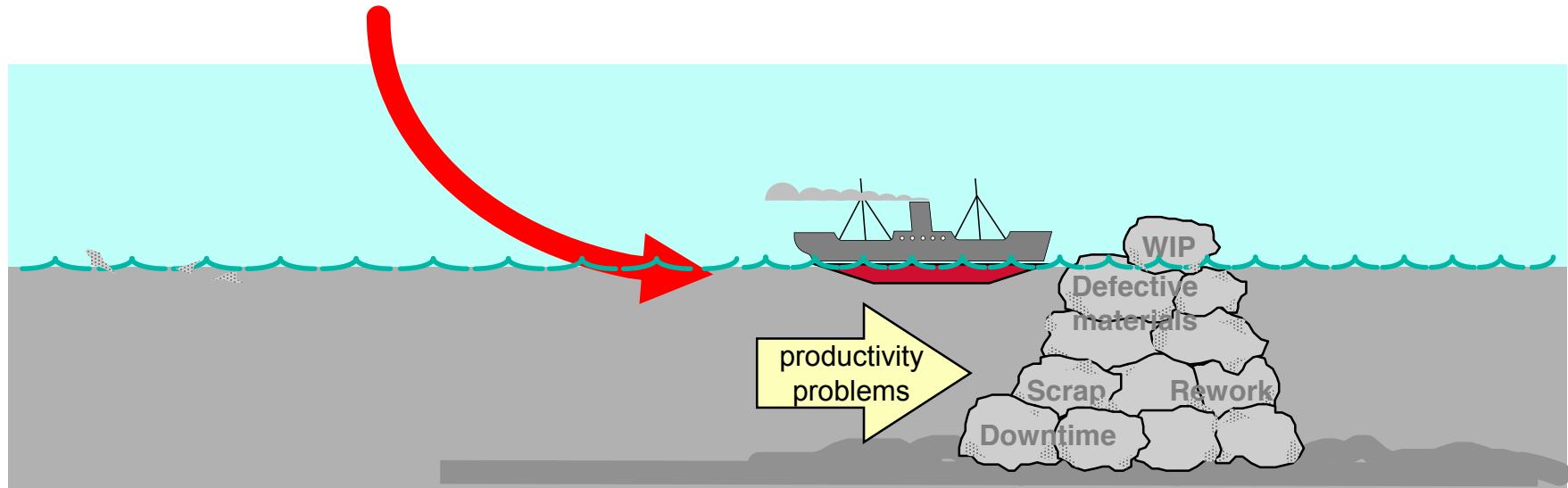
→ influencing the throughput efficiency



The problem with inventory

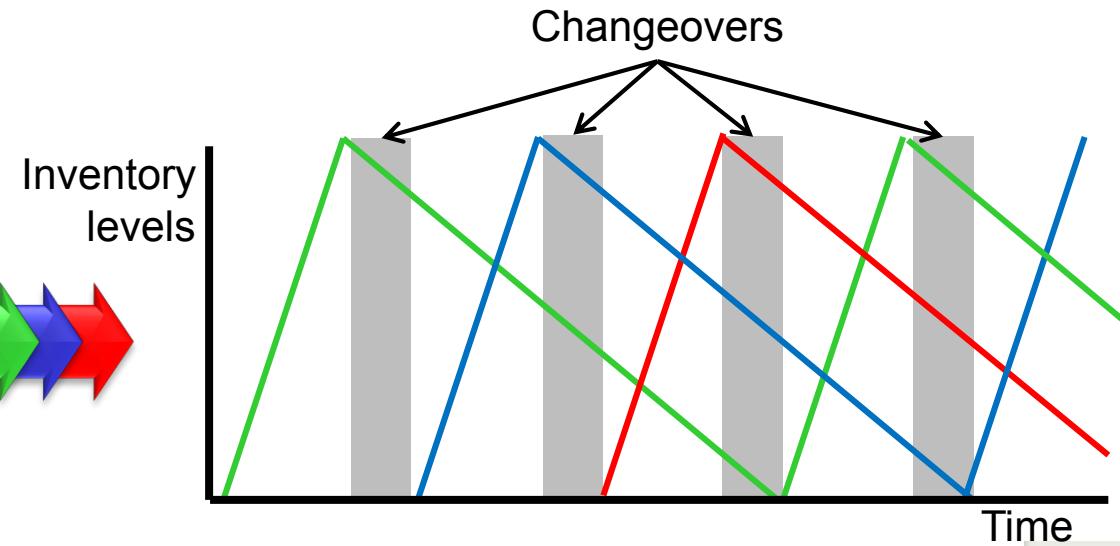
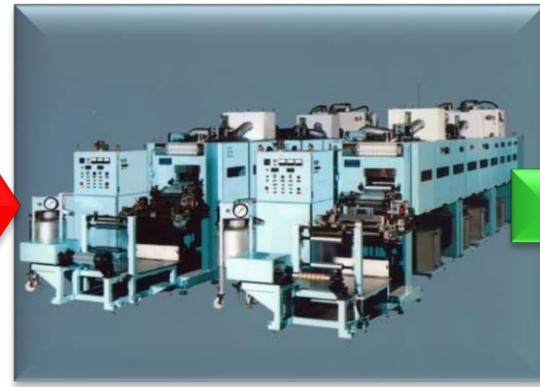


