There are also practical considerations such as:

- reliability of the supplier
- criticality of the item
- availability of item from other sources.

The concept of 'balance' is most important in ensuring that the maximum service is produced from a minimum of stockholding cost.

The best level of service will be provided if there is an equal chance of all items being available for the customer. High stocks of one item and no stocks of another will reduce the overall availability and increase the inventory cost. The percentage availability target (see Chapter 2) should therefore be the same for all items in the stock range unless there are specific marketing reasons for favouring some customers or products.

If the cost of managing the inventory is also considered, then the value of items being ordered and controlled becomes important. Valuable inventory management resources should be confined to the most cost-effective jobs. This means that time should be spent on high turnover value items and not wasted on items whose value is insignificant. The best balance of inventory leads to an optimization of costs and service over the full range of stock lines within the time available.

The inventory performance of each item can be monitored using a figure of merit for stock balance. This is the 'stock cover', which is defined as:

$$\text{Stock cover} = \frac{\text{Current stock} \times 52}{\text{Forecast annual usage}}$$

This gives the result in terms of weeks on hand. The same answer could be calculated for a month's predicted usage and multiplying the stock by 4.2 instead of 52. This is more convenient sometimes, but should only be used when demand is consistent. It is also convenient to use historical average usage in this equation. (See Chapters 10 and 11.)

A sample of stock items is shown in Table 3.5. Which of these items requires attention first?

Stock cover gives an insight into the priority for action. It is not an infallible guide, but it does indicate where review is required. The first instinct would be to look at 1P4 and 1P8 in Table 3.5, where the stock cover is small. However, there may not be a problem with these since a delivery

Table 3.5 Stock cover

Item code	Stock (units)	Annual usage (units)	Stock cover (weeks)
1P1	250	2000	6.50
1P2	700	1625	22.40
1P3	500	400	65.00
1P4	15	1000	0.78
1P5	20	25	41.60
1P6	40	250	8.32
1P7	500	200	130.00
1P8	8	400	1.04
1P9	6	40	7.80
1P10	65	20	169.00

may be arriving. At the other end of the scale 1P3, 1P7 and 1P10 have over a year's worth of stock, so means of reducing this level will have to be found. Stock cover shows whether the stock is 'in the right ballpark': if it is not correct, attention to the items which are obviously well outside acceptable stock levels will keep the shape of the inventory reasonable. Stock cover is used by inventory controllers because it is easily understood in terms of usage rates and lead times. Stock cover is the time in which the stock will run out at average usage rate.

Use stock cover for analysis but not control.

As well as being a crude analysis tool for each stock item, stock cover is also an important tool for measuring the total inventory. Overall stock cover is calculated from the total value of stock divided by the annual issue value and multiplied by 52 to change the answer to weeks. In many distribution stores the answer is between one and eight weeks. In fast-moving consumer goods, one to eight days is more appropriate. Financial managers are often more interested in the use of funds, and therefore measure the effectiveness of inventory management using 'stock turnover' or 'stockturn'. This is just the reciprocal of the stock cover, taken on a value basis for the complete stockholding.

$$\text{Stock turnover} = \frac{\text{Value of annual usage}}{\text{Value of stock}}$$

This calculation gives the number of times the stock would be used up per year.

Example of stockturn calculation

Value of stock in the stores is £150 000

Issues for the last twelve months amount to £900 000

Stockturn is therefore 900 000 ÷ 150 000 = 6.

This means that the stock value would be used up completely six times per year so that the stock cover for the total stock will be two months, or by the stock cover calculation as

$$\text{Stock cover} = 150\,000 \times 52/900\,000 = 8.67 \text{ weeks.}$$

Stockturn is based on historical data and is used for financial reporting. Stock cover is an inventory management tool for planning stockholding and can be based on known data and the forecast usage rate, so that the stock will meet the expected demand for the item. When the stock level is being assessed for accounting purposes, the ratio uses the historical usage rate, which enables a conservative view to be taken of the stock level. Although this sometimes leads to a divergence of views on the necessary stockholding, the assessed future demand should always be used when controlling stock or placing orders.

Setting stock targets

For good stock balance the stock cover of all the items should have similar value. In practice differences in the variability of usage and the order cycles leads to a range of acceptable values for the items. Stock cover should not be used for working out reorder levels – there are proper accurate ways of doing this (see Chapter 7). Stock cover ratios can be used to calculate the broad ranges of weeks' cover which would be needed for inventory items. For instance it is unlikely that more than twenty-six weeks' worth of stock is planned for any inventory item, therefore a figure of more than twenty-six could be the boundary between 'OK.' and 'needs attention'.

