This article explains the origins and evolution of BPM technology. It explores the differences between BPM and related technologies, core concepts and vocabularies used in the context of BPM technology, various standards around BPM technologies, driven by industry as well as academic initiatives, and current perspectives of BPM technologies.

Introduction

In the current global competitive environment, companies are continually seeking to differentiate themselves with newer, faster and ever more valuable offerings in the markets in which they operate. Companies use business processes to encapsulate activities required to generate value for stakeholders. Business processes become foundations for companies to build competitive advantage or seek differentiated business offerings. Business processes help companies understand, measure and build on existing practices to create new or improved practices.

Drivers of BPM adoption

Companies adopt BPM technology solutions for various reasons, with the dominant reasons being the need for agility and improved business performance in the face of the emerging business challenges of a global business environment. BPM technology solutions are helping spawn innovations resulting in the creation of new value for customers.

Other reasons companies are adopting BPM solutions include increased productivity, improved quality, innovation, improved compliance and transparency, ability to respond to market changes, and more.

BPM characteristics

BPM is a cross-business discipline theory with its roots derived from a wide variety of knowledge sources such as organizational management theory, computer science, mathematics, linguistics, semiotics and philosophy. It can be defined as supporting business processes using methods, techniques and software to design, enact, control and analyze operational processes involving humans, organizations, applications, documents and other sources of information.

BPM provides knowledge workers the tools required to transform the business processes and in so doing enhances their productivity. BPM achieves enhanced transparency by enabling analysis.
of process history leading to visibility of bottlenecks, exceptions and errors. State of the art BPM technologies permit users to define their business-aligned key performance measures and enable collection of these measures in near real time. Usage of these key performance measures leads BPM systems to upgrade the business process models by interpreting previously uncorrelated activities. In this manner, BPM enables businesses to gain new visibility and transparency into their processes. The newly enhanced business process models then become baseline foundations for the next round of new, repeatable, best practices in a continuous business process improvement approach.

Depending on whether business processes are inward looking or outward looking, they can be viewed as private or public in nature. If public business processes span the organizational boundaries in the supply chain, in the current global environment, the business processes involved become collaborative business processes.

Based on a traditional hierarchical organizational perspective, BPM can be viewed as supporting operational control or management control or strategic planning aligned business processes. Viewed from a core competency perspective, on the other hand, business processes can be categorized as core business processes (revenue generating), management business processes (control and accountability), or supporting business processes (non-revenue generating).

BPM typically features a lifecycle, and there are multiple views of this life cycle. As shown in Figure 1, a BPM lifecycle can include Process Design, System Configuration, Process Enactment and Diagnosis phases:

**Figure 1. The BPM lifecycle**

![BPM Lifecycle Diagram]

**Note:** Figure credit Mariska Netjes, Hajo A. Reijers, Wil M.P. van der Aalst

At its core a BPM system is a unique process-centric and design-driven architecture platform. BPM grew out of industrial engineering, ISO certification, Six Sigma, Sarbanes-Oxley, enterprise business architecture, audit and compliance, Rummler-Brache, Integrated Definition Function Modeling (IDFM) and lean thinking practices. BPM systems and tools enable concurrent, computer-assisted re-engineering of business practice and IT systems. Business Process Modeling Language (BPML) language is the first complete, formal, concurrent, persistent, industrial, transactional, distributed, computer language of BPM system.
BPM systems enable us to describe and capture multiple independent concurrently executing threads exchanging and processing information simultaneously with each other and with people, as business process models. They permit the process models to be stored in computer systems to process business processes as data, so that they can be described and managed, and tools can be developed based on them. BPM systems help us capture the real world's concurrent processes. They enable us to perform interactive computational processing where computations and communications are combined for richer processing and where communications are permitted during the processing of computations. Interactive computations are founded on Pi calculus, can be described by BPML language, and consist of concurrent, reactive, embedded, role-based, agent-oriented, distributed, component-based computational systems.

BPM systems support modeling of performing a task or providing a service with dynamic interleaving streams. Earlier values of a computation may affect subsequent values of input and vice-versa. The computational model consists of the computing environment and everything else outside of computing environment, including humans, sensors, and other computing environments. The computing environment dynamically receives the inputs from outside the computing environment while the outside computing environment consumes the results actively generated by the computing environment in a concurrent fashion. In this model, elements of computation are non-static and non-pre-computable.

