B

balancing loss

David Bennett

Balancing loss is the quantification of the lack of balance in a production line, defined as the percentage of time not used for productive purposes with the total time invested in making a product. The importance of this measure lies in its ability to assess perhaps the most problematic of all the detailed design decisions in product layout, namely that of LINE BALANCING. Achieving a perfectly balanced allocation of activities to workstations is nearly always impossible in practice and some imbalance in the work allocation between stages results. So the effectiveness of the line-balancing activity can be measured by balancing loss. In effect it is the time wasted through the unequal allocation of work.

See also *bottlenecks; business process redesign; layout; process layout*

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beer distribution game

Arne Ziegenbein and Joerg Nienhaus

The beer distribution game is a simulation of a supply chain. Participants take the role of a company and decide – based on their current stock situation and customer orders – how much to order from their suppliers. The goal is to minimize costs for capital employed in stocks while avoiding out-of-stock situations. The simulation explains inefficiencies of supply chains known as the bullwhip effect.

See also *supply chain dynamics; supply chain management; supply network information systems*

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benchmarking

Nick Oliver

Benchmarking first arrived on the management scene in the late 1980s. The first book specifically about benchmarking was Camp's *Benchmarking: The Search for Industry Best Practices*, which was published in 1989. As with any relatively recent phenomenon, particularly in the field of management, there has been extensive discussion as to whether benchmarking represents a passing fad or is destined to become an established practice in the long term. A search

on the management database *ProQuest Direct*, undertaken in early 2000, resulted in 2,256 hits, and demonstrated a massive rise in interest in benchmarking between 1990 and 1992.

Since peaking in the early 1990s, interest in benchmarking appears to have been sustained, and articles have appeared on how and how not to benchmark and the benefits and costs of benchmarking. These have covered many different sectors, including manufacturing, product development, logistics, healthcare, education, plant maintenance, customer satisfaction, as well as many others. Significantly, the vast majority of these articles are short (typically one or two pages) and appear predominantly in practitioner journals. Although a number of large-scale benchmarking studies have been published, most benchmarking activity has occurred outside the public domain, undertaken by practitioners for practitioners.

This entry addresses four main issues: (1) What is benchmarking and how widespread is the practice? (2) What techniques of and approaches to benchmarking exist? (3) What public domain examples of benchmarking studies exist and what can be learned from them? (4) What assumptions underpin the benchmarking process and what criticisms may be leveled against it?

Benchmarking Defined

Several definitions of benchmarking exist, the vast majority of which possess the same basic themes: "Benchmarking is the continuous process of measuring products, services and practices against the toughest competitors or those companies recognized as industry leaders" (Camp, 1989: 10); "Benchmarking is a continuous search for and application of significantly better practices that lead to superior performance" (Watson, 1993: 4); "Benchmarking is the process of comparing business practices and performance levels between companies (or divisions) in order to gain new insights and to identify opportunities for making improvements" (Coopers and Lybrand/CBI, 1994: 3).

The key elements of benchmarking are simple: at its core, benchmarking is about systematically comparing the performance of operations with a view to stimulating performance improvement – either from the "shock value" of the comparison or from the extraction of the principles of best practice from high(er)-performing operations. It is this combination of identifying differentials in performance or processes and then *using* this information to leverage improvement, learning, and change which best characterizes benchmarking. Significantly, this also confers on benchmarking a political dimension.

Camp (1989) identifies four types of benchmarking:

1 benchmarking against internal operations;
2 benchmarking against external operations of direct competitors;
3 benchmarking against the equivalent functional operations of non-competitors;
4 generic process benchmarking.

These approaches all involve comparison of the performance and management of processes. One could add a fifth category of product benchmarking, which compares the features and performance of products. For example, car manufacturers routinely carry out "tear down" analyses of competitor's vehicles to see how they compare in terms of design, manufacturability, and other features. The focus in this entry is on benchmarking as process, not product, comparison.

Internal benchmarking, as the name suggests, refers to the comparison of processes within the same organization. It is most likely to be found in large multidivisional or international firms where subunits have comparable operations. Examples might include comparisons in assembly hours per car or assembly defects per vehicle between different car assembly plants within a multinational car company. This raises the question of the differences between the collection of information for benchmarking purposes versus normal operational control purposes. In theory, the distinction is clear – benchmarking is undertaken as a one-off exercise, for the purpose of learning and improvement, rather than control. In practice, benchmarking studies are inevitably likely to function as occasions for apportioning glory – or blame – and therefore may have a profoundly political dimension. For example, Delbridge, Lowe, and Oliver (1995) describe how the findings of a benchmarking study were

used by a plant director to publicly criticize his managers for the poor performance of the plant. Lack of cooperation from the operating units whose performance is to be benchmarked is a common problem in internal studies for this very reason.

"Competitor benchmarking," as the name suggests, involves performance comparisons between organizations which are direct competitors. The logic behind this is clear; if firms are operating in exactly the same marketplace, then, in theory at least, many issues of comparability should be overcome. This is relevant as the biggest single challenge of benchmarking lies in establishing the *legitimacy* of the comparison. Clearly, if all the comparison reveals is that apples are different from oranges, then little of value has been learned. Delbridge et al. (1995) describe the difficulty in attaining comparability between units on measures of physical productivity and document how this was achieved in a benchmarking study in the automotive industry.

Some competitor comparisons are possible from public sources, for example, company accounts, but these are generally of limited detail and hence of limited utility. Direct competitor benchmarking can be difficult to carry out owing to the commercial sensitivity of much of the information. However, examples of this do exist, typically where the benchmarking has been carried out by trusted and independent third parties, as for example in the INTERNATIONAL MOTOR VEHICLE PROGRAM (IMVP) (Womack, Jones, and Roos, 1990).

"Functional" or "generic" benchmarking refers to the comparison of specific processes (functions) between organizations whose overall mission or operations may be very different. Camp (1989) gives the example of Xerox's use of L. L. Bean as a benchmark against which to judge the performance of its own distribution operation (data from this are shown in table 1.)

Table 1 Warehouse performance: L. L. Bean vs. Xerox

	L. L. Bean	*Xerox*
Orders per person-day	69	27
Lines per person-day	132	129
Pieces per person-day	132	616

The rationale behind studies such as the Xerox/L. L. Bean exercise is that it is as important to understand the processes which generate outputs as to quantify the outputs themselves. The quest is for models of good practice in core business functions – models which may be independent of specific products or services. Benchmarking is one method of unearthing such models and revealing any deficiencies in contemporary practice. Activities such as business process reengineering may then build on this knowledge.

There is currently widespread interest in benchmarking. However, it is difficult to assess precisely the extent to which this interest is being translated into actual benchmarking activity. One indicator is that several companies have set up units specifically to carry out benchmarking. A study of benchmarking among the *Times 1000* UK companies carried out by Coopers and Lybrand and the Confederation of British Industry (CBI) in 1994 concluded that 78 percent of companies were engaged in benchmarking. Manufacturing companies were more likely to carry out benchmarking studies than were service companies. Benchmarking was found across all business functions, but its use was highest in customer service, sales, and logistics and lowest in the less tangible area of product development and research and development.

The Coopers and Lybrand/CBI study noted that the majority of organizations that had engaged in benchmarking had found it to be a successful exercise, and reported that the main benefits were: assistance in setting meaningful and realistic targets; improvement in productivity; gaining of insights into new or different approaches; and motivating employees by demonstrating what was achievable. The main problems reported in benchmarking were: difficulty in gaining access to confidential information, especially information concerning competitors; the lack of resources; and problems in establishing the comparability of data from different organizations. These difficulties notwithstanding, a sizable majority of companies predicted that they would expand their benchmarking programs in the next five years.

