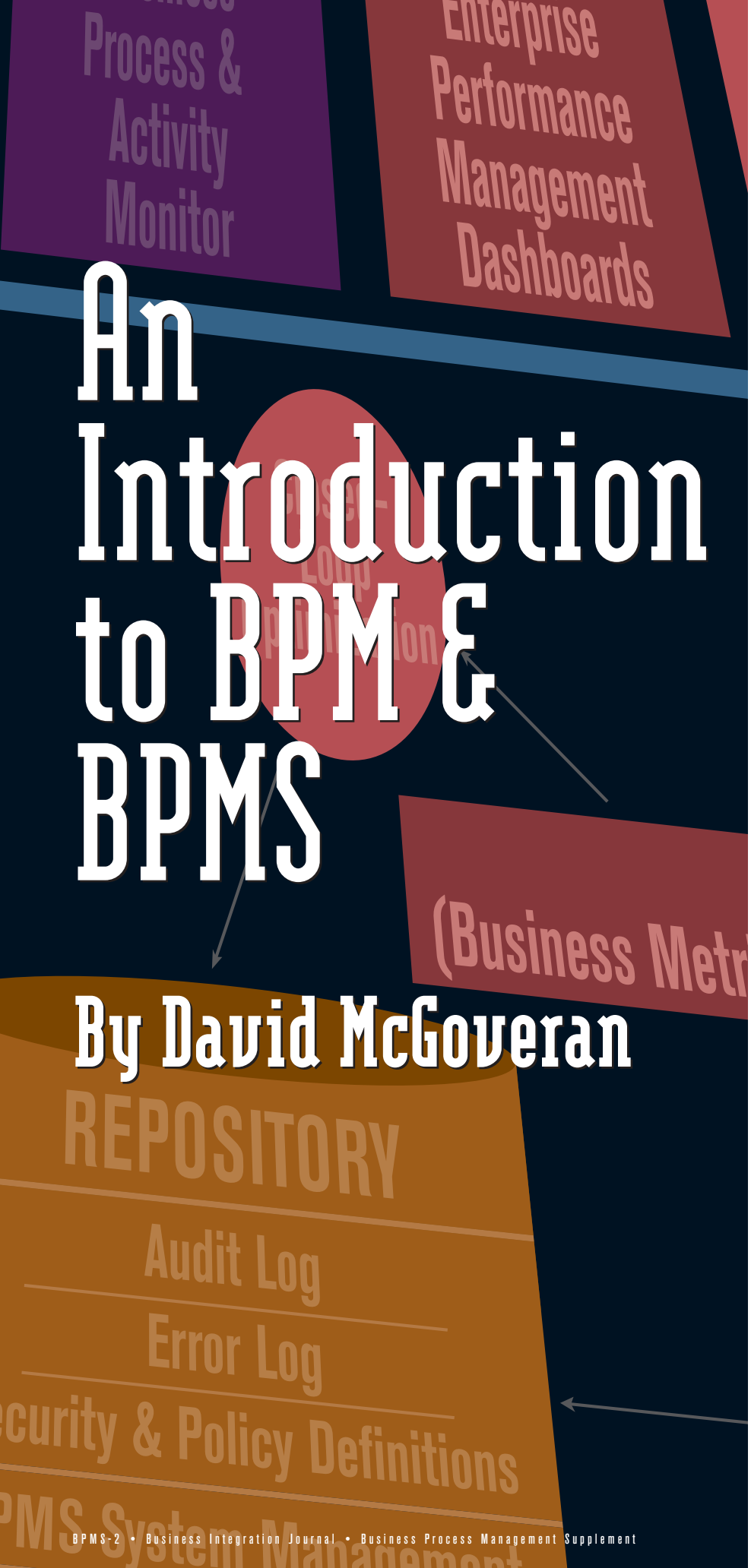

An Introduction to BPM & BPMS

By David McGoveran

The phrase "business process management" and the BPM acronym are used in multiple ways. Most usages are imprecise and informal, with the result that discussing BPM often generates more confusion than clarity. In this article, we take the position that BPM properly refers to a theory or strategy of business management that precedes and forms the foundation for a rapidly evolving, extremely valuable, though immature, technology solution. BPM technology solutions comprise multiple components, a suite of which may be referred to generically as a business process management system (BPMS). To understand the technology and why it's different from its predecessors, let alone how to use it, we must first understand the business principles that underlie BPM.

In this article, we'll review some informal, albeit common, uses of BPM, provide a more formal definition that departs from some of the informal uses, and discuss some important BPM principles. We then consider the technology for supporting BPM as a business management strategy.

Business Process Management

Informal uses of the phrase BPM are not only common, but often incompatible, and are proliferating. The cause of this situation is threefold:

The phrase BPM isn't new and has evolved from a history of usage in related business process fields such as business process improvement, business process reengineering (BPR), and business process innovation. The supporting technologies have evolved from earlier technologies for workflow management, EAI, process automation, process integration, process modeling, process optimization, and so on.

The rapid success of BPM-related technologies in recent years has motivated both vendor marketing departments and industry analysts to define the term, each to their own advantage.

Because maturation of BPM discipline and technology is likely to continue, with both academic and industrial research increasing in pace, our understanding of what should constitute the best formal definition will continue to evolve.