BPM systems are capable of supporting knowledge workers who are central to the innovation that is driving the business growth. Knowledge workers encapsulate skills, experience and inventiveness. BPM systems are capable of supporting advanced knowledge worker interactions amongst themselves and with systems, such as knowledge workers declaring work, offering work, requesting work, promising work, agreeing to work, assessing work and declining work. These knowledge worker interactions may lead computing systems, in turn, to communicate, compose, transform, store and retrieve information, as a dynamic outcome rather than a concerted goal. The results of computing systems processing may lead to changes to knowledge workers' subsequent interactions.

In typical BPM systems, process instances represent dynamic, living documents, having past and present states and a plan of execution for future. BPM systems can be viewed as document and knowledge management systems. BPM systems can manage non-static process knowledge. Additionally, they are capable of viewing processes as integrated plans, consisting of tasks, events and resources, with flexibility engineered into them so that they can take into account evolving real-time circumstances in order to achieve business value.

BPM systems facilitate tight or loosely coupled knowledge worker collaborations in a ground-up manner, and support ad-hoc interactions between other knowledge workers and system. BPM systems support optimization of knowledge workers' business process innovation, in which knowledge workers are central to innovation.

Creative process re-design requires computers to execute and manipulate end-to-end business processes and BPM systems facilitate the achievement of this objective.
BPM systems typically come with no specific processes defined, though some BPM systems may come with process templates for certain business processes common in certain industry segments. On the other hand, BPM systems are capable of being configured at all levels of processing. BPM systems enable businesses to capture and represent business processes in standard digital formats. Processes in formal digital models encapsulate how information systems can be directly aligned to the objectives of business executives. BPM system platforms support process analysis, design, deployment, execution, operations, analysis and optimization tools. BPM systems provide a scalable and reliable process execution environment in the form of an embedded process virtual machine adhering to a reliable model of process semantics. A process container with an embedded process engine, running on top of a general purpose application server, provides the predictable execution environment needed for running multiple instances of complex and concurrently executing process instances. BPM systems provide enhanced capability with greater reliability. However, they require proper governance and change management strategies.

**Case for BPM systems and tools**

BPM systems help address the challenges arising out of the growing complexity of the IT infrastructure, the need to build new IT systems that are flexible and built for change and the need to build IT systems that support differentiated business value.

Typical business process work is distributed in nature. Success often requires teams to work in a coordinated manner. Participating business process knowledge workers take part in end-to-end business processes, and bring to the table unique and distinct knowledge related to the business process.

Knowledge work by definition is not easily defined. It is of an inherently non-routine nature. In a knowledge worker environment, business processes emerge as a result of practice and in response to specific, ad hoc, unforeseen events that occur in the business environment, in the form of team-based responses.

Processes emerge from the bottom up as a result of practice rather than being imposed from the top down. They are executable, adapting on the fly, always under control and continuously proceeding to new work practice. Work consists of an organized set of collaborating tasks, giving rise to differentiated value additions to customers or stakeholders. Process encapsulates the work in its entire form. Competitive advantage is achieved from designing unique, differentiated, end-to-end processes. Automation of this process is what BPM aspires to deliver. Automation consists of process discovery, design, deployment and governance. BPM offers strategies for managing processes and knowledge.

BPM systems provide flexible workflow and data query capabilities, that encompass distributed end-to-end business processes, featuring computational and communicative tasks. BPM systems provide an ability to represent processes as data with the associated capability to manipulate them.
BPM systems aspire to lower costs and increase productivity. They provide an efficient foundation on which to build new processes capable of integrating with diverse heterogeneous systems that are flexible and cost effective to build. BPM systems have a unique ability to integrate data, computations, collaborations and business processes. BPM systems are a result of the convergence of work flow, ERP, integration, messaging, and application server and business rules technologies. Additionally BPM systems represent the future architecture of these technologies built around new abstract data types, the process and unified view of all data processing and communications.

BPM tools achieve reductions in cost-to-build by reducing cost-to-adjust component of overall costs. This is achieved by delivering incremental IT change. Unlike in rapid application deployment, BPM tools enable the development of business process models that are usable, operationally ready and completely in place, at every stage of development life cycle.

BPM tools help IT organizations redefine and reinvent their roles from IT-focused competencies to more business-aligned business change agents. Additionally, BPM tools, coupled with management practices, enable business professionals to realize their contributions to process redesign efforts more immediately, since they are enabling both design and delivery with single stroke.

BPM tools potentially alleviate IT backlogs by getting the right business professionals, with business domain knowledge, to create more business process models that are of higher accuracy and bigger impact in less time. BPM systems permit business domain professionals to craft BPM solutions instead of just IT domain professionals.

