O

O*NET

SEE: Occupational Information Network

OBJECT-ORIENTED PROGRAMMING

Object-oriented programming (OOP) focuses on grouping, simplification, streamlining, and standardization. For example, it would seem unreasonable if every time someone traveled between two cities that they would experiment and do it by trial and error. A more reasonable methodology would be to develop maps and identify a standardized shortest route to travel, thereby simplifying the traveling process. However, this type of simplification has not always been obvious and even today we find many instances where it is not used. For example, in manufacturing there are numerous instances in which the same exact part was designed from scratch several times. It has separate drawings, separate part numbers, and is stored in separate places. Until recently, no grouping methodology existed to identify opportunities for part standardization. The grouping process that was finally developed is called group technology and comes from Russia. However, most manufacturers still do not use the technique.

OOP can be found in the modularization and interchangeability of computer hardware. You can open the box of almost any personal computer (PC) and interchangeably replace storage drives, memory, peripherals, and so on. This standardization was driven by competition and by the speed at which the technology has changed, but it has significantly simplified and streamlined the computer hardware updating and servicing process.

OOP has also made its way into management practices. For example, the implementation of change is always traumatic. One of the reasons for this is that no one seems to have a standard, objective measure for the success of the change process. By utilizing tools such as total quality management (TQM) for the standardization of the change process, which incorporates systematic problem solving (SPS), the implementation process becomes grouped and streamlined so that anyone can review the status of a change process.

The term *object-oriented programming* originally comes from the systems development and computer programming world. After years of programming and systems development, someone realized that there are many repetitive functions. For example, file adds, changes, and deletes occur frequently and during multiple processes. It would seam reasonable that one add-change-delete routine could be developed in a modular form that could be accessed any time an add-change-delete process needed to occur. Developers grouped these functions into accessible and executable modules that became known as objects. Developing programs using objects became known as object-oriented programming (OOP).

OOP significantly reduced the level of confusion between software developers. For example, when multiple developers were working on the same project, they did not need to thoroughly understand each other's code in order to develop their piece of the project. Similarly, in software maintenance, developers did not need to relearn the previous code in order to

make changes. Understanding the OOP modules was sufficient to focus the change appropriately.

The design of the OOP process came partially out of a reaction to the slow development time for computer programs, and partly because of the high demand for computer developers. Using object-oriented programming, fewer people can accomplish more.

Operationally, OOP attempts to lead software development away from the abstract and refocus it on real-world objects. Examples of objects that could be the focus of a programming effort would be a user, display screen, and local-area network (LAN), not bits, bytes, and files. These objects become the focus of OOP programming attention.

In OOP the various properties of an object are analyzed. Understanding the properties assists in developing efficient modules. These properties include:

1. State—the properties of the object that cause a specific reaction to any specific event. For example, a terminal has several states: off; on and running; on and idle; and under maintenance.
2. Behavior—the way an object reacts to interactions from and with other objects. Behavior is determined by the set of operations defined as functional for that object. For example, an invalid entry from the person object is reacted to by an error message by the application package object.
3. Identity—objects are unique, merely because they exist separately. Objects are not grouped with other objects because of similar behavior. Nor can any object have more than one identity or name.
4. Encapsulation—this is where data and functionality are combined. Data and corresponding programs are elements that are isolated together. This prevents the corruption of their internal state.
5. Messaging—objects send messages to each other in order to access each other and to request a response. The object responds back to the requestor based on its defined behavior.
6. Collaboration—objects use each other to accomplish tasks. They share the responsibility for task completion.
7. Information hiding—this is where the activities within the object are hidden from other objects on the outside. This prevents corruption of the object or interference between objects.
8. Inheritance—this is a process of building objects by combining other objects together. By linking one object to another, one often inherits the properties of the other.

