Bb

Back flush

Back flush or back flushing aims to simplify the management of an organization's inventory. An organization may adopt the policy of noting a reduction in the inventory when components are taken from stock in order to be incorporated into another product. Technically, the components, until they are shipped, are still within the inventory system and until they are shipped there may be a requirement for the organization to select more of those components to go into the current production process. Back flushing means that the organization only reduces the number of components on the inventory once the finished products containing those components have been shipped and they are no longer in stock.

The system does mean that the organization will not have a clear idea of how many of the relevant components are still physically within the organization, and it may not take into account the fact that components, having been removed from stock for production, are subsequently not all used. However, providing the organization is aware of how many components are being used to create a particular product and then multiplies that by the number of products in a given shipment, it can arrive at an accurate estimation of how many of those components need to be removed from the inventory count. This means that back flushing reduces the requirement for the organization to carry out data collection exercises to track the progress and location of components while they are still within the organization's premises.

Back office/front office

A business will often determine which part of the organization will have contact with customers. The front office is the customer interface area which aims to deal with customer demands and expectations, allowing the back office to continue to concentrate on tasks which support the running of the organization as well as supporting the efforts of the front office.

The front office handles the delivery of service systems to the

customer, allowing the back office not to be exposed and pressurized by customer demands, thereby spreading the demands and managing the capacity of the organization.

Back order

Back orders occur when a business is unable to fulfil a customer order immediately. The customers are informed that items from their order are at present unavailable, but that their order will be fulfilled as soon as the manufacturer is in a position to place additional stock at their disposal.

Backward loading

Backward loading or back loading is a production planning methodology. As the term implies, the production plan is calculated backwards from the date by which the product or products are required. The production plan is then inserted into the overall production schedule of the organization, taking into account available slack periods in production capacity. In other words, the time on machinery, or employees' time, is allocated to that particular production on the basis of available gaps. By slotting in the requirements of the production to available machine or man hours, the organization is able to identify a precise start date for the production. Backward loading does not aim to create a detailed schedule, but simply seeks to ensure that either machines or employees are working to full capacity on any given day by the addition of this extra work.

Backward scheduling

Backward scheduling can be differentiated from **backward loading** as it aims to create a detailed schedule for each stage in the production process and then matches available periods of under-capacity, in which particular stages of the production could be allocated. Like backward loading, as the term implies, backward scheduling begins with the date by which the product is required and then, by allocating each operation from the detailed schedule, a start date can be determined.

Balance delay

'Balance delay' is a term associated with line-balancing problems. Line balancing itself is one of the most important problems in the preliminary design stage for flow-line production systems.

For a given set of manufacturing operations and a given cycle time, the line-balancing problem is the assigning of each operation to a work station in such a way that the number of work stations is minimized and precedence constraints are satisfied. The work station time (which is the sum of the times required for all operations at this work station) must not exceed the given cycle time.

The difference between the cycle time and work station time is called 'idle time' and the sum of idle time for all work stations is called 'balance delay time'. The balance delay time will be minimal in cases where the number of workstations is kept to a minimum. A generalized line-balancing problem consists of distributing operations among work stations while minimizing criteria different from the number of work stations (i.e. costs, productivity, reliability, maintainability) and then taking into account some additional constraints.

Balanced scorecard

A balanced scorecard is an integrated means of measuring organizational performance. Aside from looking at the organization's ability to innovate, manage finances and deal with customers, it also addresses internal operations, including human resource management.

Very few organizations are able to effectively align their strategies and thus operate at maximum efficiency. Using the concept of a balanced scorecard, a business can seek to understand, all the way down to individuals within the organization, the exact nature of the key performance indicators that need to be controlled, and facilitate the understanding of relationships within the organization. Whilst the deployment of a balanced scorecard system can help in this understanding, its true value is in enabling a business to implement and track key initiatives. This means providing across the length and breadth of the business a greater vision and utilization of resources.

Kaplan, Robert S., Lowes, Arthur and Norton, David P., *Balanced Scorecard: Translating Strategy into Action*. Cambridge, MA: Harvard Business School Press, 1996.

