Performance measurement system design: A literature review and research agenda

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ORIGINAL PAPER

Performance measurement system design

A literature review and research agenda

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Abstract

Purpose – This paper, originally published in 1995, aims to focus on the importance of performance measurement.

Design/methodology/approach – Focuses on the process of performance measurement system design, rather than the detail of specific measures. Following a comprehensive review of the literature, proposes a research agenda.

Findings – The importance of performance measurement has long been recognized by academics and practitioners from a variety of functional disciplines.

Originality/value – Brings together this diverse body of knowledge into a coherent whole.

Keywords Competitive strategy, Manufacturing industries, Operations and production management, Activity based costs

Paper type Conceptual paper

Introduction

When you can measure what you are speaking about, and express it in numbers, you know something about it ... [otherwise] your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in thought advanced to the stage of science. (Lord Kelvin, 1824-1907).

Performance measurement is a topic which is often discussed but rarely defined. Literally it is the process of quantifying action, where measurement is the process of quantification and action leads to performance. According to the marketing perspective, organizations achieve their goals, that is they perform, by satisfying their customers with greater efficiency and effectiveness than their competitors (Kotler, 1984). The terms efficiency and effectiveness are used precisely in this context. Effectiveness refers to the extent to which customer requirements are met, while efficiency is a measure of how economically the firm's resources are utilized when providing a given level of customer satisfaction. This is an important point because it not only identifies two fundamental dimensions of performance, but also highlights the fact that there can be internal as well as external reasons for pursuing specific courses of action (Slack, 1991). Take, for example, one of the quality-related dimensions of performance – product reliability. In terms of effectiveness, achieving a higher level of product reliability might lead to greater customer satisfaction. In terms of efficiency, it might reduce the costs incurred by the business through decreased field failure and

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warranty claims. Hence the level of performance a business attains is a function of the efficiency and effectiveness of the actions it undertakes, and thus:

- *Performance measurement* can be defined as the process of quantifying the efficiency and effectiveness of action.
- *A performance measure* can be defined as a metric used to quantify the efficiency and/or effectiveness of an action[1].
- *A performance measurement system* can be defined as the set of metrics used to quantify both the efficiency and effectiveness of actions[2], (Neely, 1994).

Even with these definitions performance measurement remains a broad topic. Hence this article will focus on the issues associated with the design of performance measurement systems, rather than the detail of specific measures.

The remainder of the article has been split into four main sections. It is structured around the framework shown in Figure 1, which highlights the fact that a performance measurement system can be examined at three different levels:

(1) the individual performance measures;

(2) the set of performance measures – the performance measurement system as an entity; and

(3) the relationship between the performance measurement system and the environment within which it operates.

As an example of this, take the "set of measures" shown in Table I, which are used by a leading US supplier of computer-based information-processing equipment (Kaplan, 1990). At the level of the individual measure, this "performance measurement system" can be analysed by asking questions such as:

- What performance measures are used?
- What are they used for?

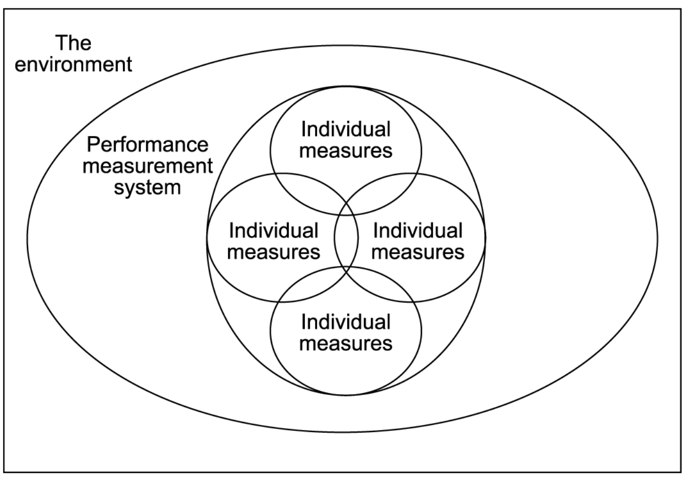


Figure 1. A framework for performance measurement system design

Category of measure	Measures used
Shipments	Actual
	Performance-to-build plan
	Current backlog
Inventories	Total (weeks and $)
	Scrap
	Excess
	Obsolete
Variances	Purchase price
	Production burden
	Materials acquisition
	Materials burden
	Materials usage
	Labour
Labour performance	Efficiency
	Utilization
	Productivity
	Overhead percentage
	Overtime
	Absenteeism
	Indirect direct radio
Capital	Appropriations
	Expenditures
Spending	Salaries and benefits
	Controllable expenses
	Non-controllable expensed
Headcount	Direct
	Indirect
	Total
	By functional areas

Source: Adapted from Kaplan (1990)

Table I. Typical monthly performance measures

- How much do they cost?
- What benefit do they provide?

At the next higher level, the system can be analysed by exploring issues such as:

- Have all the appropriate elements (internal, external, financial, non-financial) been covered?
- Have measures which relate to the rate of improvement been introduced?
- Have measures which relate to both the long- and short-term objectives of the business been introduced?
- Have the measures been integrated, both vertically and horizontally?
- Do any of the measures conflict with one another?

And at the highest level, the system can be analysed by assessing:

- whether the measures reinforce the firm's strategies;
- whether the measures match the organization's culture;

- whether the measures are consistent with the existing recognition and reward structure;
- whether some measures focus on customer satisfaction; and
- whether some measures focus on what the competition is doing.

In the next three sections the issues surrounding these, and similar questions, will be explored more fully. In the fourth, the implications of this review will be summarized in the form of a research agenda.

Individual measures of performance

As Figure 1 shows, all performance measurement systems consist of a number of individual performance measures. There are various ways in which these performance measures can be categorized, ranging from Kaplan and Norton's (1992) balanced scorecard through to Fitzgerald *et al.*'s (1991) framework of results and determinants. The rationale underlying this article is that performance measures need to be positioned in a strategic context, as they influence what people do. Measurement may be the "process of quantification", but its affect is to stimulate action, and as Mintzberg (1978) has pointed out, it is only through consistency of action that strategies are realized.

Following their review of the manufacturing strategy literature, Leong *et al.* (1990) claim that it is widely accepted that the manufacturing task, and hence the key dimensions of manufacturing's performance, can be defined in terms of quality, delivery speed, delivery reliability, price (cost), and flexibility. Despite this assertion, however, confusion still exists over what these generic terms actually mean. Wheelwright (1984), for example, uses flexibility in the context of varying production volumes, while Tunälv (1992) uses it to refer to a firm's ability to introduce new products rapidly. And, as shown in Table II, other authors such as Garvin (1987), Schonberger (1990), Stalk (1988), Gerwin (1987), and Slack (1987) have all pointed out that the generic terms quality, time[3] cost and flexibility encompass a variety of different dimensions (Neely and Wilson, 1992). It would be impractical, then, to review all the possible measures of manufacturing's performance in this article. Hence only a selection of the most important measures relating to quality, time, cost and flexibility will be discussed.

One of the problems with the performance measurement literature is that it is diverse. This means that individual authors have tended to focus on different aspects

Quality	Time	Flexibility	Cost
Performance	Manufacturing lead time	Material quality	Manufacturing cost
Features	Rate of production introduction	Output quality	Value added
Realiability	Deliver lead time	New product	Selling price
Conformance	Due-date performance	Modify product	Running cost
Technical durability	Frequency of delivery	Deliverability	Service cost
Serviceability		Volume	
Aesthetics		Mix	
Perceived quality		Resource mix	
Humanity			
Value			

Table II.
The multiple dimensions of quality, time, cost and flexibility

of performance measurement system design. Business strategists and organizational behaviourists, for example, have explored the rationale underlying the use of performance measures more fully than the production and operations management community, and as this is an important part of the performance measurement system design process, it will also be explored in this section.

One of the techniques used to gather data for this review was a survey which examined the use of performance measures in UK SMEs – small and medium-sized manufacturing enterprises (Neely and Mills, 1993; Neely *et al.*, 1994). A key finding of that survey was that the cost of measurement is an issue of great concern to managers in SMEs. Indeed in the free-form section of the questionnaire one of the respondents wrote:

> For small and medium sized companies often the best justification is "feel", even when the numbers don't add up. *Measurement is a luxury* – success and failure are obvious.

To date, however, the authors have been unable to identify any studies which have explored how the cost-benefit relationship of performance measures can be analysed.

