

## 6 Know Your Processes

### CHAPTER CONTENTS

Introduction	108
Cost behaviour: random variation and interdependent events	108
Activity-based costing	112
Operationalizing activity-based costing	115
Target costing	130
Activity-based management	132
Innovation and the activity-based management trade-off	141
Operationalizing activity-based management: the time dimension	144
Value-added management	160
Summary	167

### INTRODUCTION

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A much simplified cybernetic process of the type in Figure 6.1 provides a suitable basis for the analysis and measurement of a series of activities. We should have a model in place which can predict the volume and quality of outputs, depending on the volume and quality of inputs. The degree of predictive success will depend upon the complexity of the process and the number and type of variables which may impact on the outcomes of the process. If the model does not work well we should aim to develop a new one which better reflects the involvement of key variables.

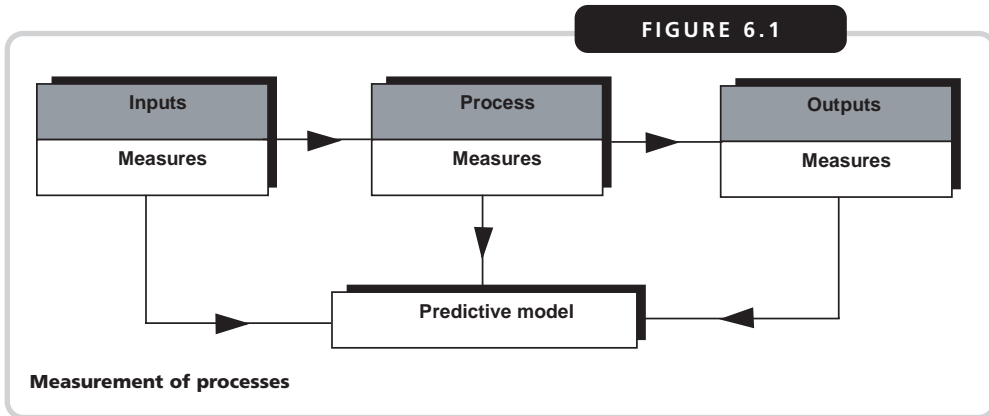
If activity-based systems do nothing more, they will at least force us to look at our cost structures again, to reappraise the systems in place and improve measurement patterns. Knowledge of process and cost behaviour is an essential feature of decision support. The database necessary to support activity-based systems requires a keener awareness of interrelationships between activities than is currently apparent in many organizations. Accordingly, these issues provide the focus for this chapter.

### COST BEHAVIOUR: RANDOM VARIATION AND INTERDEPENDENT EVENTS

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Fundamental to the development of predictive process models are three features:

- *Identification of the critical indicators.* We may not be completely aware of these if the process is complex and not clearly documented. It is likely



that we do not record data for many potentially useful variables; and, depending on the costs involved, we may be forced to collect data on new variables in case they feature strongly in the revised model of process.

- *Awareness of the mathematical relationship between variables.* This is achieved through a detailed analysis of cost behaviour. Gone are the days when management accountants can ‘average’ at whim and make straight-line assumptions when none are applicable. Statistical software facilitates the exploration of relationships and the development of knowledge relating to cost structures.
- *Weighting of the key factors.* We need to recognize the appropriate weighting to be given to the key factors in a parsimonious data set suitable for modelling and forecasting.

We can only reduce the variation in systems by understanding their cause and effect. By studying variation, rather than demanding unnecessary managerial explanations, we can implement changes appropriate to customer expectations. Variation is frequently attributable to random fluctuations, with its magnitude amplified by the effect of interdependence among functions. Such variation does not stop the process from being in control; by taking appropriate action in trying to compensate for the variation we will simply make things worse and fail to meet customer targets.

For example, familiar but inappropriate management practice would include:

- demanding explanations from managers for adverse variances and taking action to correct those variances when they merely comprise random fluctuations within a normal curve;
- adjusting budgets based on one month’s results – usually the last one – although those results may neither be representative nor reflect performance trends;
- increasing sales targets in response to a shortfall in the previous week rather than projecting fluctuations in the series over time;
- overreacting to a single customer complaint, without appropriate analysis of its cause or justification;

- revising detailed plans and schedules based on the outcome of a single job – the previous one – which is assumed to be representative of all such outcomes; and
- changing key process variables (such as time, temperature or pressure) based on the quality of the output from the most recent production batch, when the outcome may be attributable to batch-specific input causes.

Such inappropriate actions result from common misconceptions regarding the nature of variation. All of these outcomes conform to systematic statistical distributions, with means and standard deviations. Variation within such distributions is inevitable and, in itself, should not be questioned. What we need to establish are answers to two questions:

- 1 Is the system in control? In other words, is the observed variation consistent with statistical expectations?
- 2 Is the system capable of satisfying customer requirements? That is, are the observed variations within specified, acceptable limits?

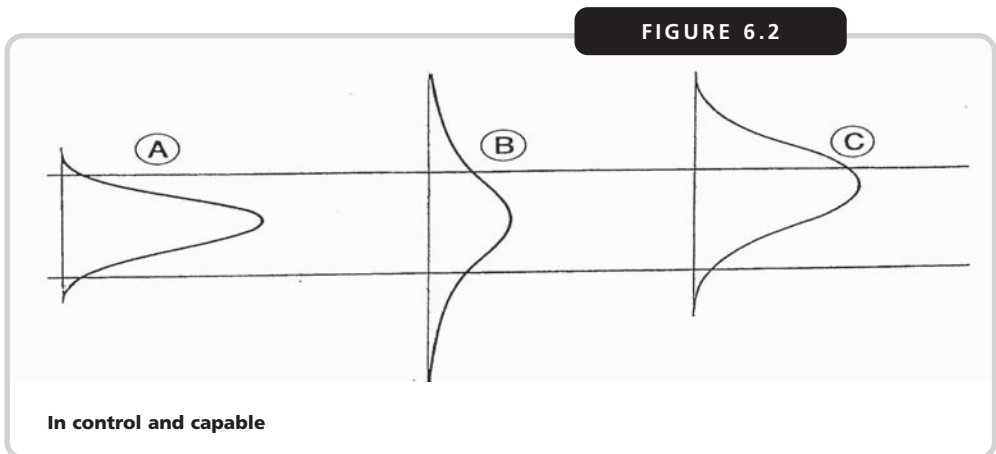
These two questions require different solutions; action taken on stable systems (in control), in an effort to compensate for variation, will only increase the variation and, inevitably, increase costs.

Figure 6.2 illustrates the nature of distributions and the extent to which they are both in control and capable. 'In control' basically means that a process is operating normally between statistical control boundaries, but not necessarily as the customer wants it. A process deemed to be 'in control' can still fail to meet customer specifications. The three cases shown in Figure 6.2 follow precise statistical distributions, but only case A fits tightly within the specified limits. Case B displays unacceptably large amounts of variation attributable to random fluctuations. Case C is wrongly targeted so that the specification limits are unrealistic and customer requirements go unsatisfied.

'Capable' refers to a process that is achieving the customers' requirements, operating between statistically defined limits. In Figure 6.2, only case A describes a system which is both 'in control' and 'capable'.

Variation in any system may be due to:

- common causes, inherent in stable and predictable systems, producing random fluctuations within specified limits; or



- special causes, events due to factors external to the system which result in instability and unpredictability.

Common causes contribute to output variability because they themselves vary, resulting in a random aggregate variability. If a process has only 'common causes' it is deemed to be in control and requires fundamental change if further improvement is to take place. Different actions, impacting upon external factors, are required to correct variations attributable to special causes. Problems arise where inappropriate actions are taken.

If the source of variation is common cause (random fluctuation), adjusting the system will result in errors – we should not tamper with a stable set-up. But if the source is a special cause (external to the system) things will get worse if we do nothing. We must identify and eradicate the effects of external factors impacting upon the system. It is, therefore, essential that we recognize the nature of the cause to which variation is attributable, because this determines the appropriate form of managerial action.

This situation is further exacerbated by the existence of a chain of inter-dependent events, each of which is subject to random fluctuation. Now the nature of the dependence and the extent of the individual fluctuations will determine the variation.

Consider the situation where service costs ( $C$ ) are dependent upon the time taken to complete two tasks ( $X$  and  $Y$ ). The tasks are normally distributed with a mean time to completion of 2 minutes and 3 minutes, and standard deviations of 1 minute and 2 minutes, respectively. The functional relationship is  $C = f(X, Y)$ , but the variation in costs attributable to common causes differs enormously depending on the nature of the relationship. If

$$C = 18X + 12Y,$$

(case 1) then the mean cost is \$72 with a standard deviation of \$24.70. But if

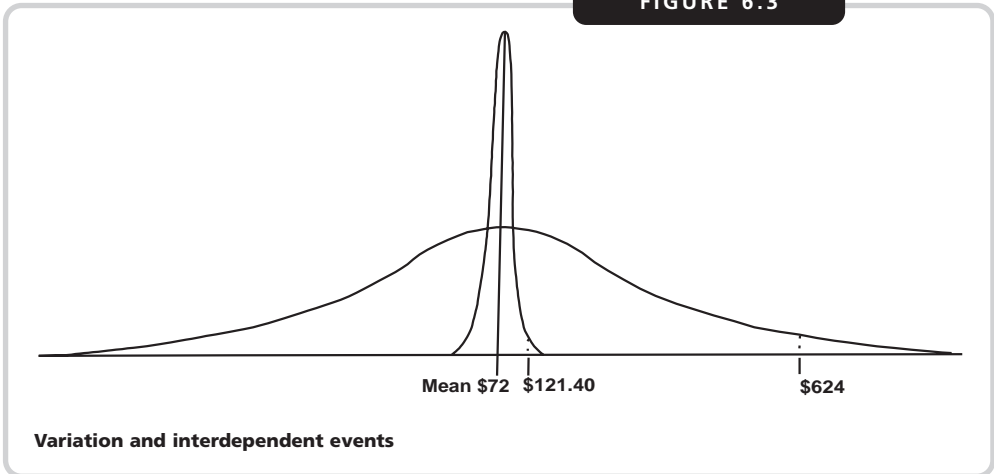
$$C = X^3Y^2,$$

(case 2) then, while the mean cost is still \$72, the standard deviation blows out to \$276. Figure 6.3 illustrates the impact on our 'in control and capable' programme. If we specify an upper control limit of two standard deviations, our definitions of 'in control' would be vastly different – under \$121.40 for case 1, but under \$624 for case 2! Clearly cost behaviour must be carefully examined.

A further complication arises if one event cannot take place until after the completion of another. Here the accumulation of fluctuations will act to increase inventory and reduce throughput. Despite the existence of a balanced system, random fluctuations of the two (or more) variables in the dependency will cause the variation of subsequent events to be determined by the maximum of preceding ones. Because of the dependency, departments get behind and work-in-process inventory builds up, the usual consequences being:

- overtime work;
- flexibility of operatives;
- management stress; and

FIGURE 6.3



- pressure on employees to get the product out of the door and reduce inventory.

This process will then inevitably be repeated because of the interdependencies unless action is taken to reduce the level of variation applicable to individual events. The alternative – stopping the production line to allow some sections to catch up – is still frowned upon because of the idle time created, even though it might reduce the cost of work in process.

Where multiple events are concerned, the fluctuations may average out, but for interdependent ones they will just accumulate. If we do not know our process then there may be nasty surprises awaiting us. The fundamentals of statistics are essential if we are to comprehend the workings of the processes and the intricacies of cost behaviour.

## ACTIVITY-BASED COSTING

The abandonment of traditional, volume-related, absorption costing bases for product costing leads to the inclusion of non-production overheads in activity-based analysis. Design, engineering, servicing, production, distribution, marketing and after-sales service are all usually considered to be relevant activities. Only excess capacity costs and research and development costs, respectively treated as period costs and asset capitalization, are normally excluded. Purchasing, scheduling and set-up costs, typically classified as fixed costs under a traditional system, respond to activity-based changes.

The essential characteristic of an activity-based costing (ABC) system is the differentiation between volume-driven costs and non-volume (activity-driven) costs. Direct costs (labour and material) are not a problem in this respect, but overhead costs necessitate the adoption of some assumptions before they can be allocated to individual products. This is especially true where no volume-based relationship can be established.

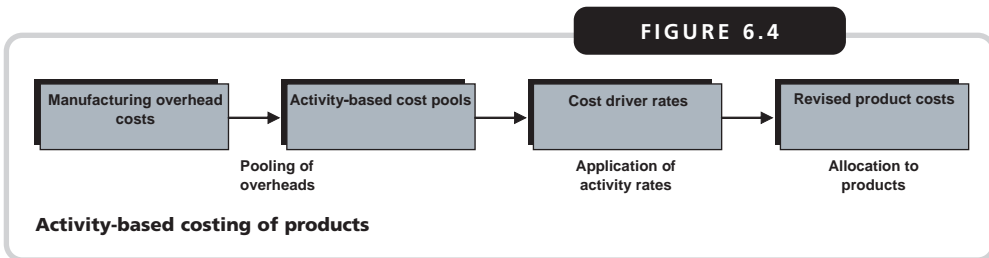
Rather than the traditional approach of allocating overhead costs to production departments and then to product lines via volume-based

overhead rates, ABC introduces an intermediary: cost pools. The revised system is still a two-stage one, but ABC charges overhead costs to activity-based cost pools and on to product lines through rates based on cost drivers. Figure 6.4 illustrates the stages.

Three further fundamental elements of ABC are therefore:

- the choice of cost pools, based on the identification of the major activities which cause overhead costs, such as maintenance, purchasing, supply and processing;
- the allocation of overhead costs to the cost pools, which will require some indication of the significance of each major activity in incurring overhead costs; and
- the choice of cost drivers for each activity-based cost pool, which will require judgement regarding the homogeneity of the activity and the representativeness of the cost drivers.

ABC systems have been put forward as a possible solution to the fact that absorption cost systems do not normally embrace marketing expenses – this despite studies which suggest that marketing costs can comprise as much as 50% of the total costs of many product lines. Physical distribution costs may be a major factor in internal operations, impacting on performance measurement and possibly preventing the implementation of just-in-time systems. The application of ABC principles in tracking marketing costs to products suggests that we should adopt a number of possible cost drivers for each sphere of activity, as in Table 6.1.



**TABLE 6.1**

<b>Allocation of cost drivers</b>	
<b>Activity</b>	<b>Cost driver</b>
Sales	Number of orders received
	Gross sales
	Number of sales calls
Distribution	Number of units
	Weight of units
Warehousing	Size of units
Accounting	Number of customer orders
	Number of invoice categories

Organizations may expect to benefit from the implementation of ABC in a number of areas of their operations. These include:

- in multi-product organizations, a completely different ranking of product costings, reflecting a correction of the benefits previously accruing to low-volume products;
- an improved awareness of the activities which are driving overhead costs and which may improve the control exercised over the incurring of such costs;
- the generation of an information base which facilitates the implementation of TQM by quantifying improvement opportunities;
- the use of non-financial indicators to measure cost drivers, providing measures of performance in addition to a means of costing production;
- the identification of non-value-adding activities;
- a new perspective on the examination of cost behaviour, and on planning and budgeting, through the analysis of cost drivers;
- costing information which is more credible and demonstrably more useful in the decision-making process, making ABC useful for inter-plant and inter-divisional comparisons.

However, despite its nuances and subtleties, an ABC system is still essentially a historic cost system. In certain circumstances the decision-usefulness of its conclusions is doubtful, especially where present and future cost considerations are of particular importance. As with all historic cost information, we should regard it as a starting point for future cost information rather than as a direct input into the decision-making process.

Far from eliminating arbitrary allocations of overhead costs, an ABC system may actually increase the number of such apportionments. The manner of the allocation may be more systematic but, nevertheless, a hint of arbitrariness remains. Thus we must determine decision rules for the pooling of common overheads into separate cost pools and common cost drivers into separate activities. Once a cost driver has been identified, there is the danger of trying to employ it alone to explain the cost behaviour of a whole cost pool, even though it may not be entirely representative. It is likely that a combination of cost drivers, appropriately integrated, will often provide a better means of explaining cost behaviour.