To analysts and most members of the press, BPM is a rapidly growing market category that has developed over the last five years, but which is merely a rebirth of old ideas. Many types of products and services are included in this category, such as those for business process model-

ing, BPR, business process automation, process integration, process analysis, process monitoring, workflow management systems, and process-driven development.

Many analysts either don't differentiate between BPMS and workflow management systems, or treat BPMS merely as providing workflow management integrated with an EAI infrastructure or Web services capabilities. There are both business and technical aspects of this issue. Presumably, BPM products and services belong to the BPM category not merely because the vendor has decided it's good market positioning, but because they have something in common. By the time you finish reading this BPM supplement, that "something" should be a bit clearer.

There are many who think of the BPM discipline as being rooted in BPR. Most of the early uses of BPM referred to the collective thinking associated with BPR and, to a lesser degree, with continuous process improvement and process change. This can be seen in, for example, articles of the *Business Process Management Journal*, the first issue of which was published in 1995. Until Vol. 2, 2001, when the *BPM Journal* espoused a "new vision," most of the published articles focused on BPR. Thereafter, it began to broaden its focus somewhat, although it still "defines" BPM as—to paraphrase—"distilling and applying the wisdom of reengineering to business processes."

One might think that, because the Business Process Management Group was founded in 1992, BPM was a common phrase dating at least from the early '90s. However, prior to 1996, when the group changed its name to "reflect a broader interest in sustaining process improvements," it was called the Business Process Reengineering Study Group. The 5,000-member group is "a global business club, exchanging ideas and best practices in business process and change management."

Although workflow management has its roots in office automation and document processing, it has evolved to encompass many types of workflow. The relationship between business processes and workflows is still being examined in the academic research literature, but two views are dominant and neither treats business process and workflow as identical.

The standard model of a workflow is as a special, well-defined, highly structured, and repeatable type of business process in which a "case" (an abstract document) is modified as it flows through a sequence of tasks. The workflow engine responds to these changes to determine routing. By comparison, a real-world business process definition isn't as rigidly constrained and may not admit of the case abstraction without overly convoluted thinking. As such, it's a generalization of workflow concepts.

The second view treats business process as a conceptual entity, while the workflow is its reduction to practice. This view has led many to use business process management as a synonym for "advanced" workflow management. This view often motivates the merger of business process modeling and BPR methodologies with those of workflow management.

Several technical organizations have been important in this evolution:

- The Workflow and Reengineering International Association (WARIA) was founded in 1992 and has as its charter "to identify and clarify issues that are common to users of workflow, electronic commerce and those who are in the process of reengineering their organizations."
- Workflow Management Coalition (WfMC) is the international, standards-setting organization of workflow vendors, users, analysts and university/research groups. In recent years, it has increasingly characterized its work as relating to BPM.
- The first group to address BPM directly was BPMI.org, founded in 1999, which has as its mission "to promote and develop the use of business process management (BPM) through the establishment of standards for process design, deployment, execution, maintenance, and optimization." The approach the organization takes to business processes is predominantly as an extension of the workflow paradigm, both in terms of terminology, standards compatibility, and conceptualization, and which emphasizes process-to-process correlation.

Principles of BPM

The phrase BPM first became popular in the context of business management strategies relating to business process in the mid-'90s. However, its meaning has changed over time, slowly usurping its predecessors. As a management theory or strategy, BPM can be characterized by a number of principles. Although a great deal has been written about BPM technology and its benefits, little has been written about the business principles that *implicitly* underlie both the successful use of that technology and the vision of its future. These principles have a firm grounding in the history of business process and management theories.

In this section, we consider these business principles, taken together, to be the current, formal meaning of BPM, and so will attempt to elucidate an *explicit* definition. A little history of business process thinking will help the reader understand the relationship between current BPM and its predecessors, from which it inherits much. As a pedagogical device, we'll use this history to introduce the principles, with the warning that no particular importance or meaning is implied by the order of presentation.

As a working definition, we treat BPM simultaneously as a theory and associated group of methods, both for the management of business from a process perspective and for the management of business processes. The first part of this definition entails a *strategic* business management position statement with far-reaching consequences. In particular, BPM is *a commitment to expressing, understanding, representing, and managing a business* (or the portion to which the theory is being applied) *in terms of an interdependent collection of business processes responsive to an environment of internal and external events.*

Adopting this idea simultaneously forces us to treat our business processes in a comprehensive, dynamic manner and to recognize business activities that aren't a part of some business process as being both unnecessary and undesirable. In this view, a business process is an interdependent set of business activities and decisions that mediate their inter-relationships, regardless of how repeatable that process is, how spontaneously it's defined or redefined, how well it's documented, or how aware human participants are of its existence.

Every business process is identifiable with at least one objective and its degree of success is either qualitatively or quantitatively measurable. Because the business is understood in terms of its business processes, it's through the management of business processes that the business is to be managed. The ideal BPM approach isn't one of forcing an organization to behave in a certain formal way, but rather of understanding that behavior through BPM concepts and principles. This is a knowledge discovery process, at times requiring considerable effort.

The second part of this definition also entails an *operational* position statement. By "management of business processes," we include process analysis, process definition and redefinition, resource allocation, scheduling, process management, measurement of both quality and efficiency in the context of processes, and process optimization. Furthermore, process optimization entails collection and analysis of both real-time measures (monitoring) and strategic measures (performance management), and their correlation, as the basis for improvement and innovation. Improvement and innovation are expressed in terms of business process creation, process change, and inter-process relationship change, and the determination of which of these to do, *which taken together is itself a business process*. This business change process enables selective closed loop control at the discretion of management initiatives and therefore *business agility*.