As inventory control should be tightest for the A class items, these are the ones which can be controlled down to lower stock cover figures (leading to

the paradoxical situation of holding lowest stocks of the best sellers!) whereas extra stock of the minor C class items adds little to stock value and significantly reduces the work of controlling.

In practice the stocks could have control limits to avoid extremes of inventory, and an allowable stock cover range can therefore be set by the ABC inventory classes in a ratio which is theoretically 1:3:7. An illustration of the acceptable ranges for category A, B and C items is shown as:

- A class: between one and four weeks.
- B class: between two and eight weeks.
- C class: between three and twenty weeks.

A stockturn ratio (weeks of stock) for all the items in the category should lie in the ranges shown (see Figure 3.4.)

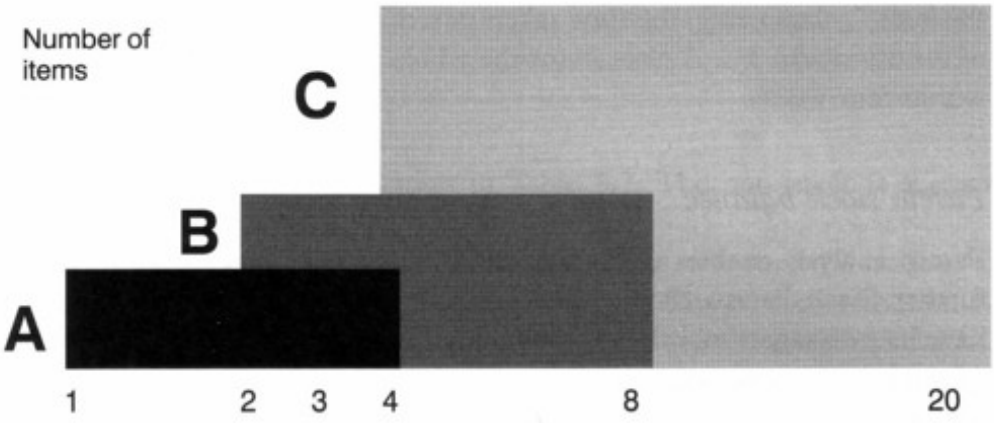

Figure 3.4 Ranges of stock cover

In theory the distribution of the population of items within a class is shown in Figure 3.4. Also shown in this figure is what the curve looks like in practice. (Note that the horizontal scale is logarithmic.) The theoretical curve allows for the variability of demand, the usage of the safety stock for some items and some slow movers, causing some of the items in a class to fall naturally outside the expected limits. The actual population curve when plotted against cover has an entirely different shape. Some items have high stock cover ratios, and since the stock value has to be limited, some of the other items have very low stocks to compensate. The shape of this curve is caused by the response systems initiated by low stock levels and the less effective action which normally is seen when the stock levels for some of the

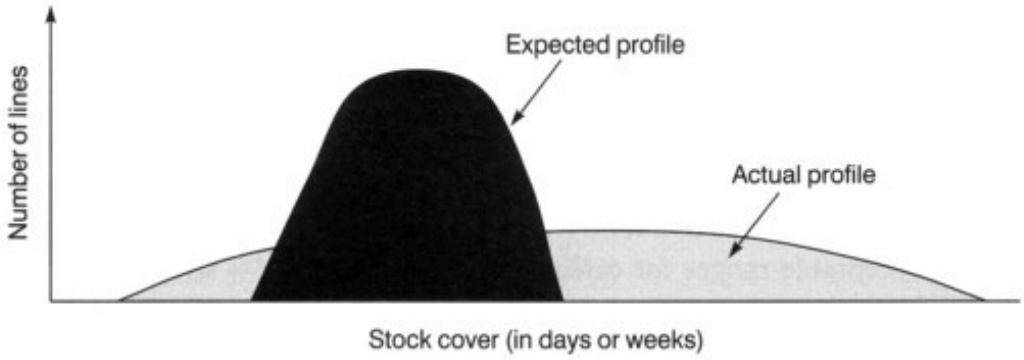

Figure 3.5 Expected and actual stock profiles

items rise over the maximum. The profiles of stock turn ratio in Figure 3.5 are typical, even where inventory management practices are good.

The weeks of stock cover shown in Figure 3.4 indicate how long it would take at best to reduce stock levels. If the stock reduction is to be made through C class items, the time taken to reduce the levels will be in excess of twenty weeks. For A class items the whole process should be completed within four weeks.