An alternative approach is to adopt a strategic approach to the choice of cost drivers. By choosing drivers which are consistent with strategic goals, rather than 'correct' in some sense, we may deliberately penalize certain parts of the production process whose operation is not congruent with corporate goals.

An often neglected problem of ABC systems is that of data collection. To justify the sophistication and potential complexity of ABC, the training of those inputting data into the system is essential. They must be able to measure the NFIs employed as cost drivers and must appreciate the importance of accuracy and reliability to the credibility of the whole system. Similar problems exist with financial indicators under traditional cost systems.

While ABC studies documented so far have predominantly been conducted in manufacturing environments, the extension of the ABC methodology to the service sector in more recent studies is a welcome extension, allowing more accurate measurement of indirect costs and more appropriate service costing. Reported cases include successful applications

in banking (Mabberly, 1992; Hart and Smith, 1998) and in airlines, hotels, telecommunications, transport, marketing, wholesale and distribution, health and information services (Cooper and Kaplan, 1992; King et al., 1994; Banker et al., 2000).

The emergence of ABC has undoubtedly forced management accountants to reappraise their costing systems and to identify improvement opportunities. Clear advantages have been demonstrated in particular working environments, notably in multi-product organizations. However, equally clear doubts have been expressed about the costs of changing to an ABC system, especially when there have been few documented studies of successful implementations, to suggest, conclusively, that ABC generates bottom-line improvements in profitability. The findings of Kennedy and Affleck-Graves (2001) are important in this regard in that they show that for a matched sample of UK firms, those adopting ABC outperformed the non-adopters by 27% over a three-year period; they suggest that ABC adds value through cost control, asset usage and access to greater financial leverage. The take-up of management accounting innovations is slow worldwide, and ABC implementation provides a good example: Innes and Mitchell (1995) reported adoption rates in the UK of less than 14%, while in the USA Ness and Cucuzza (1995) report that fewer than 10% of ABC adopters continue to support the innovation. The evidence seems to suggest (e.g., Askarany and Smith, 2004) that the perceived benefits of implementation do not outweigh the costs, and that this perception is borne out among adopters too.

## OPERATIONALIZING ACTIVITY-BASED COSTING

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The motives for pursuing an ABC implementation, or at least for investigating its feasibility, must be established at the outset. Most commonly, these will be:

- to improve product costing where a belief exists that existing methods undercost some products and overcost others; or
- to identify non-value-adding activities in the production process which might be a suitable focus for attention or elimination.

In practice, the former is the most quoted goal, even though the latter may be more appropriate. This is especially so for firms which are highly labour-intensive and which do not have a great diversity of products in their range, and where allocation of overheads based on direct labour hours may already function efficiently.

Direct costs, like materials and direct labour, are easily assigned directly to products. Some indirect costs, particularly those selling costs which are product specific (e.g., advertising), may be directly assigned to the product too. The remaining indirect costs are those which are problematical and provide the focus for ABC, with resource costs indirectly assigned to the cost object via cost pools and activity drivers. A number of distinct practical stages in the ABC implementation exist:

- *Staff training.* The co-operation of the workforce is critical to the successful implementation of ABC. They are closest to the process and most aware of the problems. Staff training should be, as far as possible, jargon-free,



and create an awareness of the purpose of ABC. It should be non-threatening in nature, stressing that increased efficiencies resulting from a successful implementation will mean rewards, *not* redundancies. The need for the co-operation of staff in a concerted team effort, for mutual benefit, must be emphasized throughout the training activity.

- *Process specification.* Informal, but structured, interviews with key members of personnel will identify the different stages of the production process, the commitment of resources to each, processing times and bottlenecks. The interviews will yield a list of transactions which may, or may not, be defined as 'activities' at a subsequent stage, but in any case provide a feel for the scope of the process in its entirety.
- *Activity definition.* The problem must be kept manageable at this stage, despite the possibility of information overload from new data, much of which is in need of codification. The listed transactions must be rationalized in order to aggregate those in similar categories and eliminate those deemed immaterial. The resultant cost pools will likely have a number of different events, or drivers, associated with their incurrence.
- *Activity driver selection.* A single driver covering all of the transactions grouped together in an 'activity' probably does not exist. Multiple driver models could be developed if the data were available, but cost-benefit analysis has rarely shown these to be desirable. The intercorrelation of potential activity drivers will be so strong as to suggest that it really does not matter which one is selected. This argument might be employed to avoid the costly collection of data items otherwise not monitored, nor easily accessible.
- *Costing.* A single representative activity driver can be used to assign costs from the activity pools to the cost objects. If, for example, the number of engineering set-ups has been identified as a driver of process costs and the total set-up cost is £40,000 for a company producing four products (A, B, C and D) then the number of set-ups per product can be used to assign these costs. If product A requires two set-ups, B four set-ups, C 24 and D 10, then the average cost per set-up of  $40,000/40 = £1000$ , a misleading figure taken at face value, which does not imply the different demands of the set-up resource made by the different products. However, total set-up costs can be distributed to product groups in proportion to use (A, £2000; B, £4000; C, £24,000; D, £10,000) and then assigned to individual units of product in proportion to the total level of output. Thus if 20,000 units of A were being produced each would attract £0.10 of costs attributable to set-ups. This procedure can then be repeated for all material activities, as in the following case study. The existing literature suggests that the likely outcome will be a demonstration of costing errors of varying degrees; these will most commonly be the undercosting of low-volume products and the overcosting of high-volume products.

The onerous nature of this recosting exercise should not be underestimated and may make it advisable to concentrate on the most important products in the range. Thus for a 100-product firm a focus, at least initially, on the most prominent 20 products, say, could yield the outcomes desired. The question of how to use the revised costings resulting from the ABC implementation is more problematical. It may show that some products are unprofitable at current price levels, so that a financial analysis suggests that they should be dropped from the product mix. Such a decision should not be made without reference to inter-product implications and to strategic and

non-financial considerations concerning the overall impact of the product concerned.

We now present a case study which highlights the deficiencies of traditional methods of product costing, employing single-volume methods of overhead allocation. It provides the opportunity to apply ABC methods in order to demonstrate differences in cost and price outcomes.

## CASE STUDY

### **RAVE Holdings: Activity-based costing for pricing decisions**

This case study highlights the potential difficulties associated with traditional methods of product costing which employ single-volume methods of overhead cost allocation. It provides the opportunity to explore alternative costing methodologies and to apply activity-based costing methods, and demonstrates both the differences in cost and price outcomes associated with different methods, and the marketing implications of the new cost information for pricing practice.

Teddy Rodhouse was born to be a salesman. He traded football cards and postage stamps at school, before he was 10, and by his teens was selling car radios, stereos and aerials from a market stall. School soon came to have little meaning for him because he loved buying and selling, always at a profit, and always in cash. He bought himself a van (the lack of licence and insurance seemed only a minor obstacle) and traded daily on the circuit of street markets in central and south Sydney. His absence from school was noted, and his father responded by cutting his pocket money, but at 16 Teddy was already earning more in a week than his father did in a month!

Teddy's genius was in spotting unmet consumer demand early, and taking rapid steps to supply it, particularly in the areas of home entertainment and audio-visual systems. Thus was RAVE Holdings born (Rodhouse Audio Visual Entertainment), initially as a selling arm, but increasingly as a vehicle for externally sourced and designed products. By providing products in anticipation of the market, and bringing them in ahead of competitors, RAVE became more profitable. Teddy had always been reluctant to do his own manufacturing, but as the organization grew in size and reputation, he recognized the enormous profit opportunities from vertical integration which made use of low-cost sources off Australia's northern shores. Twenty years on, Teddy Rodhouse is now Chief Executive of a thriving business with an enviable reputation among the market leaders for hi-tech products. But now Teddy's lack of schooling may become his Achilles heel; costing and pricing have always been low on his priorities because new, well-marketed products have always been successful in the past.

The management at RAVE are now worried, and the shareholders restless. Table 6.2 indicates why: the company's bottom line displays a disconcerting downturn for the second successive year – the first time this has happened in the company's 20-year history. The reason for this relatively poor performance is largely attributable to lack of sales revenue stemming from an inexplicable failure to win orders.

## CASE STUDY (cont.)

TABLE 6.2

## RAVE Holdings financial performance

Year Ending	31/12/2000 (\$000)	31/12/1999 (\$000)	21/12/1998 (\$000)
<b>INCOME STATEMENT</b>			
Sales Revenue	336,420	229,716	218,928
Profit before Tax	17,680	18,580	24,410
<b>BALANCE SHEET</b>			
Current Assets	292,848	174,754	148,012
Inventory	89,856	35,496	24,624
Current Liabilities	501,648	262,053	140,423
Total Assets	460,162	316,842	265,813
Total Liabilities	723,157	396,101	266,647

The Chief Executive feels that the pricing policies must be wrong and has called for a full investigation of current procedures in order to identify deficiencies.

RAVE has always prided itself on staying at the cutting-edge of new manufacturing technologies and has diversified to take advantage of new marketing opportunities. It reckons itself to be the most efficient producers worldwide of its two traditional products:

- Astra, an efficient and cost-effective portable compact disc system, originally designed for in-car use but successfully adapted as a portable single-disc system integrating radio and double tape-deck.
- Bueno, a streamlined and sturdy six-head video cassette recorder with G-code and a reputation for reliability.

Both the Astra and the Bueno are mature and proven products. They regularly receive minor upgrades, but this requires a minimal investment commitment.

The future of RAVE Holdings is heavily dependent on the success of its two recently launched products:

- Cisco, an attractively designed flat screen TV targeting the bottom end of a still emerging market, and which quickly achieved prominence just a short time after initial penetration, taking advantage of the demand for new technologies.
- Delta, a compact and lightweight DVD unit, targeting the top-end of the market and with advanced features relating to picture quality and theatre-style 'surround sound'.

The initial success of the two new products has surprised even the most optimistic of management. Although the new products have been successfully launched, it is the sales of the traditional products which are the greatest cause of concern. RAVE has lost out to competitors

## CASE STUDY (cont.)

TABLE 6.3

Breakdown of average monthly sales revenues 1999/2000

	2000		1999	
	UNITS SOLD	REVENUE (\$)	UNITS SOLD	REVENUE (\$)
ASTRA: PORTABLE CD	20,000	7,200	23,000	8,280
BUENO: VCR SYSTEM	15,000	9,585	17,000	10,863
CISCO: FLAT SCREEN TV	8,000	4,680		
DELTA: DVD SYSTEM	10,000	6,570		
		<u>28,035</u>		<u>19,143</u>

that it views as inferior and less efficient. Inferior producers have been able to tender at more competitive prices, suggesting that there is something wrong with pricing procedures at RAVE.

An analysis of the breakdown of monthly sales revenue (in Table 6.3) confirms the decline in the sales of the two traditional product lines. Teddy Rodhouse's worst fears are confirmed when he checks out the current selling prices of comparable products in the Toshiba, Samsung, Panasonic and Sony ranges:

	Selling Price (\$)	
	RAVE products	Competitors' products
Portable CD	360	323 (Panasonic)
Six-head VCR	639	529 (Sony)
Flat screen TV	585	899 (Samsung)
DVD system	657	775 (Toshiba)

Teddy orders an urgent investigation and re-evaluation of costing and pricing methodologies.

Each of the products proceeds through the same four-step production process, though the time spent and resources consumed at each step varies between products:

- 1 supply of raw material components;
- 2 set-up and run of production engineering;
- 3 vacuum packing of finished product;
- 4 distribution of product to wholesalers and retailers.

Table 6.4 shows the monthly cost information which is employed by RAVE in its current pricing procedures.

Prices are currently calculated with respect to unit costs computed on the basis of direct labour, direct material and a share of overhead costs. Overheads are allocated on a direct labour hour (DLH) basis, using an overhead rate of  $10,800,000/90,000 = \$120$  per DLH. Table 6.5 illustrates the calculation of selling prices for each of the products.

**CASE STUDY (cont.)****TABLE 6.4****Cost information for four products**

	TOTAL				TOTAL
	Astra	Bueno	Cisco	Delta	
<b>Units of Output</b>	30,000	20,000	8,000	10,000	68,000
<b>Resource Use per Unit:</b>					
Raw Materials	4	5	10	15	450,000
Labour Hours	1	2	1.25	1	90,000
Machine Hours	1	1	2.5	1	80,000
<b>Production Costs per Unit:</b>					
Raw Materials (\$)	72	90	180	270	\$8,100,000
Direct Labour (\$)	48	96	60	48	\$4,320,000
<b>Overheads:</b>					
Machining (\$ per hour)	\$60	\$60	\$60	\$60	\$4,800,000
Engineering Set-ups	3	7	20	10	\$240,000
Component Receipts	20	40	240	100	\$2,400,000
Orders Packaged	10	2	20	18	\$1,800,000
Distribution Deliveries	10	10	25	20	\$1,560,000

**TABLE 6.5****Product pricing**

	PRODUCT			
	Astra	Bueno	Cisco	Delta
Direct Labour (\$)	48	96	60	48
Direct Materials (\$)	72	90	180	270
Allocated Overhead (\$)	120	240	150	120
<b>TOTAL COST (\$)</b>	<b>240</b>	<b>426</b>	<b>390</b>	<b>438</b>
Mark-Up (50%) (\$)	120	213	195	219
<b>SELLING PRICE (\$)</b>	<b>360</b>	<b>639</b>	<b>585</b>	<b>657</b>

We are required to examine the current method of establishing product costs and prices and make recommendations for an improved system. Our report should embrace a consideration of the impact on prices of alternative cost bases and of alternative methods of allocating overhead costs to products.

**CASE ANALYSIS**

The traditional products have not been performing well lately, as a result of which RAVE's profitability has been adversely affected.

**CASE STUDY (cont.)**

For the first time in its history, RAVE has experienced a downturn in profit for the second successive year. This relatively poor performance is mainly due to loss of orders.

Although the new products have exceeded management's expectation in sales performance, the sales of traditional products are apparently the greatest cause of concern.

A SWOT analysis is performed to identify the internal factors and external factors that have impact on RAVE. Detailed findings of the analysis are presented in Table 6.6. In general, the rapidly changing nature of the hi-tech electronic industry provides both opportunities and threats. RAVE excels in anticipating customer needs, but shows lack of emphasis on the revenue-generating functions of the business, with the result that, despite the superior quality of its traditional products and popularity of its new products, profits have still fallen.

However, analysis of RAVE's financial performance in Table 6.7 demonstrates the extent of the problem. The build-up of inventory because of the lost sales of Astra and Bueno products has seriously impacted on liquidity, with the quick assets ratio (QA/CL) down to a low of 0.40 from 0.88 just two years ago; the current ratio (CA/CL) shows a similar decline. The gearing ratio (TL/TA) has deteriorated over the period and has now become a matter of concern. The cash-flow issue must be addressed in order to reduce the growing liabilities. Attention to the profit ratios highlights a further cause for alarm: a decline from a relatively healthy position in 1998 which has been exacerbated by the launch of the two new

**TABLE 6.6****SWOT analysis for RAVE Holdings**

<b>Strengths</b>	<b>Weaknesses</b>
<ul style="list-style-type: none"> <li>• Respected position among market leaders</li> <li>• Ability to anticipate market needs</li> <li>• New manufacturing technologies</li> <li>• Efficient producer</li> <li>• Ability to diversify product range</li> </ul>	<ul style="list-style-type: none"> <li>• Little attention to costing/pricing strategies</li> <li>• Insensitive to market competition</li> <li>• Failure to win orders for the Astra and Bueno products</li> </ul>
<b>Opportunities</b>	<b>Threats</b>
<ul style="list-style-type: none"> <li>• Constant market demands for new products</li> <li>• Possible product upgrades</li> <li>• Diversification</li> <li>• Command instead of respond to market needs</li> <li>• Promote product quality</li> </ul>	<ul style="list-style-type: none"> <li>• Low barrier of entry to the industry</li> <li>• Short Product Life Cycle (PLC)</li> <li>• Astra and Bueno products at mature age of PLC</li> <li>• Fast competitor catch-up</li> <li>• Huge R &amp; D investments on new products</li> <li>• Price competition</li> </ul>

## CASE STUDY (cont.)

TABLE 6.7

## Financial ratio trends (1998–2000)

Year Ending	31/12/2000	31/12/1999	31/12/1998
Profitability:			
PBT/S (%)	5.3	8.1	11.1
PBT/TA (%)	3.8	5.9	9.2
Liquidity:			
CA/CL	0.58	0.67	1.05
QA/CL	0.40	0.53	0.88
Gearing:			
TL/TA	1.57	1.25	1.00

products; while the Cisco and Delta have expanded sales revenue, profits have fallen. Clearly something has gone wrong here, and the pricing methodology and associated product costing require urgent attention.