The Benchmarking Process

Virtually all the available books specifically about benchmarking are aimed at practitioners and hence emphasize "how to benchmark" or "the process of benchmarking." Although the terminology of these models varies, the principles are similar, involving a series of stages through which the would-be benchmarkers should pass. The stages shown in table 2 are drawn from Camp (1989) and are typical of those found in many texts.

An illustration of this approach in action is provided by Lucas Industries, the UK-based engineering firm, which has interests in the aerospace and automotive industries. In the early 1980s Lucas was faced with its first ever loss in over 100 years of trading. In the words of its chairman, Lucas had to face up to the fact that its "overall performance in most of its major markets had become fundamentally uncompetitive" (Vliet, 1986: 21). At this point Lucas began a radical program of reform. Financial responsibility was focused into business units and each unit was required to submit a competitiveness achievement plan (CAP) to Lucas Corporate Headquarters on an annual basis. The CAP was a plan for the achievement of performance levels comparable with the leading international competitor in the area. Business units that did not institute CAPs risked being closed or sold and during the 1980s over 40 were disposed of. Vliet (1986: 21) characterizes the process as a combination of "vigorous decentralization with an active program of measuring up."

Table 2 The process of benchmarking

Planning	• Identifying what processes to benchmark • Identifying organizations to benchmark against • Establishing sources of data and collection methods
Analysis	• Establishing the gap between top benchmarks and own performance
Communication	• Disseminating the findings of the benchmarking process
Action	• Development of performance goals and targets • Development of plans to achieve performance goals

This approach clearly embodies several of the stages of the benchmarking process identified by Camp and others. The trigger to action is the establishment of a gap between existing performance and competitor performance, which in turn feeds into a series of actions designed to close the gap (JUST-IN-TIME principles, quality improvement, and so on). It is interesting to note that the agenda behind the Lucas approach was stimulating change and improvement in response to a rapidly deteriorating situation; the function of benchmarking appeared to be to kick-start the process of change by providing substantial and unassailable proof of the need to improve. However, the Lucas case also demonstrates that actions which demonstrate the need for change cannot of themselves overcome long-term historical and structural issues. In the late 1990s Lucas was forced to merge with the Varity Group, a move that was widely seen as a takeover of the former by the latter. The merged group was taken over again, by TRW, in 1999.

Benchmarking Studies

Benchmarking studies may be divided into two main types. The first are commercial studies undertaken by or on behalf of companies at their own expense and for their own benefit. For obvious reasons, these rarely enter the public domain and so it is difficult to generalize about the extent and sophistication of these studies. The other type of benchmarking study, of which there are several examples, constitutes what might be termed "public domain" research and is typically undertaken by universities and/or management consultancy firms. The purposes of this type of benchmarking study are varied but typically involve an academic agenda of investigating the characteristics of high-performing organizations and a consultancy agenda of spreading alarm in order to generate consultancy work.

One of the earliest and best known examples of benchmarking which is in the public domain is the first IMVP, which was coordinated by MIT. This program aimed to systematically compare the performance of car assembly plants around the world to identify the reasons behind

this performance. The program ran from 1985 to 1990 and culminated in the publication of the influential *The Machine That Changed the World* (Womack et al., 1990). This book represents a powerful cocktail of startling statistics (concerning the superior performance of car assembly plants in Japan vis-à-vis those in the West) and prescriptions for success (in the form of LEAN PRODUCTION concepts, the main explanation offered for this performance superiority). The impact of this book is a useful illustration of the potential leverage of a benchmarking study. Hundreds of thousands of copies of the book were sold in the five years following publication and many managers, particularly (but not exclusively) in the automotive industry, took it as the blueprint for achieving high-performance manufacturing. The process at work here is twofold: on the one hand there is the shock of a comparison which reveals that one's own organization is being massively outperformed by others. In the aftermath of this, people are likely to be very receptive to alternative models (such as lean production), which appear to be tried, tested, and vastly superior.

Other benchmarking studies that are publicly available include studies into the autocomponents industry (Delbridge et al., 1995) and general manufacturing (IBM Consulting Group, 1993, 1994; Miller, Meyer, and Nakane, 1994). The industry-specific studies tend to emphasize precision and comparability of performance and therefore restrict the products covered in order to achieve this. The more general studies (e.g., the IBM Consulting Group studies) attempt to be more generic and tend to use executive self-reports as the measure of whether each company is more or less competitive than others in its field, a practice that generates performance data of questionable validity.

Criticisms of Benchmarking

Benchmarking as a field of activity is insufficiently developed to have attracted widespread comment, but individual benchmarking studies have attracted criticism, particularly the first IMVP study (Williams et al., 1994). Many of the criticisms leveled against this study concern general issues around the benchmarking process itself, and so it is instructive to examine them.

The first premise on which the IMVP has been attacked lies in its choice of unit of analysis, namely, the individual firm or operating unit; most benchmarking studies focus on this level. Critics point out that this tacitly inflates the importance of some factors and diminishes the significance of others:

> An unconscious politics of managerialism runs through the text: at every stage [in *The Machine That Changed the World*] the company is the unit of analysis and the world is divided into good companies and bad companies with managers as the privileged agents of change who can turn bad companies into good companies. (Williams et al., 1994: 323)

Seen from this perspective, benchmarking tacitly assumes a free-market, survival-of-the-fittest position. Efficient and well-run companies survive and prosper, inefficient ones do not. Although the market may be the final arbiter on performance, benchmarking provides detailed operational indicators of strengths and weaknesses. This may be valid when comparisons are made between units operating in the same markets or economies, but the legitimacy of some comparisons that are made across national boundaries can be challenged, because explanations tend to center on the firm and not on the context within which it is embedded. The contrast between the conclusions of the IMVP and those of their critics as to why the Japanese car makers – in particular Toyota – outperform their western counterparts could not be more stark: "We believe that the fundamental ideas of lean production are universally applicable anywhere by anyone" (Womack et al., 1990: 9); "These techniques are a historical response to Toyota's dominance of the Japanese car market which is uniquely non cyclical" (Williams et al., 1994: 352).

The argument here is not that benchmarking inevitably generates data that are *wrong*, but rather that by its very nature it generates data which are *partial* and which may overlook issues of context and market and environmental constraint. In a somewhat different vein, Cox,

Mann, and Samson (1997) criticize benchmarking on the grounds that it represents "a mixed metaphor." The language of benchmarking, they argue, is dominated by notions of competition, although the exercise of benchmarking itself requires cooperation. The argument of the Cox et al. paper is itself somewhat confused, but the paper does at least attempt to explore some of the assumptions that lie behind benchmarking – unlike most of what is written about the topic.

It is clear that there is widespread interest in benchmarking among practitioners; this is evidenced by the large number of (expensive) seminars and workshops on benchmarking run by the major consulting firms and by the large volumes of writing on the topic from a practitioner's perspective. Currently most of the material specifically on benchmarking is in the form of "how to do it" documents, although there is academic interest in benchmarking as a tool to identify and explain differences in performance between firms. In this respect benchmarking represents another strand to the empirical, positivist research tradition popular among the ranks of some management researchers. Like so many fashionable management topics, there is little about benchmarking *per se* which is of itself novel – systematic comparisons of performance and processes have been around for decades.

