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STEVENS ALLIANCE FOR TECHNOLOGY MANAGEMENT

Business Process Management and Innovation

Michael zur Muehlen

The improvement of corporate processes has long been recognized as a source of operational efficiency gains. As early as 1931 processes were discussed in scholarly publications (Nordsieck 1931) and the structuring of organizations among their processes was postulated in the early 1960s (Chapple et al. 1961). Business processes have been most prominently featured in the popular reengineering literature (Davenport 1993), but organizational resistance to change was frequently underestimated and led to many failed reengineering projects (Davenport 1995). As a consequence, talking about processes was often equated with reengineering and downsizing, and evoked a "we've been there before – and we're not going there again" response from affected managers (Rummler 2004). Today, our ability to measure and improve processes has increased beyond what was possible with the technology of the early 1990s, and process-aware information systems are firmly embedded in the IT infrastructure of organizations. A process management strategy will help companies maximize the benefit that can be derived from these systems. In this article we examine the components of a contemporary Business Process Management strategy, and illustrate the use of process-oriented technology for the evaluation and improvement of process performance.

Process Management: Technical or Organizational Issue?

Over the last few years we have seen organizational processes regain prominence as a source of competitive advantage. This can be attributed to a number of reasons: The conclusion of Y2K efforts, which absorbed a lot of energy and stifled innovation in other areas, new requirements for compliance with auditing and governance standards that require an analysis of current organizational practices, and the availability of a new (and increasingly mature) generation of process-aware information systems that are becoming commodities in the IT portfolio of corporations. Applications such as document management systems with routing functionality, workflow management systems, enterprise application integration platforms and other work management technologies have led to an increasing awareness of business processes in corporate IT departments. State-of-the-art application architectures are often designed around a process layer that allows for the easy adaptation and

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DIRECTOR'S NOTE

This edition features articles by two faculty members of the Howe School of Technology Management, Michael zur Muehlen and Richard Reilly.

Professor Zur Muehlen deals with the management of business processes, which as he points out has often been associated with reengineering and downsizing. In the broader sense, this topic deals with a structured approach to the evaluation and continuous improvement of business process performance. SATM has addressed various aspects of this subject, such as the management of the new product development process, in many of our forums over the years. We are pleased to provide this look at the components of a contemporary business process management strategy.

Professor Reilly gave the well-received keynote presentation at the 2004 SATM Conference on retaining and motivating technical personnel. We have asked him to provide his overview for the broader audience reached by our publication. In his article, he summarizes the relevant research in the field of organizational behavior, and discusses important implications for R&D management practices.

Larry Gastwirt

STEVENS Institute of Technology

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reconfiguration of applications when business needs change.

This development has shifted the process focus from organizational designers and line managers into the domain of CIOs, who are looking to deploy process-centric applications in "quick win" scenarios. As a consequence, many process improvement projects are initiated by IT staff and are treated as software development projects. This is not surprising, as the deployment of a process-aware information system at least initially looks like the deployment of any type of application system. In the long run, this perspective may lead to a one-time process performance change, an advantage that may erode over time if the competition catches up. As an alternative, organizational process management focuses on the continuous monitoring and improvement of process performance. While the first round of improvements may be significant, subsequent adaptations of the process in question will lead to incremental gains in process performance. In an ideal scenario organizations can adopt a combination of both approaches. First, stake out the "quick fixes", then deploy technology that will support the revised process, and then continuously monitor and adjust the process. Figure 1 illustrates the difference between the three approaches.

Foundations of Business Process Management

Management in general controls the use of resources and choreographs the operational activities of an enterprise. Management functions follow a lifecycle of planning, organizing, staffing, directing, controlling, and budgeting. In essence, Business Process Management is the application of this management cycle to an organization's business processes. Business Process Management has become an industry buzzword over the last few years, but its roots are clearly not new. Zairi and Sinclair state that BPM is "a structured approach to analyze and continually improve fundamental activities such as manufacturing, marketing, communications and other major elements of a company's operations" (Zairi et al. 1995). Elzinga et al. characterize BPM as a "systematic, structured approach to analyze, improve, control, and manage processes with the aim of improving the quality of products and services" (Elzinga et al. 1995). Harmon echoes this idea (Harmon 2004): "BPM refers to aligning processes with the organization's strategic goals, designing and implementing process architectures, establishing process measurement systems that align with organizational goals, and educating and organizing managers so that they will manage processes effectively."