Kaplan, Robert S. and Norton, David P., *Strategy-focussed Organization: How Balanced Scorecard Companies Thrive in the New Business Environment*. Cambridge, MA: Harvard Business School Press, 2000.

Baldrige Award

The Baldrige Award is based on an analysis of the factors which contribute towards the creation and running of an effective organization.

The critical factors are identified as being leadership, a people focus,

a customer focus, a supplier focus, planning for improvement, process optimization and organizational performance. In this respect, the Baldrige Award examines the quality of an organization's activities in seven categories:

- Leadership
- Information and Analysis;
- Strategic Planning;
- Human Resource Development and Management;
- Process Management;
- Business Results;
- Customer Focus and Satisfaction;

The seven categories are examined in terms of 'Examination Items' and 'Areas to Address'. Examination Items consist of sets of Areas to Address; there are 24 Examination Items. Although the award was designed primarily for the private sector, it is equally applicable for the public sector.

www.quality.nist.gov
European Federation for Quality Management (EFQM) at www.efqm.org

Bar code

See **electronic point of sale (EPOS)**.

Basic research

Basic research is typified as being an attempt to increase general knowledge of production and manufacturing issues, without this necessarily having any immediate application. Basic research investigates key areas of operations management, principally fundamental issues which affect a number of different industries across a number of sectors. The results of the research do not offer either the research organization or the organizations which contribute towards the investigations during the research any short-term expectation of commercial gain.

Batch

A batch is a defined quantity of a product or material produced under uniform conditions.

The term 'batch', when applied to a system or a mode of production, implies that all of the necessary operations are collected and processed at one time. This is as opposed to them being processed as they arrive.

Once a batch is under way it proceeds to completion without additional input or user interaction.

Batch processing

Batch processing is a somewhat traditional means by which an organization periodically produces a set amount of a particular product, before switching production to the processing of another product. In this respect the processing of a batch of items aims to build up a stock which can meet subsequent demand. One of the biggest problems that a business faces in using batch processing is to work out exactly how large each batch should be. There are implications related to whether the batch sizes are small or large. Clearly every time the manufacturing process is reconfigured in order to produce a batch of a particular product there are associated set-up costs and delays. However, when an organization is tempted to produce larger batches, there are implications with regard to the value of that stock, which may not be sold to customers immediately, and equally, the fact that the business cannot be processing other products while the larger batch is being processed. On the one hand larger batches offer lower costs in terms of set-up, as the change-overs are less frequent, but on the other hand there is the problem of having to carry excess inventory until such a time as it is sold. Increasingly businesses try to be flexible and adaptable in the way they configure their processing equipment and switch from one batch to another. Characteristically, a **flexible manufacturing system (FMS)** is now applied to most traditional batch manufacturing situations.

It is generally held that there are four types of batch processing operations; these are shown in Table 2.

Central to the planning of batch processing are three key factors:

- The sequence of the batches, which will determine the order in which the batches of different items or customers are processed.
- The decision regarding batch sizes or **lot sizing**. In other words the quantity of each item, or customer, that is processed or dealt with at any one time.
- The scheduling of the batches, which aims to determine how the batches are to be processed using the available equipment, and the implications of processing a particular product or customer, in relation to other customers or products which need to be processed.

Hansen, Per Brinch (ed.), *Classic Operating Systems: From Batch Processing to Distributed Systems*. New York: Springer Verlag, 2001.

Table 2 Batch processing systems

Type of operation	Description
Supply	There are considerable cost benefits in being able to deliver to several customers simultaneously. Using batch processing in supplying situations, the business will accumulate customers, probably by geographical area, until such a time as it is cost effective to load the customers' orders into a single vehicle for delivery. In this application the customers are dealt with in batches rather than the products themselves.
Service	In some service situations, particularly in the entertainment or leisure industries, customers are also batched. A particular event, such as the departure of a tour, or the beginning of a ride, will not commence until sufficient customers warrant the activity to begin.
Transport	Increasingly some transport systems operate on a batch processing basis. Rather than running scheduled and timed routes, transport will leave a location (within given parameters) once a specified number of passengers have arrived and await transportation. This is an increasing trend, notably in the 'route-less hopper-style' bus transportation within city centres.
Manufacture	In manufacturing situations batch processing is often used to create output stock which is produced in anticipation of future demand. Batch processing can also be applied to situations when the organization has received sufficient orders from a variety of customers which then warrants the setting up of a batch process.