What does appear to be novel is the function that benchmarking is performing. Many benchmarking programs represent specific attempts to bring the "reality" of the outside world within the boundary of the organization and therefore serve to provoke and legitimate change. For this reason, critics have challenged the "unconscious managerialism" that lies behind benchmarking on the grounds that the causes of productivity and other business performance problems are laid squarely on the shoulders of managers, to the neglect of economic and institutional context. This does not of itself negate the value of benchmarking, but it does suggest that some care is necessary in interpreting and acting upon the findings of benchmarking studies, particularly when these span national boundaries.

See also *breakthrough improvement; business excellence model; continuous improvement; total quality management*

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best practice

Marek Szwejczewski

Over the last decade the notion of "best practice" has taken a firm hold in both practitioner discourse and operations management (OM) literature. The term can be defined as "a practice that has been shown to produce superior performance," and correspondingly, the adoption of best practices is viewed as a mechanism for improving the performance of a process, business unit, product, service, or entire

organization. If best practices are (tautologically?) located within "best-in-class" organizations, the logic is that other firms should learn from them and not rely exclusively on home-grown resources and activities. Companies that only look inwards will not be able to learn and benefit from the progress made by others.

The activity of looking for best practice can bring about a greater awareness of the external world. Its value is in learning about practices used by others that are better than those currently in place internally. The concentration on uncovering industry best practices is a good route to superior performance. By not focusing solely on the company's own sector, there is a higher likelihood of finding a breakthrough business practice used by the best organizations. Also, the action of looking for industry best practices helps to reduce the impact of "not-invented-here" syndrome: finding practices already in operation effectively neutralizes the argument that they are not applicable, since a company is implementing what has been shown to work. For a practice to be called "best" it must, of course, produce a positive and significant improvement in performance. The use of the practice should result in a sustainable, rather than transitory or one-off, improvement. Also, it should have the potential to be replicated and used by other organizations. A best practice tends to be innovative; it is a new or creative approach, and is associated with progressive or innovative companies (Martin and Beaumont, 1998).

History of the Concept

The concept of best practice really came to prominence with the rise of the benchmarking movement in the late 1980s. Benchmarking is the search for industry best practices that lead to superior performance (Camp, 1989). It involves the identification of those companies, irrespective of industry, that have demonstrated superior performance in the area being benchmarked. Once the firms have been found, their processes and methods can be examined and the best practice identified. Once identified, these practices can then be used or modified to achieve superior performance. The spread of the idea of benchmarking has helped to raise the profile of the concept of best practice (Voss, 1995). In addition, other factors have helped to increase awareness of the concept. The introduction of various league table and award schemes for high-performing companies has had an influence: for instance, the US Malcolm Baldrige National Quality Awards, the European Quality Awards, and the Management Today Awards for UK Manufacturing have all highlighted the practices award-winning organizations are using (*see* SELF-ASSESSMENT MODELS AND QUALITY AWARDS). In parallel, the rise of Japanese manufacturing meant that many western companies became extremely interested in adopting and adapting the practices used by them. The most obvious example of this has been the adoption by western firms (especially car manufacturers and component suppliers) of the various practices used by Japanese firms in the automotive sector. Consultants have also played their part in promoting best practices. Equally, the adoption of best practices has been encouraged by governmental organizations: the UK Department for Trade and Industry, for instance, launched a "Fit for the Future" campaign, run jointly with the Confederation of British Industry (CBI), as a mechanism for improving the competitiveness of UK manufacturing.

From a more critical standpoint, one of the assumptions that underpin the concept of "best practice" is that there is a single best way to carry out a process or activity. However, given the fact that all practice is to some extent context specific (Davies and Kochhar, 2002), adopters should actively consider whether the practice is in fact appropriate for the intended use (and the different context it will be used in). Similarly, it is important to examine the practice in detail to see what its impact really is. Is there convincing evidence to support the claim that it is best practice? As part of the investigation it is important to examine the performance difference between the new practice and the normal approach. If the new practice outperforms the current approach, then this helps to support the case for the adoption of the new approach. Looking at evidence from more than one source can help to validate the superiority of the practice. For example, if several organizations are using it, then it could be a practice worth adopting. It may also be a good idea to consider the opinions of independent experts. For

example, the views of industry experts and academics about the proposed practice can be taken into consideration. Of course, some best practices may not require validation since they have been in use by companies for some time and have become tried and tested over the years.

The Transfer of Best Practices

While there may be some evidence (usually case-study based) to support the case of specific practices improving performance, a few writers have drawn attention to the fact that there are relatively few large-scale studies that empirically link practices with performance (Davies and Kochhar, 2002). They point to a need for more research into the relationships between operational practices and performance. For instance, the transfer of practice from one organization is based upon a number of assumptions (Wareham and Gerrits, 1999), each of which needs to be critically appraised.

- *Homogeneity of the organization.* The introduction of a best practice from one organization to another assumes a certain degree of homogeneity. The two organizations should resemble each other, in some measure, in order to allow the transfer to take place. In particular, the process, the technology, or the environment may need to be similar to a certain extent.
- *Universal yardstick.* Another basic assumption of best practice is the existence of some kind of absolute measurement against which the superior performance of a practice can be measured (and then compared to other practices to determine which is best). However, there is some question whether such a universal yardstick can ever exist.
- *Transferability.* It is normally the case that some adjustment to the practice will be required to comply with the characteristics of the receiving organization. Only on rare occasions can the best practice be transplanted into another organization with a minimal amount of modification. In most instances, the best practice has to be adapted before it can be implanted.

The adoption of a best practice may improve performance in one area but result in deterioration in another (Davies and Kochhar, 2002). Adopters need to be aware of the impact on performance of the implementation of a best practice. Which areas of performance does it impact, are there any areas where performance may in fact decline?

There are several specific barriers to the successful transfer of best practice (Szulanski, 1995; O'Dell and Grayson, 1998; Wareham and Gerrits, 1999). One of the major barriers to transfer is the absorptive capacity of the recipient. A manager may not have the resources (time and/or money) or enough practical detail to implement it. A further barrier to transfer is the lack of a relationship between the source of the practice and the recipient. If a relationship does not exist, then the source may be hesitant in helping the recipient; the recipient may not make the effort to listen and learn from the source. Moreover, a lot of important information that managers and workers need to implement a practice cannot be codified or written down. It has to be demonstrated to the recipients of the practice. If the practice contains a lot of tacit knowledge (know-how), then it is likely that the transfer will not be simple. It is important that the organization recognizes the value of trying to capture tacit knowledge – the know-how, judgment, and intuition that constitute the non-codified knowledge that may make the difference between success and failure in the process of transfer. The transfer of employees who know about the practice and/or insuring that personnel have been extensively trained should improve the chances of a successful transfer. Given the barriers that exist to the transfer of best practices, it is important that organizations take the time and plan the transfer of practices.

See also *benchmarking; breakthrough improvement; business excellence model; continuous improvement; importance–performance matrix; Six-Sigma*

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bill of materials

Peter Burcher

The bill of materials (BOM) is a file or set of files which contains the "recipe" for each finished product assembly in a material requirements planning (MRP) system. It consists of information regarding which materials, components, and subassemblies go together to make up each finished product, held on what is often known as a product structure file. Associated data about each item, such as part number, description, unit of measure, and lead time for manufacturing or procurement, are held on a part or item master file.

For each finished product, a bill of materials is originally created from design and process planning information. The designs might be developed internally or be supplied by the customer. They will initially be in the form of drawings and material lists. The process planning information may be in the form of assembly charts. Together with information on the relevant lead times, these form the basis of the inputs to the BOM.