We are in an increasingly complex world. Traditionally, systems did not require interaction much beyond the traditional keyboard, screen, user, and disk drive. Now we have massive networks, servers, firewalls, storage units, intranets, e-mail, e-commerce, electronic data interchange (EDI), and so on. OOP reduces the complexity of these massive systems by reducing them into object interactions. OOP offers:

1. Real-world modeling—natural, real-world modularization of systems. We take events and group them into real-world steps that then become objects. We no longer need to deal in the abstractions of computer developers.
2. Large-scaled systems—natural decomposition of real-world problems. We can decompose problems into realistic pieces that make sense.
3. Reusability in the software—software objects can be shared and reused.
4. Iterative development cycles—stages of the development process can be prototyped, allowing for feedback, earlier interaction, and early correction and testing.

OOP has allowed some specific features to be developed that have grown out of the benefits of OOP environment. These include:

1. Graphical user interface (GUI)—the user interface (for example, the screen display) is customizable independent of the software objects.
2. Client/server computing—this allows for the encapsulation of computer information objects, allowing them to be treated as building blocks for both expansion and downsizing.
3. Software reengineering—this allows for the reengineering of some objects while maintaining the integrity and the investment of other objects that do not require change. Entire systems do not need to be altered because a minor change, like a forms change or a new tax law, is enacted. Only the object associated with the change needs to be updated or replaced. Additionally, if pieces of a system become obsolete, they can simply be dropped from the system.

The benefits of OOP include:

- OOP offers usability and reusability of programming code without complete overhaul and replacement.

- OOP has significantly increased the speed of the programming process, both in development and in maintenance.
- OOP offers easier understanding of programming code for co-developers and outsiders trying to understand the code.
- OOP makes it easier to break down complex systems into components and then allows for the prototyping of these systems.
- OOP offers simplified implementation in that basic objects can be independently debugged and do not require as much testing.
- OOP is flexible and highly adaptable to changing business requirements

SEE ALSO: Complexity Theory; Computer Networks; Knowledge Management; Technological Forecasting; Technology Management; Technology Transfer

Gerhard Plenert
Revised by Wendy H. Mason

FURTHER READING:

Chisholm, Al. "Object-Oriented Programming: a Primer." *Control Engineering* (February 2004).

Korah, John. *Object Oriented Methodology: A Primer.* Dearborn, MI: SME Blue Book Series, 1994.

Plenert, Gerhard. *World Class Manager.* Rocklin, CA: Prima Publishing, 1995.

OCCUPATIONAL INFORMATION NETWORK

O*NET, or the Occupational Information Network, is an electronic replacement for the *Dictionary of Occupational Titles* (DOT). Like the DOT, which was last published in 1991, O*NET provides a comprehensive database of worker attributes and job characteristics. By describing the tasks to be performed and the levels of education that must be achieved, the O*NET database can be used as a tool for training and education, career guidance, employment counseling, and for writing job descriptions.

The U.S. Department of Labor developed the *Dictionary of Occupational Titles* (DOT) in the mid-1930s, soon after the federal-state employment service system was established. O*NET was also developed by and is supported by the U.S. Department of Labor. The main difference between the DOT and the O*NET database is the flexibility of the new database and its depth of information. Rather than having information for 12,000 occupations, as the DOT did, the O*NET database has 974 occupations which are related to a common framework describing job requirements and worker characteristics, the content, and the context of work. A second difference between the DOT and the O*NET database is that O*NET can be updated more frequently; the Department of Labor uses a data collection program that provides for an update to the database twice annually. The most recent update was in December 2004. Additionally, there is now a Spanish-language version of the O*NET database available.

O*NET USES

O*Net can be used by many different people for a variety of reasons. Some of the uses for managers are:

- Writing and updating job descriptions and job specifications.
- Develop criteria for recruitment and selection.
- Develop criteria for performance appraisal systems.
- Structuring training and development activities.
- Structuring compensation systems.
- Improve career counseling.

O*NET DEVELOPMENT: COMMON LANGUAGE AND THE CONTENT MODEL

The O*NET database provides a common language that can be used to communicate in different areas of the economy and in workforce development efforts. This common language provides definitions and concepts for describing worker attributes and workplace requirements that can be widely understood and accepted. Knowledge, skills, and abilities (KSAs), interests, content, and context of work are described in comprehensive terms, and there is a common frame of reference in O*NET for understanding how these characteristics relate to successful job performance. O*NET's common language is intended to aid those who communicate about jobs in understanding one another, even when operating in different segments of the economy. The goal is for job descriptions and worker requirements to have the same meaning for human resources professionals, employees, educators, and students.