RAVE currently employs an *absorption* or *full costing* method to derive unit costs for its products. The unit costs consist of variable cost components and fixed cost components. Overheads are allocated on a DLH basis at a rate of \$120 per DLH, as explained above. A cost-plus approach has been adopted. The unit cost of each product is marked up 50% to cover selling and administration expenses and the profit.

The current costing method is *full-cost single-volume costing*, which includes sunk cost and could potentially lead to sub-optimum decision-making, especially where overheads are allocated on a DLH basis.

The Cisco and Delta products are relatively more complex and have used up more units of overheads than the mature Astra and Bueno products. However, they are not allocated higher overheads. This suggests the single-volume method using DLH as its basis is inappropriate.

The composition of total production costs for these four products, as indicated in Table 6.4, is: direct labour cost \$4,320,000, direct materials \$8,100,000, and overhead costs \$10,800,000. An analysis of the composition of production costs shows that the direct labour cost component constitutes only 18.6% of RAVE's total production costs, whereas raw materials make up 34.9% and overheads 46.5%. DLH is therefore unlikely to be the most suitable basis for RAVE's overhead allocation as it does not reflect the total cost structure. As a consequence, the high-volume products are overcosted and the low volume products are undercosted.

RAVE adopts a convenient and simplistic approach in pricing its products. It imposes a 50% mark-up across the board, which does not provide any incentive for cost reduction. This pricing approach does not recognize the necessity of considering the individual characteristics and position of each product. It is not sensitive to

**CASE STUDY (cont.)**

the market and the actions of competitors. It would be preferable were pricing determined within a marketing framework with due consideration given to the marketing mix of individual products.

The apparent overcosting of the Astra and Bueno products must hamper their competitiveness in the market. A 50% mark-up on these already overcosted products results in a market price for the products which is just too high. As a result, these products lose their competitive edge in a hostile retail environment despite their superior product quality.

The Cisco and Delta products are more successful because they are new products with good market demand, and also because they are undercosted and subsequently underpriced. It is possible that, despite the apparent success of these two products, when compared with their actual full costs, RAVE is suffering a loss on each unit of these products sold. If the marked-up prices simply do not cover their actual production costs, then this will significantly contribute to the sudden decline in RAVE's financial position.

There are clear deficiencies in the current method of establishing product prices. We need to investigate alternative means of costing and pricing the four products under consideration to embrace single- and multiple-volume methods for the allocation of overhead costs to products.

*Alternative costing methods*

The original allocation of overhead costs to products based on labour hours (alternative 1) is potentially misleading, especially since much of the overhead is incurred on a non-volume-related basis. The arguments for using DLH are unconvincing and we might initially consider the use of alternative single-volume-based methods.

Alternative 2 might be to switch from DLH to machine hours in the allocation of overhead:

$$\frac{\text{Total overhead}}{\text{Total machine hours}} = \frac{\$10,800,000}{80,000} = \$135 \text{ per machine hour.}$$

Overhead allocated to each product would then be \$135 instead of \$120 for Astra, \$135 instead of \$240 for Bueno, \$337.5 instead of \$150 for Cisco, and \$135 instead of \$120 for Delta. Thus the total costs per unit would be \$255, \$321, \$577.5 and \$453 respectively, still not adequately reflecting the range of activities. Bueno benefits from its relative labour intensity, although Cisco is penalized for its use of technology.

Alternative 3 might be to switch from DLH to raw material utilization as the basis for allocation:

$$\begin{aligned} \frac{\text{Total overhead}}{\text{Raw material volume}} &= \frac{\$10,800,000}{450,000} \\ &= \$24 \text{ per raw material component.} \end{aligned}$$

Overhead allocated to each product would then be \$96 for Astra, \$120 for Bueno, \$240 for Cisco, and \$360 for Delta, and total costs



**CASE STUDY (cont.)**

per unit would be \$216, \$306, \$480 and \$678 respectively. This method greatly benefits the old products (Astra and Bueno) but penalizes the new ones, especially Delta. We might argue that this single-volume base is more appropriate than either DLH or machine hours alone, because of the relative prominence of raw material costs to the total costs of the operation.

Alternative 4 might be to combine the three basic resources to form a multiple-volume-based allocation method comprising the extremes of the three separate measures. We thus split the total overhead of \$10,800,000 as follows. The overhead directly attributable to machining is \$4,800,000. If the remaining \$6,000,000 of overhead is attributable to raw materials and labour, then an estimate of the split between the two can be made using the production costs applicable from Table 6.4: \$8,100,000 for raw materials and \$4,320,000 for labour. Simple proportions would then give a breakdown of the remaining \$6,000,000 overhead as:

$$\frac{8.1}{12.42} \times 6,000,000 = 3,913,044$$

for raw materials and

$$\frac{4.32}{12.42} \times 6,000,000 = 2,086,956$$

for labour. Then the labour allocation rate would be

$$\frac{\$2,086,956}{90,000} = \$23.16 \text{ per DLH,}$$

the machine time allocation rate

$$\frac{\$4,800,000}{80,000} = \$60 \text{ per machine hour}$$

and the raw materials allocation rate

$$\frac{\$3,913,044}{450,000} = \$8.70 \text{ per component.}$$

This combination would give allocated overheads as follows:

	Astra	Bueno	Cisco	Delta
Labour	23.16	46.38	28.98	23.16
Machinery	60.00	60.00	150.00	60.00
Raw Materials	34.80	43.50	87.00	130.50
Total	117.96	149.88	265.98	213.66

resulting in total costs per unit of \$237.96 for Astra, \$335.88 for Bueno, \$505.98 for Cisco and \$531.66 for Delta. The Astra costings

**CASE STUDY (cont.)**

are little altered from the original, but the Cisco costings are reduced and a considerable trade-off has taken place between Bueno and Delta, reflecting the 'raw material' penalty to which these products are subject.

The three new alternatives highlight the differences in product costs consequent upon the adoption of different bases. But none of them is obviously 'right'; we might argue, for example, that alternative 3 over-emphasizes machine costs and gives an insufficient allocation to raw material components. All of the methods considered thus far ignore non-volume-related alternatives.

Alternative 5 adopts a more radical activity-based approach, eliminating DLH as an allocation base altogether and directing attention to five overhead components.

We might allocate the whole of the overhead on the basis of a single allocation base (cost driver) – that is, for machinery, set-ups, receipts, packaging and distribution separately, as we did for the three resources above. But it is probably more appropriate to allocate each additional component of the overhead in accordance with the weighting attributed it:

$$\begin{aligned}\text{Cost per set-up} &= \frac{\$240,000}{40} = \$6000, \\ \text{Cost per receipt} &= \frac{\$2400,000}{400} = \$6000, \\ \text{Cost per package} &= \frac{\$1,800,000}{50} = \$36,000, \\ \text{Cost per delivery} &= \frac{\$1,560,000}{65} = \$24,000.\end{aligned}$$

The resultant allocation by activity is shown in Table 6.8. Reallocating the activity costs to products on the basis of the cost (see the final row of Table 6.8) gives total costs of \$204.60 for Astra,

**TABLE 6.8****Cost allocation for four products**

	Astra	Bueno	Cisco	Delta	Total
Machinery	1,800,000	1,200,000	1,200,000	600,000	4,800,000
Set-ups	18,000	42,000	120,000	60,000	240,000
Receipts	120,000	240,000	1,440,000	600,000	2,400,000
Packaging	360,000	72,000	720,000	648,000	1,800,000
Delivery	240,000	240,000	600,000	480,000	1,560,000
<b>Total</b>	<b>2,538,000</b>	<b>1,794,000</b>	<b>4,080,000</b>	<b>2,388,000</b>	<b>10,800,000</b>
No. of units of output	30,000	20,000	8,000	10,000	68,000
Costs per unit	84.60	89.70	510.00	238.80	

## CASE STUDY (cont.)

TABLE 6.9

## Effect of alternative overhead allocation bases on product costs

Overhead Allocation basis	Product costs (\$)			
	Astra	Bueno	Cisco	Delta
<i>Single-Volume:</i>				
1 Direct labour hours	240	426	390	438
2 Machine hours	255	321	577.50	453
3 Raw materials	216	306	480	678
<i>Multiple-Volume:</i>				
4 Labour/Machinery/ Materials	237.96	335.8	505.98	531.66
<i>Multiple Non-Volume:</i>				
5 Machine time/Set-ups/ Receipts/Packaging/ Delivery	204.60	275.70	750.00	556.80

\$275.70 for Bueno, \$750.00 for Cisco and \$556.80 for Delta, and selling prices, based on a 50% mark-up, of \$306.90, \$413.55, \$1125.00 and \$835.20 respectively.

The differences from our original costing/pricing combination apparent from Table 6.9 are startling. The variations in the non-volume-related costs favour the traditional products (Astra and Bueno) and penalize the new ones, suggesting that Cisco and Delta products are vastly undercosted (and underpriced) when DLH is the only consideration.

The returns on costs from the 'old' products, Astra and Bueno, are excellent at 76% and 132% per unit. But they are too high, because they disguise a selling price per unit which is hitting sales revenue hard because too few units are being sold. The markets for these products are extremely price-sensitive, so that price reductions (though perhaps not to the extent suggested by the analysis of alternative 5: \$53 per unit and \$225 per unit, respectively) will increase sales volume and probably sales revenue.

Table 6.10 demonstrates that the 'successful' launch of the two new products is indeed a myth: Cisco is not covering its product costs, and Delta is making only a modest contribution to profits. Such low prices may have been justified on market penetration arguments, but they are unsustainable in the long term. The analysis of alternative 5 suggests that price increases of \$540 per unit and \$178 per unit are required; clearly these are impossible to achieve in the short term. Of most concern, Cisco needs to generate an additional \$165 per unit just to cover its production costs.

The logical extension of Table 6.10 highlights more problems for RAVE Holdings. Table 6.11 shows that Cisco is contributing an annual loss of approximately \$15.8 million, but even so the four products

**CASE STUDY (cont.)****TABLE 6.10****Product profitability at RAVE Holdings**

	Astra	Bueno	Cisco	Delta
Current Price per unit (\$)	360	639	585	657
Product Cost per Unit suggested by activity analysis (\$)	204.60	275.70	750	556.80
Contribution per unit (\$)	155.40	363.30	(165)	100.20
Return on Costs (%)	76	132	(22)	18
Revised Selling Price (ALT.5)	307	414	1125	835

**TABLE 6.11****Contributions to profitability in 2000**

	Astra	Bueno	Cisco	Delta
Contribution per unit (\$)	155.40	363.30	(165)	100.20
Units sold per month (2000)	20,000	15,000	8,000	10,000
Average Monthly Contribution to Profit (\$000)	3,108	5,449	(1320)	1,002
Annual Contribution to Profit (\$000)	37,296	65,394	(15,840)	12,024
Total Contribution (\$000)	98,874			
Reported Profit before Tax (\$000)	17,680			

together contribute nearly \$99 million annually to corporate profits. Yet reported profit before tax is less than \$18 million, suggesting that RAVE Holdings must urgently pay more attention to its selling and distribution expenses and the costs of product development.

**Alternative pricing methods**

Establishing the most appropriate costing method to be employed is only one of the priorities. The appropriate pricing method to be used has a direct impact on the profitability of individual products, and thus the overall bottom line of the company. RAVE's 50% across the board mark-up pricing method is too cost-oriented, inflexible and not sensitive to market and external factors. A more sensitive, 'outward-looking' method is required.

One alternative would be to base the pricing on the nature of individual products. For instance, the Astra and Bueno products are in the mature stage of their product life cycle, a stage characterized by keen price competition. Although the products are of superior quality and product differentiation is possible, there is little scope

**CASE STUDY (cont.)**

for non-price competition. The only way to excel in this market is to drive prices down in order to compete on a price basis. Reference to variable costs is essential in making strategic pricing decisions for these products. As long as the prices are sufficient to cover the variable cost, RAVE can maintain the low price policy in the market and win orders. By doing so, the profit derived could contribute to the recovery of fixed costs. Continued production of these products could utilize the investment in production line by reducing the slack in manufacturing capacity.

On the other hand, the Cisco and Delta products have been exceptionally successful since their launch in terms of number of units sold. This is largely attributable to their being undercosted and subsequently under-priced. For the Cisco even the existing 50% mark up on DLH cost does not cover actual manufacturing costs so that RAVE is suffering a loss on this product and a minimal profit on the Delta. These two products are at the growth stage of the product life cycle, and the company might have derived a better profit performance from them. For new products RAVE might have adopted a cost-plus approach, with a variable mark-up to a level that the market can bear. This approach is market-sensitive, and maximizes return on investment in new products.

In practice, several factors must be considered to derive effective market-driven pricing strategies. Among the internal factors are the following:

- Pricing policies should align with the company's corporate goals and marketing objectives. Different strategies could be formulated for different objectives, be they profit maximization, increased market share or product images.
- Pricing strategies should be formulated in conjunction with the market mix of the products. A market skimming strategy would suggest a high price, whereas a market penetration strategy might suggest a lower price.
- Cost is a significant factor in any pricing decision, with different costing approaches impacting on the market prices of products.
- Organizational factors should be considered in establishing product prices. For example, it would be difficult for RAVE to promote high-quality, high-price products if the company were known in the market as a cheap product provider.

The external factors are as follows:

- A detailed assessment should be made of market demand and product price elasticity in order to establish a realistic pricing approach for individual products.
- Market intelligence is an important aspect of market competition, and information gained from competitors should be used in setting product prices in order to maintain a competitive position in the market, and to be aware of likely competitor reaction.
- The condition of the economy should be considered in setting product prices. Consumers may be able to afford higher prices in

**CASE STUDY (cont.)**

boom time, but they tend to be more careful of their spending during a recession.

- Government may impose restrictions in price setting in order to protect the industry as a whole. Such regulations should be examined carefully when setting product prices.

**RECOMMENDATIONS**

RAVE should assess its position in the market and establish long-term and short-term corporate goals. This is important for the company's long-term development and allows the formulation of congruent short-term and long-term strategies.

- For the traditional products, Astra and Bueno, a reduction of product prices should be implemented as soon as possible to contain the loss of market share. A target costing approach might be adopted to regain competitiveness. Competitive prices should be determined from market intelligence to facilitate successful tender bidding.
- In future, RAVE should consider adopting activity-based costing as the basis of new product costings. Where possible, RAVE should establish itself as price leader for its new products, setting a price close to what the market will bear.
- As for the two new products, prices below cost have already been established in the market. Therefore, it is necessary to increase the product prices in order to return to profit for these two products. However, the market is not able to absorb a sudden surge in prices, which could turn away potential customers or create an unfavourable image of the company. Sales volume is likely to drop as a result. Therefore, RAVE should offer and promote product enhancements as far as possible and take the opportunity to adjust the prices. A phased enhancement programme might be implemented and prices adjusted upwards on a gradual basis.

Thus, for Cisco, RAVE might promote enhancements in product reliability, picture and audio quality, while the further inclusion of a digital decoder might justify modest price increases. For Delta, enhanced picture quality functions, multiple-disc facilities and a 'karaoke' function might be added at a modest investment cost, to justify a price hike.

**CONCLUSIONS**

The case of RAVE illustrates the importance of costing and pricing policies to the revenue and thus the profitability of a company. Costing policies should best reflect the cost structure of products, and correspond with the corporate goals of the company. Allocation of overhead costs results in cross-subsidization among the products, and the basis of allocation should support the company's marketing strategies.