While most MRP systems can cope with part numbers allocated at random, it is necessary for all items within the organization to be given a unique part number. Clearly, the information on the BOM needs to be accurate, since inaccuracies can lead to incorrect items or incorrect quantities of items being ordered. This accuracy needs to be audited. However, in many operating environments, there are continual changes to the BOM in the form of product modifications. These modifications may originate from many sources, such as safety legislation, production process changes, improvements for marketing purposes, or value analysis exercises. The control of the implementation of modifications can be a time-consuming task, especially since factors such as the depletion of unmodified stocks and the timing of combined modifications have also to be considered.

There is an accepted numbering system for BOM levels which allocates level 0 to the finished product and increases the level number as the raw material stage is approached. Items that appear at several levels in a BOM, e.g., in the final assembly as well as in subassemblies, are usually assigned the lowest-level code at which the item occurs. This insures that when MRP processing proceeds from one level code down to the next, all gross requirements for the item are accumulated before continuing any further (*see* NETTING PROCESS IN MRP).

The number of levels of assembly breakdown is determined by the complexity of the product; however, some BOMs are unnecessarily complicated by including too many subassembly stages, and many companies have made determined efforts to flatten their BOM structures.

Bills of materials for hypothetical products are sometimes created to help in the forecasting and master production schedule of products which could have an extremely wide variety of saleable end items. These are referred to as planning BOMs, and may take the form of modular BOMs or BOMs which separate out common items from optional items and features. For example, in car production, there may be thousands of items common to each model; there may also be optional items such as air-conditioning assemblies and features such as an automatic gearbox or a manual gearbox. If forecast ratios of the take-up of these optional and feature subassemblies can be determined, then a planning BOM can be created using these ratios as the "quantity per" parent hypothetical finished product. It is these planning BOMs that are then used for master production scheduling in this environment.

See also *family bill; kit bill; manufacturing resources planning; material requirements planning; modular bill; super bill*

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blueprinting

Robert Johnston

The term "blueprinting" refers to the documentation of a service process: it is a means of evaluating, developing, and designing service processes. Blueprinting is not just confined to documenting customer processes but is intended to help design the interrelationships between material, information, and customer flows. There are several ways of documenting service processes, e.g., decision charts, process charts, customer processing framework, and blueprints (as described by Shostack, 1984). All of these methods essentially involve the identification of the different stages in a service process. They can be made more sophisticated by the addition of lines of visibility, lines of interaction, time frames, the identification of control points and mechanisms, and the location of responsibility for each stage of the process. The benefit of blueprinting in the design of service processes is that the process can be checked for completeness and over-complexity, to see whether it meets the strategic intentions of an organization and to help identify and remove potential failpoints as well as to help identify potential improvements.

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bottlenecks

Colin Armistead

Bottlenecks are the parts of an operation or process that are the constraints on its capacity. Bottlenecks are an important issue in operations management because most operations attempt to maximize the output from a given set of resources, and maximizing output means minimizing capacity "leakage" and improving throughput efficiency, which depends on understanding bottlenecks.

The question that arises for operations managers is the extent to which bottlenecks are fixed or moveable as the variety or mix of products or services alters. There are two main approaches to managing bottlenecks. The first is to try to eliminate the bottleneck, recognizing that this will create another bottleneck step in the process. The alternative is to manage the bottleneck so that it is never unnecessarily idle by insuring that resources needed at the bottleneck are always available (perhaps by using buffers), and insuring that changeovers cause minimum loss of capacity. Managing a bottleneck means insuring that its utilization is as high as possible. If the bottleneck is fairly stable, there is also the need to make sure subsequent stages in the process after the bottleneck do not become bottlenecks themselves, otherwise the important work at the main bottleneck may be wasted. The theory of constraints gives simple rules for managing bottlenecks when they are reasonably stable in a process (*see* OPTIMIZED PRODUCTION TECHNOLOGY).

The rules are:

1 Balance flow not capacity.
2 The level of utilization of a non-bottleneck resource is not determined by its own potential (capacity) but by some other constraint (i.e., bottleneck) in the system.
3 Making a resource work (activation) and utilization of the resource are not the same.
4 An hour lost at a bottleneck is an hour lost for the total system.
5 An hour saved at a non-bottleneck is a mirage, unless resources can usefully be employed elsewhere.
6 Bottlenecks govern both throughput and buffer stocks.

7 The size of the batch we move between stages may be less than the process batch size at one stage. This allows us to prevent bottleneck stages running short of material.
8 The process batch should be variable, not fixed, allowing us to influence lead time and throughput efficiency.
9 Schedules should be established by looking at all constraints simultaneously. Lead times are a result of the schedule.

See also *balancing loss; business process redesign; layout; line balancing; product layout*

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bow-tie and diamond perspectives

Pietro Romano

Cooper et al. (1997) reported an analogy attributed to the late Sam Walton according to which firms can choose between the bow-tie and the diamond approaches to interfirm relationships. The bow-tie is made up of two triangles meeting at a point. The traditional, often adversarial, relationship uses a bow-tie approach where the primary or only interaction between firms is the buyer of one firm and the seller of the other firm. All information is transmitted through these two filters. The diamond occurs when the triangles are rotated so that two sides are together. In this case all the functions can talk with one another across firms. The salesperson and the buyer are at the farthest points and may essentially disappear in some instances. Both expected and serendipitous efficiencies can occur from these closer, partnership-style relationships across other functions.

See also *purchasing; strategic account management; supply chain management*

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breakthrough improvement

Nigel Slack

The breakthrough approach to improvement (or innovation-based improvement) sees the main vehicle of improvement as major and dramatic changes in the way an operation works. The impact of these improvements is relatively sudden, abrupt, and represents a step change in practice (and hopefully performance). Such improvements often call for high investment of capital, often disrupting the ongoing workings of the operation and frequently involving changes in the product/service or PROCESS TECHNOLOGY. The archetypal breakthrough improvement method is sometimes cited as that of business process reengineering with its emphasis on radical change. The breakthrough improvement approach is often contrasted with that of CONTINUOUS IMPROVEMENT, but in reality may be combined with it.

See also *business excellence model; business process redesign; sandcone model of improvement*

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build-to-order

Matthias Holweg

Build-to-order (synonym: make-to-order) represents the classic "pull" production strategy whereby production is initiated by an actual customer order, as opposed to a "push" strategy whereby production is driven by a long-term forecast, and products are sold from existing finished goods inventory (FGI) in the marketplace. Essentially, the goal of any manufacturing system is to produce exactly what customers want, when they want it. Building exactly what the customer wants in short lead times not only provides high customer service levels and significantly reduces inventory costs, but also can provide a crucial competitive advantage in the marketplace (Stalk and Hout, 1990). Some companies attempt to meet individual buyers' needs through a mass customization strategy, such as late configuration (Lampel and Mintzberg, 1993; Gilmore and Pine, 1997), but often manufacturers revert to manufacturing standard products, in bulk, according to long-term forecasts in the hope that the supply will be in line with actual demand. The driver behind this strategy is the notion that forecast-driven operations enable efficient production, as capacity can be kept stable even if demand drops temporarily (Raturi et al., 1990). Any industry that supplies customized high-volume products – such as automobiles, furniture, and electronics, for example – will be tempted to rely on strategies that push finished goods into the market, because of the more predictable revenues that are crucial to offset production and development costs. In markets where product customization is explicitly demanded, however, forecast-driven systems show clear strategic disadvantages.