Performance measures relating to quality

Traditionally quality has been defined in terms of conformance to specification and hence quality-based measures of performance have focused on issues such as the number of defects produced and the cost of quality. Feigenbaum (1961) was the first to suggest that the true cost of quality is a function of the prevention, appraisal and failure costs. Campanella and Corcoran (1983) offer the following as definitions of these three types of cost:

(1) Prevention costs are those costs expended in an effort to prevent discrepancies, such as the costs of quality planning, supplier quality surveys, and training programmes.

(2) Appraisal costs are those costs expended in the evaluation of product quality and in the detection of discrepancies, such as the costs of inspection, test, and calibration control.

(3) Failure costs are those costs expended as a result of discrepancies, and are usually divided into two types:

    (1) Internal failure costs are costs resulting from discrepancies found prior to delivery of the product to the customer, such as the costs of rework, scrap, and material review.

    (2) External failure costs are costs resulting from discrepancies found after delivery of the product to the customer, such as the costs associated with the processing of customer complaints, customer returns, field services, and warranties.

Crosby's (1972) assertion that "quality is free" is based on the assumption that, for most firms, an increase in prevention costs will be more than offset by a decrease in failure costs. Basically, the logic underlying the cost of quality literature is that for a given set of organizational conditions there is an optimal level of quality. The cost of quality is a measure of the extra cost incurred by the organization because it is either under- or over-performing. It is commonly argued that this can be as much as 20 per cent of net sales (Campanella and Corcoran, 1983).

Plunkett and Dale (1988) point out that, although conceptually appealing, the academic rigour of the cost of quality model is debatable. It is based on assumptions and estimates, rather than on data. And like the economic order quantity (EOQ) model, it is questionable whether an optimum level of quality really exists. More relevant for performance measurement system design, however, is the point made by Crosby (1983). He says that many companies fail to integrate the cost of quality model with their management process. That is, although managers estimate the cost of quality they fail to take appropriate actions to reduce it.

With the advent of total quality management (TQM) the emphasis has shifted away from "conformance to specification" and towards customer satisfaction. As a result the use of customer opinion surveys and market research has become more widespread. The establishment of the Malcolm Baldrige National Quality Award in the USA and the European Quality Award reflects this trend. Table III (adapted fromGarvin (1991)) shows how entrants for the 1991 Baldrige Award were judged. Note how the strongest weighting was given to customer satisfaction (300 of the 1,000 points available).

Other common measures of quality include statistical process control (Deming, 1982; Price, 1984) and the Motorola six-sigma concept. Motorola is one of the world's leading manufacturers and suppliers of semiconductors. It set a corporate quality goal of achieving six-sigma capability (3.4 defects per million parts) by 1992 and recently one 27 person unit reported its 255th consecutive week without a single defect (Zairi, 1992). These last two measures of quality raise an important issue relevant to performance measurement system design because they focus on the measurement of the process rather than the output.

Performance measures relating to time

Time has been described as both a source of competitive advantage and the fundamental measure of manufacturing performance (Stalk, 1988; Drucker, 1990). Under the just-in-time (JIT) manufacturing philosophy the production or delivery of goods just too early or just too late is seen as waste (Potts, 1986). Similarly, one of the objectives of optimized production technology (OPT) is the minimization of throughput times (Goldratt and Cox, 1986).

Galloway and Waldron (1988a, b, 1989a, b) have developed a time-based costing system known as throughput accounting. It is based on the following three assumptions[4]:

(1) Manufacturing units are an integrated whole whose operating costs in the short term are largely predetermined. It is more useful and infinitely simpler to consider the entire cost, excluding material, as fixed and to call the cost the "total factory cost".

(2) For all businesses, profit is a function of the time taken to respond to the needs of the market. This in turn means that profitability is inversely proportional to the level of inventory in the system, since the response time is itself a function of all inventory.

(3) It is the rate at which a product contributes money that determines relative product profitability. And it is the rate at which a product contributes money compared to the rate at which the factory spends it that determines absolute profitability (Galloway and Waldron, 1988a).

1.0	*Leadership (100 points)*
1.1	Senior executive leadership (40)
1.2	Quality values (15)
1.3	Management for quality (25)
1.4	Public responsibility (20)
2.0	*Information and analysis (70 points)*
2.1	Scope and management of quality data and information (20)
2.2	Competitive comparisons and benchmarks (30)
2.3	Analysis of quality data and information (20)
3.0	*Strategic quality planning (60 points)*
3.1	Strategic quality planning process (35)
3.2	Quality goals and plans (25)
4.0	*Human resource utilization (150 points)*
4.1	Human resource management (20)
4.2	Employee involvement (40)
4.3	Quality education and training (40)
4.4	Employee recognition and performance measurement (25)
4.5	Employee well-being and morale (25)
5.0	*Quality assurance of products and services (150 points)*
5.1	Design and introduction of quality products and services (35)
5.2	Process quality control (20)
5.3	Continuous improvement of processes (20)
5.4	Quality assessment (15)
5.5	Documentation (10)
5.6	Business process and support service quality (20)
5.7	Supplier quality (20)
6.0	*Quality results (180 points)*
6.1	Product and service quality results (90)
6.2	Business processes, operational and supportive service quality results (50)
6.3	Supplier quality (20)
7.0	*Customer satisfaction (300 points)*
7.1	Determining customer requirements and expectations (30)
7.2	Customer relationship management (50)
7.3	Customer service standards (20)
7.4	Commitment to customers (15)
7.5	Complaint resolution for quality improvement (25)
7.6	Determining customer satisfaction (20)
7.7	Customer satisfaction results (70)
7.8	Customer satisfaction comparison (70)

Source: Adapted from Garvin (1991)

Table III.
Scoring the 1991 Baldrige award

Galloway and Waldron's philosophy is that contribution should be measured in terms of the rate at which money is received rather than as an absolute. Hence they define the key throughput accounting ratio as return per factory hour divided by cost per factory hour, where: Equation 1.

Practical examples of the use of throughput accounting are still rare. One of the first to be published was the case of Garrett Automotive (Darlington *et al.*, 1992). In that report it was claimed that throughput accounting was one of the factors that helped Garrett Automotive double its profits. Interestingly the authors also identified three problems with the adoption of throughput accounting, namely:

- It can be difficult to identify the constraints and the bottlenecks correctly.
- The reduction in stocks and work-in-progress stemming from the use of throughput accounting means a short-term profit problem as fewer overheads are carried forward in the stocks. This gives a one-off profit reduction.
- Reduced inventories highlight problems which have been hidden for years.

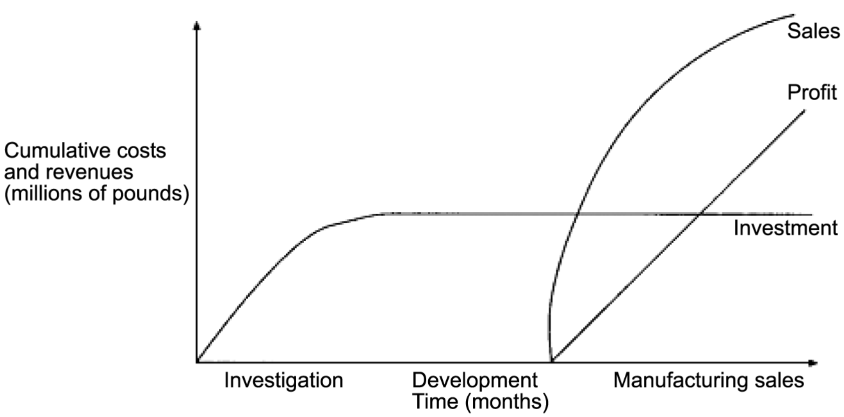
Of course, one can argue that these problems are not due to throughput accounting. Indeed they appear to be more akin to the problems (and opportunities) that arise from an OPT implementation.

In a different context House and Price (1991) recommend the use of the Hewlett-Packard return map to monitor the effectiveness of the new product development process. Figure 2 shows a sample return map. Note how it integrates the dimensions of time and cost. House and Price argue that the return map can be used to provide superordinate goals which, given an appropriate organizational culture, will encourage managers from marketing, R&D and manufacturing to work together.

Fooks (1992) reports that Westinghouse has used similar cost-time profiles for more than a decade. Basically the idea is that any set of business activities or processes can be defined as a collection of costs over time. In Westinghouse:

> Vertical lines on the profile represent purchased materials and services. In a factory, they are the raw materials; in the office, they are supplies, outside services, and information. Diagonal lines represent work – dollars per hour of cost added over time. The slope of the line depends on the workers' pay rates and on the duration of the work. Horizontal lines are wait times – when nothing is happening to the process but time is going by. In factories the material sits in storerooms or in the aisles; in offices, the information resides in in-baskets or electronically inside computers. Reducing wait times – which can approach 95 per cent of elapsed time – offers the most immediate opportunity for improvement efforts (Fooks, 1992).