The importance of business process emerged over a century ago in the work of Frederick W. Taylor, who eventually published *Principles of Scientific Management*. Well-known for its evangelizing of time and motion studies, it was also perhaps the earliest work that sought to improve business efficiency by identifying certain business processes to which the techniques would be applied. Taylor's methodology was clearly one of the earliest examples of BPR. It also put forth two of the most fundamental and enduring principles of BPM. Contrast the following two principles with the 19th century view (still appallingly pervasive) that every business activity in a business process is executed by a supervisor *commanding* the use of people and other resources:

The efficient execution of a business process depends on the smooth functioning of a collaborative team.

The members of the team (e.g., supervisor and supervised) must have synergistic objectives and work ethics, appropriate skills, and rewards commensurate with contribution, production constraints, and market constraints.

Peter Drucker's 1954 treatise, "Management by Objectives and Self-Control," laid out the basic principles of management by objective (MBO). Subsequently elaborated by G. S. Odiorne, it clearly built on the lessons of Taylor. MBO is essentially a theory of managerial delegation, providing a framework for defining business functions that can be delegated with a means for determining success or failure of the execution. Peter Drucker's oft repeated maxim that, "you can't manage what you can't measure," is taken to heart by BPM. MBO provides us with the basis for two more BPM principles:

Every business activity in a business process has a well-defined, detectable set of qualitative and quantitative conditions that determine when that business activity may begin (successfully completes).

Every business activity in a business process has a well-defined, detectable set of qualitative and quantitative conditions that determine when that business activity achieves its objectives (successfully completes).

The very definition of MBO provides the relationship between managerial and delegated business activities. Managerial activities include identifying activities that can be delegated and determining the parameters under which the task should be performed. These parameters include the context or constraints for the task's initiation and execution, resources available for or required by its execution, objectives it must fulfill to be successful, and metrics or measures by which success or failure may be determined. Additionally, determining how delegated activities are *necessarily* interrelated (i.e., what comes before and what comes next) to satisfy higher-level objectives is a key managerial activity. In terms of business process, we can recognize these managerial activities as essential aspects of process definition. In addition, however, some inter-relationships involve managerial discretion determined, for example, by the quality of the delegated activity. Furthermore, in an agile business, even necessary inter-relationships may change periodically and so require that the process definition itself make explicit recognition of managerial discretion.

In terms of BPM, MBO makes it clear that a business process can be decomposed into a *delegation* or *management hierarchy*. Each level of business process description consists of delegated activities interspersed with managerial activities. The process may be partitioned into sets of connected activities that we call a responsibility set. Each responsibility set is defined as being the responsibility of a particular managerial role. In crossing from one responsibility set to another, the responsible managerial role changes, resulting in a handoff of responsibility.

Managerial activities constitute the manager's response to one or more prior activities by authorizing and initiating subsequent activities. A managerial activity forms a decision point (or node) in the business process, determining how to combine the results of prior activities and which subsequent activities will be authorized and initiated. Some decisions are relatively fixed, and so may be captured in advance as rules, procedures, and the like. Others involve judgment and so require interactive decision-making. Either way, decision nodes are the primary managerial control points in the business process short of process redefinition.

If a delegated activity can be decomposed into a set of activities and decisions (which themselves form a process) so that further delegation of responsibilities is permitted, a multi-level delegation hierarchy can be created. This decomposition can proceed consistently through many levels only by satisfying an important principle of BPM:

Every non-atomic business activity is equivalent to an interconnected set of simplified business activities and decisions (a more detailed business process) to which BPM principles apply.

Thus, a business process can be understood as a business activity and every non-atomic business activity can be understood as a process involving activities and decisions, thereby enabling the decomposition of a business process into a hierarchy of processes whose responsibility sets conform to the management hierarchy relevant to that process:

The decomposition of any business process into a hierarchy of processes should conform to the hierarchy of management responsibilities.

Dr. William Edwards Deming's work raised the bar considerably with a form of business process improvement, which came to be known primarily as total quality management (TQM) and the

predecessor of Six Sigma. Among other things, popular applications of Taylor's and Drucker's work often led to a destructive approach to increasing process efficiency, ignoring quality and timeliness in favor of volumes. Surely neither Taylor nor Drucker would have approved of this effect and would have agreed with Deming that a focus on quality must pervade every aspect of the process. TQM demands that we prevent poor quality and not let it propagate. Quality-related errors should be prevented by good process design, which means identifying what works and what doesn't. We're always able to identify what has occurred in the business process through quality measurements that are meaningful at all levels up the management hierarchy:

The definition of every business activity includes quality measures defined in a business process context so as to preserve semantic consistency when "rolled-up" along the management hierarchy.

But quality management is impossible if all we know is how well or how poorly a business activity was performed: It's not enough to recognize symptoms of a problem. We must also have ways of identifying the proximate causes. In process terms, this leads to one or more chains of causes that result from the specific process path taken of all possible alternatives:

Every alternative means of achieving or failing to achieve the objective of a business process (i.e., all the permissible paths through the process) and the possible causes of error, including reduced quality, are identified.