Apart from the costing and pricing issues, other issues should also be considered in view of the company's long-term development

**CASE STUDY (cont.)**

and growth. The costing system should be regarded as a component of the company's management information system. Internal costing information, production capacity and efficiency, together with external market and competitor information, should all be utilized for corporate decision-making.

**TARGET COSTING**

Target costing is a simple idea with potentially powerful cost-reduction capabilities. Its adoption has spread from Japanese companies (e.g., Sakurai, 1989; Tanaka, 1993) to manufacturing operations in Europe, the USA and Australia. The major objective of the tool is cost reduction, but the focus is moved from the production stage to the planning and design stages. The ultimate aim is to explain 100% of product costs at the initial planning stages and then to implement tools which reduce their incidence, particularly through the control of design specification. Target costing therefore moves away from standard costing and towards management and engineering.

It may be defined as:

**a comprehensive program to reduce costs, which begins even before there are any plans for new products. It is an activity which is aimed at reducing the life-cycle costs of new products, while ensuring quality, reliability and other consumer requirements, by examining all possible ideas for cost reduction at the product planning, research and development and prototyping phases of production. (Kato et al., 1995: 39)**

This definition recognizes that most product costs are committed through decisions made at the planning and pre-production stages. Philosophies such as total quality control (TQC) and kaizen, which focus on continuous improvement, once production has already commenced, can only address a relatively small proportion of total costs (perhaps as low as 5%). Cost-cutting post-implementation therefore has a very restricted scope compared to the potential savings that might be made in the planning stages. Target costing shifts the focus to the determination of an acceptable level of costs, consistent with both corporate profit requirements and customer price expectations, so that:

$$\text{Target cost} = \text{Target price} - \text{Target profit.}$$

These costs are those necessary for surviving in a global market, since 'price' is essentially determined by the competition, and 'profit' set at a level determined by wider corporate requirements. Once price and profit targets have determined a target cost, management must act to 'fill the cost gap' by designing the product so that costs can be reduced appropriately.

The management accountant plays an important role in this process by providing cost estimates and by investigating cost behaviour relationships for the different activities involved. Activity analysis is an important aspect of this work too, in order to specify cycle time. The achievements of the target costing approach in practice have been impressive: cost reductions of the order of 30–50% without loss of quality, reliability or increasing time to market. These successes have been confined to mass manufacturing industry (most notably the motor industry) and as yet there is no evidence of the successful implementation of target costing in process industry.

Customer focus is paramount in the procedure, in that products must be of high quality and must satisfy customer needs, but beyond that target costs are set early on in the specification stage.

Targets are attained through:

- value-engineering customer-required functions;
- the use of standard costs at the production stage; and
- the search for continuous improvement throughout.

There is a downside to the implementation of target costing. A trade-off must be achieved between cost cutting and customer-oriented product development: costs may be reduced by reducing the number of product varieties, for example, while additional new products may attract customers without necessarily increasing profits. Supplier fatigue and dissatisfaction are inevitable, since if manufacturers have difficulty in identifying inefficiencies they will put even greater pressure on suppliers to cut costs. Design engineers will face similar pressures in that a cost focus may reduce motivation because innovative flair is less rewarding. Internal organizational conflict is inevitable too, as target costing seeks to change the corporate culture with a mindset that combines minimum cost with customer preference; resistance and manipulation will be apparent much the same as is observed with TQM implementations. In the medium-term the effects of this can be overcome with training, documentation (in the form of target costing manuals) and the encouragement of employee creativity in diffusing target costing techniques down the organization.

Ramesh and Woods (1996) detail some of the design changes that the big motor manufacturers are making, to save millions of dollars by eliminating little-noticed non-essential items from their specifications.

- Ford reduced the range of its horn tones from 37 to 3 in number, and saves \$0.40 per car by not painting the inside of the ashtray.
- Toyota no longer uses a white cigarette symbol on the lighters of some models.
- Mercedes dropped the spring-loading from the ashtrays on its E-class sedans, and replaced the oil pressure gauge with a warning light.
- Honda replaced the electric aerial on its Civic coupé with a manual one.
- Rover introduced generous employee incentives for those who can identify cost-cutting opportunities which do not perceptibly change the look of the car.

Although these changes to specifications reap cost savings for manufacturers, they also provide the opportunity for the introduction of innovations (e.g., airbags, air-conditioning) which target customer preferences through competitive diversifications.



## ACTIVITY-BASED MANAGEMENT

The limitations of ABC discussed earlier mean that we must recognize that it is not a holy grail nor a universal panacea for management ills. We are *management* accountants, not just *cost* accountants; while ABC is a useful starting point, we must not be blinkered by the vested interests involved in its marketing. There are other, arguably more important, aspects which must be considered too.

All the evidence suggests that it will be impossible to eliminate arbitrary allocations of overhead totally, even under an ABC system, so perhaps we should be looking beyond product costing to a more appropriate emphasis on process management.

The key to the extension of ABC into activity-based management (ABM) is a wider appreciation of the concept of 'drivers'. We can no longer focus on cost drivers alone, but must investigate the manner in which resources are consumed in non-monetary areas. Current research suggests that customers have perceived needs in four areas, all of which must be satisfied simultaneously: lower costs, higher quality, faster response times and greater innovation. Management information systems must therefore embrace drivers across each of the areas shown in Table 6.12, focusing on all without giving undue emphasis to one. Let us consider the four elements of competition, in each case referencing appropriate activity drivers. Smith (1990), referred to in Chapter 8, surveys the range of NFIs in use in manufacturing and service industry. This approach can be adapted to give an indication of the type of non-financials that would be useful in each of our four areas.

### Costs

The scope of ABC applications and implementations must be extended in both directions from traditional process activities to:

- a reappraisal of traditionally fixed costs, so that costs might be classified as product- or process-sustaining, allowing increased tracing of cost to product;
- a consideration of white-collar service areas traditionally consigned to the 'too-hard' basket; and
- the adoption of radical cost reduction strategies, such as business process re-engineering (BPR).

Table 6.13 lists a number of useful non-financial measures of costs.

TABLE 6.12

#### The drivers of ABM

Customer needs	Drivers
Cost	Cost behaviour and distribution
Quality	Factors inhibiting improved performance
Time	Bottlenecks and inertia
Innovation	New product and process inflexibility

TABLE 6.13

**Non-financial measures of cost**

Area	Measure
Quantity of raw material	Actual v. target number inputs
Equipment productivity	Actual v. standard units
Maintenance efforts	No. of production units lost through maintenance; no. of production units lost through failure; no. of failures prior to schedule
Overtime costs	Overtime hours/total hours
Product complexity	No. of component parts
Quantity of output	Actual v. target completion
Product obsolescence	Percentage shrinkage
Employees	Percentage staff turnover
Employee productivity	Direct labour hours per unit
Customer focus	Percentage calls; percentage claims

**Business process re-engineering**

Business process re-engineering is a radical technique designed to encourage radical organizational change – frequently by starting from scratch and attempting to rebuild the organization from the bottom up.

Hammer and Stanton (1995: 3) define re-engineering as ‘the fundamental rethinking and radical redesign of business processes to bring about dramatic improvements in performance’. Unfortunately, the implementation of re-engineering has been clouded by the interpretation of the Hammer and Champy (1993) definition of the technique which focuses on short-term profit through a blinkered commitment to cost-reduction programmes where ‘head-count’ is the measure which features most appropriately. Radical redesign to create breakthrough performance means cost-cutting and rapid downsizing; employees may be retrenched, but the volume of work remains the same.

In practice this will be a short-term expedient; as Mumford and Hendricks (1996) point out, BPR results in companies becoming ‘lean and lame’ rather than ‘lean and mean’, with negative effects on both profitability and future vitality. Short-termism with respect to issues, contracts and management behaviour will produce an alienated workforce, working longer hours under greater stress, and no longer able to identify with the long-term goals of their employer.

Eisenberg (1997) details the negative impact that BPR will have on the competitiveness of the organization by discouraging both innovation and risk-taking. When downsizing is employed without reference to a clearly articulated vision of the future:

- teamwork will deteriorate, because more is expected of those that remain;
- delays will take place in decision-making for fear of making an error;
- support functions, always the most vulnerable to retrenchment, will be crippled;
- conditions of anger and anxiety will cause decreased creativity, and lost opportunities from lost incentives to contribute;
- caution and protective attitudes will predominate, to preserve the employment of those who remain.

Eisenberg despairs that companies continue to repeat the mistakes of the past, making major errors when dealing with rapid change because too little time is devoted to assessing critical success factors and learning from historical precedent. He highlights the damaging impact of BPR and rapid downsizing on organizational morale and performance, citing numerous examples of BPR failure, and makes a plea for enlightened decision-making in the pursuit of long-term economic performance fully utilizing the intellectual capital of the organization.

Adopting a more positive perspective, Booth (1995) looks upon BPR as a means of identifying and prioritizing the key processes within any organization so that they can be grouped into one of four categories:

- supply chain management – defining customer requirements from order to despatch and specifying delivery and scheduling operations, capacity management, supply procurement and inventory supervision;
- customer development – acquisition, maintenance and the management of customer profitability;
- business development – product planning, brand management and product/service development;
- business maintenance – attention to activities which may not be directly value-adding, but which must be undertaken for the organization to continue (e.g., human resource management, financial management, infrastructure maintenance).

Process mapping specifies the linkages between the major processes of a typical company and aids an understanding of the interrelationships; activity mapping can locate the activities within each of these processes and highlight errors and omissions. However, the decomposition of processes and activities may not identify conditional paths. Ideally process modelling should:

- help to eliminate duplicated or redundant activities;
- avoid unnecessary data collection;
- simplify the process by avoiding unnecessary decision points;
- offer opportunities for moving from a serial process to a parallel process (with consequent lead time reduction, better due date performance and the elimination of duplication);
- achieve economies of scale by combining currently separate operations; and
- help to avoid unnecessary product movement and data transfer.

## Quality

The cost of quality is a potentially important component of management accounting systems which may facilitate the implementation of total quality management. The classification of quality costs is useful in order to allow a closer examination of the drivers of quality:

- 1 *Prevention costs*. These include the costs of plant, product and process planning, preventive maintenance, training and the implementation of statistical process control systems.
- 2 *Appraisal costs*. These include the costs of inspection and testing of both incoming and outgoing materials, and the cost of maintaining and

administering appraisal systems and equipment.

3 *Failure costs.* ‘Failure’ here embraces both the internal and external aspects of operations. Failure costs thus include:

- (a) at the internal level, the costs of scrap, rework, redesign and safety stocks necessary to provide a buffer against such failure; and
- (b) at the external level, the cost of repairs, customer returns, warranty claims, investigations and losses associated with customers, good will and reputation.

Measurement and analysis of the costs of external failure is increasingly becoming the focus of attention in this area, reflecting the renewed customer orientation of management accounting.

Table 6.14 lists a number of useful non-financial measures of quality.

### Time

Surveys of manufacturing executives in large, successful companies in Europe, the USA and Japan consistently rank three time-based characteristics among their top five competitive priorities: dependable delivery, fast delivery, and rapid design changes. A time-based focus has a number of positive implications for the management accountant in designing improved management information systems which:

- ensure that our decision-making is linked to an appropriate time horizon by matching short-run and long-run costs with decisions which have corresponding time implications;
- reduce new product lead time by halving planning and engineering lead times for manufacturing operations – the amount of process time is often less than 10% of the total manufacturing lead time for many organizations, with the remaining 90% adding costs but not value;
- monitor customer feedback regarding the reliability of delivery and develop new indicators to measure delivery and distribution performance;

**TABLE 6.14**

**Non-financial measures of quality**

Area	Measure
Quality of purchased components	Zero defects
Equipment failure	Downtime/total time
Maintenance effort	Breakdown maintenance/total maintenance
Waste	Percentage defects; percentage scrap; percentage rework
Quality of output	Percentage yield
Safety	Serious industrial injury rate
Reliability	Percentage warranty claims
Quality commitment	Percentage dependence on post inspection; percentage conformance to quality standards
Employee morale	Percentage absenteeism
Leadership impact	Percentage cancelled meetings
Customer awareness	Percentage repeat orders; number of complaints

- focus on product cycle time and use throughput time as a measure of performance; and
- focus on bottlenecks in the production or service processes with a more appropriate emphasis on activities which alleviate bottlenecks.

The focus on throughput time and bottlenecks highlights the question of capacity and constraints in the production or service process. Capacity, and the associated availability of services to meet demand, may require management science techniques such as queuing theory to determine acceptable delays and appropriate provisions. Constraints require the identification of bottlenecks, together with stringent efforts to increase their efficiency and, potentially, inventory build-ups to ensure that idle time at the bottlenecks is avoided. The issue of interdependent events suggests that the use of productivity and utilization performance measures among non-bottleneck activities is pointless. Further, we may have to tolerate, or even encourage, idle time for these activities in order to prevent the build-up of unnecessary inventory.

Table 6.15 lists a number of non-financial measures which might prove useful in the analysis of time-related factors. The 'time' dimension of ABM has become such an important feature that a separate section is devoted to its operational aspects later, and to the theory of constraints here.

### Theory of constraints

Goldratt and Cox (1986) developed the theory of constraints (TOC) as a technique to increase sales, and reduce inventory, by focusing on production scheduling. TOC is a consequence of criticism of the negative consequences of a cost focus in management accounting, particularly:

- the neglect of sales and operating costs by focusing totally on overheads;
- the neglect of throughput and optimum profitability by focusing on lowest cost per unit; and
- overproduction and the build-up of unnecessary inventory resulting from a focus on equipment efficiency.

TOC focuses on bottlenecks, targeting the single most binding constraint in the production process for action. Improved efficiencies elsewhere in the production process are deemed a waste of time and money, since they serve merely to build up queues and inventory in front of the bottlenecks. The focus on throughput, and increasing profitability by

**TABLE 6.15**

#### Non-financial measures of time

Area	Measure
Equipment failure	Time between failures
Maintenance effort	Time spent on repeat work
Throughput	Processing time/total time per unit
Production flexibility	Set-up time
Availability	Percentage stockouts
Labour effectiveness	Standard hours achieved/total hours worked
Customer impact	No. of overdue deliveries; mean delivery delay

generating more sales revenue per period, necessitates an appreciation of the interdependence of process events and the random fluctuations evident in processing times. Although 'breaking' a bottleneck involves additional equipment expenditure, increasing cost per unit, more finished product passes through the production process per period, allowing more to be sold. The 'drum-buffer-rope' mechanism is central to the Goldratt and Cox methodology, where the 'drum' is the constraint which governs the pace of production, the 'buffer' protects that binding constraint from disruption from other causes, and the 'rope' signals the release of materials.

Blackstone (2001) argues for closer communication between production and marketing departments. Awareness of the differences in 'throughput dollars per constraint' between products should allow salesmen to shift the focus away from products with the highest selling prices, or highest contribution margins, since these factors may not determine the optimum short-term product mix in practice.

The focus of throughput implementations is normally on the reduction of manufacturing cycle times – that is recognition that improving efficiencies in non-critical activities will not impact on overall throughput. Its impact is, therefore, necessarily short-term in nature. However, a number of authors (e.g., Carter and Hendrick, 1997; Chen and Kleiner, 2001; Buzby et al., 2002) emphasize that this oversimplifies the situation. They suggest that manufacturing cycle times may account for a very small proportion of total job flow time, and that the time spent in processing the customer purchase order will frequently exceed the product manufacturing time. They highlight that the next area of focus must be on the services which support manufacturing and an analysis of the links between cycle time and financial performance.

Consider, for example, the following case study, adapted from Darlington et al. (1992) Garrett Automotive illustration.