The core task of Business Process Management is to create alignment among individual process components: Input (information and resources), Output, Structure, and Goals. If alignment between these components is achieved the overall process performance should increase both in terms of qualitative (e.g. faster adjustment to environmental changes) and quantitative factors (e.g. shorter cycle times, less waste, idle time, rework).

The BPM Life Cycle

Since Business Process Management consists of recurring activities, it is best described as a life cycle (compare figure 2). The starting point for any process improvement project is an analysis of current strategy and goals. Processes should contribute to the overall strategy of an organization, therefore the individual process goals should align with the strategic goals of the organization. For example, if the overall goal of the organization is to become a quality leader in its respective market, process goals such as "shortest execution time" may lead to counterproductive behavior by process participants, who receive incentives for finishing work fast, even if it does not meet the highest quality standards.

Today, our ability to measure and improve processes has increased beyond what was possible with the technology of the early 1990s, and process-aware information systems are firmly embedded in the IT infrastructure of organizations.

Based on these goals the analysis and design of individual processes can commence. This is typically done using (semi-)formal graphical notations, such as Event-driven Process Chains, Petri Nets, or Flowcharts. In focus groups we have also encountered organizations that use tabular process descriptions, such as RACI charts with success. Graphical process descriptions have the advantage of being easily communicated, although they may not capture all intricacies of a process, such as business rules that are invoked to make routing decisions.

The process models generated in the design phase are then transferred to the process implementation phase (Build Time). At this stage, decisions have to be made whether the activities of a given process should be carried out manually, with the help of information systems, or be completely automated. Furthermore, the process analysts need to determine whether the routing of the process (i.e. the control flow) should be controlled by a process-aware information system (e.g. a workflow management application), or