On an alternative tack, an interesting approach to the design of time-based performance measures is proposed by Azzone *et al.* (1991). They suggest that companies that seek to employ time as a means of competitive advantage should use the generic set of measures shown in Table IV. Note how these reflect the efficiency



Source: Adapted from House and Price (1991)

Figure 2. The Hewlett-Packard return map

	Internal configuration	External configuration
R&D	Number of changes in projects	Development time for new projects
Engineering time	Δ average time between subsequent innovations	
Operations	Adherence to due dates	Outgoing quality
Throughput time	Incoming quality	Manufacturing cost
	Distanced travelled	
	Value-added time (as a percentage of total time)	
	Schedule attainment	
Sales and marketing	Complexity of procedures	Cycle time
Order processing lead time	Size of batches of information	Bid time

Source: Adapted from Azzone *et al.* (1991)

Table IV.
Measures for time-based competition

(internal configuration) and effectiveness (external configuration) dimensions of performance that were discussed earlier.

Performance measures relating to cost

The development of management accounting has been well documented by Johnson (1972, 1975a, b, 1978, 1980, 1981, 1983) among others, and his work shows that many of the management accounting systems used today are based on assumptions that were made 60 years ago. Indeed Garner's (1954) review of the accounting literature indicates that most of the so-called sophisticated cost accounting theories and practices had been developed by 1925 (Kaplan, 1984a). Take, for example, return on investment (ROI). In 1903 the three DuPont cousins decided to adopt a decentralized structure for their diverse business interests and hence had to face the problem of how they could control them.

Pierre DuPont rejected the [then] widely used measure of profits or earnings as a percentage of sales or costs, because it failed to indicate the rate of return on capital invested (Kaplan, 1984a).

Instead, DuPont developed the accounting measure ROI and used this to assess both the efficiency of each business unit, and DuPont's success as a whole (Johnson, 1975; Chandler, 1977). ROI is still commonly used for the same purpose today, but it is now widely recognized that it often induces short-termism (Banks and Wheelwright, 1979).

Johnson and Kaplan's (1987) thesis is that because the business environment has changed dramatically in the last 60 years, management accounting is based on assumptions which are no longer valid. One of the most widely criticized practices is the allocation of indirect labour and overhead according to the direct labour cost (Johnson and Kaplan, 1987). In the early 1900s direct labour made up the majority of the full product cost. Hence it made sense to allocate overheads to products according to their direct labour content. With the increasing use of advanced manufacturing technologies, however, direct labour cost now typically accounts for only 10-20 per cent of the full product cost[5], while overhead constitutes 30-40 per cent (Murphy and Braund, 1990). This leads to overhead burdens of between 400 and 1,000 per cent and hence even a relatively small change in a product's direct labour content can have a massive impact on its cost structure. Furthermore, the practice of allocating overheads according to direct labour hours encourages managers to concentrate on trying to minimize the number of direct labour hours attributed to their cost centre, while ignoring overhead. Johnson and Kaplan (1987) argue that these problems are likely to become more severe in the future as product life cycles become shorter and hence an ever increasing proportion of the full product cost will take the form of research and development overhead.

It should be noted that there is not universal agreement within the accounting fraternity that Johnson and Kaplan (1987) are correct. In 1988 the UK's Chartered Institute of Management Accountants (CIMA) instigated a study designed to explore what criticisms were then being levelled at management accounting in the USA. Following their investigation, Bromwich and Bhimani (1989) reported that the perception at the time was that management accounting systems had a short-term orientation, lacked a strategic focus, relied on redundant assumptions concerning the manufacturing process, and were too often used to provide data for external financial reporting rather than that which was necessary for managing the business. In their conclusion, however, Bromwich and Bhimani contend that contrary to the suggestions of, among others, Johnson and Kaplan:

> The evidence and arguments advanced by advocates of wholesale changes in management accounting are not yet sufficient to justify the wholesale revision of management accounting in the UK (Bromwich and Bhimani, 1989).

Murphy and Braund (1990) support this thesis and question the academic rigour of some of the data with which Kaplan supports his position.

As a result of the criticisms levelled at traditional management accounting Cooper (1987a, b, 1988a, b, 1989a, b) developed an approach known as activity-based costing (ABC). Jeans and Morrow (1989) argue that ABC overcomes many of management accounting's traditional problems, such as:

- Management accounting has become distorted by the needs of financial reporting; in particular, costing systems are driven by the need to value stock, rather than to provide meaningful product costs.
- Direct labour has shrunk as a percentage of total cost for the majority of manufacturing companies, yet it is still by far the most common basis of loading overheads onto products.
- Overhead costs are no longer a mere burden to be minimized. Overhead functions such as product design, quality control, customer service, production planning and sales order processing are as important to the customer as are the physical processes on the shopfloor.
- Complexity has increased. Production processes are more complex, product ranges wider, product life cycles shorter, quality higher.
- The marketplace is more competitive. Global competition is a reality in most sectors. Every business should be able to assess the true profitability of the sectors it trades in, understand product costs and know what drives overhead. The cost management systems (CMS) should support process improvement and the performance measures should be in line with strategic and commercial objectives.

In 1985 Miller and Vollmann (1985) pointed out that while many managers focus on the visible costs, e.g. direct labour, direct material, etc., the majority of overheads are caused by the "invisible" transaction costs. Cooper appears to have based his early work on this paper and the central assumption underlying ABC is that it is activities, and not products, that cause cost:

> In an ABC system, the cost of a product is the sum of all activities required to manufacture and deliver the product (Cooper, 1988).

Troxel and Weber (1990) say that ABC is not really a new concept and they suggest that it has undergone three phases of development. In the first, ABC was not formally recognized. It was merely seen as an advanced version of traditional cost accounting and indeed there is evidence to suggest that some firms were using ABC in the late 1960s. In the second phase of its development, which was led by academics such as Cooper, ABC became recognized as a costing system in its own right, but many practitioners were put off by the thought that they might have to scrap their existing cost accounting system in order to introduce it. Troxel and Weber (1990) argue that it was not until phase three that it was finally recognized that ABC was not an alternative to traditional cost accounting, but that it could be used as part of the strategic decision-making process. Hence they agree with Kaplan's (1988) assertion that there should be a disconnection between external financial reporting and the systems used to gather information for strategic decision making.

Despite the fact that ABC is seen by many US firms as a low payoff activity it has been subject to only a small amount of criticism (Kim and Miller, 1992). Piper and Walley (1990, 1991) question whether the assumption that activities cause cost is valid. They point out that the claim that ABC provides more accurate product costs has, first, never been proven and second, is based on a comparison with traditional cost accounting systems, rather than more modern ones such as contribution costing. Allen (1989) pursues a similar theme when he points out that ABC bases its analysis on the existing cost structure of a firm. Hence it does not encourage managers think radically and examine whether their business processes can be redesigned. Other problems with ABC include the fact that it ignores opportunity costs (Dugdale, 1990) and that most of the data required has to be estimated (Maskell, 1988). Currently the view in the ascendancy appears to be that ABC is best used as a means of analysis on a one-off basis (Troxel and Weber, 1990). Indeed, a KPMG consultant recently told one of the authors that in his experience the greatest benefit of ABC was that it forced managers to think about how they could reduce the hidden or "invisible" cost of transaction.

For the purpose of this article, then, it is sufficient to note that ABC was originally driven by the need to generate more accurate product costs. Recently, however, it has become increasingly apparent that ABC's benefit is largely a function of process analysis (Cooper and Kaplan, 1991). This links in with the concept of business process redesign which involves looking at information, which flows across, rather than down through, an organization. For the interested reader a fuller review of the ABC literature is provided by Innes and Mitchell (1990a, b).

Another widely documented cost-based performance measure is productivity. This is conventionally defined as the ratio of total output to total input (Burgess, 1990). Hence:

> Productivity is a measure of how well resources are combined and used to accomplish specific, desirable results (Bain, 1982).

Ruch (1982) has pointed out that higher productivity can be achieved in a number of ways, including:

- increasing the level of output faster than that of the input (managed growth);
- producing more output with the same level of input (working smarter);
- producing more output with a reduced level of input (the ideal);
- maintaining the level of output while reducing the input (greater efficiency); and
- decreasing the level of output, but decreasing the level of input more (managed decline).