## CASE STUDY

### Orion Signalling: A TOC case study

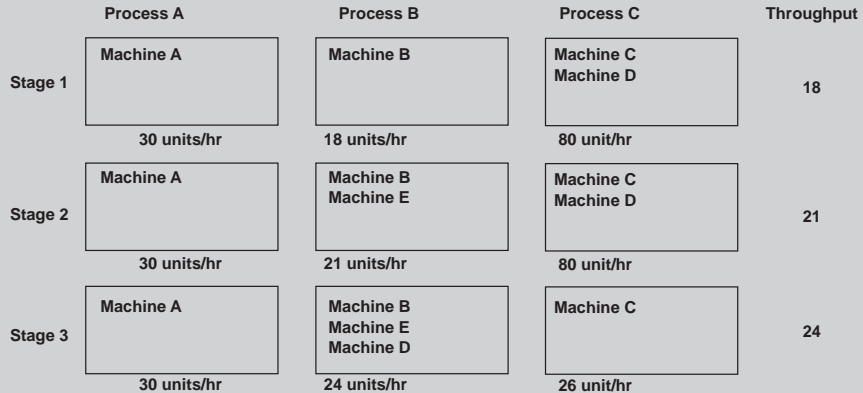
Orion operates a manufacturing process with three sequential processes: A,B,C. Units of product pass through each of the processes where they are engineered by machines A, B, and either C or D. The current (stage 1) production flow is illustrated in Figure 6.5. Each process operates with a target schedule adherence of 80%. The plant operates a 125-hour week at 90% utilization (i.e., 112.5 usable hours). Weekly output is 2025 units. The bottleneck in process B restricts the total throughput to only 18 units per hour, even though process A and process C have the capacity to deal with many more (30 units/hour and 80 units/hour, respectively). The management at Orion wants to break the bottleneck in process B and increase the throughput.

### CASE ANALYSIS

At stage 2 Orion invests in a new piece of equipment (machine E) at a cost of £6000 to relieve the pressure in process B. As a result a

## CASE STUDY (cont.)

FIGURE 6.5

**Throughput at Orion Signalling**

throughput of 21 units per hour can be achieved. At stage 3 Orion adapts a piece of machinery currently in use in process C (a non-bottleneck activity) at a cost of £2000 to increase the throughput further, even though process C will operate less efficiently. As a result a throughput of 24 units per hour can be achieved, and although process B remains the production bottleneck, process C is now a constraint on further improvements.

The changes in the production system mean that 2362 units are processed at stage 2 and 2700 units at stage 3. The increased throughput will have an immediate impact on cash flows as long as it is sold and not consigned to finished goods inventory.

The marginal cost per unit will be higher than at stage 1:

- £6000 invested to secure an additional 337 units per week throughput;
- £8000 invested to secure an additional 675 units per week throughput in total.

The whole process at stage 3 may appear less efficient in cost per unit terms than it did at stage 1. But manufacturing efficiency is measured to include unwanted units, those produced for inventory; throughput focuses on making the most of capacity to produce

**CASE STUDY (cont.)**

immediate sales. The interdependence of the process makes schedule adherence paramount. Orion must produce:

- the right amount;
- the right mix of components;
- on time.

Even so, with 80% schedule adherence in each of three consecutive processes the customer may only expect 51.2% adherence (i.e.,  $0.8 \times 0.8 \times 0.8$ ). Unscheduled production, in either quantity or mix is, therefore, potentially very disruptive.

There will be problems in implementing a bottleneck-breaking scheme like Orion's, when it is used simultaneously with a policy of eliminating inventory (except for buffers in front of bottleneck process B):

- It may become more difficult to identify bottlenecks in the future, especially as processes become more complex.
- Inventory reductions will give a one-off profit reduction.
- Reduced inventories will highlight new problems, most seriously those associated with suppliers unable to meet delivery schedules.
- Corporate culture must change by learning to accept the existence of idle time at non-bottleneck activities.

**Innovation**

'Innovation' may include pure and applied research, developmental applications, new product development, operational and process development and cost reduction techniques. Innovation is essential to the long-term survival of an enterprise and to the maintenance of its market share and competitive advantage. The uncertainty associated with innovation may make traditional management accounting systems inappropriate for a variety of reasons. Such systems may:

- focus on short-term financial performance, so having an adverse effect on products or processes at the early stages of their life cycle;
- use measurement indicators which, while suitable for mature products and processes, emphasize cost minimization to an extent unsuitable for new methods; and
- judge management performance on the basis of a manager's success in implementing cost-reduction strategies, with deleterious consequences on creativity and innovation.

These problems suggest the need for non-financial indicators which reflect the special requirements of innovation, including the ability to



introduce new products, the flexibility to accommodate change, and a reputation for leading-edge operations. The special requirements of innovation necessitate the development of a new range of NFLs (Table 6.16).

The overlapping of the requirements and corresponding measures of cost, quality, time and innovation is inevitable, as is shown by the development of new accounting measures to monitor the effectiveness of companies in bringing new products to the market promptly. We might speculate that new product strategies will focus on the cost of lead times in bringing new product concepts to the market, in conjunction with the time taken to recover research and development and marketing expenditures from the projected sales of a quality product.

Existing measures of throughput are weak (see Waldron and Galloway, 1988) and demand more attention. Horngren et al. (1994) detail the break-even time (BET) measure developed by Hewlett Packard to measure market lead times and industry leadership. BET, a variation of the discounted payback procedure, measures the time which elapses between the initiation of a project and the time when the implemented project breaks even for the first time, that is, when the cumulative present value of cash inflows equals the cumulative present value of total cash outflows.

Shorter break-even periods, and lower BET values promote earlier sales revenue consistent with reduced product-to-market times. This accelerated product development also acts as an innovation indicator contributing to the company's competitive advantage.

BET therefore provides a dual indicator of lead time and innovation, and a potentially powerful measure. Innovation measures are often difficult to cite, partly because of difficulties associated with definitions of innovation. In practice, real-world problems often involve simultaneous concerns about costs, throughput and innovation.

Common issues in the implementation of each of the cost, quality, time and innovation strands of ABM are:

- the considerable demands on the time of those involved, necessitating widespread co-operation and total organizational involvement;
- the need for a commitment to change which must come from the top, especially if an unreceptive corporate culture needs to be overcome – an

TABLE 6.16

**Non-financial measures of innovation**

Area	Measure
Ability to introduce new products	Percentage product obsolescence; no. of new products launched; no. of patents secured; time to launch new products
Flexibility to accommodate change	No. of new processes implemented; no. of new process modifications
Reputation for innovation	Media recognition for leadership; expert assessment of competence; demonstrable competitive advantage

awareness that improvements are possible in the way in which we operate is a good starting point;

- the need for appropriate kinds of documentation and data which will, most likely, not exist, so that key drivers and non-financial indicators need to be determined and measured; and
- the need to identify cause and effect carefully with an eye to potentially damaging organizational and behavioural consequences.

Doubts have been expressed about the costs of changing to ABC and ABM systems, especially since studies to suggest that they generate sufficiently large bottom-line improvements in profitability are rare. There have still been far too few documented instances of success which take into account both the problems of implementation and the wider implications of an ABM environment.

## **INNOVATION AND THE ACTIVITY-BASED MANAGEMENT TRADE-OFF**

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Given the perceived needs of customers in terms of cost, quality, time and innovation, management accounting information systems must address drivers in each of these areas (see Table 6.12). Cost, quality and time have received much attention in the management accounting literature, innovation very little. The balanced scorecard (Kaplan and Norton, 1992, 1993, 1996, 2004) has raised the profile of innovation, and the factors driving innovation, by emphasizing new goals (new products and processes, technological advantage, manufacturing learning) and new performance measures (time to market, time to develop innovations, process time to maturity).

The focus on cost, quality and time has generated a plethora of management changes with significant accounting implications: activity analysis, ABC and BPR, where the accent is on cost, continuous improvement and TQM, where the concern is with quality; and JIT, throughput and TOC, where time is of interest. But it may not be possible to pursue innovation as a key success factor while simultaneously tackling the other three areas with the above tools. There may need to be a significant trade-off because of the conflicting cultures involved. Let us consider each in turn.

### **Cost**

Traditional performance indicators and costing methodologies developed for mature products and processes may be unsuitable for new developments. Activity-based costing could be the enemy of product diversification. By burdening low-volume new products with punitive levels of overhead, ABC threatens the opportunities for successful innovation.

Where management performance is judged on success in the implementation of cost-reduction strategies, the long-run consequences for innovation and creativity could be devastating. Cost-reduction programmes based on drastically cutting head count may have a deleterious long-term effect because of the loss of skills and morale.

## Quality

Possible cost–quality trade-offs are readily apparent where cost reduction strategies (and the short term) are seen to have greater priority than quality (and the long term). Eskildson (1995) notes that successful turnarounds are rarely, if ever, accomplished through numerous incremental improvements, and that the fundamental reasons underlying downturns are not quality, but high costs, excess debt, strategic errors and inventory control problems. He notes the many companies and divisions in the USA which have received the prestigious Malcolm Baldrige National Quality Award and have subsequently:

- failed;
- scaled back operations;
- downsized in quality management departments, because programme costs outweighed benefits;
- replaced their chairman because of substantial and sustained corporate losses; or
- expressed disillusionment with TQM.

Harari (1997) suggests ten reasons why TQM methods have failed business:

- The focus is on internal processes and not external results, so that forward-looking, customer-oriented improvements are subjugated by attention to current procedures. He notes that 'before we invested in TQM we turned out poorly made products that customers didn't want; now, after TQM, things have changed; we turn out well-made products that customers don't want'.
- The focus is on minimum standards – but zero defects is no longer enough; there needs to be an 'excitement' factor which generates customer preference. Quality alone may be losing its role as a differentiator between the top companies, with innovation growing in importance to take its place.
- TQM is much too bureaucratic. Involvement in a TQM implementation employing Deming's (1986) 14-stage procedure (or similar) can be a very frustrating experience. The sequence of painful meetings designed to progress from stage 2 to stage 4, say, is often too much for the participants; they start to vote with their feet or arrange other meetings which 'accidentally' coincide with the TQM timetable. Continuous improvement has its appeal, but even the mention of the TQM acronym may be sufficient to raise the barriers and the hackles.
- Quality cannot be delegated. Where quality becomes the domain of a 'champion' and does not receive support from the chief executive sufficient to ensure commitment, ownership, identification and involvement from all, then it is doomed to failure. Quality must become a normal part of everyone's job, at all levels, if it is to stand a chance of success.
- Radical organizational reform is rarely addressed, and the focus throughout is on small incremental changes. TQM is 'orderly, sequential, linear and predictable, while real quality emerges from a chaotic, disruptive, emotional process that tears the organization apart and then rebuilds it from the bottom up'.

- TQM is divorced from issues of management compensation. In traditional TQM schemes there is no link between quality achievements and reward systems, merely an appeal to the self-motivation of the individual. More realistically firms implementing TQM have adopted ingenious schemes to reward and encourage participation. For example, the awarding of 'points' to the participants of TQM teams based on the impact of a successful implementation; at year's end these points are aggregated and team members can use their points to buy items from a catalogue as a quasi-financial reward in a manner similar to airline frequent flyer schemes.
- TQM ignores the value chain and relationships with outside partners. Symptomatic of the internal navel-gazing, the focus on small improvements and blinkered value-adding may be losing sight of the long-term big picture and the interdependencies of modern business.
- TQM appeals to quick fixes with the minimum of confrontation, because it is often associated with small, even trivial, instances of change. Though the bureaucracy of the scheme is designed to slow the decision-making process down, to eliminate quick fixes, it may also constrain the generation of innovative alternatives because of the desire for a satisfactory short-term solution.
- TQM drains entrepreneurship and innovation from the corporate culture. Obsession with internal processes, the standardization and routinizing of internal procedures so that there is a single, acceptable 'right way', may slow down the development of path-breaking innovations. The 'do it right first time' stricture may be a dangerous long-term policy if it impairs organizational entrepreneurship and innovation. The paradox is one of TQM pursuing continuous improvement and zero defects with what it already has, while the organization needs to encourage risks and tolerate errors to create something new.
- TQM lacks excitement. It has become unemotional, detached and mechanical and may potentially facilitate the development of a matching corporate culture. Where the new challenge is to create an innovation culture within an organization to sustain high value-added operations in a global economy, then successful players are unlikely to have a TQM orientation.

If the conflict between TQM and innovation in the quality arena is apparent, does BPR fare any better? Some authors suggest that TQM and BPR can co-exist happily within most organizations, with continuous improvements taking place between radical changes, with both emphasizing customer focus, teamwork and empowerment. An alternative view suggests that morale among the survivors of BPR is so terminally damaged that the incentive to involve themselves in TQM is destroyed.

This alternative view is more widely accepted. Siew and Boon (1996) warn that the abandonment of traditional management control functions, like segregation of duties, in a BPR environment, may mean that by ignoring critical risks such systems will fail. With compression of responsibilities, empowerment of the workforce, reliance on external partnerships and reductions in checks and controls there will be fewer opportunities to control individuals and more reliance on self-management. In such an environment the development of an innovation culture may be difficult, and serious doubts arise about the compatibility of TQM and BPR.

## Time

Improvement techniques such as JIT attempt to squeeze all of the variation out of a process so that there are fewer surprises. A rigid system pursuing a single 'right way' is unlikely to reinforce risk-taking, innovation and entrepreneurship. Interdependence of events means that normal variations in time and quality for sequential operations will reduce the overall rate of throughput below that of the slowest operation. Simplifications, standardization, conformity and adherence, terms all commonly linked with JIT, are not the words one would normally associate with an innovation culture.

The throughput approach, with its emphasis on those completed products actually sold, is more cash- than profit-based; it seeks to focus on the rate at which a product contributes money in an undeniably short-term manner. By focusing on bottleneck constraints and ignoring other binding constraints until they become bottlenecks, a tightly targeted approach for investment is enforced. This may encourage innovation in the short term by facilitating the search for alternative solutions to the bottleneck creating problem; it would discourage the random generation of innovative ideas which might have allowed improvements to take place in non-priority areas.

Teamwork and wholehearted commitment from the top are essential ingredients of the successful implementation of improvement schemes like TQM, ABC, JIT and TOC. Properly implemented JIT can be used to improve lead times and due date performance, TQM to improve interpersonal relations, ABC to provide non-financial data and TOC to provide a focus for the whole improvement process. But competent implementation requires a shift of the corporate culture to accommodate and encourage change.

The changes in corporate culture required to encourage organizational innovation are not necessarily the same. Evidence from Gosselin (1997) suggests that the most entrepreneurial of organizations are *not* the ones that fully incorporate administrative procedures like TQM and ABC, but are the ones that flirt with activity analysis and continuous improvement. He suggests that specific aspects of the organizational structure drive the adoption of accounting initiatives. The implication is that these firms are taking on the useful and creative aspects of the new tools, those that will aid their innovative pursuits, but are not interested in the bureaucracy or data burden associated with full adoption.

Until we are less uncertain about the best way to develop an innovation culture in our organizations, we might have to conclude that systems which encourage and facilitate new products and processes are not necessarily consistent with accounting innovations.

### **OPERATIONALIZING ACTIVITY-BASED MANAGEMENT: THE TIME DIMENSION**

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One of the major benefits of the focus on activity-based relationships has, not surprisingly, been the development of new non-financial measures. These may have been employed as cost drivers in activity-based costing but have a potentially wider application when they also impact on the quality, time and innovation dimensions.

Focus on product cycle time, throughput time, bottlenecks and delivery reliability highlights the need for new measures of operating performance and better indicators to measure delivery performance and the degree of operations interdependence. The use of some measure of 'set-ups' provides a useful illustration. Set-up times as a cost driver will inevitably penalize small batches and encourage larger batches. While set-up cost can be reduced through shorter set-up times, it can be more easily lowered by fewer set-ups, larger batches and consequently higher inventory levels. Reducing set-up times to make more set-ups possible provides a flexibility facilitating the meeting of customer requirements. But more product lines and smaller batches mean more non-productive set-up time. The congruence of production objectives and measurement implications must be ensured. Set-up times tend to ignore the question of dependence, both in terms of the way jobs are sequenced and backlogs generated, and in the way that set-up is a variable subject to the impact of special causes (e.g., unpredictable external factors) and common causes (e.g., random fluctuations within otherwise stable systems).