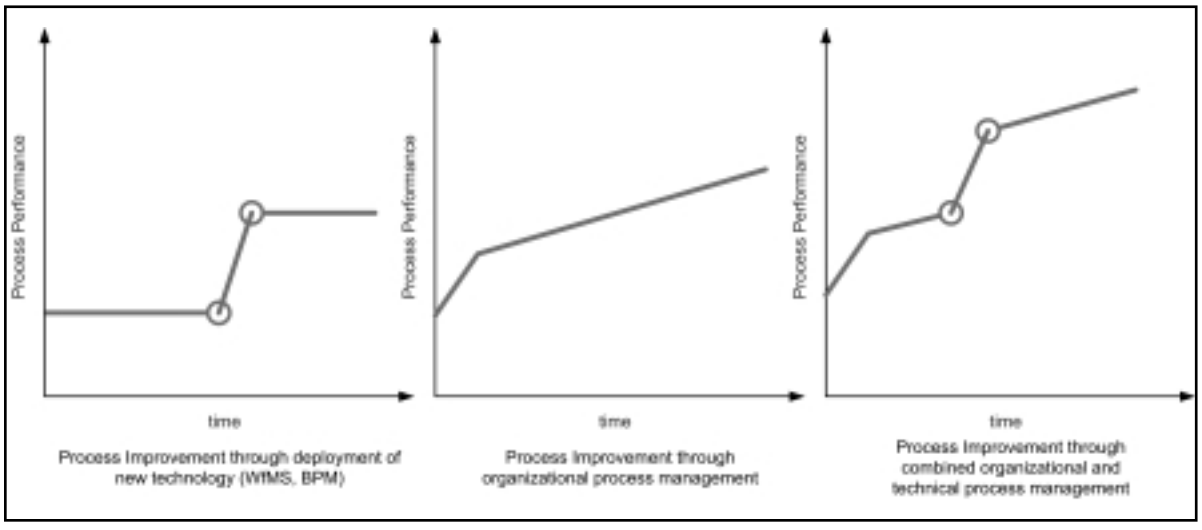

Figure 1: Organizational vs. Technical Process Improvement

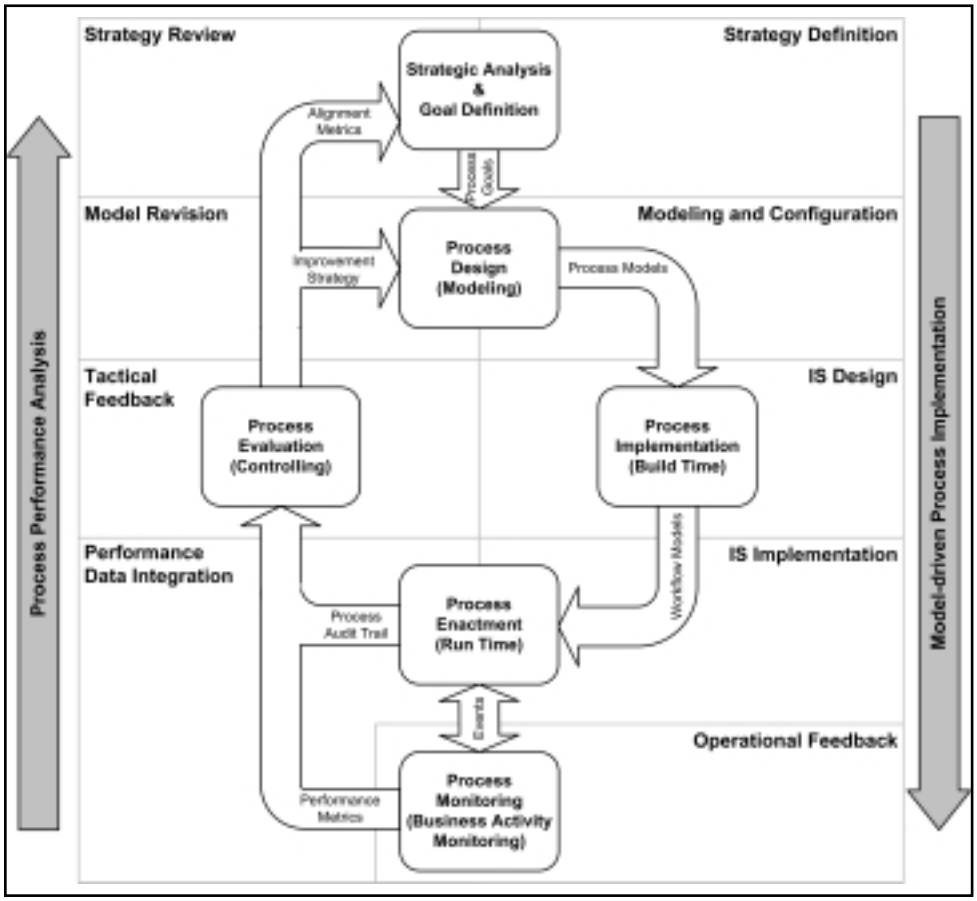

Figure 2: Business Process Management Life Cycle

whether manual processing rules and employee training are sufficient to ensure the desired process performance.

The transformation of design models into implementation models is a critical step, and the mismatch of methods and modeling perspectives can lead to a great deal of rework and re-documentation in this phase. The reason for such mismatch is the fact that the process design perspective (i.e. the purpose of the process model) determines the elements captured in the process design phase. For instance, a simulation model would contain activity execution frequencies and resource utilization, while an application integration model would contain detailed information about the invoked applications, their data format, and their invocation interfaces. If the modeling purpose during the design phase differs from the implementation phase, information will be missing from the process models and will need to be documented in the implementation phase.

Once the process implementation is completed, individual process instances can be derived and executed from the implemented process models (Run Time). At this stage process participants are informed about pending tasks via work allocation and distribution mechanisms (such as web-based task lists) and carry out their respective activities. Modern Business Process Management Systems allow for the collection of precise metrics in this phase, which can be fed to dashboard-style applications, known as Business Activity Monitoring systems.

While the purpose of Business Activity Monitoring systems is the active support of process managers during the day-to-day supervision of processes, they typically do not support higher-level decision support functions such as the display of performance trends or aggregate process information. This is the domain of process controlling applications, which are fed with data both from the process execution infrastructure and existing data warehouses that capture business data linked to individual process instances. Process controlling applications allow process managers to analyze process performance with regard to the business objects that were manipulated in the individual process instances. Questions such as "how does our process performance differ between frequent and first-time customers?" can be answered at this stage.