Current business environments demand BPM systems achieve business and IT changes in an integrated and coordinated manner. This implies that operational and IT innovations have to happen in a coordinated manner. BPM system process modeling tools enable business professionals to define the manner in which business systems should function. Business analysts develop process models to deploy onto BPM systems. The deployed business process models consume the existing IT assets in the new processes. BPM tools enable process owners to control and manage changes brought by systems, workforce and organizations participating in the business process. BPM systems represent a new IT architecture that provides enhanced flexibility while extending the value of existing IT investments and assets. BPM systems facilitate rapid IT reconfiguration in response to business changes.

BPM systems bring processes to life as executable systems simply and immediately. They help manage running processes, and facilitate a direct path to implementation and results in better alignment with the business and IT domains. BPM systems enable business professionals to see immediate value from their contributions to the process re-design efforts. Re-designed processes become operational immediately. BPM system tools are both design and implementation tools. BPM systems enable the leveraging of both existing business and technology assets.

BPM systems use design-driven architecture (DDA) rather than a top-down approach or a variation known as model-driven architecture (MDA). The top-down or MDA architecture approaches lead to business and IT domain misalignments. In DDA, to capture business process model
intent, a single language is used at all levels of operations, by collaborating between IT and business domains. This removes the distinction between a business process and its software in notation or semantics at any level of detail. The DDA approach leads to reduced process design to production time and resource costs. It enables BPM systems to support executable processes in which the process and the system are one and the same. Business process models may be represented in BPEL or BPML languages. However, these process models are not translated into code for execution just as data is not translated into relational models before being managed by relational databases, such as DB2® or Oracle®. The DDA of BPM system tools provides a stable architecture for building IT and business capabilities. Using BPM system tools, business process owners can build out business process models to run on top of IT capabilities built by IT professionals, as IT services with an enterprise-wide scope and scale similar to ERP deployments.

Even though BPM system tools facilitate development of new business processes in a rapid application development manner, BPM solution development is unlike rapid application development prototyping. Rapid application development typically envisions risk reduction that occurs in earlier phases of prototyping, due to misunderstanding of requirements between IT and business professionals at later phases. BPM systems are complete software infrastructure platforms that are more than techniques and that are unconnected to or unrelated to speed of prototyping. The difference between rapid application development and BPM system tools can be summed up as "what you see is what you will get in rapid application development" versus "what you see is what you do get in BPM".

BPM system tools, by capturing the best of management theory and re-engineering experiences, foster efficiency, innovation, flexibility and smoother compliance with changing regulations.

Current BPM concepts evolved from earlier efforts and insights gained from technologies and approaches involving Business Process Reengineering (BPR), Enterprise Resource Planning (ERP), Workflow (WfM), Business Rules (BRM) and Service Oriented Architecture (SOA). In order to better gain insight into the value of BPM and see how BPM evolved from its precursors, and how it differs from them, we need to understand the basic philosophies of these related but different technologies and approaches.

**Business process reengineering and BPM**

IBM's ability to manufacture inexpensive office PCs in the early 1980s coupled with the availability of productive applications, such as word processors and spreadsheets, led to a new vision of office automation. Companies began to computerize routine work at businesses in a widespread manner. The Office Automation Group at MIT envisioned an approach to building office application systems to be run on office workstations using an integrated set of tools consisting of document production, database management, image handling and communications to enable knowledge workers to exercise a wide range of capabilities on personal and interactive office workstation computers.

The MIT group also realized that it was more appropriate to redesign office processes prior to bringing productive office automation systems into businesses. When companies faced financial pressures in the mid-1990s and realized that knowledge workers were expensive to companies,
they began to look for ways to free up knowledge workers performing routine computer tasks to do more creative, customer-focused knowledge work, and they found an answer in business process reengineering (BPR). BPR was used to develop, test and deploy collaboration tools, workflow systems and numerous custom packaged applications. Businesses used BPR to downsize departments and companies. However, BPR efforts of creative process redesign did not lead to an easier way of executing, manipulating and managing whole business processes or integrating existing intellectual assets with newly re-designed processes. A new approach known as BPM was needed.

BPR envisions radical change of existing business processes in a disruptive manner, while BPM envisions practical, iterative, incremental approach to refining business processes.

**Enterprise resource planning and BPM**

Enterprise resource planning (ERP) systems offer alternatives to costly in-house development by offering cost-effective best practices. In ERP systems, the system encapsulates the process and manipulating the process becomes non-trivial and challenging. ERP modules are typically inflexible and require organization-specific customization. On the other hand, enterprises require unique processes to compete and win in the market place, and ERP systems have the difficult challenge of encapsulating these unique processes and encapsulating the capabilities to manage these processes in a cost-effective manner. ERP systems feature data management and precise record keeping of data capabilities as their foundations, rather than process management.