The Vicious Cycle of Making to Forecast

The basis for push strategies is a demand forecast, which due to the very nature of forecasting is bound to be wrong (*see* FORECASTING PROCESS) and subsequently often results in over- or understocking, or quite simply having the wrong products in stock. Either way, service levels suffer, and cost goes up. As a result, companies are burdened with inventory holding costs and, if demand proves weaker than expected, frequently have to resort to selling their products using costly sales incentives, such as discounts. Furthermore, with increasing product variety offered in the market, the likelihood of finding a customer–product match decreases significantly, further increasing the need for these sales incentives. In particular in markets where high customization levels are required, this can lead to a vicious cycle (Holweg and Pil, 2001): as incentives are used to clear unwanted stock, or persuade customers to accept a poor customer–product match, the revenue per product sold decreases. To compensate for eroding profit margins, even more emphasis is put on pushing volume into the market, and in this way recovering the development and production cost.

Second, even when the customer asks for a custom-built product, the delivery lead time is bound to increase the more the company uses push strategies, as the system was not created to support build-to-order (BTO), and thus customer and forecast orders will compete for production resources. As a result, order-to-delivery (OTD) lead times will increase, discouraging customers from ordering, and fostering sales from readily available products in stock. The more products a company sells from stock, however, the more disconnected it becomes from real customer demand and the less likely its sales forecasts will match real customer requirements. As the cycle perpetuates, the company finds itself building a larger and larger proportion of products to forecast, and the use of the more profitable build-to-order strategies becomes increasingly remote. In summary, the vicious circle of making to forecast has two elements: in the first, the company must rely on larger

economies of scale to compensate for the use of push-based selling. In the second, the company loses sight of real customer requirements because it is selling too many products from stock, and is unable to capture actual demand patterns in the market.

Responsive System versus Efficient Factory

In sectors where products are customized to order, i.e., where non-standard products are manufactured (e.g., automobiles), or standard components are assembled to customer order (e.g., electronics), or standard products are configured to customer wishes (e.g., bicycles), making products to forecast has significant disadvantages.

Building products to order, rather than to forecast, can circumvent the problems inherent in the make-to-forecast scenario. The strategic focus in a build-to-order environment turns away from production efficiency and unit cost toward adopting a systemic, or holistic, view of the effectiveness of the whole supply chain system. Here production efficiency is still a concern, but so are customer fulfillment and the responsiveness to customer demand. The key measure is maximizing revenue per unit, not minimizing manufacturing cost per unit. A build-to-order strategy aims to develop the capability for a company to react quickly to changes in demand, so the system can operate with the costly practices of holding inventory costs and using sales incentives.

On the downside, build-to-order makes the manufacturer susceptible to demand swings in the market. Ultimately, any production system will fail if demand subsides, yet in forecast-driven manufacturing systems, a buffer of finished goods can insure that the capacity is utilized even during seasonal troughs (cf. production smoothing). A build-to-order system hence needs to create flexibility on multiple dimensions to achieve such systemic responsiveness, including for example, the alteration of information systems or the alignment of product designs. In order to implement a successful build-to-order strategy, one needs to have flexibility on three dimensions: process, product, and volume flexibility. It is the synergy between flexibility on all three levels that creates true system responsiveness to customer demand and enables the sustainable adaptation of a build-to-order strategy (for a comprehensive discussion see Holweg and Pil, 2004).

Process Flexibility

Process flexibility essentially means to connect the customer to the value chain, or make the customer order the pacemaker of the entire supply chain. With regards to SUPPLY CHAIN DYNAMICS, making to order (as opposed to forecast) has a dampening impact on the so-called "Forrester" or "bullwhip" effect, which is much less likely to occur in demand-driven supply chain settings (Forrester, 1958; Lee, Padmanabhan, and Whang, 1997). The bullwhip effect is an artificial demand distortion caused by forecasting, batching, and multiple decision points and worsened by inventory and long lead times in the system. Process flexibility centers on the speed at which the company can make decisions, alter schedules, or amend existing orders to customer needs. It determines, for example, how quickly the company can translate information at the customer interface into organizational decisions and operating mandates. Because it cuts across all parts of the value chain, process flexibility cannot be achieved without involving suppliers and distributors. Main strategies here include the close integration of supplier and logistics service providers, and the use of Internet-based intercompany communication, in order to achieve seamless and synchronized deliveries.

Product Flexibility

Product flexibility refers to the company's ability to adapt a product to the customer's specification, as well as the company's ability to delay or reduce the degree to which it must tailor the product. This level of flexibility provides a critical interface between marketing (i.e., the variety offered to the customer), design (i.e., how the variety is integrated into the product), and manufacturing (i.e., how complex the product is in manufacturing). Essentially it is the product design that determines how the *external* variety in the marketplace translates into the *internal* variety in the manufacturing process. Strategies

related to product flexibility include the mass customization continuum, modularity, postponement, and late configuration. The general notion in a build-to-order system is to bring customization closer to the customer in order to reduce both lead times and the adverse impact of variety on the manufacturing operations. Managing product variety through common part ratios and the introduction of mutable support structures are common approaches, for example. Mutability implies that the same support structures can be utilized to provide the level of uniqueness and customization required by each customer. Mutable support structures, such as product platforms for example, enable greater variety while reducing internal complexity.

Volume Flexibility

Volume flexibility is a company's ability to respond to overall changes in demand by altering production volume accordingly. The ability to cope with short-term variability, seasonality, and changing demand over the life cycle of the product is critical to the success and sustainability of a build-to-order system. In particular, reducing the dependency on full capacity utilization and the ability to reduce and increase capacity without large cost penalties require critical assessment. The impact on capacity utilization is a major concern many companies have in implementing build-to-order. When existing capacity is not used, and especially when demand falls below break-even levels, the temptation will rise to revert to forecast-driven production. However, any production system will fail if demand drops, regardless of whether it stockpiles products or builds to order. Thus, being able to manage short-term variability in demand is key. Achieving volume flexibility has two key elements: first, focusing on increasing responsiveness at factory level, and second, actively managing the demand flow.

One way to achieve responsiveness at factory level is to reduce the financial need to keep the factory going at the same rate all year through the introduction of flexible work hour arrangements (such as "hour banks," sometimes also referred to as "annual hours"), which alleviate the cost penalty of using overtime and temporary workers to cope with demand swings. Furthermore, a diversification of production plants means that large, efficient, but less flexible plants could provide for the stable base demand, and smaller, less efficient, but flexible plants could cater to low-volume demand and provide additional capacity if demand changes (Mini mills in the steel industry are a classic example; see also Pil and Holweg, 2003). It is further important to note that the volume rigidities that exist at the factory level also exist at supplier organizations, so volume flexibility at the manufacturing plant level alone is of little impact if the supply chain does not match this capability.

In terms of demand management, the concept of revenue management, i.e., the use of differentiated pricing to manage demand with the objective of maximizing revenue, is common in service sectors, yet an often missed opportunity in manufacturing supply chains. Relating price to the speed of delivery means that price-sensitive customer segments can be used to smooth demand: products ordered well in advance create long-term visibility and lower the cost of making the product, hence can be offered at a lower price. The demand visibility created helps to manage and smooth capacity utilization in both product assembly and the wider supply chain. This cost saving is partially passed on to the customer to encourage the most beneficial flow of demand for the manufacturer. Long-term visible orders can also help buffer the short OTD lead times needed for lead time-sensitive customer segments, which generally yield high margins (e.g., luxury and fashion products).

Related Concepts

In a wider sense, build-to-order fits into the discussion centered around mass customization strategies. Many operations concepts have been proposed on how to achieve mass-produced, customized products, yet most fail to go beyond the product or process dimensions (e.g., late configuration, which only touches upon the product dimension). The key to a successful build-to-order strategy, however, is to strive for flexibility in all three organizational dimensions – product, process, and volume – in order to attain the critical responsiveness at system

level, and not simply create further islands of excellence in the supply chain.