Batch shop

The term 'batch shop', when used of a manufacturing facility, may describe the entire manufacturing organization or a part of that organization which is designed to undertake **batch processing**. Typically a batch shop is an ideal manufacturing process set-up for products which warrant neither **mass production** nor small-scale production.

Bay

A 'bay' is a term most closely associated with a specified area within a warehouse. Normally each bay will be located between pillars or supporting structures within the overall building. In other words, a facil-

ity would have *n* number of interior sections, each of which would be called a bay. For organizational purposes the warehouse may choose to identify specific bays with the storage of specific products or ranges of products.

Bays may also be situated adjacent to a production line, either at the beginning of the line or at the end, as, in effect, holding areas or 'holding bays', with parts and components being held at one end and finished products housed at the other.

The term 'bay' is also associated with the process of loading and unloading vehicles, either at warehouses or at factories or retail outlets. Again, specific parts of an area which have vehicular access will be designated as loading or unloading bays for incoming or outgoing products or waste materials.

Benchmarks/benchmarking

Benchmarking is a process of identifying and learning from the best practices of similar activities being undertaken by other organizations. Benchmarking is used to:

- improve the business's understanding of the external environment;
- learn from the successes and failures of others;
- identify and compare elements of a competitor's strategy;
- learn best practices from any industry, to apply to and improve your own internal processes;
- minimize complacency; in other words, recognize that internal progress may not be apace with that of competitors;
- learn to be creative or proactive and not reactive.

It is generally believed that there are five steps towards benchmarking:

1 *Identifying what is to be benchmarked*. As it is not possible to benchmark everything at once, benchmarking should be applied to the most critical areas. A detailed study and measurement should be undertaken in the selected areas to identify base data as well as ensuring managerial support and the involvement of staff within those areas.
2 *Determining who to benchmark with*. It is essential to determine which other organization should be approached. Direct competitors are unlikely to be responsive, but non-direct competitors may be more willing to exchange information. Benchmarking candidates should encompass both small and large businesses, as well as those in the public or private sector.
3 *Data collection*. Face-to-face interviews and visits to other busi-

nesses often provide the best quality information. The correct questions need to be asked and cross-checked. Inaccuracy at this point may invalidate the whole process.

4 *Data analysis*. Meaningful comparisons need to be made between the business and the benchmarked organization. Steps should be taken to identify dissimilar or divergent issues, as well as entrepreneurial or novel ideas.

5 *Identifying and implementing proposals*. Having identified desirable components, the business now needs to plan how these will be implemented, ensuring clear communication. Changes may result in a need for training and for new criteria to be understood. There will be a period before full efficiency is achieved, and a monitoring system needs to be implemented to provide feedback.

The benchmarking process may reveal more valuable information to a potential competitor than the business may receive from that competitor. It requires a fundamental trust which reflects the rights and legalities of both parties. There are key ethical aspects in relation to benchmarking:

- dealing with individuals and organizations in an honest manner;
- ensuring that other parties understand how information will be used;
- promptly informing other parties if the use of information is to be changed;
- ensuring that all activities are carried out with integrity;
- the establishment of precise ground rules if a competitor is used in the benchmarking process.

Bogan, Christopher E. and English, Michael J., *Benchmarking for Best Practices: How to Define, Locate and Emulate the Best in Business*. New York: McGraw-Hill Education, 1994.

Best operating level

Given the fact that the term 'capacity' implies an attainable rate of output, it does not consider how long that rate can be sustained. In other words, if a manufacturing facility has a capacity of *x* units, it is unclear whether this refers to an average over a period of time or a peak performance at some point in the past.