The conceptual foundation of the O*NET database is the Content Model; it provides a framework that identifies the most important types of information about work, integrating them into one system. Information in the model reflects both the character of occupations and of people, and it allows for information to be applied across jobs, sectors, or industries and within occupations. The Content Model was developed using research on job and organizational

analysis, and thus has a strong theoretical and empirical foundation.

The Content Model has six domains:

1. Worker Characteristics—enduring characteristics that might influence job performance and the ability to acquire knowledge and skills used for effective work performance; this includes abilities, interests, values, and work styles.
2. Worker Requirements—work-related attributes gained and/or developed through a worker's education or experience; this includes knowledge, experience, and skills (basic skills and cross-functional skills).
3. Experience Requirements—previous activities, linked specifically to certain types of work activities, that are required for effective job performance; this includes formal education, certifications, licensures, and training.
4. Occupational Characteristics—global contextual characteristics that define and describe occupations and that may influence requirements for that occupation.
5. Occupational Requirements—detailed information regarding typical activities required in various occupations; generalized work activities (GWAs), or dimensions that summarize the kinds of tasks that may be performed within a single occupation are identified; additionally, information about the context, such as physical and social elements of the work, that may create specific demands on the worker are included.
6. Occupation-Specific Information—elements that apply only to a single occupation or a narrowly defined job family; this domain provides related information available in other areas of the Content Model, but is used when developing specific applications of O*NET information, such as writing a job description.

SEE ALSO: Job Analysis

Marcia Simmering

FURTHER READING:

O*NET Consortium. "About O*NET." Available from <http://www.onetcenter.org/overview.html>.

OFFSHORING

SEE: Outsourcing and Offshoring

OPEN AND CLOSED SYSTEMS

A system is commonly defined as a group of interacting units or elements that have a common purpose. The units or elements of a system can be cogs, wires, people, computers, and so on. Systems are generally classified as open systems and closed systems and they can take the form of mechanical, biological, or social systems. Open systems refer to systems that interact with other systems or the outside environment, whereas closed systems refer to systems having relatively little interaction with other systems or the outside environment. For example, living organisms are considered open systems because they take in substances from their environment such as food and air and return other substances to their environment. Humans, for example, inhale oxygen out of the environment and exhale carbon dioxide into the environment. Similarly, some organizations consume raw materials in the production of products and emit finished goods and pollution as a result. In contrast, a watch is an example of a closed system in that it is a relatively self-contained, self-maintaining unit that has little interacts or exchange with its environment.

All systems have boundaries, a fact that is immediately apparent in mechanical systems such as the watch, but much less apparent in social systems such as organizations. The boundaries of open systems, because they interact with other systems or environments, are more flexible than those of closed systems, which are rigid and largely impenetrable. A closed-system perspective views organizations as relatively independent of environmental influences. The closed-system approach conceives of the organization as a system of management, technology, personnel, equipment, and materials, but tends to exclude competitors, suppliers, distributors, and governmental regulators. This approach allows managers and organizational theorists to analyze problems by examining the internal structure of a business with little consideration of the external environment. The closed-system perspective basically views an organization much as a thermostat; limited environmental input outside of changes in temperature is required for effective operation. Once set, thermostats require little maintenance in their ongoing, self-reinforcing function. While the closed-system perspective was dominant through the 1960s, organization scholarship and research subsequently emphasized the role of the environment. Up through the 1960s, it was not that managers ignored the outside environment such as other organizations, markets, government regulations and the like, but that their strategies and other decision-making processes gave relatively little consideration to the impact these external forces might have on the internal operations of the organization.