A close sibling of build-to-order is the *assemble-to-order* concept, whereby the end product is assembled to customer order based on standard components that are kept in inventory on site. This concept works well in low-complexity environments with modular products, which allow for "plug and play" configuration. A strategic disadvantage here is the component inventory that has to be held close to the assembly operation, which also represents a decoupling point in the system (a decoupling refers to the point where "push" and "pull" elements in a supply chain meet). Assemble-to-order is best known through the case of Dell Computers, which has applied the concept very successfully in its "direct" business model. Misleadingly, Dell sometimes refers to its approach as *build-to-order*, although technically speaking it is an *assemble-to-order* system.

See also *flexibility; P:D ratios*

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business excellence model

Rodney McAdam

The European Quality Award (EQA) model was launched in 1992. Since then the title of the model has undergone several permutations, although it is mainly recognized as the business excellence model (BEM). Those involved in the formation of the model included leading total quality management (TQM) practitioners and academics from organizations and universities in the UK and Europe. Since its inception the model has remained largely unchanged. In April 1999 minor modifications were introduced to improve and clarify wording. The model is used in the European Quality Award, while the Malcolm Baldrige model is the equivalent in the US. Other models used in National Quality awards are usually based on these models. The model is shown in figure 1 (EFQM, 2003).

The model is supposed to represent the process of TQM and the aspiration toward business excellence in organizations from all sectors. It is formed on the underlying assumption of cause and effect. The nine boxes are the nine criteria, which are split into five enabling (or causal) criteria and four results (or effect) criteria. The backward-facing arrow in figure 1 indicates that learning cycles, fostering innovation and learning, are seen as being present in the model.

Each enabler criterion is subdivided into subcriterion parts, which can be assessed for a given organization. The process of self-assessment is used to evaluate organizations in relation to the model. Typically, for a large organization, a trained internal self-assessment team will assess the organization down to a subcriterion part level. For each subcriterion part, strengths, weaknesses, areas for improvement, and a score will be identified.

The results criteria are mainly divided into perceptive and non-perceptive data with a focus on the excellence and scope of the results. Once again, the self-assessment team identifies strengths, weaknesses, areas for improvement, and a score, this time at criterion level.

The assessment process is referred to as RADAR logic, an acronym for results, approach, deployment, assessment, and review. Assessment and review are used when assessing enabler

criteria and the results element is used when assessing results criteria.

The process of self-assessment can be carried out in a number of ways. The generic approach is shown in figure 2. Two typical approaches are the simulated award process and the management workshop approach. In the simulated award approach, the organization or the department being assessed constructs a written document describing how the organization addresses the areas outlined in the model down to subcriterion part level. This document is then assessed

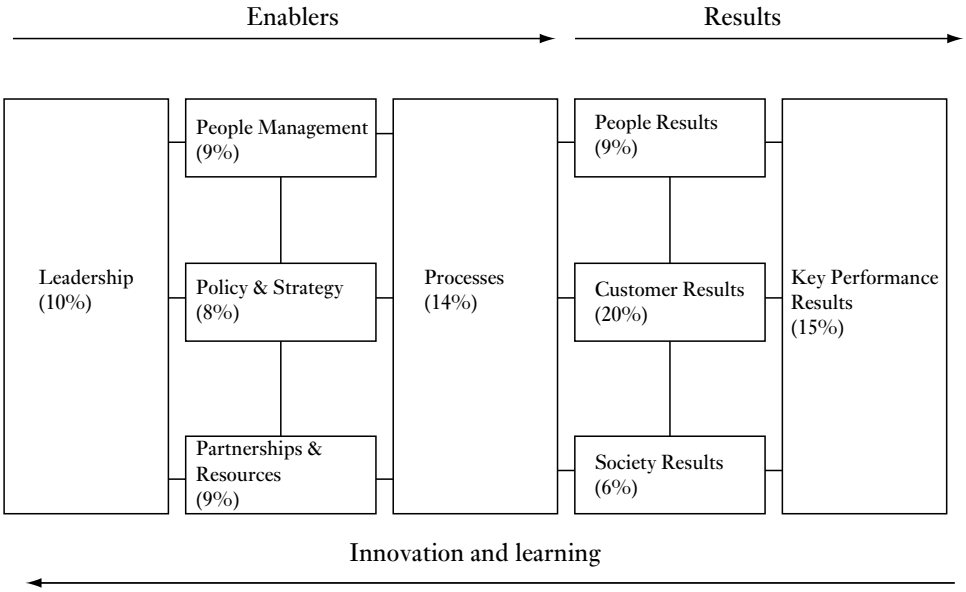

Figure 1 The business excellence model

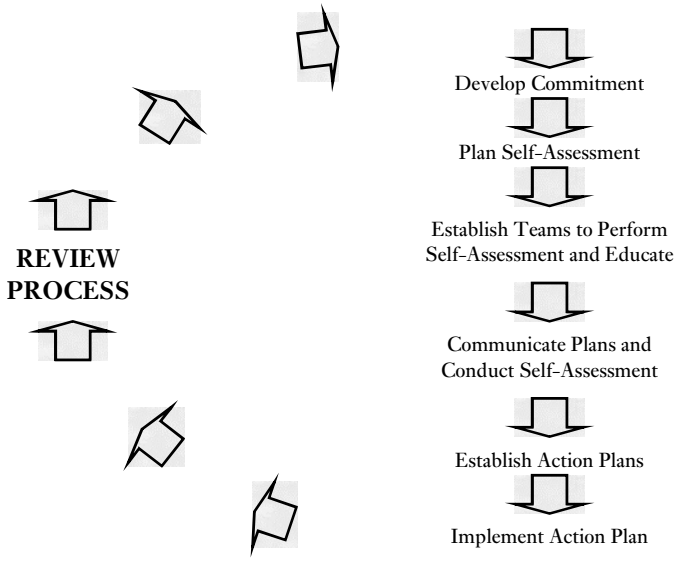

Figure 2 The process of self-assessment

by the internal self-assessment team. This method is rigorous but takes considerable time and resources. The management workshop approach involves a group of managers reaching consensus on an electronically displayed proforma of the model and its subcriterion parts. This approach relies on the Pareto principle of identifying 80 percent of the vital points while at the same time using little time and resources (*see* PARETO ANALYSIS). The model is described as follows.

Leadership

Excellent leaders develop and facilitate the achievement of the mission and vision. They develop organizational values and systems required for sustainable success and implement these via their actions and behaviors. During periods of change they retain a constancy of purpose. Where required, such leaders are able to change the direction of the organization and inspire others to follow.

Leadership covers the following five criterion parts that should be addressed.

1(a) Leaders develop the mission, vision, values, and ethics and are role models of a culture of excellence.
1(b) Leaders are personally involved in insuring the organization's management system is developed, implemented, and continuously improved.
1(c) Leaders interact with customers, partners, and representatives of society.
1(d) Leaders reinforce a culture of excellence with the organization's people.
1(e) Leaders identify and champion organizational change.

Policy and Strategy

This criterion covers all aspects of the development and communication of business strategy and business plans. The subcriteria are as follows:

2(a) Policy and strategy are based on the present and future needs and expectations of stakeholders.
2(b) Policy and strategy are based on information from performance measurement, research, learning, and external related activities.
2(c) Policy and strategy are developed, reviewed, and updated.
2(d) Policy and strategy are communicated and deployed through a framework of key processes.