In order to work around this problem, the concept of the best operating level is used as this is the level of capacity for which the process was designed. In addition, it is also the volume of output at which average unit cost is at a minimum.

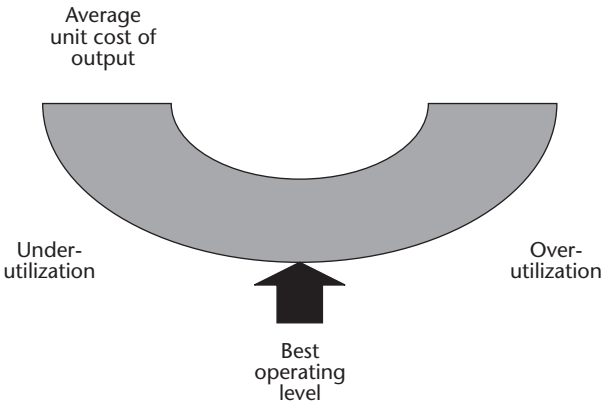

Figure 4 Best operating level

The best operating level can be shown as in Figure 4. If the output falls below this level, there is an instance of under-utilization and the average unit cost will increase as overheads must be allocated to fewer units. If the output goes above this level, there is an instance of over-utilization and the average unit cost also increases, due to the fact that there are overtime payments to made, increased equipment wear and tear, as well as higher levels of defects.

Bill of lading (BOL)

A bill of lading is a contract issued to a transportation company (a shipper), listing the goods shipped, acknowledging their receipt and promising delivery to the person or business named. Bills of lading are also known as manifests or waybills.

Bools, Michael, *The Bill of Lading – Document of Title*. London: LLP Professional Publishing, 1997.

Bill of materials (BOM)

A bill of materials (BOM) aims to list all of the parts, components and individual items which were used to create or manufacture a specific product. In essence, a bill of materials is rather like a list of parts, but it goes one stage further than this as the components, parts and other items are listed as they were added to the product. In other words, a careful examination of a BOM indicates how a product was assembled. Some organizations refer to a BOM as a formula or recipe. Careful

examination of the BOM should indicate to the organization the precise ordering of production units and processes within the premises. Assuming that most products are constructed or assembled in this manner, a BOM should help the organization to identify the most common route along which the product passes on the shop floor.

Blocking

See **bottleneck and non-bottleneck**.

Bottleneck and non-bottleneck

'Bottleneck' and 'non-bottleneck' are terms associated with the management of the production process. A bottleneck is effectively a system which cannot, for a variety of reasons, reach the levels of capacity which are demanded. A bottleneck can, therefore, seriously limit the total amount of production on a given production line because production is limited to the total capacity which the bottleneck is able to achieve.

A non-bottleneck is part of a production process that does not appear to have an inherent limit on its ability to produce. In other words, its capacity is considerably higher than the demands placed upon it. Normally an organization would choose to block a non-bottleneck process in order to ensure that it only produces the level of output required. There are a number of reasons for this, the most important of which is that partly finished products produced by a non-bottleneck process consume items from the inventory, and therefore increase the amount of **work in progress**. A non-bottlenecked process will normally be limited to a defined level of output, usually controlled by a specified storage area. Once this storage area is full, production in the non-bottlenecked process is temporarily terminated.

Clearly, organizations seek to avoid blocking a bottleneck process because the bottleneck is already unable to reach the desired capacity levels and this would simply further limit the production capability.

See also **theory of constraints**.

Brainstorming

Brainstorming sessions would be carried out as a group activity. Individual members of the group are encouraged to put forward their first ideas about a problem and how it might be solved, in order to generate as many ideas as possible, even if they are not always usable alternatives. Brainstorming would involve members from various parts

of the organization and is seen as a way of encouraging creativity and innovation. Sometimes the members of the group are required to literally shout out their first thoughts about a subject.

Breakeven analysis and the breakeven point

In order to identify an organization's breakeven point, it is necessary to consider the relationships between the various costs and sales in an integrated manner. The breakeven point is defined as being the point at which the level of sales is not great enough for the business to make a profit and yet not low enough for the business to make a loss. In other words, earnings from sales are just sufficient for the business to cover its total costs. This occurs when total revenue from sales exactly equals the total cost of production.