Pareto stock balance

Pareto analysis enables us to take the discussion of stock balance a step further. Each Pareto class, calculated according to annual turnover, can have its own target months of stock range, as shown in Figure 3.4. The use of these two techniques (ABC analysis and stock cover) together is fundamental in forming the basis of the stockholding policy. Another illustration of the power of the Pareto rule is shown when the overall value of stock has to be reduced to meet a new target. Say the inventory investment currently amounts to six weeks' of stock and this needs reducing by a minimum of 10 per cent, then ABC analysis of the inventory items would follow the pattern given in Figure 3.5.

In Table 3.6 the A, B and C classes have average stockturns of 2.0, 5.0 and 11.5 weeks, and therefore constitute a well controlled inventory. If these amounts of stock cover appear to be over generous, then the substitution of the word 'day' for the word 'week' in the heading will suit all but those involved in JIT supply (see Chapter 4). The classes contribute 65 per cent, 25 per cent and 10 per cent to the inventory value, respectively. This means that the total stock values arising from A, B and C classes are equal.

There are several options for decreasing the stock value. One way is to cut A items down to an average of 1.5 weeks of stock. This new situation is

Table 3.6 ABC stock cover

Class	Moving lines (%)	Stock cover (weeks)	Turnover (%)	Weeks of value
A	0.1	2.0	0.65	1.30
B	0.2	5.0	0.25	1.25
C	0.7	11.5	0.10	1.15
Total				3.70

Table 3.7 Options for reducing stock value

Class	Moving lines (%)	Stock cover (weeks)	Turnover (%)	Weeks of value	Reduction in weeks of value	Number of lines involved
A	0.1	**1.5**	0.65	0.975	0.325	100
B	0.2	5.0	0.25	1.250		
C	0.7	**8.0**	0.10	0.800	0.350	700
Total				3.025		

shown in the A class calculation in Table 3.7. The net result is a stock reduction of 0.33 weeks.

An alternative way to achieve the same result is to reduce the stock of C class parts down to 8 weeks (from 11.5 weeks). The new contribution to stock cover is 8×0.10 (= 0.8) weeks of value, a reduction of 0.35 weeks.

Tighter control of A items is the better alternative because:

- the change required is less (0.5 week as opposed to 3.5 weeks' cover)
- there are fewer lines involved, so less disruption of planning
- less work will be involved – 100 stock items instead of 700 (last column of Table 3.7)
- the effect will be more rapid.

This last point can be proved by looking at the stock cover for each of the ranges in Figure 3.5. The average taken for stock cover for A, B, and C, are 2.0, 5.0 and 11.5 weeks respectively. If the classes were perfectly balanced, and the supply was stopped, then the A class would run out after 2 weeks, the B Class after 5 weeks and the C Class after 11.5 weeks. Stock reduction through natural usage will take at least these respective times. As stocks are not often perfectly balanced, the true time to reduce the stock is normally over twice this long.

Using ABC and stock cover together saves time and inventory.

Purchase order patterns based on Pareto analysis have been devised to save stock value and management time. This is well illustrated by the ordering process shown in Table 3.8. Consider an inventory of 1000 different lines. If each line is purchased each month from the suppliers, then there are 1000 lines ordered each month, or 12 000 per year, and a stock cover of just over two weeks plus safety stock. (Stock goes up by 4.2 weeks' worth on receipt and then reduces to nil, so the average is 2.1 weeks.) Safety stock can be omitted from the discussion since it is taken to be independent of the order pattern. The order pattern is A weekly, B fortnightly.

Table 3.8 Number of purchase orders with ABC inventories

Class	Moving lines (%)	Stock cover (weeks)	Turnover (%)	Weeks of value	Orders per year[1]
A	10	1	65	0.33	5 200
B	20	4	25	0.50	2 600
C	70	10	10	0.50	3 640
Total	100		100	1.33	11 440

Note: [1]Per 1000 lines.

C then weekly gives a reduction in both inventory and orders.

Further, if the A Class items were ordered twice as frequently and the C class half as frequently, what would be the effect?

The result is that:

- the total stock value is reduced from 2.1 weeks' cover down to 1.55 weeks' cover (excluding safety stock in each case)
- the number of line orders placed is also reduced from 12 000 per year down to 9750.