People Management

Excellent organizations manage, develop, and release the full potential of their people at an individual, team-based, and organizational level. They promote fairness and equality and involve and empower their people. They care for, communicate, reward, and recognize, in a way that motivates staff and builds commitment to using their skills and knowledge for the benefit of the organization.

People Management covers the following five criterion parts that should be addressed.

3(a) People resources are planned, managed, and improved.
3(b) People's knowledge and competencies are identified, developed, and sustained.
3(c) People are involved and empowered.
3(d) People and the organization have a dialogue.
3(e) People are rewarded, recognized, and cared for.

Partnerships and Resources

Excellent organizations plan and manage external partnerships, suppliers, and internal resources in order to support policy and strategy and the effective operation of processes. During planning and whilst managing partnerships and resources, they balance the current and future needs of the organization, the community, and the environment.

Partnerships and Resources cover the following five criterion parts that should be addressed.

4(a) External partnerships are managed.
4(b) Finances are managed.
4(c) Buildings, equipment, and materials are managed.
4(d) Technology is managed.
4(e) Information and knowledge are managed.

Processes

Excellent organizations design, manage, and improve processes in order to fully satisfy, and generate increasing value for, customers and other stakeholders.

Processes cover the following five criterion parts that should be addressed.

5(a) Processes are systematically designed and managed.
5(b) Processes are improved, as needed, using innovation in order to fully satisfy and generate increasing value for customers and other stakeholders.
5(c) Products and services are designed and developed based on customer needs and expectations.
5(d) Products and services are produced, delivered, and serviced.
5(e) Customer relationships are managed and enhanced.

Customer Satisfaction

Excellent organizations comprehensively measure and achieve outstanding results with respect to their customers.

Customer Results cover the following two criterion parts that should be addressed.

6(a) Perception measures.
6(b) Performance indicators.

People Satisfaction

Excellent organizations comprehensively measure and achieve outstanding results with respect to their people.

People Results cover the following two criterion parts that should be addressed.

7(a) Perception measures.
7(b) Performance indicators.

Society Results

Excellent organizations comprehensively measure and achieve outstanding results with respect to society.

Society Results cover the following two criterion parts that should be addressed.

8(a) Perception measures.
8(b) Performance indicators.

Key Performance Results

The measures are key results defined by the organization and agreed in their policy and strategies. Key Performance Results cover the following two criterion parts that should be addressed. Depending on the purpose and objectives of the organization, some of the measures contained in the guidance for key performance outcomes may be applicable to key performance indicators, and vice versa.

9(a) Key performance outcomes.
9(b) Key performance indicators.

Calculation of Total Points

To calculate the total points scored in a self-assessment, the scores of each criterion out of 100 are multiplied by their respective weighting factor and the total obtained from the summation of all nine criteria. The criterion weightings have remained constant since the formation of the model and were arrived at by averaging the weightings suggested by each participating organization.

Although the BEM was formed primarily on the basis of large private sector organizations, there have been attempts to adapt the model for use in the public sector and for small organizations. In the case of the public sector, the wording of the model has been adapted to reflect public sector language and limitations in regard to strategy and finance. In small organizations the number of criterion parts have been condensed in an attempt to make the process less bureaucratic.

Critique of the BEM

The development of TQM in the latter part of the 1980s can be attributed to a number of reasons, not least the continued criticism of ISO 9000 for failing to deliver continuous improvement. However, ISO 9000 was measurable and achievable while TQM remained somewhat ill-defined. Thus, there was a need for a model or framework within which TQM could be defined and measured. In response to this

need, the BEM was developed as being based on TQM principles and as being a measuring framework for TQM. Therefore, organizations applying TQM could measure their progress. Moreover, the scoring process enables TQM-based BENCHMARKING between organizations or parts of organizations which are using the BEM. The danger in this approach is that benchmarking scores can be misleading and a more fundamental comparison of criterion part strengths and weaknesses is needed.

The European BEM (similar to the Baldrige model) is now in widespread use in many organizations. Various approaches to applying the model, emphasizing its advantages in the area of TQM, are well documented in the literature. These advantages include improved approaches, measurement, and benchmarking.

The key premise of the BEM is that it represents TQM within an organization. One way of critiquing this claim is to compare the model against each of the principles of TQM. Over the past ten years there has been a proliferation of TQM frameworks in the literature. Jamal (1998) provides a useful synthesis of the literature based on the work of Hackman and Wageman (1995) and Spencer (1994). The resultant key principles of TQM are:

1 TQM is strategically linked to the business goals.
2 Customer understanding and satisfaction are vital.
3 Employee participation and understanding at all levels are required.
4 There is a need for management commitment and consistency of purpose.
5 The organization is perceived as a series of processes which incorporate customer–supplier relationships.

This TQM framework is used to critique the BEM's claim to represent TQM in an organization.

1 *TQM is strategically linked to business goals*. The EQA model claims to support this TQM principle in a number of ways. First, the nine criteria represent a business in its totality; second, policy and strategy is a key criterion; and third, the result criteria give some idea of successful strategy. However, the EQA model does not formulate strategy, nor does it properly evaluate strategy, it evaluates the process of forming strategy. The danger in this limited involvement in the strategic process is that TQM could be seen as simply a strategic audit tool rather than as intrinsically linked with strategy.
2 *Customer understanding and satisfaction are vital*. In this area of TQM the EQA model is seen as making a significant contribution. Customer satisfaction is a key result criterion and links must be shown back to enabling criteria. Customer satisfaction ratings can also be benchmarked across other organizations. One cause for concern is the lack of a predictive element that would help identify new customers and markets, reflecting the lack of strategic integration referred to already.
3 *Employee understanding and participation are required at all levels*. The EQA model has both people management and people satisfaction enabler and result criteria, respectively. This enables approaches to people involvement to be evaluated and benchmarked. However, there are a number of problems in this area. First, the model is an audit tool of what is already happening, it does not indicate best or preferred practice in an organizational context. Second, TQM is often translated through the workforce by simple, easily understood approaches. The EQA model remains rather complicated and bureaucratic in this respect.
4 *There is a need for management commitment and consistency of purpose*. The leadership criterion is a key enabler within the model. It is based on a coach/mentor style of leadership that advocates a role-modeling approach. This style of leadership is very supportive of the TQM framework. Perhaps this definition of leadership is not appropriate in all business circumstances and emphasizes the limitations of defining all organizational settings within a rigid model.
5 *The organization is perceived as a series of processes*. Central to the EQA model is the business process criterion. This criterion defines a series of steps for systematic management and improvement of business

processes. However, the model does not show how business processes can be identified or improved – it remains as a detached audit tool. Also, it may not be appropriate for organizations to be completely process based; there may be a partial process-functional structure. The model takes no account of this situation.

In summary, the EQA model has merit as a business audit approach but should not be viewed as synonymous with TQM; rather, it is a technique within TQM. If the model is taken as synonymous with TQM, then its limitations as described above could lead to unwarranted questioning of the broad field of TQM.

The use of the term excellence in the BEM also helps in critiquing the BEM in relation to TQM. Organizational excellence (OE) is currently a key stage on the TQM journey and is composed of contributions from various management discourses. TQM terminology associated with quality as a continuous journey is used by Ruchala (1995): "a continuous quest ... [from] employee improvement to achieving excellence." Periera (1994) describes stages in this journey as self-assessment, customer service, and commitment to excellence. Castle (1996) describes the overall TQM journey as stages of a learning and culture change process. Dale and Lascelles (1997) divide the TQM journey into several key stages, dependent on organizational growth and development, culminating in "world-class" status. Organizations who refer to their TQM progress in regard to a particular stage frequently state that their organization has "started the journey to business excellence," each key stage of this journey being characterized by the use of differing methodologies, all dependent on the same TQM theoretical framework.