Reduce the level of inventory (water) to reveal the operations' problems



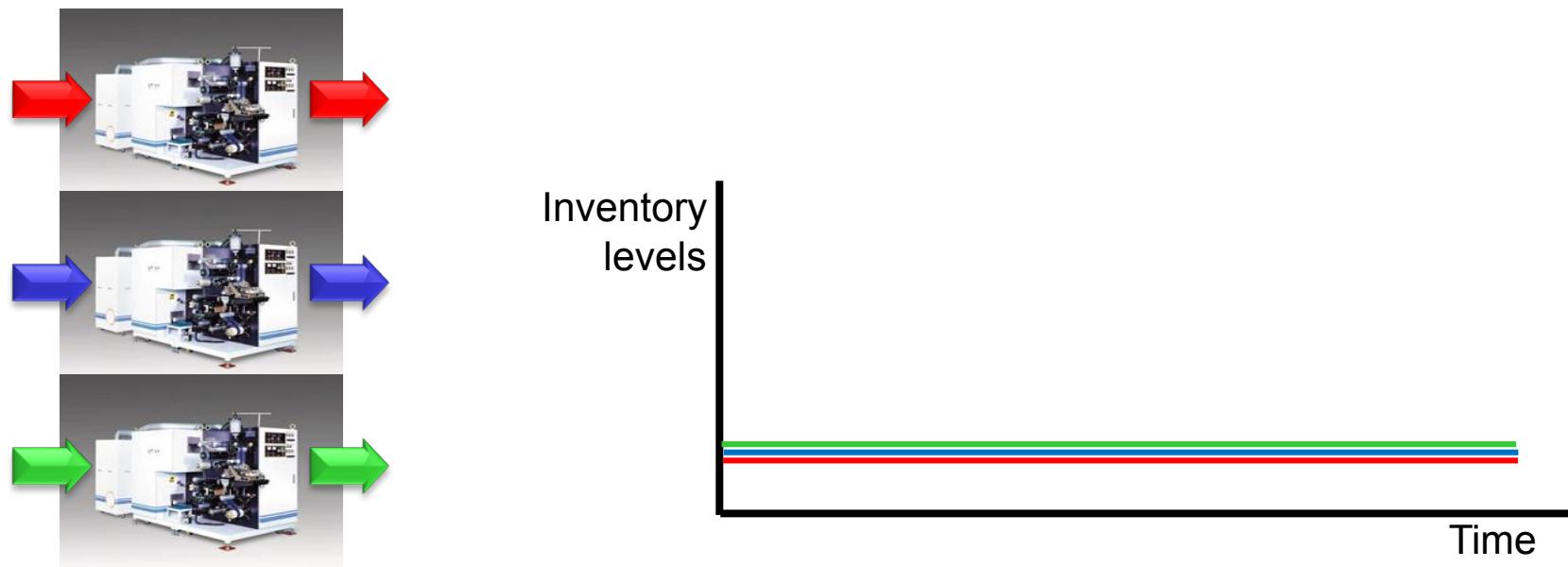
Small machines

- Conventional Western approach is to purchase large machines to get “economies of scale”.
- These often have long, complex set-ups, and make big batches quickly creating “waste”.



Small machines

Using several small machines rather than one large one allows simultaneous processing, is more robust and is more flexible.....