Problems arise with the measurement of productivity because it is difficult not only to define inputs and outputs, but also to quantify them (Burgess, 1990). Craig and Harris (1973) suggest that firms should seek to measure total, rather than partial, productivity. This point was later picked up by Hayes *et al.* (1988) when they described how firms could measure total factor productivity. For the interested reader more detail on productivity is available in Clark *et al.* (1985), Kendrick (1984), Lieberman *et al.* (1990), Mundel (1987), Sink (1985), Skinner (1986), and Womack *et al.* (1990).

Performance measures relating to flexibility

Slack (1983) identifies range, cost and time as dimensions of flexibility, although he later modifies this model so that it includes only range and response, where range refers to the issue of how far the manufacturing system can change and response focuses on the question of how rapidly and cheaply it can change (Slack, 1987).

Gerwin (1987) observes that very little is known about the implications of flexibility for manufacturing management and suggests that "part of the problem arises from the lack of operational measures of flexibility". After identifying various dimensions of flexibility he suggests the following measures:

> Mix flexibility can be measured by the number of components handled by the equipment . . . Where this figure is heavily influenced by short term fluctuations in market demand an average over a given time period can be used. However, the range of component characteristics handled is probably a more sophisticated measure of mix flexibility. A manufacturing process may handle a small number of different components but they may be very different from each other. Another measure to consider is the ratio of the number of components processed by the equipment to the total number processed by the factory.

One possible raw measure of changeover flexibility is the number of component substitutions made over a given time period. However, a correction also needs to be made here for the degree to which the new and old component differ from each other. There may be a low frequency of changes but they may involve very dissimilar components. An alternative approach suggested by Gustavsson (1984) is to calculate the ratio of the equipment investment relevant for the next product to the total investment.

Modification flexibility can be measured in terms of the number of design changes made in a component per time period.

Rerouting flexibility has a long-term aspect which is salient when machines are taken out of production to accommodate major design changes. There is also a short-term aspect, which arises from the necessity to cope with machine shutdowns due to equipment or quality problems. A measure for each aspect should reflect the following mutually exclusive possibilities: it is possible to reroute components directly affected by the stoppage; rerouting is not possible but production of other components produced by the machine or manufacturing system continues; and all production stops. Alternatively Buzacott (1982) suggested measuring rerouting flexibility by the drop in production rate when a machine stoppage occurs.

Volume flexibility needs to be considered at the aggregate level as well as at the level of individual components. Volume changes depend upon how high capacity limits are set and how rigid are these limits. Flexibility can be measured in terms of the average volume fluctuations that occur over a given time period divided by the capacity limit.

Material flexibility exists when there are adjustment mechanisms at one stage of a manufacturing process which identify and then correct or adapt to variations arising previously. For example, in manual systems operators can locate bent metal and adjust it or properly position it in the machines. Otherwise, quality problems and machine breakdowns will mount. Material flexibility can be measured by the extent of variations in key dimensional and metallurgical properties handled by the equipment. Sequencing flexibility could be measured by the number of different sequences handled by the equipment with the lower limit being inviable sequence and the upper limit being random processing.

Cox (1989) sees the concept of flexibility as a measure of the efficiency with which the manufacturing process can be changed. He focuses on the issues of product-mix and volume flexibility and argues that the measures shown in Table V can be used to operationalize the first of these concepts.

Applications of performance measurement

Managers find it relatively easy to decide what they should be measuring. As mentioned earlier one of the ways in which data were collected for this review was through a survey of small-to-medium-sized manufacturing enterprises in the UK. Of the respondents to that survey 69 per cent agreed or strongly agreed with the statement

Element	Measure(s)
Vendor lead time	Percentage which can be obtained in *X* days or less
Labour: job classes	100 less the number of job classes
Labour: cross training	Percentage of workforce trained to do two or more jobs
Labour: transference	Percentage of workforce doing more than one production job in any given month
Set-up time	Percentage of equipment changed over in *X* minutes or less
Cycle time	Make time divided by total time in system
Programmable equipment	Percentage of equipment programmable
Multipurpose equipment	Percentage of equipment with multiple versus single product
Lot size	Percentage of products for which economic lot size is smaller than X
"Pull" production	Percentage of product made under kanban or a similar system
WIP inventory	Work-on-station divided by total work on floor

Source: Adapted from Cox (1989)

Table V.
Measures of product-mix

"we find it easy to decide which of the financial aspects of manufacturing we should be measuring", while 72 per cent agreed or strongly agreed with the statement "we find it easy to decide which of the non-financial aspects of manufacturing (quality, lead times, etc.) we should be measuring". Indeed it could be argued that managers find it too easy to decide what they should be measuring. When, for example, four senior managers were recently asked to identify what they thought should be measured in their firm they identified over 100 different measures. The problem facing this particular company, then, is not identifying what could be measured, but reducing the list of possible measures to a manageable set. One way of doing this might be to explore the rationale underlying the introduction of specific measures of performance.

In the manufacturing literature it is frequently argued that performance measures should be derived from strategy; that is, they should be used to reinforce the importance of certain strategic variables (Skinner, 1969). And although this does not always appear to happen in reality (Neely *et al.*, 1994), the link between performance measurement and strategy has been extensively explored in the business strategy literature. Many of the early writers on strategy, such as Andrews (1971) and Ansoff (1986), believed that strategies were synonymous with plans. In reality, however, strategies are much more complex because they evolve as decisions are made and courses of action are pursued (Mintzberg, 1978). Take, for example, Nissan, where the espoused business strategy is "to build profitably the highest quality car sold in Europe" (Gibson, n.d.). If Nissan's purchasing manager were to decide independently to buy low-cost, low-quality components then Nissan could end up following a strategy radically different to the one it had planned to adopt.

The key theme here is consistency – consistency of both decision making and action – because a strategy is only realized as decisions are made and courses of action are pursued. Indeed, it has been argued that a strategy can only be said to exist when one can identify a consistent pattern of decisions and action within a firm (Mintzberg, 1978). Hence an important question is how can one induce consistency of decision making and action within a firm?

Hrebiniak and Joyce (1984) argue that as humans are "calculative receptors" a strategic control system can be used to influence their behaviour. The process starts with the receipt of a stimulus; an external crisis, the normal job/task demands, or a request from a supervisor. Calculative receptors interpret the stimulus, assess the perceived costs and benefits of various responses and are likely to select whichever course of action they believe will maximize their gain. Control, which in this context includes performance measurement and feedback, follows action. Finally, rewards or sanctions are used to reinforce or modify behaviour depending on the employee's performance and on the appropriateness of the course of action pursued. Hence to business strategists the rationale underlying the introduction of a performance measure is that it is one element of a strategic control system and can be used to influence behaviour.

Despite the academic interest in strategic control systems, there has been relatively little empirical research on their use (Goold and Quinn, 1990). In 1979 Horovitz surveyed 52 European companies and found little evidence to suggest that firms actually use strategic controls. He does, however, describe how one firm used their performance measurement system to reinforce the importance of customer service:

> In one British electronics company investigated, top management has in fact put emphasis on a critical element in control. Whereas usual performance (i.e. financial results) is only reported every quarter, top management closely monitors – daily if needed – customer satisfaction, explicitly defined to be its major strategic strength: no equipment sold to a customer shall be down for more than 12 hours. To check on this, every morning and afternoon the chief executive is warned when any equipment has been down for more than 12 hours and corrective action is immediately taken at the highest level to replace or send a part to the customer. A systematic procedure has been set up whereby a service man unable to repair equipment within 2 hours notifies his superior, who in turn notifies his superior after 2 more hours (and so on up to the chief executive) in order to allow close control over what has been defined as a distinctive competence by the company: no down time whatever the costs (Horovitz, 1979).

More recently Goold and Quinn (1988) surveyed 200 of the largest British companies and report that only 11 per cent of them claimed to have a strategic control system. Interestingly these findings can be contrasted with those of Daniel and Reitsperger (1991). They surveyed 26 Japanese automotive and consumer electronics firms and found that:

> Japanese firms have taken to heart the strategic management literature advocating strategic controls ... Our findings indicate that modifications of management control systems by Japanese manufacturers are applied in Japanese plants as well as in operations abroad. These findings and the success of Japanese manufacturers in penetrating world markets support the normative theory that management control systems should be modified to fit strategy (p. 616).

There is also some evidence that Japanese firms use their management accounting systems to influence behaviour. Hiromoto (1988) argues that "high-level Japanese managers seem to worry less about whether an overhead allocation system reflects the precise demands each product makes on corporate resources than about how the system affects the cost-reduction priorities of middle managers and shop-floor workers". Morgan and Weerakoon (1989) concur with this view. It should be noted, however, that this is not a particularly novel idea. Indeed as long ago as Hopwood (1974) suggested that managers should pay more attention to the behavioural implications of management accounting.