Just as the focus on the efficiency of machines may not be particularly useful in a sequence of operations, so may be set-up times. Increasing the efficiency of non-bottleneck operations incurs expense but also creates spare capacity and unnecessary units of production. Similarly, the consequences of a set-up on a bottleneck operation, with the generation of idle time in a constraining activity, will far outweigh that on a non-bottleneck activity.

Recognition of the existence of a bottleneck where demand exceeds supply for a resource, and the focus on processing time, leads naturally to a consideration of throughput, and throughput accounting. Throughput accounting represents a movement away from ABC, since it is not concerned with overhead costs, and represents a movement towards ABM, the time taken to generate profits and the rate at which raw materials are turned into sales. It identifies selling price, sales volume and material cost as the three key variables determining profitability and focuses on product flow, by treating overheads and labour costs as fixed in the short term. As with the linear programming approach to the solution of product-mix problems, throughput focuses on scarce resources and the relative contribution per unit of such resources for each product. As a result, a single bottleneck activity will usually become the focus of attention. Other binding constraints will exist, but these will only become bottlenecks, in the future, as a result of successful investment in overcoming prior bottlenecks. A number of consequences of throughput focus quickly become apparent:

- It is pointless investing resources in order to increase the efficiency of non-bottleneck resources. This will not improve throughput until the bottleneck activity has first been attacked.
- Queues will develop in front of bottlenecks which increase production lead time. However, such inventory provides an essential buffer to eliminate the possibility of idle time in the bottlenecks.
- Throughput will reduce inventory and work in process, making efficient JIT procedures and reliable supplier relationships essential.
- Lower inventory will mean fewer overheads available for carrying forward under absorption costing and a likely negative impact on short-term profits.

## CASE STUDY

### Crustybake Pies: A throughput case study

Crustybake Pies is a small food manufacturer which produces two varieties of catering-size pie – meat ( $X$ ) and vegetarian ( $Y$ ). Each type of pie undergoes six separate operations in the production process, using the same equipment resources but requiring different amounts of time in each resource. Resource capacity, material costs, selling price and operating time are all detailed in Table 6.17. These figures allow the calculation of relative contribution per unit for each of the products.

A linear programming (LP) problem for the determination of optimum product mix of the two pies will maximize contribution ( $\pi$ ) subject to the operating constraints. (There are many PC-based LP programs available commercially; even spreadsheet software, such as Excel's 'Solver' function, facilitates the solution to small problems like this one.)

The aim to maximize contribution yields an objective function,  $\pi = 5X + 3.20Y$ , which is to be as large as possible, subject to the time capacity constraints:

$$0.10X + 0.20Y < 6500 \quad (\text{for operation 1})$$

$$0.30X + 0.15Y < 6000 \quad (\text{for operation 2})$$

$$0.15X + 0.30Y < 9600 \quad (\text{for operation 3})$$

$$0.20X + 0.25Y < 8000 \quad (\text{for operation 4})$$

$$0.40X + 0.30Y < 9600 \quad (\text{for operation 5})$$

$$0.10X + 0.20Y < 7000 \quad (\text{for operation 6}).$$

TABLE 6.17

Resource capacity at Crustybake Pies

Products	Operations time (hours per unit)						Total (Hours)
	1	2	3	4	5	6	
X	0.10	0.30	0.15	0.20	0.40	0.10	1.25
Y	0.20	0.15	0.30	0.25	0.30	0.20	1.40
Capacity	6500	6000	9600	8000	9600	7000	

Products	Material Cost (£)	Labour Cost (£/Hr)	Selling Price (£)	Direct Costs (Material & labour)	Contribution (£/Unit)
X	5	12	25	20	5.00
Y	5	12	25	21.80	3.20

**CASE STUDY (cont.)**

Since we cannot produce *minus* quantities of product, we also have two non-negativity constraints,  $X \leq 0$  and  $Y \leq 0$ . The above matrix yields only two binding constraints (operations 2 and 5) and three potential optimum combinations as corner points on the feasible region of available combinations:

- option A, where  $X = 0$  and  $Y = 32,000$ ;
- option B, where  $X = 12,000$  and  $Y = 16,000$ ;
- option C, where  $X = 20,000$  and  $Y = 0$ .

Examination of the objective function reveals the total contribution from the three alternatives to be £102,400 from option A, £111,200 from option B and £100,000 from option C. So the LP solution suggests that the optimum product mix is  $X = 12,000$  and  $Y = 16,000$ , a total production of 28,000 units per time period.

A closer inspection of the maximum possible throughput of product for the sequence of operation reveals:

Products	Operations time (hours per unit)					
	1	2	3	4	5	6
X	65,000	20,000	64,000	40,000	24,000	70,000
Y	32,000	40,000	32,000	32,000	32,000	35,000

**CASE ANALYSIS**

For each of the three options A, B and C above there are only two binding constraints. Only operations 2 and 5 are used to capacity, providing an effective constraint on production. Considerable excess capacity exists in each of the remaining operations. Operation 2 is the production bottleneck, restricting the throughput of product  $X$  to the marketplace to a maximum of 20,000 units per period.

Although product  $X$  has a superior profit contribution to that of product  $Y$ , and a combination of  $X$  and  $Y$  yields a greater contribution per batch than producing  $Y$  alone, it is possible to bring more of product  $Y$  to the marketplace (32,000 units) than of  $X$  and  $Y$  together. Sales revenue would be optimized by producing/selling 32,000 units of  $Y$  (yielding £800,000) rather than the optimum  $X$ ,  $Y$  combination (revenue of £700,000). We can process twice as many units of  $Y$  (40,000) through the bottleneck operation 2 as of  $X$  (20,000). But the constraints in successive operations restrict the output per period to only 32,000. A throughput approach would justify a switch to product  $Y$  if the faster processing allowed more units to be marketed and sold, despite the lower contribution per unit. The approach is, therefore, more cash- than profit-based, seeking to focus on the rate at which the product contributes money, but might be justified were 'sales revenue maximization' the preferred strategic goal.

LP yields a static solution based on several inflexible assumptions. It ignores set-up times between operations, variation in the time taken to complete operations and the intricacies of job scheduling.

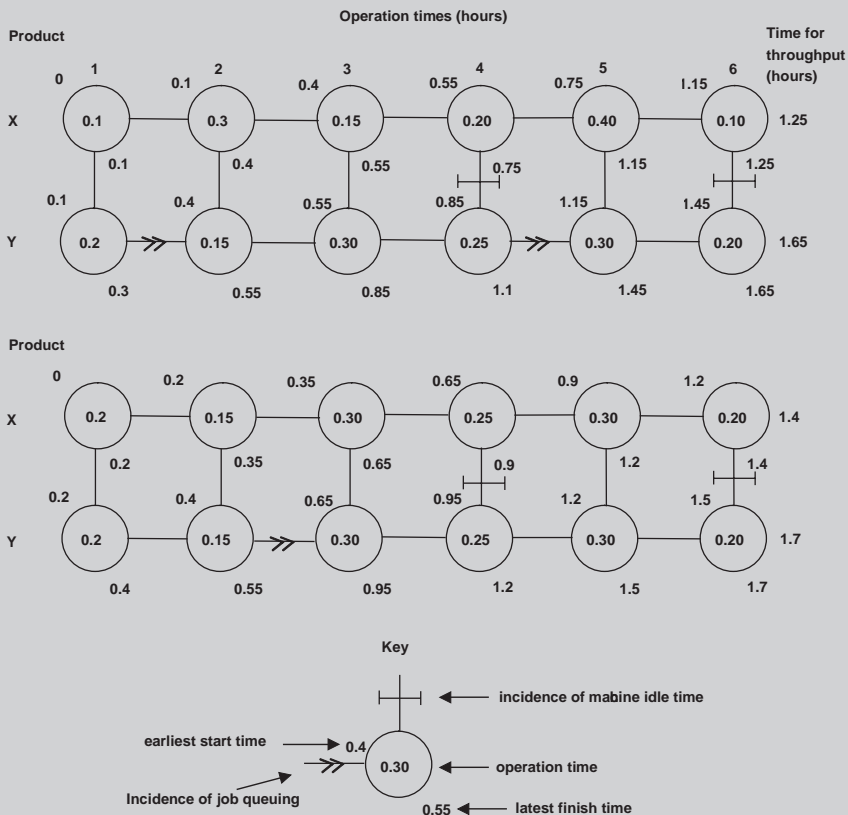


## CASE STUDY (cont.)

Scheduling complexities may lead to substantial operating delays, especially where we have more than two products all relying on the same equipment resources and competing for processing time. Each batch – 32,000 of *Y*, or 16,000 of *Y* with 12,000 of *X* – will take a total of 9600 hours to process but delays will occur at operations 2 and 5, the effective constraints on production. The mixed product, within the batch, can be brought to the market quicker through an *X* followed by *Y* sequence (1.65 hours) compared to 1.7 hours for two of product *Y*, as illustrated by Figure 6.6. The mixed product (*X*, *Y*) system has material queuing in front of the binding constraints (operations 2 and 5) whereas the single product (*Y*, *Y*) system has idle time in the bottleneck resource (operation 2).

If we had treated the production of products *X* and *Y* as multiple events, instances of fluctuation in operating time might have averaged out. But where, as here, one event cannot take place until the

FIGURE 6.6



Alternative product scheduling systems for Crustybake

**CASE STUDY (cont.)**

completion of another, the fluctuations will accumulate. With product queuing for machine availability, coupled with enforced machine idle time, inventory will increase and throughput will be reduced. Even with a balanced system, random fluctuations will cause the variation of operating time to be determined by the maximum variation of the preceding operations. Interdependence will continue to increase inventory levels and reduce throughput unless we reduce the level of variation applicable to particular operations, or create idle time by stopping that non-bottleneck part of the line in which the inventory build-up is occurring, to allow the bottleneck activities to catch up. Knowledge of the process and the statistical implications of operation dependencies are essential if bottlenecks are to be managed effectively.

Throughput time and project lead time are frequently the variables to which project outcomes are most sensitive. We need to estimate both the likelihood of delays (as part of a risk management strategy) and their financial impact (as part of an analysis of the sensitivity of returns). There may be some scope for varying the order in which the project is completed or the amount of resources each component consumes. Either way, we need to know the alternatives available and be aware of their costs and benefits, as part of our detailed analysis. Trend diagrams, Gantt charts, network and critical path analysis are all useful techniques to assist choices concerning timing and associated costs.

The most common form of individual scheduling problem, for both batch and process production flows, is job shop scheduling (JSS). This is characterized by the ordering and allocation of multiple jobs ( $n$ ) to alternative machines ( $m$ ). There are a very large number of alternative schedules even for a relatively small number of jobs to be processed (e.g., the scheduling of only five jobs on three machines produces  $(5!)^3$  or 1.7 million alternatives).

In practice, technological restrictions and the existence of specified processing routes will reduce the number of alternatives. Jobs may be sequentially ordered (with all jobs subject to the same procedures in the same sequence), sequentially broken-ordered (so that certain jobs miss out certain stages) or randomly assigned (non-sequential and non-ordered). Even so, the feasible set of alternatives is still usually too large for complete enumeration and results in the adoption of heuristics to provide satisfactory solutions. These short-cut rules generate alternative schedules which may be judged on their achievement of particular targets, for example:

- minimum time to complete the entire current job schedule (makespan time);
- minimum number of jobs in progress;
- minimum waiting time for jobs in the queue; and
- minimum lateness of completion (i.e., delivery date minus due date).

Scheduling problems can be represented graphically or through networks, similar to those used in the Crustybake Pies example. Calculations of expected completion time are complicated both by the variability in job processing times and the interdependence of jobs and machines. Unless

both jobs in process and machines are free simultaneously then a delay will result because one is waiting for the other. This is characterized by either machine idle time or job queuing. These complications are identical to those associated with earliest start/latest finish time for sequential projects. Although heuristic rules are rarely developed from scientific principles, they are generally better than intuition and may provide optimum solutions in specific circumstances. A number of commonly employed rules of thumb (heuristics) exist for the ordering of jobs:

- first come, first served (FCFS);
- shortest operating time (for entire job) first (SOT);
- shortest operating time (for first processing operation) first (SPT);
- longest operating time (for first operation) first (LOT)
- critical ratio method (work content  $\div$  time remaining available) lowest (C/T)

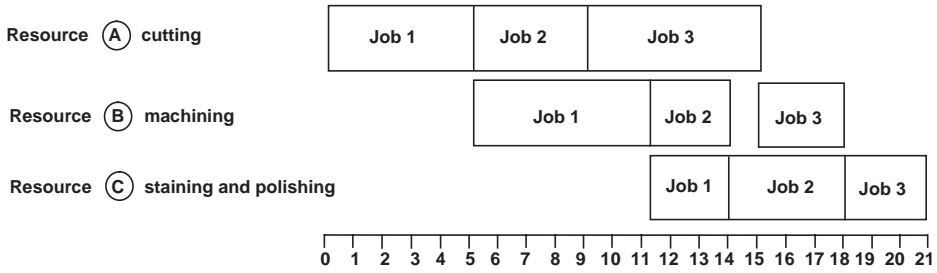
Simulation-based research has shown that adoption of the SOT rule will, on average, minimize the targets specified above. But it may have some socially unacceptable disadvantages, in that some jobs may remain in the queue for a very long time! A truncated SOT rule may, therefore be necessary in practice so that normal priorities can be overridden to bring a job to the front of the queue if it has been in the system longer than a specified time. This could be accomplished less arbitrarily by using C/T as a priority index in conjunction with the normal SOT rule. This would allow higher priority to attach to a job as its due date approaches, but complicates the single-rule method.

Consider another simple numerical example: a manufacturer, Ashby Furnishings, processing an order for three different styles of chair, designated jobs 1, 2 and 3 respectively. Each of the jobs passes through the same operations in the same order, but each makes different requirements of the resource. Job 1 requires 5 hours in cutting, 6 hours in machining and 3 hours in staining and polishing. Job 2 requires 4 hours in cutting, 3 hours in machining and 4 hours in staining and polishing. Job 3 requires 6 hours in cutting, 3 hours in machining and another 3 hours in staining and polishing. The minimum time to process each job separately, independent of the requirements of the others, is, therefore, 14 hours, 11 hours and 12 hours, respectively.

Ashby's target time for the completion of all three jobs is 16 hours, but they wish to minimize total throughput time while at the same time ensuring that machine idle time, job waiting time and job delivery times are as low as possible. They are investigating alternative job schedules.

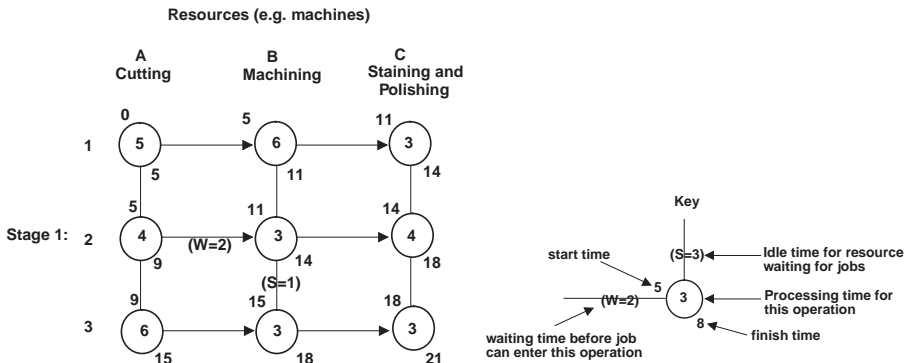
The Gantt chart, detailed in Figure 6.7, shows how resources are consumed and jobs completed relative to the horizontal time scale. It provides a means of facilitating job scheduling, but one which might be improved upon with a matrix approach. The latter shows waiting time, resource slack and the completion times for each separate operation more clearly. Figure 6.8 shows the outcome of adopting the FCFS scheduling rule processing the jobs 1, 2 and 3 in that order. It shows all jobs to be completed within 21 hours using the FCFS (i.e., 1–2–3) rule, but with the incurrence of both machine idle time and job queuing time. Job 2 must wait for 2 hours for the availability of resource B (machining), and spare capacity of 1 hour exists in machining while it waits for job 3 to clear cutting. Both jobs 2 and 3 fail to meet the target time of 16 hours; job 2 is 2 hours late and job 3 is 5 hours late (i.e., 3.5 hours per late job on average).