Breakeven point occurs when total cost = total revenue

From this it can be assumed that if total revenue from sales is greater than the total costs, then the organization concerned will make a profit. Conversely, if the opposite is true, and the total revenue is less than the total costs, then the organization can make a loss. It is essential that organizations take this very important factor into account. The organization will find that it is essential to determine how many units of output it must produce and sell before it can reach its breakeven point.

The total cost of the unit of production is made up of two factors, the fixed and variable costs, where:

Total cost = fixed costs + variable costs

And the total revenue is given by the number of products sold, multiplied by the selling price:

Total revenue = price × quantity

The drawing up and labelling of a breakeven chart makes the calculation of the breakeven point easier. The breakeven chart requires a considerable amount of labelling in order to be able to identify exactly what the chart is describing about the breakeven point.

As can be seen in Figure 5, the breakeven chart will include:

- Units of production – which is considered to be the number of completed products and not, importantly, the components which make up those products.
- Fixed costs (FC) – which are the costs that do not alter in relation to changes in demand or output. They have to be paid regardless of the business's trading level.

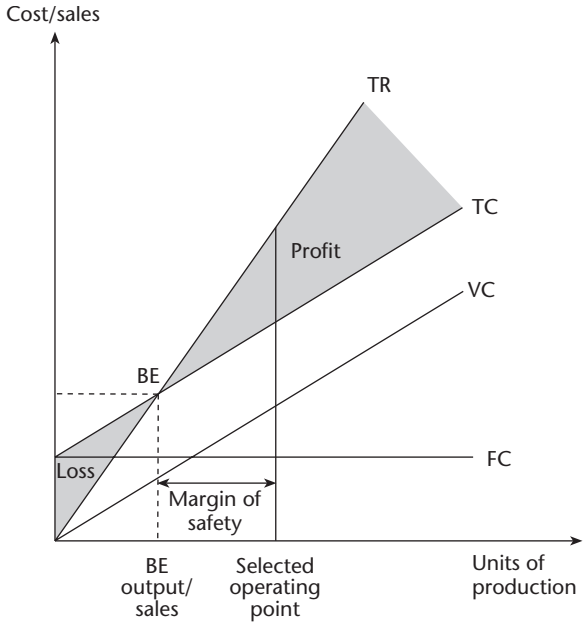

Figure 5 A breakeven chart

- Variable costs (VC) – which change in direct proportion to changes in output, such as the cost of raw materials, components, labour and energy. Breakeven charts require the assumption that some costs vary in direct proportion to changes in output. In fact, it is unlikely that any costs are totally variable as raw materials, for example, are likely to cost less per unit if the organization buys in bulk. In this instance, it cannot be assumed that the cost of raw materials will double if output doubles.
- Total costs (TC) – these are simply the sum of all fixed and variable costs.
- Sales and costs – sales are the income generated from the selling of the units of production to customers. Costs, on the other hand, are expenses incurred by the organization in the purchase of raw materials, other fixed costs and variable costs.
- Breakeven point (BE) – this is the point at which sales levels are high enough for the organization not to make a loss, but not high enough for it to make a profit. In other words, this is the point where total sales equal total costs.
- Profit – in terms of the breakeven chart, and the breakeven point, this is achieved when sales exceed total costs.

- Loss – in terms of the breakeven chart, and the breakeven point, this occurs when the total revenue (TR) from sales has not met the total costs.
- Selected operating point – this is the planned production and sales level.
- Margin of safety – this is the amount by which the selected operating point exceeds the breakeven point. This indicates the amount by which sales could fall from the planned level before the organization ceases to make a profit.

Bucket brigade

Bucket brigades are a means of organizing the workforce on a flow line so that the line actually balances itself.