Data on Japanese management accounting practices are relatively rare. Yoshikawa *et al.* (1989) surveyed 200 Scottish and 500 Japanese manufacturing companies and found that the Japanese cost accountants placed more emphasis on the generation of financial statements than did the Scottish ones. It is interesting to compare this finding with Johnson and Kaplan's (1987) assertion that the fact that cost accounting is driven by the need to generate financial statements is one of its greatest weaknesses. Yoshikawa *et al.* (1989) also found that Japanese companies pay more attention to product costing at the design stage. This is consistent with Sakurai's (1989) paper on target costing. He argues that many Japanese firms, especially those in the automotive industry, assume that selling prices are set by the market and hence if a company knows what return it wants to achieve, a target cost for the product can be established.

Simons (1987, 1990, 1991), Fitzgerald *et al.* (1991), Mintzberg (1978), Leong *et al.* (1990), Wheelwright (1984), Tunälv (1992), Garvin (1987), Schonberger (1990), Stalk (1988), Gerwin (1987), Slack (1987), Neely and Wilson (1992), Neely and Mills (1993), Neely *et al.* (1994), Feigenbaum (1961), Campanella and Corcoran (1983), Crosby (1972), Plunkett and Dale (1988), Crosby (1983), Garvin (1991), Deming (1982), Price (1984), Zairi (1992), Drucker (1990), Potts (1986), Goldratt and Cox (1986), Galloway and

Waldron (1988a, b, 1989a, b), Darlington *et al.* (1992), House and Price (1991), Fooks (1992), Azzone *et al.* (1991), Johnson (1972, 1975a, b, 1978, 1980, 1981, 1983), Garner (1954), Kaplan (1984a), Chandler (1977), Banks and Wheelwright (1979), Johnson and Kaplan (1987), Murphy and Braund (1990), Bromwich and Bhimani (1989), Cooper (1987a, b, 1988a, b, 1989a, b), Jeans and Morrow (1989), Miller and Vollmann (1985), Troxel and Weber (1990), Kaplan (1988), Kim and Miller (1992), Piper and Walley (1990, 1991), Allen (1989), Dugdale (1990), Maskell (1988), Cooper and Kaplan (1991), Innes and Mitchell (1990a, b), Burgess (1990), Bain (1982), Ruch (1982), Craig and Harris (1973), Hayes *et al.* (1988), Clark *et al.* (1985), Kendrick (1984), Lieberman *et al.* (1990), Mundel (1987), Sink (1985), Skinner (1986, 1969), Womack *et al.* (1990), Slack (1983), Gustavsson (1984), Buzacott (1982), Cox (1989), Andrews (1971), Ansoff (1986), Gibson (n.d.), Hrebiniak and Joyce (1984), Goold and Quinn (1990), Horovitz (1979), Goold and Quinn (1988), Daniel and Reitsperger (1991), Hiromoto (1988), Morgan and Weerakoon (1989), Hopwood (1974), Yoshikawa *et al.* (1989), and Sakurai (1989) extends the notion that performance measures can be used to influence behaviour[3,4,5]. He argues that management control systems can also be used as a means of surveillance, motivation, monitoring performance, stimulating learning, sending signals or introducing constraints. These are all themes that will be picked up again later. Before then, however, we will explore the concept of a performance measurement system as an entity and also the relationship between the performance measurement system and the environment within which it operates.

The performance measurement system as an entity

The previous section focused on the individual measures which together constitute a performance measurement system. This one will adopt a slightly different slant and examine the performance measurement system as a whole. It will begin by identifying the various dimensions of a performance measurement system. Then it will review a specific performance measurement system design process which has been proposed.

As discussed earlier Leong *et al.* (1990) have suggested that the manufacturing task, and hence the key dimensions of manufacturing performance, can be defined in terms of quality, time, price (cost), and flexibility. Other authors take a different stance. Following their study of performance measurement in the service sector, Fitzgerald *et al.* (1991) suggest that there are two basic types of performance measure in any organization – those that relate to results (competitiveness, financial performance), and those that focus on the determinants of the results (quality, flexibility, resource utilization and innovation). This suggests that it should be possible to build a performance measurement framework around the concepts of results and determinants.

Perhaps the best known performance measurement framework is Kaplan and Norton's (1992) "balanced scorecard" (Figure 3), which is based on the principle that a performance measurement system should provide managers with sufficient information to address the following questions:

- How do we look to our shareholders (financial perspective)?
- What must we excel at (internal business perspective)?
- How do our customers see us (customer perspective)?
- How can we continue to improve and create value (innovation and learning perspective)?

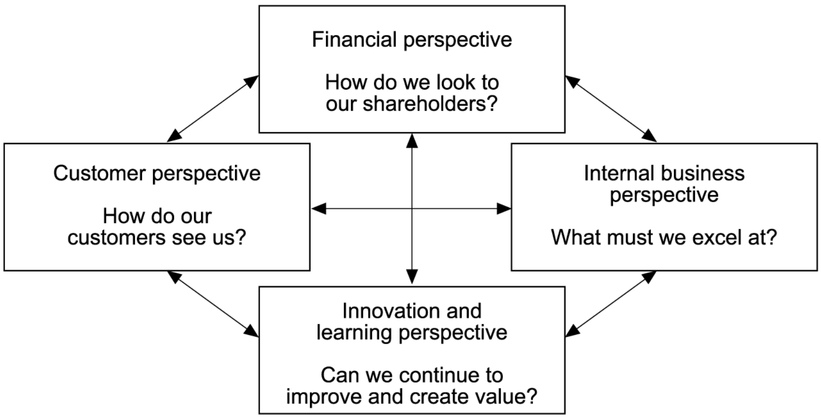


Figure 3.
The balanced scorecard

Source: Adapted from Kaplan and Norton (1992)

Consultants from KPMG claim to have used the balanced scorecard successfully both internally and with a number of their clients, but while it provides a useful framework there is little underlying it, in terms of the process of performance measurement system design (Hazell and Morrow, 1992; Kaplan and Norton, 1993). In addition, the balanced scorecard contains a serious flaw because if a manager were to introduce a set of measures based solely on it, he would not be able to answer one of the most fundamental questions of all – what are our competitors doing (the competitor perspective)?

Keegan *et al.* (1989) proposed a similar, but lesser known performance measurement framework – the performance measurement matrix. As with the balanced scorecard, its strength lies in the way it seeks to integrate different dimensions of performance, and the fact that it employs the generic terms "internal", "external", "cost" and "non-cost" enhances its flexibility. That is, the performance measurement matrix should be able to accommodate any measure which fits within the framework provided by the balanced scorecard, while the converse – take, for example, competitor performance – may not be true.

Rather than proposing frameworks, other authors prefer to provide criteria for performance measurement system design. Globerson (1985), for example, suggests that the following guidelines can be used to select a preferred set of performance criteria:

- Performance criteria must be chosen from the company's objectives.
- Performance criteria must make possible the comparison of organizations which are in the same business.
- The purpose of each performance criterion must be clear.
- Data collection and methods of calculating the performance criterion must be clearly defined.
- Ratio-based performance criteria are preferred to absolute number.
- Performance criteria should be under control of the evaluated organizational unit.

- Performance criteria should be selected through discussions with the people involved (customers, employees, managers).
- Objective performance criteria are preferable to subjective ones.

Similarly, Maskell (1989) offers seven principles of performance measurement system design:

(1) the measures should be directly related to the firm's manufacturing strategy;

(2) non-financial measures should be adopted;

(3) it should be recognized that measures vary between locations – one measure is not suitable for all departments or sites;

(4) it should be acknowledged that measures change as circumstances do;

(5) the measures should be simple and easy to use;

(6) the measures should provide fast feedback; and

(7) the measures should be designed so that they stimulate continuous improvement rather than simply monitor.

In the late 1980s General Motors invested some $20 million defining a set of 62 primary measures that could be applied consistently at various organizational levels. (Figure 4). They distinguish between measures of results, e.g. quality and responsiveness, and measures of the process of strategy implementation (Merchent, 1985 and Fitzgerald *et al.*, 1991 make similar distinctions[6].) The rationale underlying this "integrated" performance measurement system is that it should ensure that GM employees retain their focus on continuous improvement through teamwork in the key business activities[7].