FIGURE 6.7



Gantt chart for Ashby Furnishings

FIGURE 6.8



FCFS matrix for Ashby job schedule

Several more heuristics might be employed to schedule these jobs, with the following results. The SOT (2–3–1) rule results in:

- a total processing time of 24 hours;
- waiting time of 0 hours;
- idle time of 7 hours (5 in B and 2 in C); and
- only job 2 fails to meet the delivery target, but it is 8 hours late.

The SPT (2–1–3) rule processes the Jobs 2, 1, 3 and results in:

- a total processing time of 21 hours;
- waiting time of 0 hours;
- idle time of 6 hours (2 in B and 4 in C); and
- both job 1 and job 3 failing to meet delivery target, being 2 hours and 5 hours late, respectively.

None of the other alternatives, 1–3–2, 3–1–2 or 3–2–1, results in a total throughput time of less than 21 hours. In choosing between FCFS and the

widely used SPT scheduling, Ashby must rank their requirements for minimizing job queuing time or machine utilization. Similar matrix-based approaches can be employed in the analysis of larger projects and capital expenditures. Thus, network techniques represent the jobs by nodes and designate the schedule sequence with arrows for an 'activity on node' approach, or vice versa for an 'activity on arrow' approach like critical path analysis or the programme evaluation review technique. Whichever method is employed, they all recognize the same basic features:

- the time taken to complete the operation;
- the earliest time at which the operation may start;
- the latest time at which the operation may finish; and
- the interdependence and sequencing of operations.

Realistic problems acknowledge that in practice all of these are variables because:

- time to complete will follow a distribution with a mean and standard deviation. The degree of acceptable variation will be critical to the progress of the project;
- time to complete an activity may be reduced by employing additional resources; and
- the degree of interdependence might be influenced by additional equipment and/or job flexibility to reduce bottlenecks.

We now consider a case which highlights the problems arising when a company lacks clear strategic goals or the management accounting control procedures to supply the information necessary to monitor or direct the progress of the business. It provides the opportunity to identify and correct serious bottleneck problems.

## CASE STUDY

### **Lincoln Furniture: An ABM case study**

Lincoln is a manufacturer of high-quality lounge suites run by its two directors, the husband-and-wife team of Eileen and Paul Hayton. The company produces leather and fabric output in its Norwich factory and operates exclusively on a factory-direct basis in East Anglia and through appointed agents and retailers in the South of England. They have no other outlets in East Anglia other than the factory showroom.

The company has been established for 10 years and recently moved to purpose-built accommodation adjacent to its original site to coincide with a rapid expansion into the South East and the markets of western Europe. While producing a range of standard lounge suites, its output is largely market-led, with the great majority of suites produced in response to orders. With the exception of minimal showroom requirements, no suites are specifically produced for stock and three product lines account for nearly 90% of total production. The goal of avoiding mass production techniques has allowed the company to stay small, employing only eight full-time staff: two in the frameshop; one in the cutting room; one in sewing;

**CASE STUDY (cont.)**

and four in upholstery. Each of the staff works a standard 40-hour week and each of the processes functions independently, apart from the matching up of orders at the sewing and upholstering stages.

Each suite, whether fabric or leather, undergoes four production stages. In the frameshop, the frame is constructed, assembled and polished; in the cutting department, fabric and/or leather is cut to size, ready to be sewn in the sewing shop; in upholstery the webbing is fixed to the frame, the foam cut to shape, the fabric and foam combined and the result stapled to the frame. The employee mix and inflexibility of functions effectively governs Lincoln's productive capacity. The maximum number of units of output for each process over a three-week cycle is:

Frame-making	60 (120 hours × 2 employees @ 4 hours per suite),
Cutting	15 (120 hours × 1 employee @ 8 hours per suite),
Sewing	15 (120 hours × 1 employee @ 8 hours per suite),
Upholstery	34 (120 hours × 4 employees @ 14 hours per suite).

The directors are keen to expand their presence in the South East further and can accommodate the additional four or five production staff that this would require without significant capital expenditure outlays. Currently they are only operating at 70% of maximum productive capacity.

Lincoln has no formal stock control records or procedures. Orders for leather and fabric are placed in response to orders, and availability of materials is generally good (about one week) with the exception of local materials (lead time greater than four weeks). No economic order levels are set for materials and consumables and just-in-time manufacturing procedures have never been considered appropriate. Therefore stock-outs, and consequent disruptions to the production process, have been known to occur because of minimal stocks of raw materials, and, despite this, work in progress, in the form of assembled frames and sewn materials, is very high and consistent with mass production manufacturing techniques. The standard suite produced comprises a two-seater settee and two armchairs. Production scheduling is on a three-week cycle with local sales requirements completed in week 1, those for the South East and western Europe in weeks 2 and 3. This schedule is consistent with the existing three-week period between deliveries to customers in the South East and overseas, but imposes constraints which are contributing to the company's existing cash-flow problems.

Full absorption costing is employed at present so that factory overhead (including an idle capacity allowance) and general overheads are incorporated. The hourly direct labour charge would thus be calculated as follows:

	£
Direct labour	12.00
Factory overhead @ 45%	5.40
General overhead @ 125%	15.00
	<u>32.40</u>

**CASE STUDY (cont.)**

Standard direct material costs, including a 10% wastage allowance, are added to these direct labour costs when the product is initiated, but no subsequent comparison is made with actual costs. The existing accounting system at Lincoln classifies all consumables and electricity as cost of goods sold. This, together with absence of recognition of the closing values of work in process and finished goods, contributes to reported losses in net profits.

The nature of the business, with a standard selling price in excess of £6000 per unit, dictates that the majority of sales are on credit. Bad debts are rare, but most debtors are converted into cash in a period ranging from 60 to 120 days. This long delay contributes to the cash-flow problems of the company; the debt ratio (calculated as total liabilities/total assets) has blown out to 100%, and retailers in the South East (responsible for 70% of sales) are seen to be the major culprits. But the directors are wary of pressurizing debtors for fear of losing business in a sensitive and competitive market. The directors acknowledge that the cash-flow problem did not exist prior to the South East and European marketing ventures.

The growth in sales is not being matched with corresponding profits, and the directors wish to examine the strategic alternatives available to Lincoln which make the management controls in place consistent with the goals of the company.

**CASE ANALYSIS**

The fundamental problem the company faces is an absence of accurate, reliable and relevant information upon which sound decisions can be made and the appropriate action taken. The specific problems that can be identified, detailed below, can be considered to be symptoms of this major deficiency.

*Tracking systems*

Under the existing system, there is no method of monitoring each order through the various stages of production. The business is unable to ascertain what stage a particular order is at, or the amount of resources used at any time during the production process. This creates difficulties in determining the actual costs of production, the timing and volumes of inventory required, and prevents the identification of factors that inhibit efficient production processes. The net effect is to reduce profitability and place unnecessary strain on cash flows.

*Inventory and work in progress*

Lincoln have no formal stock control records or procedures. The availability of materials is subject to fluctuations and leads to stock-outs and disruptions in the production process. Bottlenecks in the

**CASE STUDY (cont.)**

production process add to the inventory problems. Differences in output capacity have resulted in inventory (work in progress) levels increasing at a disproportionate rate at each stage of the production process. The absence of any recording or monitoring system prevents management from recognizing this problem.

*Staffing mix*

The present design of the manufacturing process constitutes a poorly organized, uncoordinated and segmented mass production line. This is contrary to the directors' stated desire of seeking a quality handcrafted product. Failures to staff and monitor work-flow correctly have resulted in constantly increasing inventory levels.

The present staffing arrangements, detailed below, highlight two significant bottlenecks in the production process:

Process	Frameshop	Cutting	Sewing	Upholstery
Standard hours	4	8	8	14
Number of employees	2	1	1	4

Bottlenecks occur at the end of the frame-making and sewing processes. For each unit the upholstery section is able to complete, the sewing section completes 1.75 units and the frameshop 3.5 units. Because each unit operates independently of the capacity of the following unit the inventory accumulation and associated problems are inevitable.

*Debtor management*

Since expanding into the South East the company has experienced long delays in payments from these clients, and this has contributed to the cash-flow problems. While bad debts are rare, most debtors are converted into cash in a period ranging from 60 to 120 days; such a debt collection period is likely to be higher than the industry average. However, the directors are reluctant to pressure the debtors for earlier payment for fear of losing business in a sensitive and competitive market.

*Gearing*

The debt ratio of 100% implies that the company has a minimal equity component and is almost totally financed by borrowings. The directors' apparent reluctance to reinvest a portion of the annual profits back into the firm to reduce existing borrowings or build up working capital hampers the company's financial flexibility by making a further injection of capital a pressing need.



**CASE STUDY (cont.)***Costing systems*

The full absorption costing method used by the firm allocates costs on the basis of factory and general overheads, direct labour, and wastage and idle capacity allowances. This methodology does not provide the business with the capacity to identify the costs associated with each product line and each market. The absence of any effective order tracking mechanism also prevents the business from comparing actual production costs with forecast production costs, upon which the selling price is based.

By not being able to discriminate between costs, or make the comparison between projected and actual costs, management is unable to determine accurately the profitability of each product and each market. The ramifications impact directly on the long-term viability of the business.

*Financial reporting*

The current accounting system does not follow recognized accounting procedures. The absence of critical items in the financial analysis and a lack of consistency in recording other details (e.g., recognition of revenue and expense items) will provide a distorted view of the company's profitability.

Even after allowing for work in progress, the company's profit will still be understated due to an apparent inconsistency in recognizing revenue and expense items. Had revenue been recognized when the delivery contract was complete and not upon receipt of the actual funds, recorded profit for the period would be much higher. This recognition problem would have been accentuated with the move into the South East market where debtors are taking between 60 and 120 days to effect payment.

These deficiencies in the company's financial reporting systems prevent the business from being able to draw accurate conclusions from previous data, or forecast future trends with any degree of certainty. Distorted quarterly profit figures will result in incorrect decisions being made by internal and external users of the information.

*Customer satisfaction*

Long delivery times and unacceptable wastage rates may detract significantly from customer service perceptions. Expenditure on advertising is considerable and its effectiveness requires a detailed evaluation. There is no evidence of the business undertaking any market research or monitoring what they are selling, where, or to whom. There appears to be little monitoring of information at any level relevant to the effective functioning of the business.

**RECOMMENDATIONS**

The directors of Lincoln Furniture have a myopic perception of the overall company situation. This is highlighted by the failure to

**CASE STUDY (cont.)**

acknowledge and respond to the ever increasing levels of work in progress, evidenced by the quantity of furniture frames that has built up in the factory. The directors need to take an overall perspective of the company's position and determine:

- its objectives;
- the information and strategies necessary to support these objectives; and
- the systems necessary to provide the required information.

The following suggestions assist the directors in implementing recommended actions and also address each of the immediate concerns detailed above.

*Tracking systems*

The ability to track orders and monitor inventory levels through the production process is critical to managing issues such as quality, timeliness, costs and production problems. The current system is disjointed and has contributed to the current unsatisfactory situation. In particular, the existing system does not provide a comparison between actual and forecast costs incurred in the production of a lounge suite or highlight the inventory stockpiling problems.

The company should invest in a computerized monitoring system for orders and inventory levels, to provide meaningful information on which production and pricing decisions can be made.

*Inventory and work in progress*

It is inevitable that new financial and non-financial performance measures will be required in the provision of a modified management accounting information system.

One alternative to clear the inventory stockpiles and improve both profitability and cash flows in the immediate future is for the frameshop, the cutting section and the sewing section to stop producing until the upholstery section has been able to clear the backlog of frames and sewing output. If the staff involved in the frame-making, cutting and sewing sections have the necessary skills to assist in the upholstery section then they can be directed to this area. If they cannot be of assistance and cannot add value to the firm while waiting for the upholstery section to clear the backlog, then consideration can be given to clearing any accrued leave entitlements. Alternatively, they might participate in training that will enable them to assist in other aspects of the production process on future occasions.

Casual or temporary staff could be used in the upholstery section to correct the imbalance and increase the level of output above the other sections. This will overcome the need to stop production in the other sections and will lead to a reduction in inventories. The completion of a larger number of ordered lounge suites sooner than expected will assist in resolving the cash-flow and profitability concerns. Such an arrangement would require the redeployment of

**CASE STUDY (cont.)**

one frame maker to bring this section into line with the sewing and cutting sections.

*Staffing mix*

A longer-term and more permanent solution requires a restructuring of the staffing mix in the production process to remove bottlenecks. Such a restructuring could also include the company's plans to recruit more staff to lift output levels.

The current staffing mix might be restructured accordingly:

Process	Frameshop	Cutting	Sewing	Upholstery
Standard hours	8	8	8	8
Number of employees	1	1	1	7

This revised staffing mix requires one frame maker to be reassigned to the upholstery section, with training as appropriate, and an additional two upholsterers to be employed. Under this structure bottlenecks are removed and each section is completing a unit as it is required by the following section.

A commitment to multi-skilling employees, where possible, in each section will also assist in maintaining the production process during periods of absenteeism.

*Debtor management*

Apparently Lincoln does not want to pressurize retailers in the South East market for fear of losing business. However, it may undertake other measures to help improve debtor collections. Discounts may be offered for prompt payment. The debt collection period would be reduced if debtors were to take advantage of the discounts, and this would have a positive effect on cash flow.

Prior to offering discounts to all debtors a closer examination of individual debtors may isolate particular problem areas. These may then be addressed by offering selected discounts or applying other measures considered appropriate. The company could enter into an arrangement with a finance company or bank to provide loans to purchasers. This would alleviate the need for the company to carry the funding costs associated with the purchase of lounge suites, providing immediate cash flows plus a commission.

*Gearing*

The highly geared nature of the company supports a recommendation that the directors re-examine the company's funding mix. In particular, serious consideration should be given to using a portion of future profits to clear lending commitments which have an adverse effect on liquidity. Depending on the directors' resources,

**CASE STUDY (cont.)**

they may even consider an injection of equity or a directors' loan to improve liquidity.

*Costing systems*

The directors must re-evaluate the effectiveness of the existing costing systems and methodology. The basic need is for a system that divides costs into appropriate manageable components while providing sufficient detail, in an easily understood format, to enable quality decisions to be made.

In order to assess the relevance of any costing method the directors might consider these fundamental reasons for developing a costing system:

- valuation of inventory for financial and tax reporting;
- control of resources required and consumed;
- determining costs associated with each product and each market; and
- to understand how costs are incurred in the business in order to plan the introduction and design of new products or variations to current products.

*Financial reporting*

The directors should adopt a financial accounting system that conforms to standard accounting practices and procedures. This would include a consistent approach to the timing of recognition of revenues and expenses and incorporate all relevant details, such as work in progress, in the profit and loss statement.

*Customer satisfaction*

Many of the problems in this area arise from the physical location of the business and the rapid international expansion. With 70% of company sales occurring in the South East and further expansion planned in these markets and those overseas, a relocation strategy might be considered. The analysis would need to consider quantitative effects such as profitability and also qualitative issues. These qualitative issues would require an analysis of the firm's goals, the attitudes of the directors and their families to relocation and the likely loss of experienced staff who know the company and its products.

The key requirement for any recommended system change is to consider the individual requirements of Lincoln Furniture and the skills and abilities of the directors and staff. Any new systems must be accepted by the people involved and provide useful information that can be easily interpreted. The principal objective is to generate relevant, reliable and accurate information to enable decisions to be made that are in the best interests of the company.

## VALUE-ADDED MANAGEMENT

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Value-added management (VAM) is concerned with the identification and elimination of all non-value-adding, and thus wasteful, activity in the manufacturing process. As such it focuses principally on the following:

- *Overproduction*. This leads to wasteful stock build-ups, often deliberate or attributable to production planning errors.
- *Waiting*. Job queues and excessive work in progress.
- *Transportation*. Time spent transporting materials or product.
- *Inventory*. The level of stockholding, including safety stocks and often attributable to excessive batch sizes.
- *Motion*. Non-value-adding movement of materials or products.
- *Defects*. The production of sub-standard items and their reworking.
- *Unused creativity*. Ignoring feedback from the shop floor.