Open-systems theory originated in the natural sciences and subsequently spread to fields as diverse as computer science, ecology, engineering, management, and psychotherapy. In contrast to closed-systems, the open-system perspective views an organization as an entity that takes inputs from the environment, transforms them, and releases them as outputs in tandem with reciprocal effects on the organization itself along with the environment in which the organization operates. That is, the organization becomes part and parcel of the environment in which it is situated. Returning for a moment to the example of biological systems as open-systems, billions of individual cells in the human body, themselves composed of thousands of individual parts and processes, are essential for the viability of the larger body in which they are a part. In turn, "macro-level" processes such as eating and breathing make the survival of individual cells contingent on these larger processes. In much the same way, open-systems of organizations accept that organizations are contingent on their environments and these environments are also contingent on organizations.

As an open-systems approach spread among organizational theorists, managers began incorporating these views into practice. Two early pioneers in this effort, Daniel Katz and Robert Kahn, began viewing organizations as open social systems with specialized and interdependent subsystems and processes of communication, feedback, and management linking the subsystems. Katz and Kahn argued that the closed-system approach fails to take into account how organizations are reciprocally dependent on external environments. For example, environmental forces such as customers and competitors exert considerable influence on corporations, highlighting the essential relationship between an organization and its environment as well as the importance of maintaining external inputs to achieve a stable organization.

Furthermore, the open-system approach serves as a model of business activity; that is, business as a process of transforming inputs to outputs while realizing that inputs are taken from the external environment and outputs are placed into this same environment. Companies use inputs such as labor, funds, equipment, and materials to produce goods or to provide services and they design their subsystems to attain these goals. These subsystems are thus analogous to cells in the body, the organization itself is analogous to the body, and external market and regulatory conditions are analogous to environmental factors such as the quality of housing, drinking water, air and availability of nourishment.

The production subsystem, for example, focuses on converting inputs into marketable outputs and often constitutes a primary purpose of a company. The boundary subsystem's goal is to obtain inputs or resources, such as employees, materials, equipment, and so forth, from the environment outside of the company, which are necessary for the production subsystem. This subsystem also is responsible for providing an organization with information about the environment. This adaptive subsystem collects and processes information about a company's operations with the goal of aiding the company's adaptation to external conditions in its environment. Another subsystem, management, supervises and coordinates the other subsystems to ensure that each subsystem functions efficiently. The management subsystem must resolve conflicts, solve problems, allocate resources, and so on.

To simplify the process of evaluating environmental influences, some organizational theorists use the term "task environment" to refer to aspects of the environment that are immediately relevant to management decisions related to goal setting and goal realization. The task environment includes customers, suppliers, competitors, employees, and regulatory bodies. Furthermore, in contrast to closed-systems, the open-system perspective does not assume that the environment is static. Instead, change is the rule rather than the exception. Consequently, investigation of environmental stability and propensity to change is a key task of a company, making the activities of an organization contingent on various environmental forces. As an open system, an organization maintains its stability through feedback, which refers to information about outputs that a system obtains as an input from its task environment. The feedback can be positive or negative and can lead to changes in the way an organization transforms inputs to outputs. Here, the organization acts as a thermostat, identified previously as an example of a relatively closed-system. The difference between closed-systems and open-systems, then, is in the complexity of environmental interactions. Closed-systems assume relatively little complexity; a thermostat is a simple device dependent mainly on temperature fluctuations. Conversely, open-system such as the human body and modern organizations are more intricately dependent on their environments. The point is that closed-systems versus open-systems do not represent a dichotomy, but rather a continuum along which organizations are more open or less open to their environments. The key defining variable governing this degree of openness is the complexity of the environment in which the organization is situated.

Managers must take into consideration their organization's position along the open-closed continuum. The Linux computer operating system, for instance, is "open-source" and Red Hat, Inc., the corporation selling the bundled revisions-the multiple inputs from geographically dispersed users-represents an organization that would cease to exist if it were not for an open-systems perspective. Thus, stable environments with low complexity are more consistent with a relatively

closed-system or mechanistic management style, while rapidly-changing environments are more consistent with flexible, decentralized, or "organic" management styles.