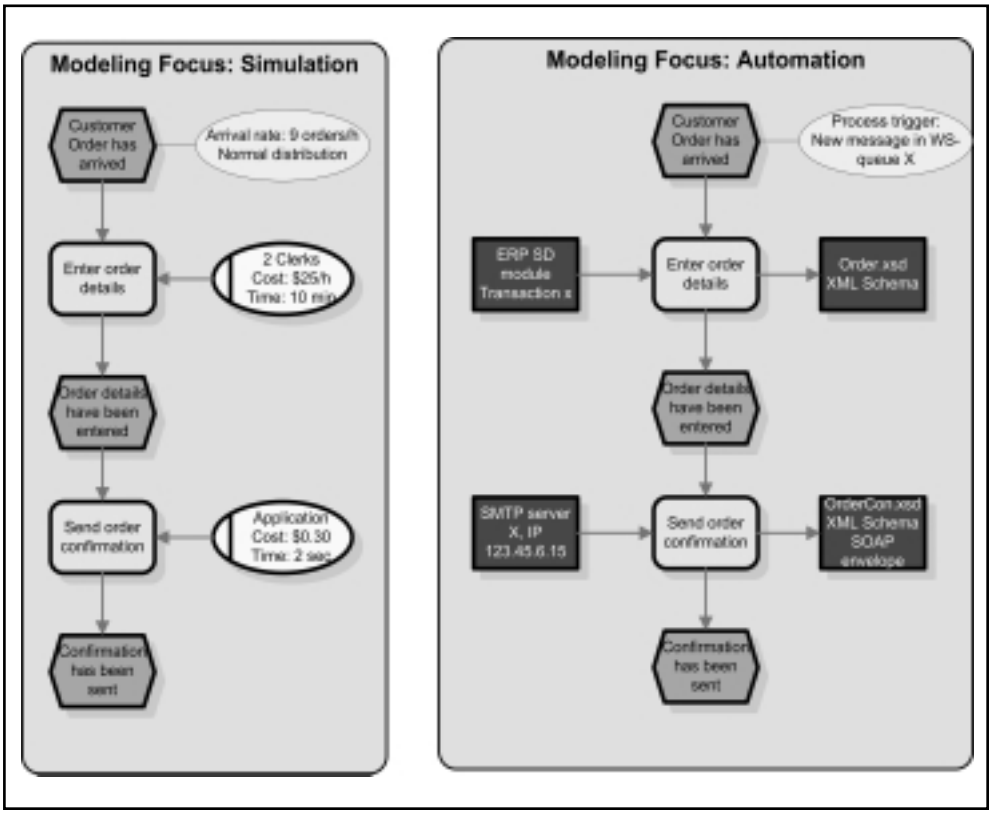

Figure 3: Results of Different Modeling Focus

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The insights gathered during the process controlling and review phase can then be used to analyze strategy alignment as defined in the first stage, and the appropriateness of the subsequent process design. To date, little work has been done to link process performance data to actionable process improvement activities, and this remains an interesting field of study.

The overall BPM life cycle as depicted in figure 2 is split into two distinct phases. The right side of the life cycle (strategy and process design, implementation and execution) echoes the model-driven implementation of information systems. Experience gathered from the management of software and reengineering projects is applicable in these stages, and therefore the "software-project-like" approach to BPM is understandable. As a consequence, many organizations that deploy BPM solutions are satisfied (or relieved) once these solutions are in place and do not want to touch them anymore, focusing just on the technical maintenance of the deployed application.

However, the software development analogy fails along the left side of the life cycle, which consists of process monitoring, controlling, and process and strategy revision. These tasks have less technical and more business focus, and should be conducted by a process manager with line responsibility. In the next section, we look at these tasks in more detail.

Business Activity Monitoring and Controlling

One of the benefits of having a process-oriented application infrastructure in place is the ability to collect process performance metrics near real-time. But does this technical advantage translate into a more nimble organization in general? Figure 4 shows the breakdown of latency that affects decision making processes in general (adopted from (Hackathorn 2002)).

Once a business-relevant event occurs (such as the cancellation of a customer order, the escalation of an activity to a supervisor, or the failure of an application system), information about this event needs to be stored, processed into a format useful for decision makers, and presented. Based on the content and context of the event, a decision on if and how to act needs to be made, and this decision needs to be implemented. Between each of these activities time is lost, and with this time business value may be lost. For example, if a customer complains about a late shipment on the phone, a skilled call