This shows that a reduction in effort and a decrease in stock are brought about at the same time. These results are typical and are borne out in practice. The effect on customer service from these changes is negligible because the safety stock remains the same in each instance. (The availability is based on the calculations shown in Chapter 6.) Stock discussed in Table 3.8 could be the same as overall inventory shown in Figure 3.4, where the total inventory includes the safety stock in the calculation.

Practical methods of reducing stockholding

The approach

Going back to the basic principle of

$$\text{Decrease in stock} = \text{Output} - \text{input}$$

shows that the way to reduce stock is to decrease input and increase output. A normal range of stock in stores comprises fast moving parts, a wealth of obsolescent and special items and fluctuating quantities of other parts, some in short supply, some overprovisioned. In this situation there is potential for decreasing stock by a significant amount, probably 30 per cent over eighteen months.

For many items there is little manoeuvrability to change the unit cost significantly. However this should be considered, since a 10 per cent reduction in price will cause a corresponding drop in inventory value in the long term. The average value of a stock line is given by multiplying

$$\text{Unit cost} \times \text{Average stock.}$$

The average stock quantity is typically halfway between maximum and minimum[1] stock. The minimum should be the safety stock and the maximum occurs immediately after a delivery. If the stock falls to safety stock level before delivery then:

$$\text{Average stock} = \frac{(\text{max.} + \text{min.})}{2}$$

$$= \frac{(\text{Safety stock} + \text{Order quantity}) + \text{Safety stock}}{2}$$

$$= \text{Safety stock} + \frac{(\text{Order quantity})}{2}$$

See Figure 3.6.

[1] The 'minimum' on some systems is set to the review level for triggering resupply even though the stock continues to fall below this level until the delivery arrives. Here, the 'minimum' is the lowest average stock level immediately before delivery.

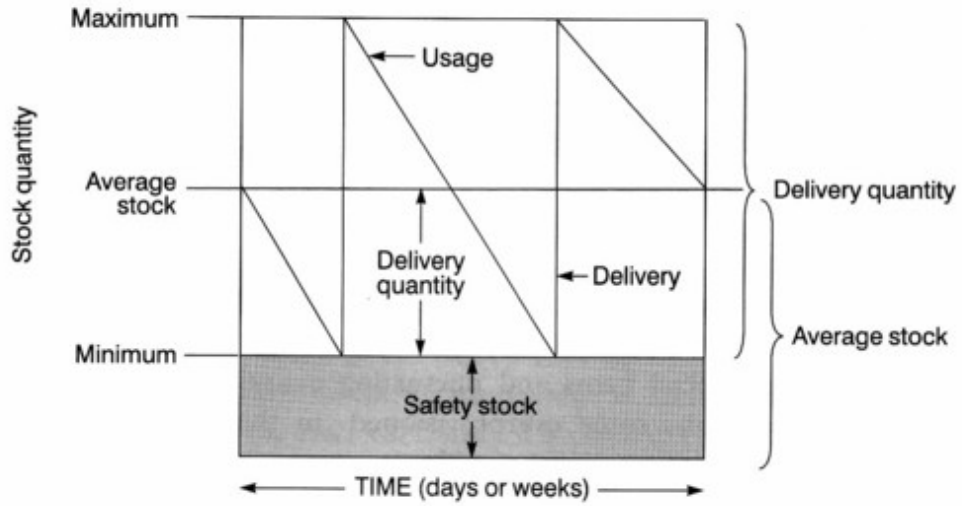

Figure 3.6

In order to reduce the average stock, therefore, there needs to be a reduction in either

- order quantity, or
- safety stock.

Batch quantity

The lowest inventory will result from receiving the same order size into stock as the issues to customers and, of course, this will be at a minimum if the order size is small. For those items which are individual, then the minimum order size is one. The parameter for order quantity on this basis is therefore the simple message 'buy one'. This is also the obvious answer for the majority of slow moving stock items. It is not so obvious when stated in the form: 'hold the least stock cover for the most important stock items', a consequence of good stock control and also of JIT supply. Minimizing the delivery quantities of the A class items (or those contributing to the highest stock value) is normally the most fruitful way of reducing stock value.

Supplier delivery quantities are more important than lead times.

Safety stock

Minimizing the safety stock could result in lower customer service. Because the balance of stock is never perfect and the levels constantly need to be

changed, availability provided by the stock management needs to be monitored continuously. Therefore, the first step in controlling the high-value stocks is to ensure that the safety stock is sufficient to provide the service required and not more. Achieving a higher availability level than necessary is very expensive. The availability for each of the high-value items has to be matched to the requirements of the market. Balancing these stocks is most important. As the safety stock depends on the availability required, the lead time and the variability of demand, the next topic to consider is lead time.