SEE ALSO: Managing Change; Reactive vs. Proactive Change

Karl Heil

Revised by Scott B. Droege

FURTHER READING:

Chesbrough, H.W. *Open Innovation: The New Imperative for Creating and Profiting from Technology.* Boston: Harvard Business School Press, 2003.

Katz, D., and R.L. Kahn. *The Social Psychology of Organizations.* New York: John Wiley & Sons, 1978.

Prahalad, C.K., and V. Ramaswamy. *The Future of Competition: Co-Creating Unique Value with Customers.* Boston: Harvard Business School Press, 2004.

OPERANT CONDITIONING

Simply put, operant conditioning refers to a systematic program of rewards and punishments to influence behavior or bring about desired behavior. Operant conditioning relies on two basic assumptions about human experience and psychology: (1) a particular act results in an experience that is a consequence of that act and (2) the perceived quality of an act's consequence affects future behavior. In addition, a central idea of operant conditioning holds that the main influences on behavior are external—that is, it is in a person's external environment that his or her behavior is programmed.

The Harvard psychologist B.F. Skinner pioneered the field of behaviorism in the late 1930s and continued to contribute to it through the mid-1970s. Operant conditioning is one of the key concepts of this school of psychology. Skinner called his brand of conditioning operant conditioning to distinguish it from the conditioning theory developed by the Russian physiologist Ivan Pavlov, now referred to as classical conditioning. Classical conditioning primarily concerned itself with reflexive or unlearned behavior such as the jerking of a knee upon being tapped with a hammer. In a famous experiment, Pavlov training dogs to salivate in expectation of food at the sound of a bell. Operant conditioning, however, deals with learned, not reflexive behavior; it works by reinforcing (rewarding) and punishing behavior based on the consequences it produces. Reinforcement is used to increase the probability that behavior will occur in the future, whereas punishment aims to decrease that probability. In addition, the process of removing reinforcement from an act is called *extinction.*

Organizational management literature often refers to operant conditioning as part of reinforcement theory and work behavior modification. Unlike other theories of management and motivation, operant conditioning does not rely on attitudes, beliefs, intentions, and motivation for predicting and influencing behavior, although Skinner and other behaviorists do not suggest that these factors do not exist. Instead, they posit that these notions find their genesis in external conditions and reinforcement. Hence, organizational management theorists who adopt this approach look to external factors—the environment—to explain and influence behavior within the work place. For example, this approach to management views motivation as a product of workers' environments, not as an internal quality of each individual worker's psychological makeup. Therefore, employees are highly motivated because that quality is reinforced with pay raises, promotions, etc. that employees find desirable.

Since most of the behavior taking place in a business is learned rather than reflexive, operant conditioning can be applied to organizational management. Workers learn various kinds of behavior before and after joining a company, and they encounter a host of stimuli in a company setting that can cause them to behave in certain ways with certain consequences. These kinds of behaviors are rewarded and punished depending on their value to a company. The stimuli in the workplace include schedules, corporate structures, company policies, telephone calls, managers, and so on. The consequences of work-place behavior include approval or disapproval from managers and coworkers, promotions, demotions, pay increases, etc. When consequences are directly linked to certain kinds of behavior, they are contingent on these kinds of behavior. The classic example is touching a hot stove and experiencing the immediate consequence of being burned. However, most consequences in a company are only partially contingent on the behavior (performance) of employees, and thus there are often entire networks of relationships between employee behavior and its consequences. These relationships are called schedules of reinforcement, and applying operant conditioning to the work place means controlling these schedules.

Reinforcement schedules are either continuous or intermittent, or partial. Continuous reinforcement schedules are those situations in which every occurrence of an act is reinforced. In contrast, intermittent schedules are those situations in which only some instances of an act are reinforced. Continuous reinforcement schedules generally facilitate new learning or the acquisition of new skills at the fastest rate. New employees learning how to process customer orders,

for example, will learn the proper procedure the fastest if they are reinforced every time they take an order correctly. However, if a continuous schedule is suspended outright after being implemented for any substantial period, the behavior being reinforced might stop altogether. In addition, after a certain kind of behavior has been learned, it will occur more often if reinforced intermittently. Hence, employees who have learned the proper procedure for taking customer orders have the greatest likelihood of continuing to do so correctly if managers adopt an intermittent schedule after the behavior has been learned.