Dixon *et al.* (1990) present an interesting structured methodology for auditing whether a firm's performance measurement system encourages continuous

	People development/ employee satisfaction	Product initiation	Operations	Marketing sales and service	Retail customer satisfaction	Shareholder satisfaction	Total
Corporate	3	8	5	7	5	9	38
Group	7	8	7	9	5	6	32
Divisional/ SBU	12	12	7	9	6	6	52
Plant/field	12	11	13	3	5	1	45
Department/ cell	12	8	8	-	1	1	30

Source: Adapted from Cami-I (1991)

Figure 4.
General Motors' integrated performance measurement system

improvement. They describe a performance measurement questionnaire (PMQ), which consists of three stages. In the first, general data on both the company and respondent are collected. In the second, the respondent is asked to identify those areas of improvement that are of long-term importance to the firm and to say whether the current performance measurement system inhibits or supports appropriate activity. In the third, the respondent is asked to compare and contrast what is currently most important for the firm with what the measurement system emphasizes.

The data are collected using seven-point Likert scales and then four types of analysis are conducted. The first is alignment analysis in which the extent of match between the firm's strategies, actions and measures is assessed. The second is congruence analysis, which provides more detail on the extent to which the strategies, actions and measures are mutually supportive. The third is consensus analysis, in which the data are analysed according to management position or function. And the fourth is confusion analysis in which the range of responses, and hence the level of disagreement, is examined.

Hayes and Abernathy (1980) focus on a different dimension of performance measurement – namely the fact that many traditional measures of financial performance encourage managers to adopt a short-term perspective. They hypothesize that the use of short-term financial controls may partly be to blame for the economic decline of the USA:

> Although innovation, the lifeblood of any vital enterprise, is best encouraged by an environment that does not unduly penalise failure, the predictable result of relying too heavily on short-term financial measures – a sort of managerial remote control – is an environment in which no one feels he or she can afford a failure or even a momentary dip in the bottom line (Hayes and Abernathy, 1980).

One of the most comprehensive studies of short-termism is the one reported by Banks and Wheelwright (1979). They conducted a series of in-depth interviews with managers and planners in six major US firms and found that short-termism encouraged managers to delay capital outlays; postpone operating expenses; reduce operating expenses; and make other operating changes such as varying the product mix, the delivery schedules, or the pricing strategy. Furthermore, they suggest that one of the ways in which short-termism can be minimized is by establishing performance measures, which reflect both the short and long term. This recommendation is supported by Kaplan (1984).

Another issue that has to be considered when designing a performance measurement system is conflict, as illustrated by Fry and Cox (1989). They cite the case of a firm where the plant manager was primarily concerned with ROI, the product group managers were evaluated according to the number of orders that were shipped on time, and the supervisors and operatives were measured according to standard hours produced. This measurement system encouraged the supervisors and operatives to save set-up time by producing batches larger than those scheduled. Hence some orders were delayed and the product group managers had to sanction overtime to ensure good due-date performance. This, in turn, had a negative impact on the plant's managers performance which was measured by ROI.

Finally, the perspective adopted by Computer Aided Manufacturing-International (CAM-I) provides an interesting insight. CAM-I is a consortium of industrialists and academics which sponsors, among other things, a research project on CMS:

The goal of a cost management system is to provide information to help companies use resources profitably to produce services or products that are competitive in terms of cost, quality, functionality, and timing in the world market. Within this context a cost management system can be defined as a management planning and control system with the following objectives:

- To identify the cost of resources consumed in performing significant activities of the firm (accounting models and practices).
- To determine the efficiency and effectiveness of the activities performed (performance measurement).
- To identify and evaluate new activities that can improve the future performance of the firm (investment management).
- To accomplish the three previous objectives in an environment characterised by changing technology (manufacturing practices)(Berliner and Brimston, 1988).

CAM-I projects tend to adopt an activity-based approach. That is, they focus on the process of doing something, rather than the output. As discussed earlier, this has implications for the performance measurement system design task because, as Deming (1986) and others have argued, gaining control over a process, and hence producing things right first time, is probably more cost effective than repairing things after the event.

This section has sought to illustrate the complexity of the performance measurement system. To attempt to produce a single unifying framework at this stage seems unrealistic. Indeed as Blenkinsop and Davis (1991) report one has to consider all of the following when designing a performance measurement system:

- Departmental goal-setting without creating inconsistencies in policy or excessive interdepartmental conflict.
- Whether the measure is a valid indicator of the performance of the group.
- An appropriate mix of integration and differentiation (i.e. goals set both horizontally and vertically within the framework of the organizational chart).
- A thorough understanding of the existing measurement systems, both formal and informal, spoken and unspoken, as they are perceived.
- Management consensus concerning the organization's objectives and the means at its disposal for attaining them.
- The corporate culture.
- Long-, short- and medium-term goals (both financial and non-financial), not a fixation with "this month's" sales figure.
- Part-ownership of problems – so that a solution has to be found across functional boundaries and the escape route, "it's somebody else's fault" (often the ethereal "company's" fault), no longer has any meaning or validation.
- Total commitment from all involved, so that the "end-of-the-month" syndrome – a system driven by sales value – does not rear its ugly head at the end of the first month following implementation and each and every subsequent month thereafter.

The authors are currently involved in a project, which adopts the view that the best way to overcome this complexity is by producing a process for designing a measurement system, rather than a framework. Work on this is rare. Indeed, the only examples of processes for the design of performance measurement systems that the authors have been able to identify consist of a set of steps with little underlying content. The work of Wisner and Fawcett (1991) is typical. They propose the following nine-step "process" for developing a performance measurement system, but make no attempt to explain how it can be operationalized:

(1) Clearly define the firm's mission statement.
(2) Identify the firm's strategic objectives using the mission statement as a guide (profitability, market share, quality, cost, flexibility, dependability, and innovation).
(3) Develop an understanding of each functional area's role in achieving the various strategic objectives.
(4) For each functional area, develop global performance measures capable of defining the firm's overall competitive position to top management.
(5) Communicate strategic objectives and performance goal to lower levels in the organization. Establish more specific performance criteria at each level.
(6) Assure consistency with strategic objectives among the performance criteria used at each level.
(7) Assure the compatibility of performance measures used in all functional areas.
(8) Use the performance measurement system to identify competitive position, locate problem areas, assist the firm in updating strategic objectives and making tactical decisions to achieve these objectives, and supply feedback after the decisions are implemented.
(9) Periodically re-evaluate the appropriateness of the established performance measurement system in view of the current competitive environment.

The performance measurement system and its environment

Once a performance measurement system has been developed it has to be implemented. Among other things this means that the performance measurement system will have to interact with a wider environment. There are two fundamental dimensions to this environment. The first is the internal one – that is the organization. The second is the external one – that is the market within which the organization competes. These will be discussed in turn in this section.

The internal environment

Earlier the concept of a strategic control system was introduced. There the performance measurement system is seen as but a part of a wider system, which includes goal setting, feedback, and reward or sanction. Business strategists argue that the wider system has to match the business strategy (Hrebiniak and Joyce, 1984; Lorange, 1982). Organizational culturists, such as Weick (1985) suggest that strategies and cultures are synonymous. Hence one can argue that the performance measurement system has to be consistent with the organization's culture. Indeed it is easy to imagine what would happen in a culture based on blame if, for example, one were to introduce a measure of the number of defects produced by each operative. The culture of the organization would encourage everyone to lie. Hence one can question whether there would be any point in introducing such a measure.

Another dimension to the problem arises because of the functional structure adopted by many organizations. Shapiro (1977) discusses the conflict between marketing and manufacturing and suggests that it is partly a result of the evaluation and reward systems used in many firms.

One prime reason for the marketing/manufacturing conflict is that the two functions are evaluated on the basis of different criteria and receive rewards for different activities. On the one hand, the marketing people are judged on the basis of profitable growth of the company in terms of sales, market share, and new markets entered. Unfortunately, the marketers are sometimes more sales-oriented than profit-oriented. On the other hand, the manufacturing people are often evaluated on running a smooth operation at minimum cost. Similarly unfortunately, they are sometimes more cost-oriented than profit-oriented.

The system of evaluation and reward means that the marketers are encouraged to generate change, which is one hallmark of the competitive marketplace. To be rewarded, they must generate new products, enter new markets, and develop new programmes. But the manufacturing people are clearly rewarded for accepting change only when it significantly lowers their costs.

Because the marketers and manufacturers both want to be evaluated positively and rewarded well, each function responds as the system asks it to in order to protect its self-interest[128, p. 108].