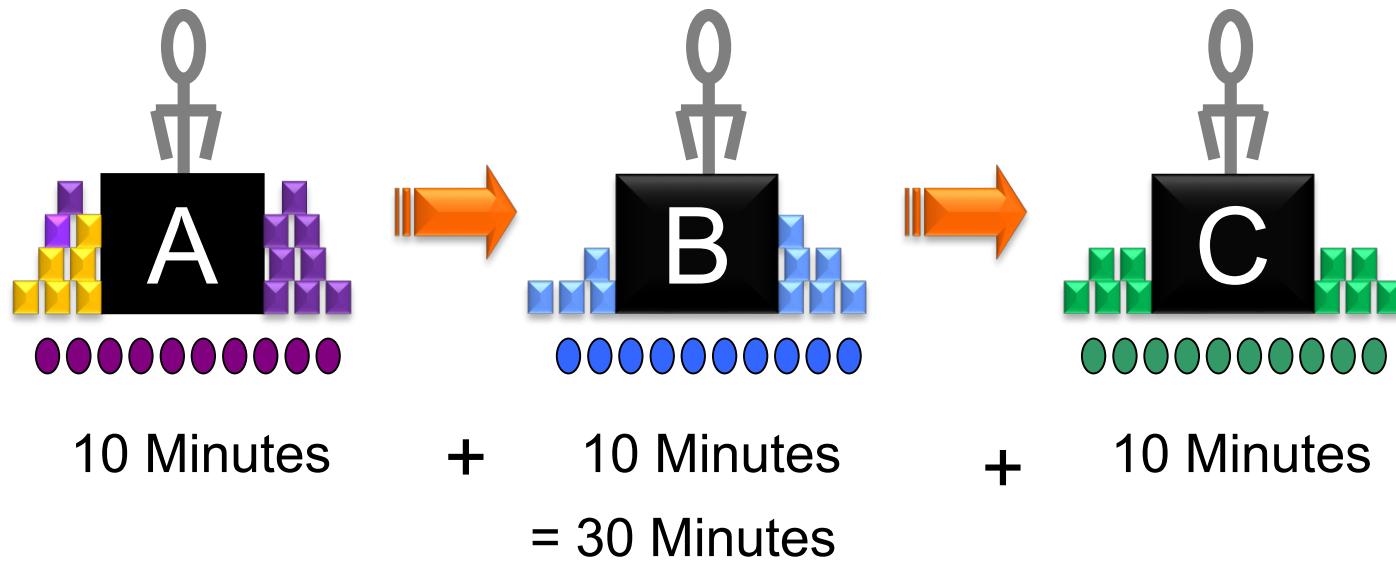
Flow Principle

A process consists of 3 steps - A , B and C.

It takes one minute to finish each step of the process. (A, B and C)

Batch Flow (units processed in batches of 10)

How much time will it take for 10 units to move through the process?



Flow Principle

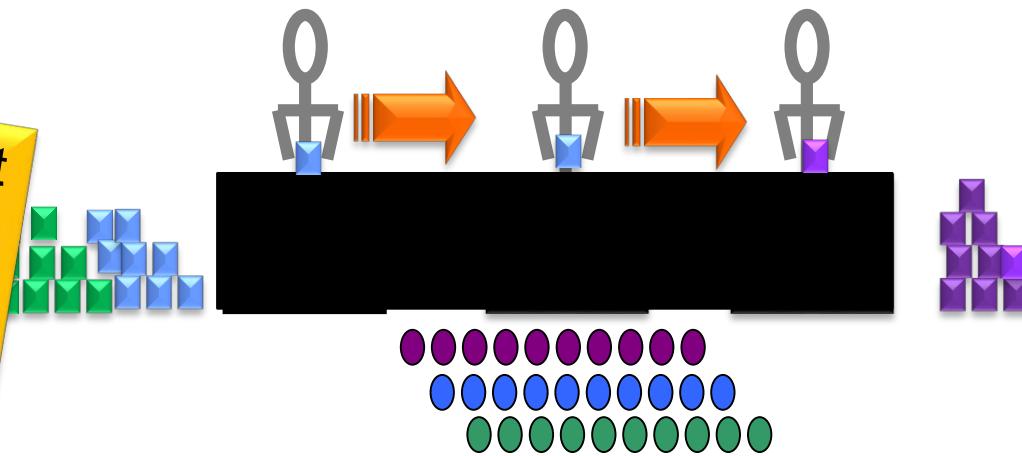
A process consists of 3 steps - A , B and C.

It takes one minute to finish each step of the process. (A, B and C)

Continuous Flow (unit processed individually, that is, process one, move one)

How much time will it take for 10 units to move through the process?