Moreover, reinforcement can be positive (adding something new, such as a raise or a promotion) or negative (the removal of something from the work environment, such as constant supervision) after new employees demonstrate they have sufficiently learned their jobs. Negative reinforcement, however, should not be confused with punishment, which involves undesirable or aversive consequences and decreases the probability of an act being repeated. Negative reinforcement, rather, is a kind of a reward that removes constraints or other elements from the work environment to encourage employee behavior.

Events or actions that increase the probability that certain behavior will occur in the future are called reinforcers, which can be divided into primary and secondary reinforcers. Primary reinforcers are things such as food, water, and shelter that are rewarding all by themselves, while secondary reinforcers are things such as money that have a reinforcing effect because of their relationship with primary reinforcers (for example, money can buy food, etc.). However, reinforcers may not always succeed in reinforcing behavior. If a person is not thirsty, for example, water may not serve as an effective reinforcer.

Because some behavior is so complex that it does not occur all at once, managers must reinforce progressive approximations of the desired behavior. This process begins with the reinforcement of behavior that may barely resemble the desired behavior, using a continuous reinforcement schedule with a progressive standard. Consequently, behavior must show improvement or greater approximation of the desired behavior to receive reinforcement as time goes on.

When managers wish to discourage certain kinds of behavior or decrease the probability of their occurrence, they can implement a schedule of punishment along the lines of a schedule of reinforcement. Punishment involves the application of undesirable consequences or the removal of positive consequences following undesired behavior. However, negative consequences must be meted out with consideration of how it will affect individual workers, because what constitutes punishment for one worker may not for another. Ultimately, these consequences or stimuli must be linked to the undesired behavior and decrease the probability of it reoccurring in order for them to constitute punishment in the technical sense of the operant conditioning approach. Moreover, effective punishment usually embodies the following qualities: it is consistent, immediate, impersonal, and contingent on specific behavior. Finally, punishment should be informative—letting employees know why they are being punished—and employees should recognize that future punishment can be avoided by refraining from the undesired behavior.

RECENT STUDY

A research article in 2004 by Timothy R. Hinkin and Chester A. Schriesheim found that in a study of 243 employees of two different hospitality organizations, those employees who received feedback from their managers, whether positive feedback or negative/corrective feedback, showed improved performance. This study also found that omission of commentary on good performance diminished worker effectiveness and reduced worker satisfaction. This supports the theory of operant conditioning that suggests a behavior that is totally ignored will eventually be extinguished.

Operant conditioning has been successfully applied in many settings: clinical, for individual behavior modification, teaching, for classroom management, instructional development, for programmed instruction, and management, for organizational behavior modification.

SEE ALSO: Motivation and Motivation Theory; Organizational Behavior

Karl Heil
Revised by Monica C. Turner

FURTHER READING:

Geiser, Robert L. *Behavior Mod and the Managed Society.* Boston: Beacon Press, 1976.

Hinkin, T.R., and C.A. Schriesheim. "If You Don't Hear From Me You Know You Are Doing Fine: The Effects of Management Nonresponse to Employee Performance." *Cornell Hotel & Restaurant Administration Quarterly,* November, 2004, 362–372.

Lutz, J. *Learning and Memory.* 2nd ed. Long Grove, IL: Waveland Press, 2004.

Malott, R.W., and E.A. Trojan. *Principles of Behavior.* 5th ed. Upper Saddle River, NJ: Pearson/Prentice Hall, 2004.

Nadler, Leanard, and Zeace Nadler. *The Handbook of Human Resource Development.* 2nd ed. New York, NY: John Wiley & Sons, 1990.

Pinder, Craig C. *Work Motivation: Theory, Issues, and Applications.* Glenview, IL: Scott, Foresman and Company, 1984.

Skinner, B.F. *About Behaviorism.* New York, NY: Alfred A. Knopf, 1974.

Smith, P., and A. Dyson. "Get with the Programme." *The Safety and Health Practitioner,* December 2004, 38–40.