This principle forces us to completely define the possible effects of a business process rather than merely that portion that normally achieves the desired objective. It provides us with a way of correlating poor quality and the specific events that have led to it. This doesn't mean we have to complicate the business process definition with all the possible chains of activities and decisions. Instead, it forces a design that enables what software quality engineers call coverage: The process definition takes into account all the possible ranges of ending conditions, given the permissible ranges of starting conditions.

With the work of James Champy and Michael Hammer, BPR was born. Although businesses had obviously been redesigning their processes for decades, Champy and Hammer gave the discipline a fresh motivation, and modern definition, method, and perspective. They insisted that a wholesale redesign and replacement of existing business processes was often necessary. A thorough analysis of the business process as it existed (resulting in the "as-is" model) and a redesign to improve logistical efficiency (resulting in the "to be" model) were required, followed by transition to the new redesign. In the light of (and perhaps despite) inherent difficulties, BPR has often had incredible success, quite possibly a tribute to the great inefficiency of most business processes.

Unfortunately, BPR is a very costly, time-consuming, and disruptive effort for many businesses, especially with respect to precisely those business processes that could most benefit from redesign. Additionally, few businesses have any formal documentation of their business processes and even fewer have accurate documentation, in part because most business processes are dynamic, ever-changing and adapting entities. These facts conspire to make it difficult to capture an accurate, complete snapshot of the business process "as is," so that both the transition plan and the redesign will be moving targets. This increases the risk of an unfavorable result. Even worse, the rules imposed by formal business process models to create provably better redesigns are often too constraining in practice, attempting to force human participants to behave in ways that limit creative response to unforeseen errors and environmental events:

Although inefficient, existing business processes often include factors that have evolved inductively to maintain robustness and take advantage of local resources.

In building on both the positive and negative experiences with BPR, BPM focuses on managing existing business processes. It recognizes that business processes and their components don't exist in a vacuum, nor are they typically implemented without subtle side effects and inter-process entanglements due to coupling between objectives, activities, resources, schedules, triggering events, and so on. Control implies considerable (often tacit) knowledge and means for acquiring, maintaining, and applying that knowledge:

A business must gain control of the relevant portions of a business process and its inter-process dependencies in order to address any optimization goals. This is a knowledge management problem.

In the final analysis, Hammer (*The Agenda*, 2001) has stated that he "was wrong" about the approach and now recommends a more incremental approach that teases his reader with BPM-related ideas. Research has shown that the BPR approach is often inappropriate, but is valuable in certain processes with high variability. BPM takes a measured approach to the rate at which a process should be changed, since this, too, is a process to be managed and optimized. Recognizing that business drivers and objectives change, perhaps rapidly, it's important to evaluate the cost and benefit of any business process change. An often-overlooked aspect of such evaluation is an estimate of the life expectancy of the change (i.e., before the same aspect of the process needs to be changed again) and the rate of return on that change. By incorporating this analysis, even if informal, high opportunity for return changes will be fostered while low opportunity for return changes will be deferred.

In effect, BPM treats continuous process improvement and BPR as a spectrum determined by the scope of process change. It enables wholesale redesign of a business process when and only when the process environment is sufficiently stable enough to foster a high opportunity for return and the existing process meets certain inefficiency conditions. At the same time, it must be recognized that most process improvement has focused on logistic and operational efficiencies, sometimes focusing on local, functional optimization rather than simultaneous optimization of multiple, strategically essential business processes. It's well-known from systems theory and operations research that such a strategy is counterproductive: The collection of local optimizations is rarely globally optimal and therefore is to the detriment of strategic goals. Thus, local process changes must be subservient to strategic objectives. This is only possible if strategic objectives are consistent:

Every business process change must be evaluated in terms of its

global effects on related business processes, and must provide a positive opportunity for return.

The objectives of business processes that are entangled must be mutually consistent.

Almost all business processes have non-deterministic elements, such as certain built-in latencies used for synchronization and recovery, or those activities improvised by an experienced human participant in resolving exception conditions. These elements are often essential for both global optimization and robustness in the face of a changing business environment. They're the essence of agility. Every business process has a strict ceiling on how efficient it can become without being redefined by changes to its objectives. Therefore, a BPM strategy that focuses on operational and logistic efficiency offers declining returns on the invested optimization effort. By contrast, a business is always faced with new opportunities and threats, reflected as changes to the competitive environment. No matter how often they're addressed, additional opportunities and threats arise. The opportunity for return obtainable by addressing these changes in a timely manner (as contrasted with the potential lost opportunity costs from merely addressing logistical efficiency) is ultimately unbounded:

BPM refers to a theory or strategy of business management that properly precedes and forms the foundation for a rapidly evolving, extremely valuable technology solution.

Business process changes must not sacrifice agility for efficiency.

The business value of so-called exception processing shouldn't be underestimated. Business people often conceive of an idealized business process as consisting of the ideal set of activities and decisions that result in fulfillment of the process objective. Of course, real business processes often encounter error conditions, some foreseen and some not. There will be activities and sometimes entire processes implemented to resolve these errors. While traditional business process modeling often captures the definition of some of this exception processing, it's almost impossible to capture it all. Traditional business process modeling treats exception processing as triggered by, but distinct from, the business process proper. These omissions have a negative effect on redesign and optimization, and a primary goal of some BPR practitioners is simply the elimination of exception processing.