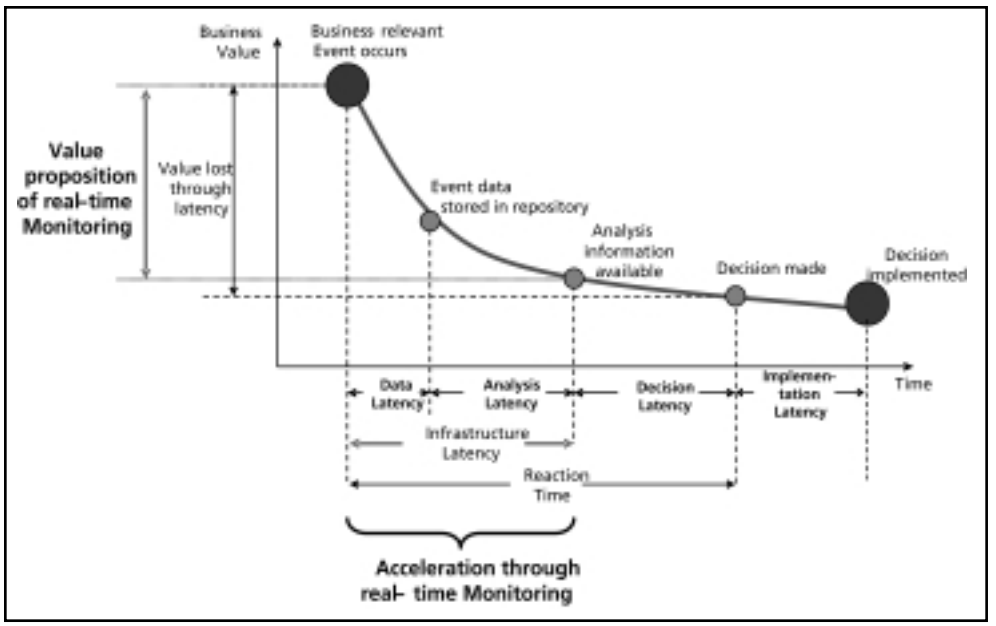

FIGURE 4. Business Process Monitoring Latency

center operator might offer concessions to the customer while he or she is still on the line. If these concessions are offered after the customer hangs up, the risk of losing the customer is significantly higher, and the potential loss of revenue greater. Some of these latencies are caused by (the absence of) technology, while others are of organizational nature.

In the context of BPM, process-related events are generated by the Business Process Management infrastructure. They need to be transferred into a Business Activity Monitoring system in order to be visible to process managers (data latency). Within the monitoring system, the updating frequency of gauges and reports determines when analysis information concerning the event is available (analysis latency). Depending on the nature of the process fixed reporting cycles may be sufficient (which may lead to a maximum analysis latency of one reporting cycle), while in time-sensitive processes an active notification of the decision maker is desirable. Once analysis information is available it needs to be interpreted by the decision maker and its implications may be assessed. While the call center example given above would benefit from a minimal decision latency, other scenarios may require decision makers to observe general trends before jumping to conclusions based on individual processes. Decision latency is also affected by the readability of information, and the alignment of monitoring data with the decision making abilities of the individual process manager. Finally, the decision made by the process manager needs to be implemented, which is expressed in the implementation latency.

Real-time monitoring shortens decision cycles by minimizing infrastructure latency. Because the origin of monitoring information and the system displaying this information are tightly integrated, data and analysis latency can be shortened, if not eliminated. However, decision and implementation latency will continue to exist. They can only be shortened if the monitoring information is aligned with the interests and responsibilities of the process managers, and if the relationship between process design and changes in process performance is well enough understood to quickly adapt processes and their execution context. Business Process Management Systems provide the technical foundation for these activities, but their deployment requires a parallel effort in process management training. Furthermore, even if process performance can be observed in real-time a reaction in real-time may not be desirable. In supply chain management the bullwhip effect is a well-known phenomenon that occurs when demand forecasts are based exclusively on information from the immediate downstream partner in the supply chain (Lee et al. 1997). Similarly, the roles of process monitoring (fixing individual process instances that run awry) and process controlling (identifying long-term trends and revising process strategy and design) need to be separated to avoid knee-jerk reactions that may affect overall process performance in a negative way.

Summary and Outlook

This article provides an overview of the Business Process Management life cycle, and illustrates the process monitoring and control-

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Motivating & Retaining Technical Employees[1]

Richard R. Reilly

Recent trends in science and engineering are troubling for the future of U.S. technical research and development. Several indicators show that the United States is losing its lead in scientific achievement. Patents granted in United States by country of inventor went from 60.2% for U.S. based inventors in 1982 to 51.8% in 2003. In a similar vein, the number of U.S. doctoral degrees in science and engineering has been declining since 1998, while the number of doctoral degrees in science and engineering has been rising in Europe and even more sharply in Asia. The reality is that we have relied on scientists from Asia and other countries for a lot of our brain power for some time. In 2000 the percentage of engineering Ph.D.'s in the United States who were born elsewhere was 51% and the percentage of physical scientist was 45%. However, the number of graduates from Asia planning to stay in the US has been declining since about 1996 probably due to increased opportunities in their home countries. An even more alarming trend is reflected in technical publications. For example, until 1995 the number of articles published in Physical Review by scientists from the U.S. outpaced articles published by all other countries. Since then the publications by scientists from Europe and other countries have caught up with and surpassed us.