BPM systems address the needs of businesses while alleviating the limitations of ERP systems. BPM systems are capable of wrapping or replacing ERP systems or can be wrapped by modernized ERP systems.

**Workflow and BPM**

Workflow management as defined by the Workflow Management Coalition (WfMC) is “the automation of a business process, in part or in whole, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural roles.”

Workflow facilitates automation of clerical and administrative tasks that are of repetitive, such as check in box, assign task, or other tasks that are predetermined in nature. Workflow systems provide certain degrees of flexibility and robustness to IT solutions. They permit simple architecting and execution. Workflow solutions connect participants and systems, to enable flow of information using visual and drawing tools. Workflow solutions feature flexibility, efficiency, accuracy, quality, auditability, compliance and cost-effectiveness.

Work needs to be predetermined and changes need to be foreseen or predictable, in workflow systems. Workflow systems do not address the collaboration patterns of knowledge workers or shine light on how to improve work practices.

Workflow systems do not capture the process logic involved in collaborative and computational environments. They do not handle many-to-many interactions between multiple participants.
Workflow systems do not support the concept of a process, encompassing the information captured in a distributed, horizontal supply chain environment. Workflow vendors have not agreed on the semantics of workflow in the past. They support task delegations between people, people to systems, and systems to people. They do not, however, support the capture of human intent in interactions (task negotiations, task delegations, soliciting of volunteers to complete a task). Workflow systems support structured processes, with repeatable work steps. These steps are recurrent and stable command and control-type steps that are hard-wired. Workflow systems do not include integrated planning. Typically, workflow represents a prescribed flow of work.

Workflow solutions have a fundamental limitation – they can only automate solutions that are design-time driven only rather than run-time or real-time driven. Workflow solutions do not represent real or natural work flows, which can lead to work being diverted around the workflow solutions. Workflow systems permit users and systems to allocate work to each other respectively, but do not permit cooperation of users and systems.

BPM is a process-centric management discipline. It is not a technology. Workflow, on the other hand, is a flow management technology often found in BPM systems. Workflow is viewed as a subset of BPM systems in some circles, due to its limited diagnosis support capabilities. Workflow systems are viewed as possessing centralized enactment engines within the boundaries of organizations, which, unlike BPM systems, limits an organization’s ability to integrate into its supply chain partners.

**Business rules and BPM**

Business rules facilitate adjusting the parameters of workflow in real time or in operational environments dynamically. Business rules provide the ability to tune workflow parameters dynamically to suit changing business conditions without involving the IT developers or redesigning or redeploying the workflow solutions.

BPM systems are software systems that capture, automate and transform processes in response to changing events around the process environments. BPM system tools give business executives a broader view into and more direct control over automated business logic using graphical interfaces.

**SOA and BPM**

SOA is an IT architectural style of viewing a business automation need. SOA organizes technology for greater agility. SOA processes are a linked collection of services to enable the coordination of distributed systems, supporting business processes.

BPM is a process-centric management discipline helped by IT. As described by Gartner, BPM organizes people for greater agility. BPM facilitates seamless consolidation of IT services into a common set of re-usable services within SOA layers, over time in an incremental manner. While services and systems are merged, replaced, updated or consolidated, stakeholders of the business processes are unaffected because BPM leverages the SOA approach to BPM leverages SOA to gain control of and visibility into business processes.
BPM deployment scenarios

BPM solutions are employed for flexibility, agility and to provide differentiated qualities of service delivery, as well as to achieve and enforce standardization, simplification and compliance requirements.

If information or data is spread around at various locations in an organization or across a supply chain and needs to be owned and maintained locally as an authoritative copy of record for integrity or governance or ownership reasons in an enterprise or across enterprise boundaries, BPM solutions can be used to achieve a consolidated enterprise-wide or supply chain-wide view of data.

For information on successful BPM solution deployment scenarios see Resources.

BPM standards

There are various standards around BPM technologies – some are driven by industry efforts, others are driven by academic efforts, with standards being at various stages of evolution. Some of these standards are in the BPM domain, others address the needs of SOA, B2B and other areas of interest. The following tables summarize the various standards.