BPM takes the position that exception processing is inherent within and integral to the definition of every business process, and recognizes that not all exception processing can be given detailed clarification. Under BPM, optimization strives to improve the quality of the business process by minimizing how often exception processing is evoked or, where possible, to convert exception processing into alternative means to achieve the business process objective. Only in this latter case can exception processing cease to be part of the definition of the business process. In general, BPM recognizes that categorizing the most costly errors and associated exception processing is an ongoing, very important task.

The value of exception processing is usually underestimated. While proprietary business processes are, by nature, unique intellectual property and competitive differentiators, the non-proprietary, idealized business processes tend to evolve toward a public definition and don't directly afford competitive differentiation. However, the exception processing associated with non-proprietary business processes is often extremely proprietary and determines the competitive success of the business. Too often, we mistakenly treat the products and services as the subjects of competitive differentiation, but these are merely the result of business processes. As Harvard Business School's Michael Porter would be quick to point out, the competitive differentiation from standard, best practice business process definitions must be optimized and preserved:

The business sub-processes for exception resolution, together with proprietary business processes, are of critical importance, effectively defining a business's primary competitive differentiation and sustainable advantage.

Summary Comments

This brief introduction to BPM should give you some understanding of the approach. Many authors may disagree with this characterization or offer other definitions, but I have yet to find a solid position stated. Following the principles cited here will certainly lead you down the path to BPM. And it starts the dialog so that better recognized writers on management and technology than myself can respond, hopefully, to the benefit of us all.

Business Process Management Systems

A BPMS is a suite of integrated software facilities designed to enable BPM as defined and described in the previous section. While many vendors have not yet addressed all the issues raised in our current definition of BPM as a business management theory, they're well on the way to doing so. As is often the case in a developing market, which facilities have been developed to support which aspects of BPM is determined by a combination of public perception of critical requirements and the background and available assets of the particular vendor. Indeed, some important vendors in the market don't offer an integrated system, but have focused on delivering sophisticated capabilities for one or two specific BPM facilities or even services.

In this section, we'll examine the vendors and provide a broad description of what they offer. We'll then discuss the key functional elements of a BPMS, and finally turn to the relationships of BPMS technologies to, and the overlap with, business process analysis and modeling (BPA/M), business intelligence (BI), online analytical processing (OLAP), enterprise performance management (EPM), business activity monitoring (BAM), business rules engines (BREs), enterprise event management (EEM), portals, business-to-business (B2B) processes, EAI, enterprise service buses (ESBs), enterprise application servers (EASes) and enterprise platform suites (EPSes), Web Service, and integrated development environment (IDE) technologies.

Vendor Categories

Vendors offering a BPMS, or as some

prefer, a BPM suite, can be categorized into a few groups. Although not foolproof, knowing which group a vendor belongs to can often provide clues as to how the vendor is likely to think of BPM and address BPMS requirements. Almost all BPMS vendors, however, espouse a technology perspective and so only indirectly address the business management principles BPM represents. This is a rather unfortunate situation since adopting a clearly defined process-oriented business management strategy is essential to a successful implementation of a BPMS (see the article, "BPMS Implementation: Issues and Strategies," in this supplement). However, there are signs this situation is changing.

The eight most prominent categories of BPMS vendors can be easily identified:

- **BPMS pure-play:** BPMS pure-play vendors set out to design a BPMS (or product that's closely related architecturally) from the beginning, and treat this as their flagship product.
- **EAI vendors:** EAI vendors found the addition of process integration and process automation a natural evolution of their software stack. It was then a short conceptual leap to recognize the need for the message flow equivalent of workflow management services and dashboards for activity monitoring and performance management, although many are still evolving to a business process perspective.
- **Workflow vendors:** Much like EAI vendors, vendors of workflow management systems have been able to enter the BPMS market with little effort. A workflow may be thought of as a particularly well-structured business process.
- **BPA and BPR vendors:** Existing business process analysis vendors gained much of their market through the interest in BPR. These vendors often have considerable process analysis, definition, and simulation experience, and some have extended their product offerings to include process execution and monitoring capabilities.
- **EAS and IDE vendors:** These vendors increasingly find migration to the BPM market attractive. The first step usually involves adding graphical rules-driven or process-driven capabilities and integration (especially for Web Services and Enterprise JavaBeans) to the IDE, enabling rapid development of process-based applications. Moving beyond this technical process view requires adding business process analysis and design, and a true process engine driven by process definitions that can work externally.
- **Enterprise application vendors:** Enterprise applications suites (e.g., ERP) have included both embedded workflow management and some EAI capabilities in their products to enable customization and integration. With recent market pressures, they've begun to expose the functionality of these facilities and to enhance and redeploy them, increasingly satisfying the requirements of a BPMS.
- **BRE, BAM, and EEM vendors:** Products from these vendors play a significant role in a BPMS. Some are extending their products to provide more complete BPMS functionality. A few vendors have used rules engines to implement a rules-driven approach to process execution. (In other articles in the BPM supplement, the relationship of BPMS to BAM and EPM is discussed.)
- **BI and OLAP vendors:** These vendors are emerging as BPMS vendors in the context of business, corporate, or EPM and dashboards for this purpose. They're beginning to recognize that support for BPM or workflow management is necessary functionality in meeting performance management requirements. They can be expected to expand support for process beyond analytical flows.