Products move progressively down the production line, gradually being added to and processed until they are completed. The products physically move and the employees remain (relatively) static. It is notoriously difficult to balance the workloads; this is usually undertaken by precise identification of the work elements, and estimates of standard work-content. Many assembly lines are balanced by engineers, who define task elements and then conduct time-and-motion studies so that the work can be divided equally among operatives on the line.

Bucket brigades, however, are designed to be self-organizing as each worker carries a product towards completion; when the last worker finishes his or her product it is sent it off and the worker moves back upstream to take over the work of his or her predecessor, who moves back and takes over the work of the next predecessor and so on, until after relinquishing the product, the first worker moves back to the start to begin a new product.

If operatives are sequenced from slowest to fastest, then the operatives will spontaneously gravitate to the optimal division of work so that throughput is maximized. It is imperative that the operatives maintain their sequence; no passing is allowed, which sometimes means that one worker is blocked by a successor and has to wait before work can resume (the successor having moved out of the way).

The primary benefits of the system are:

- there is a reduced need for planning and management;
- production becomes more flexible and agile;
- throughput is increased;
- secondary labour is reduced and quality improved;
- there is minimal work-in-process;
- training and coordination are simplified.

Buffering

Buffering is a means by which an organization attempts to ensure that it has a safe level of stock in addition to its base stock. The organization will attempt to ensure that there is sufficient inventory available to satisfy the average demand over a given period of time. The buffer stock is the extra amount which the organization holds to protect it against uncertain situations. The eternal problem is where this buffer stock should be stored and by whom. Clearly no organization in the **supply chain** wants to have the responsibility and the associated costs of holding buffer stock. None the less, at each level of the supply chain there may be an immediate need for stock in excess of the base stock. Therefore either the organization itself has to take the responsibility for holding that buffer stock, or it has to come to some arrangement with the suppliers, who will hold the buffer stock on its behalf. How complex and time-consuming the transformation of stock received from suppliers is before it can be sold on to the organization's customers, is a major determinant in who will hold the buffer stock. Manufacturers who require long **lead times** to produce a product would not consider the option of requiring their suppliers to hold buffer stock to be a viable option. In this respect there may be no other alternative but to **build to forecast** a certain percentage of their output, which can then be transferred and earmarked as buffer stock. Organizations which simply **build to customer order** may not have the facility to set aside products as buffer stock. They will need to be more flexible and more reliant on their suppliers to ensure that necessary parts and components are immediately available in the event of unexpected levels of demand.

The way in which many businesses approach the concept of buffering reflects the ways in which operations management has developed over the past few years. Examples of systems in differing businesses are shown in Figure 6. In the past, a business believed that it was unable to deal with the fluctuations which occurred external to the organization. Physical buffering had to be in place (in the form of finished products) to ensure that demand could be satisfied. This was a standard practice regardless of the fact that the business might be able to increase its output to cope with an increase in demand.

Operations managers were not considered to be expert enough to deal with organizational issues outside their immediate area of involvement. To this end, human resources managers were deployed to deal with employees who would work in operations. Operations management itself is, in effect, buffered from the outside by supporting functions within the organization, as can be seen in Figure 7.