Without the expertise of research and development professionals it will be difficult for US companies to maintain their lead in innovation and technology. R&D is the key to innovation, the rapid development of new products and sustainable company growth. Based on recent studies the demand for technical professionals is exceeding supply, and the situation will probably get worse. For technologically driven companies, the task of retaining experienced and competent R&D professionals faces additional challenges. The access to instant information about jobs and careers via the Internet and other sources has made it easier to seek out alternative opportunities. Factor in the recent history of downsizing, mergers and outsourcing and traditional company loyalty is weakened, if not a fond memory.

Beginning with the Hawthorne studies in the 1920s, the field of organizational behavior has studied issues related to retention and motivation. I provide a brief overview of this research and then discuss some of the implications for R&D management practices.

Retention

Why do people leave their jobs? One simple explanation is that dissatisfaction leads to turnover. The theory of reasoned action[2], a general model that links attitudes with behavior, can help us understand the process. Simply put, the theory says that attitudes lead to intentions and intentions lead to behavior. In the case of turnover, attitudes are related to job satisfaction. Low satisfaction leads to intention to seek alternatives and this in turn leads to leaving the organization. According to the theory of reasoned action, attitudes have three components: a cognitive component which is what you believe, the evaluative component which is how you feel and a dispositional component which is how you are disposed to act. In the case of job satisfaction there is a cognitive component with respect to what you believe about the organization, and a value component which is at root an emotional reaction to what you believe about the organization. Finally, the behavioral component sets up a disposition to act in a certain way, which may lead to turnover.

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According to Steel[3] there are three stages in turnover. First, individuals engage in passive scanning. This includes looking at unemployment or underemployment rates and knowledge is sketchy and impressionistic. In the second stage a more focused search is undertaken where the individual will read employment advertisements and become systematic with respect to searching. Knowledge obtained will be more relevant but data is still processed at an abstract level. The final stage of job search includes contacting employers to follow-up on leads and engage in interviews. Job satisfaction is the trigger that sets off this search process.

Job Satisfaction

What determines job satisfaction? Work done by Patricia Cain Smith[4] in the 1960s isolated five different factors related to job satisfaction. Decades of research has shown that this Five-Factor Model predicts overall job satisfaction. The five factors include work content, pay, opportunities for promotion, supervision, and coworkers. The first factor, work content, has to do with satisfaction with the work itself and is determined by how interesting and fulfilling the work might be. This factor tends to be most important for technical professionals who place a high value on interesting work. The second factor, pay, tends to be perceived on a relative basis. That is, how satisfied we are with our pay may depend upon how our pay compares to the pay of some significant peer group. Opportunities for promotion are important for some individuals, and since the work done in the 1960s with flatter organizations becoming the norm opportunities for promotion have become less frequent. The final two factors have to do with satisfaction with supervision and coworkers. Both of these factors can vary tremendously between individuals in terms of how important they are, but having compatible coworkers and leaders that we trust and admire can play a big role in our overall satisfaction.

A somewhat different approach to satisfaction is referred to as the two-factor theory[5]. This theory, developed by studying samples of engineers and accountants, distinguishes between "satisfiers and "dissatisfiers". Dissatisfiers, also called hygiene factors, include the quality of supervision, pay, company policies, physical working conditions, relations with others and job security. Satisfiers, also called motivators, include promotion opportunities, opportunities for personal growth, recognition, responsibility and achievement. According to the two-factor theory these two variables are quite separate in terms of their impacts on individual behavior. The hygiene factors can cause dissatisfaction and lead to turnover but cannot result in increases in motivation. Only the satisfiers, or motivators, can result in greater effort and improved performance.