BPMS Facilities

It's next to impossible to describe all the ways in which vendors have attempted to implement a BPMS. For this reason, we'll concentrate on describing the components of an idealized BPMS as represented in the accompanying poster, The 2004 BPMS Reference Architecture. Conceptually, these components can be understood as belonging to six groups. In summary, these are:

- User interfaces
- BPA/M facilities
- Run-time components
- BAM and EPM
- Infrastructure
- System management.

In the following, neither system management nor the user interfaces (i.e., B2B portals, process administration, process monitoring, workflow clients, business process and activity monitor, EPM dashboards, and business activity monitoring dashboards) are described. Their function should be obvious.

BPA/M Facilities

A BPMS incorporates a suite of BPA/M tools, shown at the far left of the 2004 BPMS Reference Architecture. These are the facilities by which users of a BPMS, rather than those who must support its use, interact with the system. They should be seamlessly integrated so the business user can move between them without losing context. The definitions produced via these facilities are stored in a repository, where they may be accessed either directly or indirectly by the run-time system.

- **Business process modeler:** The business process modeling tool is the primary process design and change interface to the BPMS. In addition to the traditional business process analysis (BPA) functionality of capturing, designing, and modifying business processes and their properties, the operational and interface properties of the business functions with which they interact need to be addressed. These include resource requirements. Although some process design methodology will undoubtedly be assumed, the modeler shouldn't impose restrictions during the capture of a process, either in terms of complexity or structure. It should permit users to define and selectively enforce process standards, and provide help in developing a transition plan between process designs. Various views of a process should be possible, depending on authorization, functional responsibility, and level of detail desired. This last requirement is crucial if process independence and process abstraction are to be supported.
- **IT orchestration modeler/mapper:** The IT orchestration modeler is used to define and maintain technical flows such as message and data flows, data transformations, transaction management of IT resources, and so on. It's this tool that's used with a process-driven IDE as may be found, for example, in an application server or application platform suite product. In an ideal BPMS, it supports mapping between business process definitions and technical orchestrations. In addition, business functions are mapped to service classes. This may be done either explicitly or implicitly (by defining the resource capabilities that can then be automatically mapped to resource requirements).
- **Business transaction modeler:** The ability to relate business transactions to business process events and to specify

transactional properties is important to a business, even if business personnel don't use the technical language of transaction processing. The business transaction modeling component provides the ability to capture and maintain business requirements for audit, consistency, and error recovery (whether traditional rollback, compensation, exception processing, or some other technique).

- **Technical transaction modeler/mapper:** A business transaction must ultimately be translated into an implementation model that maps it to a coordinated collection of flows, events, and defined technical transactions with various atomicity, consistency, isolation, and durability (ACID) properties. This tool is used to create those definitions and mappings, and maintain them.
- **Business metrics modeler:** Business processes and business functions are of little value to business managers unless they can be associated with business metrics or key performance indicators (KPIs). The ability to capture the definition of familiar business metrics and relate these computationally to raw measurements (as produced, for example, by the process engine or particular business functions) is therefore essential in a BPMS. The distinction between business metrics and raw measurements is essential. For example, expected time-to-completion of a business transaction is of business interest, whereas mean queue times, mean activity service times, and most probable path to completion are too technical and detailed. Business metrics definitions have an impact on which raw measurements are made and how long they're kept.
- **Technical measures modeler/mapper:** A business metric or KPI must ultimately be translated into a set of physical or technical measures and the operations used to obtain those measures. This tool is used to specify the technical measures required and the methods by which business metrics are derived from them, and to maintain those specifications.
- **Business process simulation and animation:** Discrete business process simulation is an invaluable aid in the design, optimization, and troubleshooting of business processes. It should permit altering the distribution of alternate paths, adjusting costs for activity-based costing (ABC) analysis, and the distribution of data values that control process path branching and merging. Visual highlighting of potential bottlenecks or inconsistencies, and identification of best-of-alternate process designs according to user-specified criteria are extremely valuable capabilities of a simulator. It should be possible to drive a simulation from user- entered, generated, or historical data. Visual presentation of a simulation as it progresses (a.k.a. animation) and of simulation results are highly desirable.
- **Simulation engine:** Simulation validity depends on accurately representing the operational characteristics of the process engine. The more finely tuned to match the target process engine and the typical mix of processes it runs, the more accurate and meaningful the results are likely to be.
- **Dashboards:** Facilities to monitor process instances (in-progress business processes) and the metrics they produce are needed by business managers and technical and system administrators. On the poster, we show three types of such dashboards: BAM Dashboard, EPM Dashboard, and Process Monitor Dashboard.
- **Dashboard designer:** Dashboards may need to be designed for a wide variety of specific user roles. The facility may make advantageous use of personalization and content management technologies.
- **Business process administrator:** Authorized users need to be able to start, stop, pause, redefine, or alter a process or business function instance. They may also need to modify (i.e., repair) a message (including production or control data), or may need to manually assign or reassign resources. The ability to perform these functions on a live process instance is one measure of the agility a BPMS is likely to provide.
- **Business analyzer and report generator:** Many of the questions that business personnel seek to answer require considerable computation and analysis. Sometimes, the analysis involves complex statistical or other mathematical models that the user need not know, but only wishes to use. Report generation (often with sophisticated graphs) is needed to view the analysis, preferably with Web distribution. These facilities are common in OLAP systems, although the business analyzer component of a BPMS should be customized for use in a business process environment. Libraries of preprogrammed analytics and wizards for understanding particular business processes would be a valuable addition. These facilities are often considered components of a BAM and EPM product.