Note – The total amount of work required to complete each batch has not changed, but the throughput time of each batch is reduced from 30 to 12 minutes



$$1 \text{ Minute} + 1 \text{ Minute} + 10 \text{ Minutes} = 12 \text{ Minutes}$$



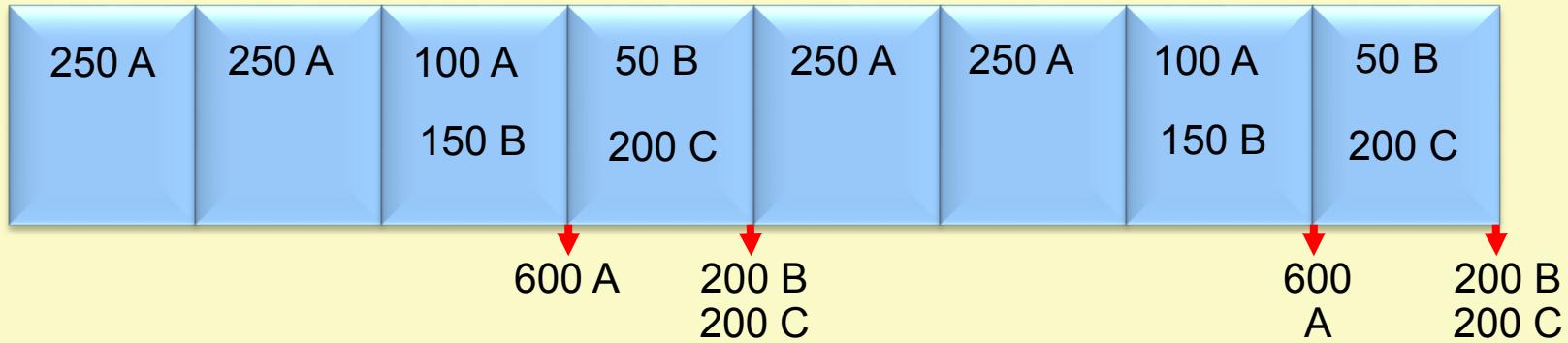
Levelled scheduling equalizes the mix of products made each day

Over an eight day period, need to make..... 1200 of A

400 of B

400 of C

Scheduling in *large batches*, where $batch\ size\ A = 600, B = 200, C = 200$



Every day, the schedule needs to be calculated. Each day can be different



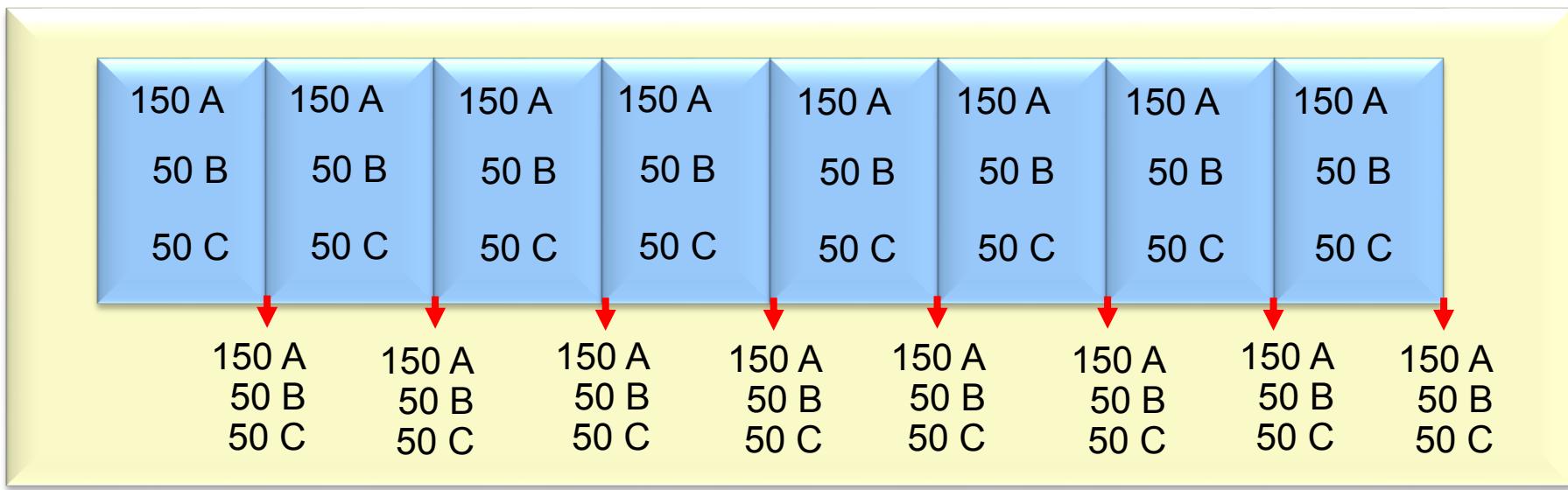
Levelled scheduling equalizes the mix of products made each day

Over an eight day period, need to make..... 1200 of A

400 of B

400 of C

With *levelled scheduling*, where $batch\ size\ A = 150, B = 50, C = 50$



Every day is the same. Easy to notice if falling behind schedule