At a higher level, KPMG, a UK management consultancy, reports that "increasing numbers of executive directors of KPMG client companies express concern that the information they receive neither enables them to measure performance against their chosen strategy and objectives, nor helps them in their strategic-decision making process. The common complaints are of too much data and too little analysis". More specifically, and following a survey of 150 of *The Times* 1,000 companies, excluding the top 200, KPMG found that:

- Most companies used targets and performance indicators based on internal financial standards. External comparisons and non-financial targets were not widely used.
- Information used to monitor performance was rated poor or average by just under half the companies contacted in terms of its relevance, accuracy, timeliness, completeness, cost-effectiveness and presentation. Dissatisfaction appeared to be most marked in the cost-effectiveness and presentation of information.
- A majority of the respondents rated the information available to formulate and review strategy as poor or average, while 42 per cent said that at times it failed to highlight critical issues. Strategic planners were less satisfied than their accounting colleagues with the relevance, timeliness and completeness of the information that was presented.
- The primary objective of most of the companies surveyed was industry leadership, achievement of target earnings per share, or a certain market share.

Achievement of these objectives was measured by financial criteria in three-quarters of the organizations.

- Internal information such as cost profiles, product profitability and past financial performance appeared to dominate the information set. External information, such as domestic and overseas macroeconomic data, demographic projections, EC policies and impending legislation was not reported as being widely used in strategy formulation or monitoring (Information for Strategic Management, 1990).

In one of the more academic studies of performance measurement Richardson and Gordon (1980) adopt an entirely different perspective and explore whether performance measures change as products move through their life cycle and hence begin to compete on different factors. At the outset of their study they hypothesized that:

- as products move through their life cycle, the appropriate performance measures will change;
- performance measures will be easier to develop for products late in their life cycle as these tend to compete on cost rather than innovativeness;
- dysfunctional consequences will result if measures are not appropriate;
- in multi-product facilities "traditional" measures will inhibit innovation; and
- manufacturing managers will respond to their perceived measures of performance.

Having collected data during interviews with the chief executive and manufacturing managers of 15 Canadian electronics companies, Richardson and Gordon (1980) observed that:

- the performance measures used did not change as products moved through their life cycle;
- the measures did not become better defined later in the products' life cycle, primarily because the performance measures used tended to focus on the plant as a whole, rather than individual products;
- inappropriate measures did introduce dsyfunctionality;
- traditional measures did inhibit innovation; and
- managers did respond to their perceived measures of performance.

Yet another perspective is adopted by Crawford and Cox (1990). They suggest that instead of trying to link measures to the manufacturing strategy, the organization's culture or the product life cycle, one should seek to integrate the measures and the manufacturing system. They therefore conducted a series of case studies and suggest that the following guidelines can be used to design a performance measurement system suitable for a JIT manufacturing environment:

- Performance to schedule criteria should evaluate group, not individual, work.
- Specific numeric standards, or goals, should be established for the performance to schedule criteria and these goals should be revised once they have been met.

- Specific numeric standards are not required for inventory and quality criteria; improving trends are needed.
- Performance criteria should be measured in ways that are easily understood by those whose performance is being evaluated.
- Performance data should be collected, where possible, by those whose performance is being evaluated.
- Graphs should be the primary method of reporting performance data.
- Performance data should be available for constant review.
- Schedule performance should be reported daily or weekly.
- A monthly reporting cycle for inventory performance and quality performance is sufficient.
- The reporting system should not replace frequently held performance review meetings.

The external environment

For the purposes of this review the external environment is assumed to consist of two distinct elements – customers and competitors. As discussed earlier a truly balanced performance measurement system would provide managers with information relating to both of these. Measures of customer satisfaction have already been discussed (see performance measures relating to quality), hence this section will focus on the measurement of competitor performance. One technique that can be used to do this is benchmarking, although benchmarking does not have to focus on competitors. Indeed there are four basic types of benchmarking:

(1) *Internal*. Internal to a corporation, but perhaps external to a plant or a particular business unit. One of the major advantages of internal benchmarking is that it minimises problems of access and data confidentiality.

(2) *Competitive*. This is probably the most beneficial form of benchmarking, but the collection of data which is directly comparable is very difficult.

(3) *Functional*. This involves functional comparison with companies which are similar, but not direct competitors.

(4) *Generic*. The study and comparison of truly generic business process, e.g. order entry, invoicing.

Benchmarking is proving to be a topic of interest to both academics and consultants. One of the first benchmarking studies to be documented was the one carried out by Garvin (1983). He collected data on the performance of USA and Japanese air conditioning manufacturers in the early 1980s. More recently Womack *et al.* (1990) have completed a study of the automotive industry. Over a 5-year period they collected detailed performance data, such as that shown in Table VI, on most of the world's major automotive plants and from these were able to identify a two to one performance gap along a number of dimensions. In 1993 Andersen Consulting (The Lean Enterprise Benchmarking Project, 1993) reported a similar finding, following their study of automotive components suppliers. While in the USA the MIT/Sloan Foundation is continuing to fund a number of industry specific benchmarking projects, including ones which focus on semi-conductors; textiles; computers; steel; pharmaceutical; chemical process; process equipment.

In terms of academic research Voss *et al.* (1992a), Galloway and Waldron (1988b, 1989a, b), Darlington *et al.* (1992), House and Price (1991), Fooks (1992), Azzone *et al.* (1991), Johnson (1972, 1975a, b, 1978, 1980, 1981, 1983), Garner (1954), Kaplan (1984a, b, 1988), Chandler (1977), Banks and Wheelwright (1979), Johnson and Kaplan (1987), Murphy and Braund (1990), Bromwich and Bhimani (1989), Cooper (1987a, b, 1988a, b, 1989a, b), Jeans and Morrow (1989), Miller and Vollmann (1985), Troxel and Weber (1990), Kim and Miller (1992), Piper and Walley (1990, 1991), Allen (1989), Dugdale (1990), Maskell (1988, 1989), Cooper and Kaplan (1991), Innes and Mitchell (1990a, b), Burgess (1990), Bain (1982), Ruch (1982), Craig and Harris (1973), Hayes *et al.* (1988), Clark *et al.* (1985), Kendrick (1984), Lieberman *et al.* (1990), Mundel (1987), Sink (1985), Skinner (1986, 1969), Womack *et al.* (1990), Slack (1983), Gustavsson (1984), Buzacott (1982), Cox (1989), Andrews (1971), Ansoff (1986), Gibson (n.d.), Hrebiniak and Joyce (1984), Goold and Quinn (1990, 1988), Horovitz (1979), Daniel and Reitsperger (1991), Hiromoto (1988), Morgan and Weerakoon (1989), Hopwood (1974), Yoshikawa *et al.* (1989), Sakurai (1989), Simons (1987, 1990, 1991), Kaplan and Norton (1993), Keegan *et al.* (1989), Globerson (1985), Merchent (1985), Dixon *et al.* (1990), Hayes and Abernathy (1980), Fry and Cox (1989), Berliner and Brimston (1988), Deming (1986), Blenkinsop and Davis (1991), Wisner and Fawcett (1991), Lorange (1982), Weick (1985), Shapiro (1977), Information for Strategic Management (1990), Richardson and Gordon (1980), Crawford and Cox (1990), Garvin (1983), The Lean Enterprise Benchmarking Project (1993), and Voss *et al.* (1992a, b, c, 1993) have produced a series of workbooks which discuss the process of benchmarking innovation[4,5,6,7]. They identify four dimensions to innovation:

(1) product innovation;

(2) product development;

(3) process innovation; and

(4) technology acquisition.

They argue that firms should seek to benchmark themselves along each of these dimensions.

Industrial interest in benchmarking is also high. The Britain's Best Factories Award, run by *Management Today*, was based on a benchmarking exercise for the first time in 1992. Each entrant filled in a self-assessment questionnaire which covered issues such as the plant profile; the nature of the manufacturing operations; the cost

	GM Framingham	Toyota Takaoka
Gross assembly hours per car	40.7	18.0
Adjusted assembly hours per car	31	16
Assembly defects per 100 cars	130	45
Assembly space per car	8.1	4.8
Inventory parts (average)	2 weeks	2 hours

Source: Adapted from Womack *et al.* (1990)

Table VI.
Comparative assembly performance data

structure; the inventory profile; the employee profile; product innovation; management information; and market positioning. The judges, all based at Cranfield School of Management, UK, analysed the data and then visited the best plants before making a final decision. This innovation lends greater credibility to the Best Factories Award as previously the judgement process was based on consultants' opinions rather than on data.

Some authors see benchmarking as a means of identifying improvement opportunities as well as monitoring the performance of competitors. Young (1993), for example, argues that benchmarking is being used in this way by many large companies. He proposes that as most of the "low hanging fruit has been picked" the identification of improvement opportunities is becoming increasingly difficult. Hence managers are adopting benchmarking as a means of searching for best practice and new ideas. He identifies four steps in the benchmarking process:

(1) planning;

(2) analysis;

(3) integration; and

(4) action.