Table 1. BPM industry-driven technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Diagnosis/Graphical/Execution/Interchange</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>BPDM</td>
<td>Interchange</td>
<td>Yes</td>
</tr>
<tr>
<td>BPEL</td>
<td>Execution</td>
<td>Yes</td>
</tr>
<tr>
<td>BPML</td>
<td>Execution</td>
<td>Yes</td>
</tr>
<tr>
<td>BPQL</td>
<td>Diagnosis</td>
<td>Yes</td>
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<tr>
<td>BPRI</td>
<td>Diagnosis</td>
<td>Yes</td>
</tr>
<tr>
<td>UML AD</td>
<td>Graphical</td>
<td>Yes</td>
</tr>
<tr>
<td>WSFL</td>
<td>Execution</td>
<td>No</td>
</tr>
<tr>
<td>XLANG</td>
<td>Execution</td>
<td>No</td>
</tr>
<tr>
<td>XPDL</td>
<td>Execution/Interchange</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Table 2. SOA standardized industry-driven execution technologies

<table>
<thead>
<tr>
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<th>Execution</th>
<th>Standard</th>
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</thead>
<tbody>
<tr>
<td>WSCI</td>
<td>Execution</td>
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</tr>
<tr>
<td>WSCL</td>
<td>Execution</td>
<td>Yes</td>
</tr>
<tr>
<td>WS_CDCL</td>
<td>Execution</td>
<td>Yes</td>
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</table>

Table 3. B2B standardized industry-driven information exchange technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>B2B Information Exchange</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>
Table 4. BPM/SOA/B2B academic-driven technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Category</th>
<th>Execution/Graphical/Theory</th>
<th>Standard</th>
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<td>EPC</td>
<td>BPM</td>
<td>Graphical</td>
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<tr>
<td>Petri Net</td>
<td>All</td>
<td>Theory/Graphical</td>
<td>N/A</td>
</tr>
<tr>
<td>Pi-Calculus</td>
<td>All</td>
<td>Theory/Execution</td>
<td>N/A</td>
</tr>
<tr>
<td>YAWL</td>
<td>BPM</td>
<td>Graphical/Execution</td>
<td>No</td>
</tr>
</tbody>
</table>

BPM concerns and issues

Typical business process-centric solutions require companies to define all or most of the processes and activities involved in crafting a solution. This approach calls for significant investment on the part of companies. It is also challenging for companies to capture, transfer and retain BPM knowledge when knowledge workers involved in projects move off or move on from BPMS projects. Other BPM issues and concerns are related to non-availability of industry or segment best practices, emerging or lack of standards or lack of interoperability between vendor implementations. Non-standard notations to represent process-centric solution artifacts and non-standard semantics when executed across vendor implementations lead to platform dependencies, vendor dependencies, non-portability of process instances across vendor implementations, lack of interoperability between vendor implementations and potential uncertainty involved when vendors or embedded process virtual machine engines become non viable. Automation leads to reduced skills in knowledge workers. One solution to many of these problems is the BPM COE approach described in Marc Fasbinder's BPM Journal column.

Conclusion

BPM as a cross-discipline theory in practice has its roots in Business Process Reengineering (BPR), Enterprise Resource Planning (ERP), Workflow Management (WfM), Business Rules Management (BRM) and Service Oriented Architecture (SOA) efforts. We have explored the offerings of these various technologies, the differences between them and the concepts on which they are based. We have touched upon the various standards driving these technologies and the contemporary perspectives of these technologies as viewed by academicians and practitioners.

IBM offers a comprehensive BPM platform consisting of the IBM Business Process Manager family (Express, Standard and Advanced), tools, and an approach to managing business processes to gain visibility and insight. The topics covered in this article have relevance to IBM BPM offerings. Specifically, IBM Business Process Manager provides simple and easy to use tooling so that not only IT, but business users as well can fully participate in business process redesign and improvement. The simplified tooling provides a unified graphical design-driven environment in
which what-you-see-is-what-you-execute for testing or implementation. The tooling enables practitioners to develop process, service, user interface and rule-based applications while fostering greater collaboration between business and IT professionals. IBM Business Process Manager provides a unified run-time engine to execute BPMN or BPEL or SCA-based applications, a unified asset repository and control center for centralized BPM lifecycle governance to achieve consistency, control and repeatability, and an embedded WebSphere Application Server run-time for high scalability and availability. Due to IBM's unparalleled expertise, level of investment, and over 15 years of industry leadership with hundreds of assets featuring the broadest, deepest solution portfolio and services, IBM BPM offerings lead the market.

Acknowledgements

The author gratefully acknowledges the insights gained from the articles listed in Resources section.