Run-Time Components

The run-time components are the heart of the BPMS. Without these, a BPMS cannot execute a process definition or enable the management of individual runs of the process (i.e., process instances). The technical architecture, features, and functions of these components largely determine operational availability, performance, efficiency, and flexibility.

- **Process engine:** The BPM process engine is clearly the central component of a BPMS, without which it would be, at most, a planning or documentation tool. Its purpose is to implement a business process, managing the real-time invocation (or activation) and termination (or completion) of business functions. Ideally, it won't dictate the form of those processes or the nature of the business functions (although it should certainly encourage standards and good design). Note that we show a traditional workflow engine as being a subset of an ideal BPM process engine, indicating that it should be able to handle structured workflows and more.
- **Distributed BPM coordinator:** For B2B, business-to-consumer (B2C), global, cross-division, or multidepartment business processes, a federated or distributed process engine is required. This has obvious implications for process engine capabilities regarding remote process invocation, communication, and coordination. In some cases, process engine-to-process engine conversations are coordinated by a so-called public or global process, or by a collaboration. Each conversant in the conversation (there may be many, for example, in a trading hub) may have an independent, preferred view of the process and distinct security policies, possibly seeing the external portion of the process as a subprocess. The coordinator is simultaneously a kind of supervisor and a firewall.
- **Resource manager:** In an ideal BPMS, a general facility is needed to enable independence between business function definition and its implementation. It's this resource independence that enables business users to focus on business objectives as a first priority, improves robustness of the business

process definition, and enables efficient, run-time management of the available resources. Business functions may be implemented by mechanical, electronic, software, or manual means. The resource manager must select a specific resource with the capabilities that match definitional and run-time requirements, and then orchestrate the execution of the requested business function. The resource must be available at the time the business function is invoked or activated, and be returned to the pool of available resources when the function is inactive, completes, or terminates. Often, a task can be parallelized and load balanced across a set of available resources at execution time. If a preferred resource is unavailable, the resource manager should automatically select an alternative. For example, a task that's performed ideally by automated means may have to be performed by manual means.

- **Scheduler:** The scheduling of business functions is an important task within a BPMS. Were unlimited resources available, were there no timing dependencies, and were there no external constraints, business functions could be executed as soon as any preceding business functions complete. However, these conditions are rarely the case. Authorizations, loads, and capabilities must be considered, and some functions are performed by agents over which we have no control. Additionally, business processes and transactions often have externally imposed timing constraints or are triggered by external events. These factors make the scheduling of business functions a complex technical problem, similar to job shop scheduling. A BPMS without such a component won't perform efficiently, nor will processes be performed in a timely manner.
- **Rules engine:** A rules engine can augment both the process engine and the resource manager. One method of representing a process's permissible transitions, and therefore the decisions that control flow between activities, is as rules. Activity initialization and completion conditions can also be represented as rules. Matching of resource requirements for a business function to the capabilities of a class of resource can be accomplished in a flexible manner with a rules engine. The rules engine can help the resource manager optimize resource assignment, although performance is sometimes critical. Note, also, that a rules engine plays an important role in BAM and EPM, especially relating events, metrics, and responses.
- **Hardware interface manager:** This facility enables a BPMS to support activities involving the control of machines using computerized numerical control (CNC), robotics interfaces, process control interfaces, and so on, in a business process. This enables the operation of loading cranes, canal locks, manufacturing equipment, valves, and much more.
- **Interface manager:** A BPMS is of little value if the process engine cannot communicate with business functions as implemented. It must be able to communicate both control flow and data flow in a coordinated fashion, though these may be separately defined and quite distinct. (This is far from trivial. Few interfaces are designed for anything other than data flow!) If the BPMS is integrated with a suite of integration components, it's this BPMS component that's responsible for the operational aspects of that integration. Communication with transports, adapters (whether to middleware, applications, or presentation software) and technical orchestration engines is handled by the interface manager.
- **Worklist manager:** Interacting with human resources requires some method of task delivery. Either a push or a pull method may be used. Traditionally, human-oriented workflow management has required logged-in users to select tasks from a list of those awaiting execution. Lists are often prioritized, with escalation as necessary to meet expected or required schedules. Today, task selection may invoke an automatically generated applet or form, or perhaps an interactive function within an enterprise application. Support for manual activities that involve external resources (either disconnected software systems or mechanical operations) should be provided.
- **Repository:** A BPMS requires a sophisticated DBMS or repository for data and metadata. There are many data objects that the repository must store, including business process definitions, integrity rules, instance histories, messages and data flows, business metric definitions and data, business analytic and report definitions, along with saved data, transaction definition and data, security and policy definitions, access histories, simulation data, error events and resolutions, and so on. Although the repository appears in two places on the 2004 BPMS Reference Architecture, a single virtual repository consisting of an arbitrary number of physical (but necessarily semantically consistent) repositories is intended.

These technical, run-time components, if not properly integrated, would be a daunting collection to use and manage. But if bound together internally with a common architecture and set of programming interfaces, they form a cohesive, collaborative unit that can be used to enhance the integrity of an enterprise.