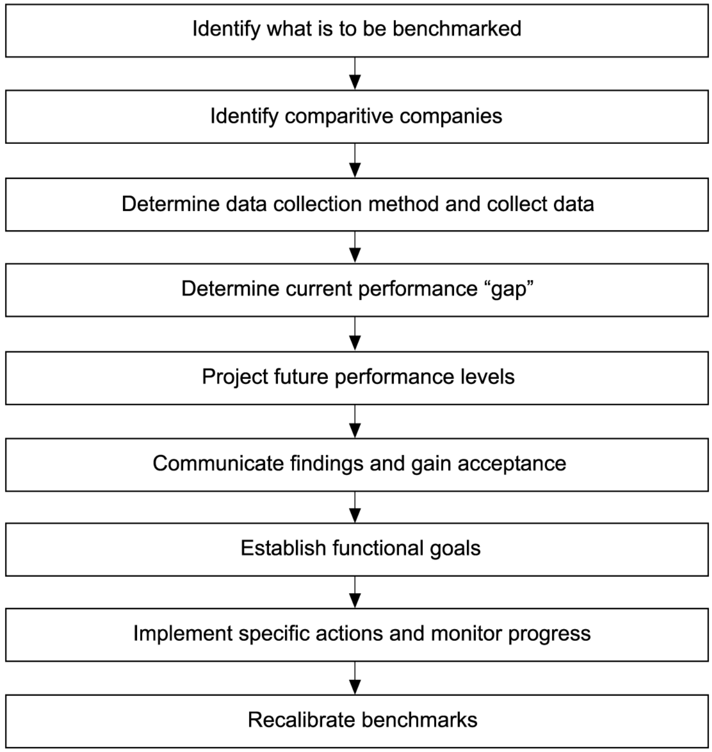
Of course one danger with this approach is that the company that is searching for best practice will always be following rather than leading.

Perhaps the most comprehensive description of benchmarking, to date, has been provided by Camp (1989). He defines benchmarking as the search for industry best practices that lead to superior performance and bases his book on the nine-step benchmarking process shown in Figure 5 (adapted to the nine-step benchmarking process for this article). In terms of performance measurement system design, however, the work of Oge and Dickinson (1992) is perhaps more relevant. They suggest that firms should adopt closed loop performance management systems which combine periodic benchmarking with ongoing monitoring/measurement (Figure 6).

Implications – performance measurement research agenda

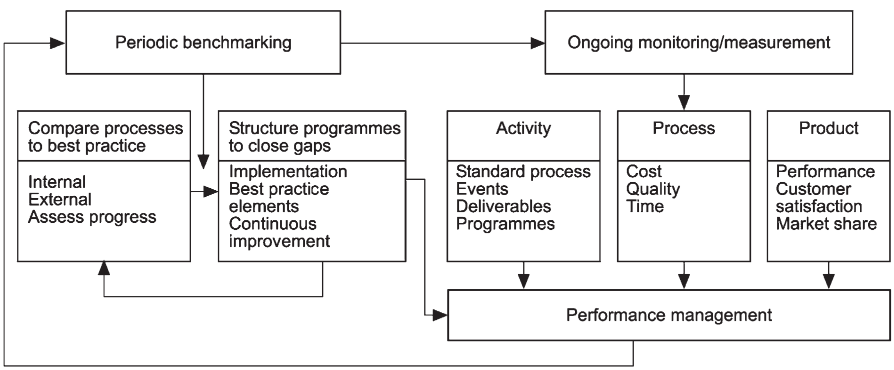
There appears to be a growing recognition that the measures of performance that companies have traditionally used are inappropriate for manufacturing businesses (Kaplan, 1984a, b, 1983, 1986), not least because they:

- encourage short-termism, for example the delay of capital investment (Banks and Wheelwright, 1979; Hayes and Garvin, 1982);
- lack strategic focus and do not provide data on quality, responsiveness and flexibility (Skinner, 1974);
- encourage local optimization, for example manufacturing inventory to keep people and machines busy (Hall, 1983);
- encourage managers to minimize the variances from standard rather than seek to improve continually (Schmenner, 1988; Turney and Anderson, 1989);
- fail to provide information on what their customers want and what their competitors are doing (Kaplan and Norton, 1992; Camp, 1989).



Source: Adapted from Camp (1989)

Figure 5.
The nine-step benchmarking process



Source: Adapted from Camp (1989)

Figure 6.
Closed loop performance management

Performance measurement system design, or re-design, is firmly on the industrial agenda (Lynch and Cross, 1991; Geanuracos and Meiklejohn, 1993). In terms of issues that need researching this review has identified the following as key.

Issues associated with individual measures of performance

Issues associated with individual measures of performance include:

(1) Is performance measurement a luxury for the SMME (small or medium manufacturing enterprise)?
- Which performance measures are of greatest value to SMMEs?
- Do the costs of some measures outweigh their benefit?
- Is this only an issue for SMMEs or does it apply to all sizes of organization?

(2) Should measures focus on processes, the outputs of processes, or both?

(3) Is time the fundamental measure of manufacturing performance?

(4) How can the measurement of total factor productivity be simplified?

(5) How can flexibility, which is often simply a property of the "system", be measured?

(6) How can performance measures be designed so that they encourage inter-functional co-operation?

(7) How can measures which do not encourage short-termism be designed?

(8) How can performance measures be designed so that they encourage appropriate behaviour?

(9) Can "flexible" measures which take account of the changing business environment be defined?

(10) How should the data generated as a result of a particular measure be displayed?

(11) How can one ensure that the management loop is closed – that corrective action follows measurement?

Issues associated with the performance measurement system as an entity

These issues ask the questions:

(1) What are the "definitive" principles of performance measurement system design?

(2) How can measures be integrated both across an organization's functions and through its hierarchy?

(3) How can conflicts between performance measures be eliminated?

(4) What techniques can managers use to reduce their list of "possible" measures to a meaningful set?
- Would a "generic" performance measurement system facilitate this process?
- Would a performance measurement framework facilitate this process?
- Or is a process-based approach required?
- What are the relative advantages and disadvantages of the above?

(5) Do "generic" performance measurement systems actually exist?

(6) What does a truly "balanced scorecard" constitute?
(7) Can a practicable performance measurement system design process be specified?
(8) Can a "flexible" performance measurement system which takes account of the changing business environment be defined?
(9) How can the cost-benefit of a performance measurement system be analysed?

Issues associated with the system and its environment

Issues associated with the system and its environment raise the following points:

- What implications do emerging concepts, such as ABC, BPR or the notion of core competencies, have for performance measurement?
- Why do firms fail to integrate their performance measures into their strategic control systems?
- How can we ensure that the performance measurement system matches the firm's strategy and culture?
- To which dimensions of the internal and external environment does the performance measurement system have to be matched?

The final issue, and one which has not yet been touched, is that of predictive performance measurement. The assumption underpinning this review, and indeed much of the work on performance measurement to date, is that managers use measures both to monitor past performance and stimulate future action. Increasingly, however, people are beginning to look for "predictive" measures. Measures, such as statistical process control (SPC), which show that something is going out of control, before too much damage has been done. A key item on the performance measurement research agenda must therefore be the identification, and/or development, of "predictive performance measures".

Notes

1. This can be expressed either in terms of the actual efficiency and/or effectiveness of an action, or in terms of the end result of that action.
2. In this context the term metric refers to more than simply the formula used to calculate the measure. For a given performance measure to be specified it is necessary to define, among other things, the title of the measure, how it will be calculated (the formula), who will be carrying out the calculation, and from where they will get the data. See Neely (1994) for a fuller explanation.
3. The two factors delivery speed and delivery reliability are both assumed to fall into the generic category time for the purpose of Figure 3. They are shown as factors T3 and T4 respectively.
4. Note how closely these assumptions match the OPT measures: operating costs, inventory and throughput. Waldron used to work for Creative Options – the company that sold the OPT system developed by Goldratt.
5. In the electronics industry it is even less – perhaps only two or three per cent.
6. Merchent suggests that as business managers need discretion, goals (and hence controls) should be set for them which relate to the results that they are expected to achieve rather than the actions that they have to take. Fitzgerald *et al.* are not as prescriptive, but still

suggest that a distinction should be made between measures which relate to results (profits, ROI . . .) and measures which report on the determinants of those results (quality, flexibility, resource utilization).

7. Minutes of the meeting held in Milan, CAMI-I, Italy, 23-25 April, 1991

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