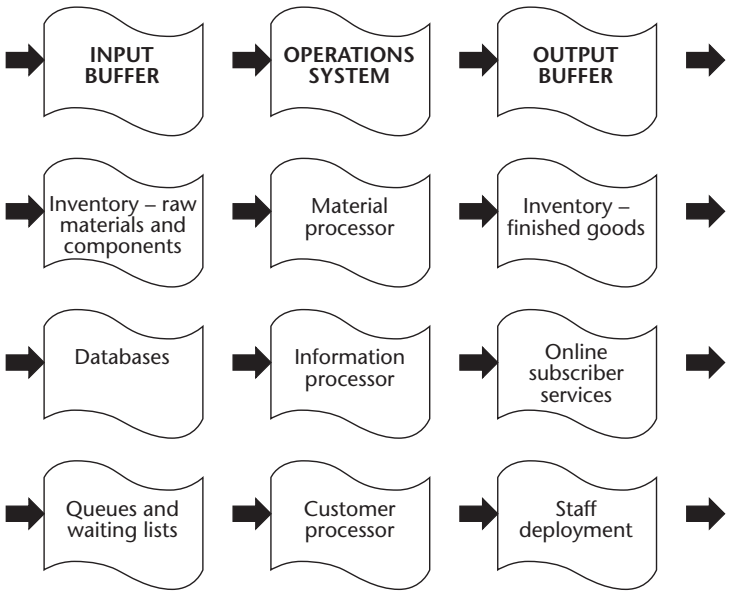

Figure 6 Physical buffering system

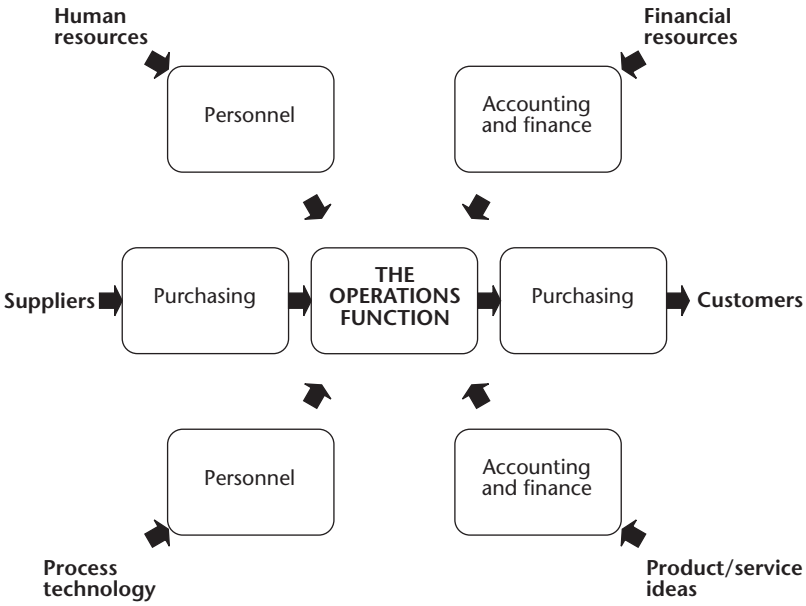

Figure 7 External buffering systems

This continued process means that operations fail to get to grips with the external issues which may well affect their ability to operate, and to learn how to cope with change. Above all, they are unable to manage their own resources as so many other elements of the organization have an input.

See also **safety stock**.

Building to customer order

The term 'building to customer order' refers to situations where an organization will wait until there is a firm order for a product. All aspects of the production process will wait, including the final assembly of the product, its packaging and its despatch. This pulling aspect of the **push and pull system**, by the customer, is in direct contrast to **building to forecast**. The major problem with building to customer order is the fact that the business is never in a position to know precisely how many materials, components or parts will be required at any given time in order to fulfil these customer orders. The problem, of course, extends to the suppliers, who may be expected to deliver the necessary supplies to the manufacturer at extremely short notice. It is often the case that manufacturing organizations which build to order actually order to forecast from their suppliers, in order to ensure that they have sufficient stock should they receive customer orders themselves.

Building to forecast

In the past, the vast majority of manufacturers built to forecast. In other words, they made an estimate, based on historical data and trends in the market, from which they set their production levels. Most markets are now very volatile and increasingly it is becoming more perilous to build to forecast because no businesses can be absolutely sure that these forecasts are real. In situations where the manufacturers do not have timely or accurate customer-needs predictions, the only option is to build to forecast and run the risk, and associated costs, of holding the inventory in their warehouses. Ultimately, if the manufacturers get the building-to-forecast estimates entirely wrong, then they may be faced with the prospect of a large number of unwanted finished goods in their warehouses, which can only be dealt with by offering heavy discounts or clearance sales. No business wishes to do this and increasingly, despite the difficulties, they are moving across to **build to customer order**,

with all of the necessary implications related to their own production schedules and those of their suppliers.