Little and often for A class.

Lead times

By negotiating shorter lead times, the safety stock can be reduced. Modern purchasing practice should eliminate random demand 'over the counter' but it does require collaboration, forecasting and supply chain management so that the supplier can arrange to make items available by the demand date with a much shorter lead time. Lead time can be reduced by negotiation, and in the context of reducing stock investment, it is the few major stock items which will offer the most opportunity to negotiate.

The third factor is demand pattern. If the demand were ten every week consistently, then there would be no need for safety stock. (There are people from some areas of business who would question this simple statement, since the holding of extra stock would enable extra orders to be serviced should they arise. This extra stock is not safety stock but an investment in opportunity – or folly – and should be considered separately.) The question to be answered is 'what opportunity is there to smooth out the demand pattern?'

Example: a case of a pan

The stock records for a range of materials sold by a major supplier of aluminium were typically as follows:

Week	1	2	3	4	5	6	7	8	9	10	11	12
Demand	225	2625	75	100	200	50	125	100	0	2050	300	125

The items were aluminium circles (flat round sheets) in various sizes used for making pans. The conventional stock level calculations suggested very high stock levels in order to cope with the demand peaks in weeks 2 and 10. This was introducing a high level of stock for these items, and inflating the inventory value.

Investigation of this order pattern showed that across the range of products, these peaks were caused by one major customer who had an order cycle of two or three months and this was causing the large demands. There are several solutions to this problem:

- ***Understand demand*** *– greater understanding of the demand pattern improves the forecast. Since safety stock is required to compensate for forecast inaccuracy, the improvement of forecasting reduces safety stock. There is, therefore, the opportunity to try to smooth customer demand by getting the customer to buy little and often.*
- ***Flatten demand*** *– remove sporadic demand from the stock by buying to order and giving the customer a longer lead time.*
- ***Agree scheduled supply*** *– It would be better to organize a continuous supply by scheduling delivery.*

The reduction project

Order quantities and safety stocks should be examined to ensure that they are synchronized, starting with the item with the most stock value and continuing down the stock value Pareto curve. A target should be set so that the stock reduction for each item can be judged against it. For example, an overall stock value reduction of 20 per cent can be achieved through a 25 per cent reduction in stock of the top 20 per cent of lines. Starting from the highest value stock line, a percentage reduction should be attempted for all lines. This is unlikely to be achieved for some items, but it is essential to concentrate on achieving the target for the highest value lines or the overall target will not be met. The value under-achievement on some items has to be compensated by extra value savings on other lines.

The approach – how to reduce stock successfully

Stock reduction is usually undertaken as a project, and concentration should be given to achieving the objective in a short time. By examining

the first few lines in the Pareto curve, major savings can be achieved in a short timescale. The next step within each area of activity is to find the major cost items. By Pareto Analysis it can be assumed that 80 per cent of the value of stock exists in 20 per cent of the item types. Items with the most stock value are likely to be a mixture of fast movers with reasonably high unit value and high-value items where there are relatively few demands per year. Pareto analysis shows that the way to reduce the stock value is to concentrate on the high stock value items, whether they are slow moving or fast moving. The value of inventory is the same for each and the financial investment is the same. In fact it is easier to vary the inventory levels for the faster moving items. As far as basic Pareto classification is concerned, there is no difference between the stock for fast-moving and slow-moving items with the same stock value. The differences will be managed through the individual stock calculations for the items.

High stock value fast movers reduce the fastest.

The stock of a fast-moving item is likely to be consumed quickly and consistently though servicing a wide variety of demands from a large customer base. The inventory profile for a fast mover is therefore large numbers of demands taking a small proportion of the inventory. Demand is relatively stable. For high-value items, there are relatively few issues to a smaller number of customers. This means that the demand is more unstable for two reasons:

- As the stock lasts longer, the risk of demand changing within the stock cover period is greater and therefore there is an enhanced risk of the stock remaining as obsolete or excess.
- The demand comes from only a few customers, if any of them reduces their offtake, this will have a much more significant effect than if there were more customers.

It is therefore especially important to manage risks on the slow-moving, A class items by forecasting, ordering little and often, and collaborating with customers and suppliers. The A items are selected for special control, applying a scheduling approach where possible and negotiating closely with the supplier. The supplier may be keeping a stock of these items specially or can be persuaded to do so if desirable. The delivery quantity for A class must be cut to a minimum and reviewed each time an order is placed.