It was not until 1982 when Peters and Waterman published their text, *In Search of Excellence*, that the word became directly associated with levels of business performance (Castle, 1996). Their work outlined a number of key business areas as contributing to excellence: strategy and structure, systems, staff, skills, shared values, and so on. There have been a number of critiques of this work, e.g., Schmidt (1999) claims that of the 36 companies profiled, three are no longer listed on the stock exchange and only 12 outperformed the Standard and Poor's index over the last five years. Thus, until the 1980s at least, there is no record of business excellence as a key business influence. Schmidt (1999) raises the issue that many "excellent" organizations are excellent by reputation and not by objective critical analysis.

Throughout the 1980s and early 1990s the rapid development of the quality movement resulted in relatively little OE activity. The advent of the quality award models in the early 1990s, e.g., the European Quality Award, the Baldrige Award, gave an impetus to OE. Some have changed their names to excellence awards, e.g., Business Excellence Award, Australian Excellence Award. Organizations scoring over or around 600 points on these models are deemed to have reached a state of excellence. However, the failure of many of these organizations to maintain their positions shows that a defined state of OE does little to bolster business confidence beyond the hype of quality or excellence awards.

See also *breakthrough improvement; continuous improvement; quality; sandcone model of improvement; self-assessment models and quality awards; total quality management*

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business process redesign

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Business process redesign (BPR) was conceived in an MIT research project during the late 1980s and popularized by an article by Michael Hammer (1990). The title of his article, "Reengineering work: Don't automate, obliterate," claimed that something new and radical was being launched into the business world. Of particular significance is the cross-functional view that BPR takes of business processes, the radical nature of the changes proposed, and the enabling role of information technology in facilitating those changes.

The term "business process" refers to sequences of related process elements which produce business benefits. Key aspects of this definition are that business processes are large scale, concerned with "the business," as distinct from small-scale, localized processes. They tend to span several business functions and they are composite, i.e., they can be conceived as comprising groupings of process elements which in turn can be broken down into activities and tasks.

BPR can be defined as the radical reshaping of business processes, taking full advantage of modern developments in information technology (IT). Key aspects of this definition are that BPR is first of all radical. Hammer (1990) refers to the need to start with a blank sheet of paper and to reinvent the enterprise. Second, it is concerned with reshaping. Existing business processes are transformed into new, greatly simplified processes that are much faster, more flexible, and better quality. Third, it is dependent on improvements in IT. A key aspect of BPR as a concept is making use of the opportunities provided by modern developments in IT. However, IT is viewed as an enabler of BPR rather than a driver.

The BPR approach aims to discard non-value-adding (wasteful) processes in favor of those adding value, as does JUST-IN-TIME. It aims to simplify business processes and thereby to reduce cycle times, e.g., where several possible tasks are combined into one. Tasks are compressed so that an individual carries out what several did before. Workers make decisions, so that decision-making becomes part of the process and management a broadly shared activity. Process elements are performed in a natural order to break the rigidity of the "straight-line sequence." There are many versions of each process so as to provide flexibility to meet different market needs. Work is performed where it makes most sense and organizational boundaries are loosened. Checks and controls are reduced to those that make economic sense. Reconciliation is minimized by cutting back on the number of external contact points of a given process. A "case manager" provides a single point of contact so that one person is responsible for the overall business process and acts as a single contact point for the customer.

While some of these recurring themes may contradict one another, the challenge of redesign is to maximize their potential in a given situation.

Origins of BPR

The concept of radical improvement is not new. For example, Hayes and Wheelwright (1984) contrast the "hare" and "tortoise" approach to change in manufacturing. At around the same time, MIT set up a five-year research program called "Management in the 1990s" or MIT90s for short. Its objectives were to develop a better understanding of the managerial issues of the 1990s and how to deal most effectively with them, particularly as these issues revolve around anticipated advances in IT.

A key aspect of the research was the recognition of IT as a strategic resource which not only provides opportunities to improve complex business processes but which can also help to extend the scope of the organization itself. MIT90s research envisaged five levels of application of IT to support different degrees of business transformation:

1 *Localized exploitation*: IT implementation is limited to a division or department, such as an order entry system.
2 *Internal integration*: IT implementation is carried out on an integrated platform across the organization.
3 *Business process redesign*: IT implementation makes new business processes possible within the organization.
4 *Business network redesign*: IT implementation is aimed at redesigning the way in which exchanges take place between members of a business network. The term "network" applies not just to electronic links, but encompasses all business dealings between members.
5 *Business scope redefinition*: The "scope" of a business refers to the range and breadth of its activities, covering the definition of its boundaries with suppliers and customers and the criteria it uses to allocate its resources.

Levels 1 and 2 are viewed as evolutionary in that IT implementation does not require redesign of business processes. Levels 3, 4, and 5 are viewed as revolutionary because IT implementation demands that business processes are redesigned.

BPR and Risk

The conceptualization of revolutionary change contrasts with the bottom-up, wide-scale involvement that is the hallmark of CONTINUOUS IMPROVEMENT. A BPR project may be a one-off, taking perhaps several years to complete and involving detailed long-term planning. This raises the possibility that, because of the long development time, a large-scale improvement promised through BPR may not be available when it is most needed. Further, the change may prove difficult to manage for an organization where change is not already part of the culture. Because BPR addresses broad, cross-functional business processes rather than individual activities and tasks, it typically is implemented top down by teams of senior personnel (process improvement teams) with top team (steering committee) support. Participation by people in the front line of the organization may not be wholehearted, especially if jobs are threatened.

The risks of mismanaging change using the BPR route are therefore much greater than with the continuous improvement route because of the very nature of the scope of the changes proposed. Some 50 to 70 percent of BPR projects are described as failing to achieve the results intended (Hammer and Champy, 1993). A misjudgment in the implementation of continuous improvement, on the other hand, may result only in one step not being fulfilled. In some circumstances, however, there is little choice but radical change.

Implementing BPR

The procedure for implementing BPR has often been packaged into a series of steps or phases. Those described by Harrington (1991) are typical.

- *Phase 1: Organize for improvement by building leadership, understanding, and commitment*. A steering committee (executive improvement team) is formed to oversee the improvement effort. A redesign "champion" is appointed to enable and coordinate action, and a process improvement team(s) formed to tackle business processes. The purpose and organization of BPR is communicated to the whole workforce.
- *Phase 2: Understanding the current business process*. The team develops a high-level understanding of how inputs are transformed into outputs, the effectiveness of meeting customer expectations, and the efficiency with which resources are used. A key tool is flowcharting, which graphically documents the activities and process elements that make up the business process.
- *Phase 3: Redesigning business processes to improve flow, effectiveness, and efficiency*. The improvement team reinvents business processes by envisioning the perfect business, aiming to simplify and reduce current processes accordingly. The role of IT here is as an enabler to achieve the redesigned process.
- *Phase 4: Developing process measurements for feedback and action*. Key measures are related to the efficiency, effectiveness, and adaptability of a process.
- *Phase 5: Continuously improve the process*. This starts with process qualification (defining and

verifying process capability), and continues with benchmarking (for goal setting and process development). Issues from this phase are fed back to phases 2 and 3.

See also *balancing loss; bottlenecks; breakthrough improvement; design; layout; line balancing; service design*

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