Business Activity Monitoring and Enterprise Performance Management

The ability to monitor events, analyze measurement data, detect trends, and compute KPIs is essential to the concept of process management. Without them, there's no ability to intelligently optimize business processes or to create effective new business processes in response to strategic events. These facilities are shown on the far right of the 2004 BPMS Reference Architecture. The semantic layer, analytics engine, and rules engine are common to both BAM (which focuses on detection and response to real-time events) and EPM (which focuses on detection, response, and prediction of trends relating to business performance).

- **Semantic layer:** This layer handles the mapping between views expected by business users, on the one hand, and technical descriptions and references on the other. This is a conceptual layer that permits business users to monitor business processes in terms of business metrics, business objects, balanced scorecards, and other familiar business objects.
- **BI/analytics engine:** The execution of complex packaged, rules-driven, or scripted analytics is often necessary for the computation of business metrics and KPIs from low-level or technical measures.
- **Portal management and personalization:** Every business user is likely to require personalized presentation of business metrics. This can be accomplished through portal management when dashboards are deployed as portals.
- **Event management:** BAM requires the ability to detect both business and technical events, interact with a rules engine

and an analytics engine to classify the event and determine an appropriate response, and ultimately to execute the response. Response execution may involve initiation of processes, raise events, triggering alerts, and so on.

- **Enterprise information integration:** EPM and BAM require access to a wide variety of data sources. Conceptually, this is the function of an enterprise information integration (EII) product, although most BPMS products (and stand-alone BAM and EPM products) will provide integrated access to a limited number of data sources.
- **Content management:** Most business data is embedded in documents. The incorporation of content management functionality within a BAM facility enables the detection of a broader spectrum of data events.

Infrastructure

The following technology interfaces can be either simple or sophisticated, but some version of them must exist if the BPMS is functional. Note that the audit, error, security, and policy facilities are grouped together on the poster.

- **System manager:** A BPMS requires an IT support facility for installation, configuration, and system management. The system manager should have all the usual desirable properties of an enterprise-class software system manager or administration component. A system administrator's job is difficult enough without adding complexity here, so usability and reliability are paramount. The goal is the elimination of manual administrative tasks, "error-proofing," and online guidance.
- **Audit facility:** The ability to audit a business process is a common business requirement and indispensable in most businesses. The audit manager keeps track of what was done and what decisions were made, when, by whom, and with what resources. Audit conditions, once defined, shouldn't be circumventable. Audit points are closely associated with, and ideally should be defined by, business transaction boundaries. Audit trail querying and report generation must be supported.
- **Error facility:** Although many errors can be anticipated and business processes established to handle them, there will always be unanticipated errors. These must be managed in a consistent, auditable fashion, even if the handling is manual and ad hoc. A guided facility to define classes of error and associated responses is desirable.
- **Security and policy facility:** As noted earlier, not all agents are authorized to perform every task or activity, to use any resource at any time, or to use any amount of a resource. A BPMS must not violate these business policies, and must enforce security. It may be necessary to support encryption, digital signatures, public key infrastructure (PKI), biometrics, and the like, as well as single sign-on, non-repudiation, and so on. The BPMS must have a security model with respect to its access, use, and administration, as business processes may represent the crown jewels of a business's intellectual property.
- **Integration infrastructure:** At one end of the spectrum, integration infrastructure consists of a set of direct-connect adapters that provide point-to-point integration between the BPMS and means used to implement business functions or activities. At a minimum, a BPMS requires a way to communicate with people for manually implemented business functions, and there are certainly many business needs that a simple BPMS with one such application or middleware adapter could address. At the other end of the spectrum, integration infrastructure may be a full suite of business integration components. Clearly, a BPMS best operates in the context of a complete integration layer. This may be a traditional EAI stack, Web services over an ESB or a variety of other architectures, and is shown along the bottom of the 2004 BPMS Reference Architecture.
- **IDE:** As BPMS usage matures, users will undoubtedly want to develop applications that take best advantage of BPMS capabilities. To this end, a suite of development tools is needed. In its simplest form, such an IDE enables the development of new adapters and Web services that are process-aware. An IDE for process-driven design and development of process-enabled, event-driven, and rule-based applications or application components is highly desirable. An integrated process-object methodology should be learned before such tools are used. A process-driven IDE is sometimes provided within application server and application platform suite products.

Conclusions

Today's BPMS products have progressed from simple workflow-like capabilities with minimal support for BPA/M and BAM a few years ago to support for more complex processes with both manual and automated activities. BPA/M support has greatly improved, and both BAM and EPM support are progressing. All this is highly encouraging.

Nonetheless, we have several improvements to look forward to in the coming four or five years. The following are particularly important:

- A broader range of business processes with less need to translate them into highly structured equivalents
- Separation between business views and technology-dependent views in design and monitoring
- An integrated approach to exception processing and resolution
- Improved federated and distributed capabilities for better enterprisewide and B2B support
- Collaborative business processes
- Coupled (a.k.a. entangled) business processes
- Robust business transaction support
- Intelligent resource managers and better resource independence
- Proven, standardized design and development methodologies
- Detailed implementation methodologies
- Integrated BAM/EPM with closed-loop optimization
- Higher levels of performance, reliability, and availability
- Libraries of standard, but easily customizable business process definitions (templates).

The vision and promise of BPM and its related technologies, as realized in a BPMS, is an exciting proposition with many potential business benefits. However, as with strong commitment to any enterprise strategy and technology, adoption should be a studied, measured activity, demanding appropriate incremental return for incremental investment. That spells BPM success. **bij**

About the Author

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