Several other theories have been used to explain job satisfaction. Value theory posits that the greater the gap is between what you

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value and what you actually get from your job the more likely you are to be dissatisfied. For example, if you place a high value on individual autonomy and your job offers you little autonomy, you will be dissatisfied and more likely to leave the organization. Social Information theory posits that job satisfaction and job attitudes are strongly influenced by one's coworkers, superiors, subordinates and customers. It also posits that valued coworkers will have the strongest influence and that cohesive groups have more influence than noncohesive groups. The implications are that the leaders' own attitudes and behaviors are important determinant of the attitudes and behavior of followers and that networked groups are major determinants of work-related attitudes including job satisfaction.

The final theory is called the Dispositional Model, which says that dispositions are stable personal individual differences and will tend to produce positive or negative attitudes regardless of the circumstances. The dispositional model received some support on research with identical twins which has shown that identical twins reared apart share approximately 25% of the variance in job satisfaction even though they have never met one another.

Studying job satisfaction is worthwhile not only because it is related to turnover. Job satisfaction, has a low but significant correlation with job performance, and is also related to a variety of other behaviors. For example, low job satisfaction can lead to disruptive behaviors in the workplace or even sabotage. High job satisfaction, on the other hand, can produce increases in organizational citizenship and higher organizational commitment. Organizational citizenship includes behaviors such as mentoring, helping behavior, sportsmanship, and other behaviors in which individuals go beyond their prescribed roles to voluntarily help the organization and other individuals be successful.

The role of pay in job satisfaction and turnover is an interesting one. Pay is generally accorded less importance than the nature of the work and satisfaction with coworkers but pay can still have an influence on retention. For example, a recent study showed that pay for knowledge increased retention but that awarding group pay decreased retention.

Organizational commitment is closely related to job satisfaction and is strongly linked to retention. Three different types of commitment have been identified. These include continuance commitment, normative commitment and affective commitment. Continuance commitment means that an individual will continue working for an organization because he or she cannot afford to leave. Normative commitment means that an individual will continue working for an organization because they face pressure from others (e.g., coworkers) to remain. Affective commitment means that an individual will continue working for an organization because they agree with the values of that organization and desire to remain there. Affective commitment tends to engender organizational citizenship behavior and increases the likelihood of retention.

Motivation

Several theories of motivation have been proposed including Needs Theories, Goal Setting, Equity Theory, Expectancy Theory and the Jobs Characteristics Model. Needs theories of motivation began with Abraham Maslow who first posited a hierarchical theory of needs which begin with physiological needs, then move to safety needs. Once these needs were satisfied individuals are motivated by social needs. Finally, needs for self-esteem and self-actualization are triggered when social needs are met. Later researchers simplified Maslow's hierarchy into existence needs, relatedness needs and growth needs.

There is a tremendous amount of research that shows the motivating effects of goalsetting. Briefly, the theory of goal setting says that once a goal is set motivation begins with the recognition of the challenge of a higher goal level. The individual must accept the goal as his or her own which leads to goal commitment. Goal commitment is also related to the desire to attain the goal and the perceived chance of attaining the goal. Ultimately, goal setting leads to higher performance, especially when goals are specific, clear and moderately difficult.

A third theory of motivation is related to rewards and is called Equity Theory. Equity theory, briefly, says that individuals make an assessment of their rewards vs. their inputs (effort, skill and ability). Their personal ratio of rewards/inputs is then compared with the same ratio for others. The theory states that if the ratio for others is perceived as higher the result will be anger and decreased motivation. On the other hand, if the ratio of others is perceived as lower the employee will feel guilty and will work harder. Equitable outcomes which result in a balance between inputs and outputs relative to perceived others will lead to job satisfaction

Expectancy Theory incorporates several major factors: Expectancies or the belief that one's efforts will result in performance; Instrumentality, or the belief that performance will be rewarded; and Valence, or the value of the rewards. According to Expectancy Theory motivation will be a function of one's expectancies, instrumentality and the belief

Implications for Management Practice

Employee Recruiting and Selection Recruiting and selection usually focuses on relevant experience and competencies necessary for the job. While these factors are clearly critical the research tells us that unless we select individuals whose values and personal styles are compatible with the values and culture of the organization, dissatisfaction, lowered commitment and turnover is the likely outcome. Organizations should incorporate an assessment of values and personal style into their recruiting and selection methods. Job candidates should be given realistic previews of the job and organization, including its values and culture.

Work Design Research on the Jobs Characteristics Model, Goal Setting Theory and Expectancy Theory tells us that work should be designed so that there is sufficient opportunity for employees to utilize a variety of skills and abilities. Employees should understand that their work is significant to the organization, should be given clear goals, control over their work, and should be provided with meaningful feedback.