VAM is concerned with maximizing the processing time spent adding value to the product and minimizing the effects of each of the above. It aims to remove, or at least reduce, the wasted effort associated with delays (i.e., inventory), excess (scrap) and unevenness (overtime). The identification and elimination of the causes of such waste require the co-operation of everyone in the organization. The whole VAM system can be thought of as comprising three sub-systems:

- *Just-in-time*. The reduction of wasteful lead time.
- *Total employee involvement (TEI)*. The co-operation and creative involvement of the workforce.
- *Quality control (QC)*. The attempt to achieve a zero-defect objective.

The systems are not mutually exclusive, but might be considered as overlapping features of the purchasing and production aspects of operations.

McIlhattan (1987) suggests that senior management efforts are disproportionately devoted to direct labour costs, even though they usually account for less than 10% of total manufacturing costs, with an inappropriately small amount of time devoted to the control of material and overhead costs. Williams et al. (1995) suggest that this might be an overstatement, in that manufacturing remains labour-intensive, typically accounting for 30% of costs and 70% of value added, with figures of 10% for labour costs attributable to standard costing methods hiding indirect labour on the one hand, and the labour costs included within materials on the other hand. Both agree that the great majority of the lead time associated with a product adds *cost* but *no value* to the product, with the great majority of the time spent in queuing and waiting (through activities such as handling, moving, picking, inspecting, counting and monitoring). Williams et al. (1995) highlight the manner in which management accounting in the manufacturing environment has become out of touch with engineering practice. They welcome the initiatives due to the likes of Cooper and Kaplan, but criticize their focus, on the grounds that we need to devote more attention to the real problems than to more arbitrary allocations. They note that while materials typically account for 50% of

manufacturing costs, these can be controlled through improved attention to design issues and supplier relations.

Neely et al. (2003) observe that as companies outsource more and more of their non-core activities, so suppliers become increasingly important stakeholders, making performance measures to monitor supplier relationships vital. Their absence from the normal balanced scorecard framework is not tolerable, though its absence from the original 1992 framework may be excusable on the grounds of 'changing business circumstances' over the last 20 years.

VAM is concerned with attacking this non-value-added waste and reducing total lead time. The great benefit of a line of attack directed at non-value-adding activities is that it is usually a low-cost option. The disadvantage is that it requires a change of attitude away from the traditional 'us and them' employee-management confrontation.

Traditionally, accounting procedures measure organizational performance on the basis of the three Es of evaluation:

- *Efficiency*. The utilization of equipment and the efficiency of the workforce.
- *Economy*. The optimum use of material.
- *Effectiveness*. The achievement of target outcomes.

Such measures are more concerned with the productivity of the business than with throughput. There is no normal measure of the flow of materials (hence the perseverance of the use of progress chasers). Little emphasis is placed on the reduction of lead times and the time spent to transform material into product.

The use of traditional daily monitoring measures may be inappropriate and misleading, with the benefits of changed processes only apparent at year end. Apparently 'inefficient' operations (where less time is spent in production, with more product change-overs) may in practice be the most appropriate. The management accountant has a duty to act positively with respect to five key issues:

- 1 Existing performance indicators are inadequate, placing too much emphasis on short-term profitability to the exclusion of non-financial aspects. Traditional budget variances should no longer be the focus of attention; more emphasis needs to be devoted to non-financial measures, including such factors as elapsed time, distance moved, space occupied, number of different part numbers and variances concerned with quality, cycle time and product complexity. (See Chapter 8 for a detailed consideration of non-financial indicators.)
- 2 The response of accountants in providing feedback to manufacturers is too slow. Too often decisions are based on incomplete or misleading information, so that product costings, product mix and pricing are all inappropriate. The allocation of overhead costs to products in other than an arbitrary manner remains an unsolved problem. Clearly, direct labour and direct materials are no longer appropriate bases under a JIT production system. Non-volume-related overhead allocation bases (as discussed in Chapter 6) may be the answer, but more work needs to be done in this area, especially in small businesses and the service sector.
- 3 Performance measurement should not be relative to industry averages, since this increases the acceptability of non-optimum levels of achievement. The aim should always be 100% perfection. Similarly, the focus on standard cost comparisons and variance reporting should be rejected as

lacking decision-usefulness. Indeed, if we adopt a 'get it right first time' philosophy we might be able to eliminate variance analysis totally.

- 4 Wherever possible, actual costs should be substituted for standard costs. Less concern should be shown for labour and equipment utilization, and more should be shown for maximizing the value added aspects of production.
- 5 The accounting system must provide an appropriate, decision-useful information back-up to the manufacturing process which does not rely excessively on externally reported financial information. That is, there must be a timely, relevant and reliable management information system.

Unfortunately, there is some credence to the view that existing accounting measures actually work contrary to VAM by encouraging waste. Thus:

- standard costs institutionalize waste and idle time within expectations;
- cost centres direct attention away from improvement opportunities and cost reductions;
- absorption costing encourages excess inventory by allowing production for stock to contribute to income;
- labour efficiency variances encourage more output, and potentially overproduction, in the cause of the productivity of the workforce;
- price variances encourage bulk-buying and unnecessarily increase inventory;
- machine utilization rates encourage the pursuit of equipment productivity, with consequential overproduction and overstocking; and
- scrap cost rates encourage costly reworks in order to avoid measured scrap outcomes.

The three VAM components – JIT, TEI and QC – form a single overlapping system, rather than three completely separate areas. We consider TEI in Chapter 7, within our 'people' focus, so we now turn to a more detailed discussion of the other two components and their mutual interaction.

### **Just-in-time**

The advent of JIT manufacturing systems has created an attitude among many management accountants which places undue emphasis on stock control methods. JIT should be considered as part of the wider VAM process of value-added management, in which attitudinal changes are central to the development of more efficient management processes and generate the adoption of more decision-useful management accounting measures.

JIT is a production technique aimed at manufacturing and delivering components in a production line immediately they are needed by processes further down the line. JIT is dedicated to the notion of zero defects and reduced buffer stocks through the search for continuous improvement in operational control. Ultimately, under JIT, customer orders might be expected to initiate a demand pull, rather than demand-pushing the manufacture of goods.

JIT is, therefore, much more than a vendor-supplier relationship, though this is important. Reduction of inventory by insisting that suppliers hold on to materials until required simply transfers the problem to the supplier and may, in the longer term, induce financial distress, and possibly failure, in trading partners.

Overall, JIT is concerned with the generation of increased profit, increased cash flow, and better-quality goods through a reduction in material costs. Lower inventory can be achieved only through co-operation with suppliers, not by attempts to exploit their apparent dependency.

There are two important aspects of JIT: inventory and supplier relationships.

### **Inventory**

The use of buffer stocks provides a production safety net – but at a cost. The stock provides a breathing space for the unexpected and for management incompetence but consumes valuable work-space and incurs additional and unnecessary interest payments. Work in progress should be reduced, but slowly, so that the consequent problems which arise can be identified and solved. The gradual reduction of inventory allows the solution of the core problems for which the inventory was originally being stocked.

The adoption of traditional economic order quantity principles dictates large batches in order to attract discounts, so that change-over times between products are relatively large and tooling-up problems are extensive. The suggestion is that the advantages of large runs may be outweighed by the rigidity of an unwieldy stocking system. The consequence is inflexibility and non-value-added waste.

The reduction in batch sizes and the elimination of unnecessary inventory may act as a catalyst, generating improved quality and a reduced level of defective output. Increased flexibility goes hand in hand with product and process simplification.

### **Supplier relationships**

The aim is one of reliability in raw material supplies in order to satisfy a zero-defect policy. This means that gaining the lowest price is no longer necessarily the most appropriate priority. An underlying need exists to work with the supplier to the mutual benefit of both parties. A close working relationship with suppliers can lead to:

- single sourcing;
- long-term contracts;
- short lead times;
- rational and achievable design specifications;
- the use of local sources, wherever feasible; and
- guarantees of quality assurance by suppliers.

Each of these factors can have extensive mutual benefits, but each requires a re-evaluation of traditional producer–supplier working attitudes.

The abandonment of lowest-price tenders focuses attention on quality and availability, even where these come at higher prices. The implication for management accounting is a reduced emphasis on purchase-price variances. Favourable purchase-price variances may be attributable to quantity discounts or the acceptance of lower-quality supplies. These contribute, respectively, to increased inventory and more wastage and reworking.

Adverse production variances may result, but the VAM system is much more concerned with *overall* performance trends than with individual variances.



## Quality control

Quality control is concerned with converting a quality problem into a productivity increase, at low cost, through more attention to product detail. The alternative is to overproduce in order to ensure the production of a serviceable set of units of acceptable quality, with the consequent buffer stock problem discussed earlier.

The JIT philosophy means that management prefers an idle workforce if the alternative is that the workers are producing for inventory. This has serious consequences for management accounting methods. A focus on labour utilization and overhead absorption as measures of the efficiency and productivity of the manufacturing process encourages overproduction and the generation of excessive inventory and has no relevance in an integrated VAM system.

The key aspect of QC is an attitude change – one of attention to and respect for quality on the part of the workforce, rather than one which aims only to ensure that a product ‘passes’ the monitoring inspector. The objectives are:

- The production of perfect parts every time (i.e., zero defects). High quality is viewed as being totally consistent with low costs, rather than the reverse.
- The transfer of production responsibility to the operators, so that they have the ability to monitor and improve production processes where continuing serious faults are apparent.
- An attitude of mutual respect between colleagues in the workforce to ensure the transfer of acceptable-quality product between them (with workers regarding the next person in the assembly line as their customer). The emphasis on teamwork and co-operation between employees means that the focus of attention must be diverted from the individual worker. Piecework payment plans must be eliminated, and an emphasis on labour variances within production units is no longer appropriate.
- Generation and analysis of relevant data, so that production quality decisions are based on a reliable management information system. This includes, for example, information about average set-up times, days of production in inventory and the average distance travelled by products during production.
- The identification of the fundamental causes of problems to ensure that the disease responsible for poor quality production is cured, rather than the symptoms treated.

Ideally, QC should be approached at the *prevention* stage through the co-operation of the workforce, rather than by facilitating opportunistic behaviour aimed at defeating the system. Such an approach dictates a new role for standard costing. Traditionally, measurement of performance relative to standard emphasizes output, not quality of output. Rather than using standards to which costs can be compared *after* they have been incurred, costing standards should provide a more decision-useful guide to prevent costs being incurred *before* they arise.

## Operationalizing value-added management

Reference back to Figure 3.1 highlights the importance of discriminating between value-adding and non-value-adding activities in the measurement

of process performance. Recognition of corporate goals and specification of cost drivers and critical indicators are all steps in the pursuit of VAM goals.

The application of VAM principles aims:

- to reduce costs by reducing lead times, change-over time, inventory, cycle time, floor space, raw material stock, wastage, work in progress, reworking, and interest payments;
- to increase quality by increasing flexibility, employee involvement and productivity.

The adoption of these principles has demonstrable and significant benefits for manufacturing industry and revolutionary consequences for management accounting. The principles underpinning VAM can be applied equally well in non-manufacturing environments with similar benefits.

For the VAM system to operate effectively, management accountants must be able to provide decision-useful information. This must allow managers to make the decisions necessary to generate long-term profitability, rather than merely monitoring current operations or providing data for the financial reporting function.

To quantify and integrate the potential benefits of value-added management, more non-financial and qualitative information is needed to complement traditional sources. Such data collection is potentially expensive and time-consuming, especially if we are unsure which non-financial indicators are the most appropriate. The following chapter considers this issue in more detail, while the following case study considers some of the issues and attitudes which prevent the successful implementation of VAM.

## CASE STUDY

### Chester Ltd: A VAM case study

Chester Ltd provides an example of a suitable case for treatment. Its characteristics are typical of organizations requiring a re-evaluation of their business strategies to allow the alignment of customer focus and employee involvement. You may even recognize your own organization in the CHESTER acronym!

- Conflict levels are high and increasing. Interpersonal conflict among colleagues is common, making for an unpleasant work environment dominated by rumour, back-biting, innuendo and gossip.
- Heavy-handed control is perceived to be necessary in order to preserve the *status quo* of 'them and us'. There is little delegated responsibility and trivial cost-cutting exercises assume the proportion of major issues. We might expect the stationery cupboard to resemble Fort Knox and up to three signatures to be required before a fax can be dispatched.
- Energy is high, but frequently misdirected. Middle managers work long hours and always take work home with them. The training of junior ranks is apparently too arduous and consequently there is no delegation of decision-making.

**CASE STUDY (cont.)**

- Stress levels are also high, with frequent short absences and doctors' appointments. The preponderance of red eyes and grey faces does not augur well for future stability.
- Turnover among staff is high, either because of movement elsewhere or because staff members actively seek internal demotion to less stressful occupations. Worse, staff turnover is tacitly accepted as a part of normal operations.
- Entrenched views and work practices persist: 'We have always done things like this and why should we change tried and tested procedures?'
- Rationalization after the event takes place on a regular basis in order to attribute blame elsewhere. High levels of inconsistency are perceived to exist in the environment, so that external factors can always be located in order to explain failure.

The solutions to Chester's problems are not easy. They require fundamental changes throughout the organization so that new attitudes allow all to give the best of themselves:

- 1 Variations in systems and procedure are inevitable. They are not a cause for panic and recriminations, but a database for the investigation of our processes. Similarly, there are no 'failures' as such – mistakes provide us with feedback, allowing the re-evaluation of subsequent strategies. We must constantly look for improvement opportunities, means of doing the job better and evidence to substantiate improved job practices.
- 2 The aim is to increase customer satisfaction with the service provided by the company. Management must establish this vision with their employees. What we do should promote customer happiness, so we must be aware of those current practices which positively reduce customer satisfaction. The identification of key problem areas will allow the implementation of solutions which vastly improve the quality of customer service, in a manner which is not transaction-specific. But that alone is insufficient. Employee attitudes must change so that employees view constant improvement as part of their job and can act in a manner which implements individual improvements.
- 3 Empowerment is a key factor. Devolved decision-making is essential to allow individuals the power to implement customer-focused solutions. In the short term, such actions may reduce profitability, but the goal is long-term, and as long as customer satisfaction is increased, along with the long-term value of the assets, short-term hiccups have to be tolerated.
- 4 Barriers and enablers to successful implementation must be evaluated. The major barriers will most likely be in two areas:
  - (a) *Attitudes to change.* Top management commitment must be wholehearted and must permeate down through all management levels. Adherence to the vision must eventually become part of everyone's work practices. Deliberate obstruction and agitation must be countered with, first, the

**CASE STUDY (cont.)**

opportunity to conform, then with damage limitation via transfer or resignation.

- (b) *Institutionalized procedures*. Entrenched work practices, relics of previous corporate goals, must be made more flexible or eliminated in order to give full rein to individual creativity. The consequent reduction in formal controls is balanced by the encouragement of self-auditing to ensure that new work practices are consistent with the vision.

5 The major enablers will be:

- (a) Management encouragement of individuality and risk-taking. The devolution of decision-making should develop responsibility and self-importance through an 'it's up to me' approach. A careful balance must be maintained here between job descriptions and managerial roles to prevent buck-passing and the elimination of *any* control by not asking subordinates to make decisions in areas outside their areas of competence.
- (b) The provision of documentation detailing procedures and working methods deemed to be industry best practice. Individual creativity should therefore not be required at the level of fundamentals but can be devoted to original situations.
- (c) A training programme which emphasizes creativity, assertiveness and teamwork to facilitate the smooth devolution of customer-focused decision-making.

**SUMMARY**

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This chapter offers a wide-ranging discussion of cost measurement and management, and the opportunities offered by new methods. The chapter progresses from a predominantly 'cost' focus (with ABC and target costing) to a more 'managerial' focus, concerned more with implementation issues and waste reduction. In doing so, it highlights the variations in current practice and the improvement opportunities available.