Bullwhip effect

The bullwhip effect occurs in a **supply chain** and is caused by differing perceptions of demand. In complex supply chains, which may involve a raw materials supplier, a manufacturer, a distributor, a series of retailers and a wide number of customers, there will always be differences, or variations, in demand. The bullwhip effect occurs when a part of the supply chain interprets the demand or forecasted demand from its customers at a different rate from the level at which the next organization in the chain had anticipated demand from them. Generally there are four reasons why the bullwhip effect occurs (these are listed in Table 3).

The bullwhip effect is sometime referred to as the Forrester effect. The Forrester effect is, similiarly, where small changes in one part of the supply chain cause wild fluctuations elsewhere.

Lee, Hau L., Padmanabhan, V. and Whang, Seungjin, 'The Bullwhip Effect in Supply Chains', *Sloan Management Review*, Spring 1997, pp. 93–102.

Business process re-engineering (BPR)

BPR makes a fundamental and systematic reappraisal of the way in which an organization operates. For many organizations this is a painful experience which may lead to considerable downsizing. BPR aims to identify and then eliminate any aspect of the business which does not add value. This would include reducing the level of employment, flattening the organization chart, and a reappraisal of any reward systems. One of the major outcomes of BPR is **job enlargement**. Generally, BPR is associated with an impersonal management approach, purely focused on profitability and productivity.

Champy, James and Hammer, Michael, *Re-engineering the Corporation: A Manifesto for Business Revolution*. London: Nicholas Brealey Publishing, 2001.

Business requirements planning (BRP)

Business requirements planning is a holistic approach which incorporates business, sales and production plans, ensuring that they are consistent with one another and that the management has seen to it that resources, where needed, are made available. Once this has been achieved, the BRP then incorporates a **master production schedule**

Table 3 Reasons for the bullwhip effect

Cause	Description and effect	Solution
Updating demand forecast	Normally a business will tend to base its forecasts of demand with reference to its own customers and demand history. Each member of the supply chain will identify different fluctuations in demand and thus amplify the bullwhip effect up and down the supply chain.	Theoretically, the members of the supply chain could attempt to use the same demand forecasts, based on the forecasts predicted by those who sell to the end-user. However, technology has begun to deal with these differences in demand forecasting, specifically through the collection of information from **electronic point of sale** systems, **electronic data interchange (EDI)** and **vendor managed inventory** systems.
Periodic ordering, or batch ordering	Normally organizations will place orders with their suppliers in order to ensure that they have sufficient products or components to last them for a specified period of time. These orders are made in the knowledge that the business will not necessarily consume them by production or sell all of the order immediately. It is done to reduce the costs of each transaction and associated transportation costs. Because organizations which supply these businesses cannot necessarily predict the frequency of the batch orders, demand fluctuations occur.	Electronic ordering systems, cumulative discounts and other methods aimed at reducing transaction costs can be used, as can the outsourcing of deliveries to businesses set up to transport smaller quantities of products or components.

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Table 3 Reasons for the bullwhip effect (*continued*)

Cause	Description and effect	Solution
Price changes	It is in a business's nature to wish to purchase products or components when prices are low, thereby having sufficient stock in order to cover periods when prices have increased. When prices are low an enormous level of demand is generated, which causes a huge bullwhip effect further up the supply chain.	Price stability is the key, and by using **activity-based costing**, a supplier can identify factors which may cause a fluctuation in price. In dealing with these aspects of production, the supplier can seek to offer a much more predictable and stable pricing level.
Rationing	In many areas of business there are inevitable periods of under-supply and over-supply caused by a variety of factors, notably seasonal trends. Customers who are aware that a period of under-supply is about to be entered will inflate their orders to ensure that they have their own sufficient supplies to last them over the under-supply period. This simply increases the under-supply problem, causing a bullwhip effect up the supply chain.	The clearest solution is to advise customers of periods when there will be shortages, which should allow them, over a period of time, to adjust their orders to compensate.

and **capacity requirements planning** in order to ensure that the overall levels of capacity are sufficient to meet expected demand. Naturally this would include an investigation into the level of supply, warehousing availability and any associated production schedules.

Schultz, Terry R., *BRP: The Journey to Excellence*. Milwaukee, WI: Forum, 1984.