The stock reduction project

Specific stock reduction can be achieved through a dedicated project. Continuous stock reduction is a background job for all inventory managers, but since insufficient focus is given to it, arranging a project tends to be more effective. The following steps may be taken:

1 Identify the potential for reducing stock.

   (a) Find the total stock value.
   (b) Find the annual material usage.
   (c) Calculate the total stock cover for the various stores or categories of stock.

   The results can then be tabulated, to identify which areas of stock have the best potential for significant value reduction, under the following categories: stock type, stock value, calculated stockturn, target stockturn.

   The analysis of stock type can be generalized for distributors. Typical classifications are: market sector, product type, supplier, or other obvious classes. For manufacturers classifications can be into raw material, work in progress, bought-out parts, finished goods, consumables, etc.

   All that is required is to reduce average stock value of significant stock lines. With this analysis it is easier to see which areas to concentrate on in a stock balancing programme. By assessing targets based on experience an initial plan can be launched, to be followed by a detailed analysis of appropriate targets at a later time.

2 The next step is to classify stock items into ABC.

3 For the few A class items, it is important that the minimum stock is held for the availability required. This is where the major effort in stock reduction should be focused. A items have to be reviewed individually and the supply arrangements reconsidered. Significant reductions are to be sought, through supply practice and better demand forecasting.

4 The reorder level and safety stock depend largely on the lead time. It is, therefore, important that lead times reflect current trading conditions and are kept low through contact with suppliers (especially for A class items).

5 For the medium price items, i.e. B class items, computer monitoring of safety stocks and order sizes will enable smaller batches to be ordered and safety stock to be reduced.

6 Avoid ordering more than (say) three months' supply of anything. Setting a limit ensures that the amount of slow-moving stock is reduced. Very long lead time items will have several purchase orders outstanding simultaneously.

7 Low value items purchased in category C are often standard products which can be obtained off the shelf. By proper planning, these need not be kept in stock. They can be purchased to meet demand or provided by a supplier on consignment. However, an efficient reorder procedure is necessary or else the works van will be touring the neighbourhood continuously picking up odds and ends.

8 From the stock turnover figures it becomes obvious that some items have too much stock cover, and are simply contributing to stock value. They are either obsolete or have very low sales. From our introduction to this section the formula shows that this stock has to be disposed of in order to have a low inventory presence.

The first step is to decide which stock is obsolete and to remove any chance of it being reordered by marking the records accordingly. The most profitable way to dispose of stock is through the servicing department. They can often sell obsolete lines to customers with old machines at full sales value or at an offer price near to it.

Stores are also likely to hold proprietary products such as components, fittings, motors, consumables, bearings and packaging which can often be sold back to the supplier at a low price. With high inflation over the past few years this return value can equal the original purchase price and so there may be no loss of assets involved.

By concentrating on major cost items the value of obsolete stock can be reduced. It generally takes time to negotiate the sale of items and therefore can be viewed as an ongoing project. Where these approaches still leave a significant number of useless items in stock, then disposal for scrap is the simplest course, and there should be an approved budget for this. The loss of assets through scrapping stock reflects directly on profit margins, and overzealous disposal projects can mean a period of poor financial results.

Armed with a budget for scrapping, items can be thrown out of stores and written off until the budget is used up. As stores are often short of space and control of slow movers is tedious, it is convenient to scrap a large number of the lowest value items in stock, thus reducing the number of stock lines and consequently freeing most space.

9 Design and planning departments can help to reduce stock requirements by very large amounts. All they need to do is to use the same items widely rather than marginally different ones for each application.

A stock rationalization exercise is normally fruitful for standard items such as electronic components, motors, fasteners, raw materials, packaging items, gearwheels and tools. This can be carried out initially by inventory control and then passed on to technical people to continue.

10 The order is the cause of increased stock. Therefore it is necessary when undertaking a stock reduction exercise to look at every order placed to ensure that:

(a) The item is required at the time purchased.
(b) A minimum is ordered.
(c) There is no stock existing which can be used instead.

11 To maintain overall control of the stock reduction project reliable management information must be available on a monthly or weekly basis for such things as the value of items on order, stock cover and availability. By plotting them on a graph the effect of these actions can be measured continuously.

Key points

- ABC analysis provides the best tool for saving time and structuring inventory.
- Stock cover enables inventory managers to look out for likely problems.
- Stock cover is not used for setting safety stock levels.
- Inventory is reduced chiefly by using Pareto analysis and controlling supply.