Organizational Structures Organizational structures should be designed to provide for cultures that are compatible with the values of technical professionals; these include cultures that are open, value learning, growth and autonomy. Structures should provide opportunities for the social needs of individuals to be met, especially with the increase in virtual work.

Pay Organizations can take steps to ensure that pay is equitable relative to the peer groups that matter most to R&D professionals: co-workers and others within their professional discipline. The research seems clear on variable or "at-risk" pay. If pay is variable, it should be linked as closely as possible to individual performance.

Supervision and Leadership R&D leaders should be involved in taking some of the steps outlined to ensure retention and motivation. Training in leadership can be helpful in teaching supervisors how to engage in a more transformational style of leadership. Not everyone can be a true transformational leader but many of the associated can be learned and will result in higher commitment and motivation.

that performance will lead to valued rewards.

The Job Characteristics Model focuses on enhancing three psychological states: meaningfulness of work, responsibility for outcomes of the work, and knowledge of the actual results of work activities. Improvement in these three states will lead to increased motivation, better performance, higher job satisfaction and lower turnover.

A final theory of motivation distinguishes two different factors called Intrinsic and Extrinsic motivation. Intrinsic motivation can be characterized as "a labor of love" or motivation based on interesting, engaging and satisfying work. Extrinsic motivation is motivation that depends solely on rewards or recognition. Research has shown that scientists are typically driven by intrinsic motivation and intrinsic motivation, has been related to creativity and innovation. There is some evidence that extrinsic motivation is negatively related to creative behavior.

Implications for Management Practice

This review of research and theory can be used as the basis for a better understanding of the factors that satisfy and motivate R&D professionals. There are clear implications for R&D management practices (see table, page 6). ■

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[1] This article is based on the keynote presentation made at the 15th Annual SATM Conference, May 11th, 2004.

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ling phases in more detail. Business Process Management is more than the deployment of workflow management technology. It encompasses strategy, design, implementation, execution, and review. While the design and implementation phases of the life cycle are well supported by technology vendors, the remaining phases of the life cycle need to be understood and implemented by the affected organization. This includes the following points:

• Process goals need to be aligned with the overall strategy of the organization, and performance incentives need to be aligned with overall process goals.

• Performance metrics need to be determined while a process is being designed and implemented. Only then are the current and future states of the process comparable.

• Just because process metrics can be obtained in real-time does not mean that an organization can (or should) react to them in real-time. Determine which activities and processes are critical to your business and design a Business Activity Monitoring framework around these. Focus on process controlling activities for the remaining processes.

It is apparent that Business Process Management is not a project. Rather, it is a continuous improvement strategy that can lead to significant performance gains.

The Center of Excellence in Business Process Innovation at the Howe School of Technology Management conducts a variety of research projects that aim at improving tools and techniques for the design, measurement, and improvement of business processes. Reports and additional information are available for download at www.stevens.edu/workflow. ■

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STEVENS ALLIANCE FOR TECHNOLOGY MANAGEMENT

UPCOMING EVENTS

Roundtable Meeting, September 20

This year's Roundtable meetings and Conference have been devoted to various aspects of the general theme of **Turning Innovation into a Powerful Business Strategy**. The February Roundtable introduced the topic with a discussion on **Mapping Innovation: An Exploration of Principles and Processes**; the April Roundtable was on **Leadership for Innovation**; the May Conference dealt with **Innovation as an On-going Strategy**; and the July Roundtable was on **Overcoming the Obstacles to Innovation**.

The next Roundtable meeting, from 2:00-5:00 PM on September 20, will continue our discussion of overcoming the obstacles to innovation. Facilitators for the meeting will be drawn from one of the SATM Sponsors, ISO, who will share recent experiences in identifying and attempting to overcome obstacles to innovation in their organization. The location will be announced on our website shortly.

Seminar Series in Technology Management, November

The fifth seminar of this series, sponsored in collaboration with the Columbia University School of Engineering, will be held in early November at Columbia University. The speaker will be Dr. Arthur Langer, on the topic **Responsive Organizational Dynamism**.

Dr. Langer introduced the concept of responsive organizational dynamism, an approach to how organizations should respond to challenges posed by new technologies, in his article published in our Spring edition. Time and date of the Seminar will be announced soon on our website.

For further information on these and other Alliance activities, contact Dr. Lawrence Gastwirt: **212-794-3637 • lgastwirt@aol.com**

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