OPERATING SYSTEMS

A computer's operating system is one of the most important "parts" of the computer. Almost every type of computer, including cellular telephones, needs an operating system in order to operate properly. When one turns on a computer, the operating system tells the computer what to do by controlling the system resources such as the processor, memory, disk space, etc. The operating system allows the user to work on the computer without having to know all the details about how the hardware works.

When choosing an operating system for a business, the primary considerations should be the hardware platform used, the number of users and attendant system security requirements, the ease of administration, the adaptability toward different uses, and the different applications that will be employed.

TYPES OF OPERATING SYSTEMS

Most simple, single-function computers (such as in microwave ovens with digital keypads) do not require an operating system. In fact, trying to implement an operating system in these computers would be overkill. On the other hand, all personal desktop and laptop computers and servers do require an operating system. While there are hundreds of operating systems available, the most popular by far are the Microsoft Windows family of operating systems, the Macintosh operating system, and the Unix family of operating systems.

There are four general types of operating systems. Their use depends on the type of computer and the type of applications that will be run on those computers.

1. Real-time operating systems (RTOS) are used to control machinery, scientific instruments, and industrial systems. In general, the user does not have much control over the functions performed by the RTOS.
2. Single-user, single task operating systems allow one user to do one thing at a time. And example of a single-user, single task operating system is the operating system used by personal digital assistants (PDAs), also known as handheld computers.
3. Single-user, multi-tasking operating systems allow a single user to simultaneously run multiple applications on their computer. This is the type of operating system found on most personal desktop and laptop computers. The Windows (Microsoft) and Macintosh (Apple) platforms are the most popular single-user, multi-tasking operating systems.
4. Multi-user operating systems allow multiple users to simultaneously use the resources on a single computer. Unix is an example of a multi-user operating system.

WHAT DO OPERATING SYSTEMS DO?

One of the operating system's main tasks is to control the computer's resources—both the hardware and the software. The operating system allocates resources as necessary to ensure that each application receives the appropriate amount. In addition to resource allocation, operating systems provide a consistent application interface so that all applications use the hardware in the same way. This is particularly important if more than one type of computer uses the operating system or if the computer's hardware is likely to change. By having a consistent application program interface (API), software written on one computer and can run on other types of computers. Developers face the challenge of keeping the operating system flexible enough to control hardware from the thousands of different computer manufacturers.

Operating systems must accomplish the following tasks:

1. Processor management. The operating system needs to allocate enough of the processor's time to each process and application so that they can run as efficiently as possible. This is particularly important for multitasking. When the user has multiple applications and processes running, it is up to the operating system to ensure that they have enough resources to run properly.
2. Memory storage and management. The operating system needs to ensure that each process has enough memory to execute the process, while also ensuring that one process does not use the memory allocated to another process. This must also be done in the most efficient manner. A computer has four general types of memory. In order of speed, they are: high-speed cache, main memory, secondary memory, and disk storage. The operating system must balance the

needs of each process with the different types of memory available.

3. Device management. Most computers have additional hardware, such as printers and scanners, connected to them. These devices require drivers, or special programs that translate the electrical signals sent from the operating system or application program to the hardware device. The operating system manages the input to and output from the computer. It often assigns high-priority blocks to drivers so that the hardware can be released and available for the next use as soon as possible.
4. Application interface. Programmers use application program interfaces (APIs) to control the computer and operating system. As software developers write applications, they can insert these API functions in their programs. As the operating system encounters these API functions, it takes the desired action, so the programmer does not need to know the details of controlling the hardware.
5. User interface. The user interface sits as a layer above the operating system. It is the part of the application through which the user interacts with the application. Some operating systems, such as Microsoft Windows and Apple Macintosh, use graphical user interfaces. Other operating systems, such as Unix, use shells.

WHICH OPERATING SYSTEMS ARE AVAILABLE?

Windows is the name of a family of operating systems created by the Microsoft Corporation for use with personal computers. Windows employs a graphical user interface (GUI), which eliminates the need for the user to learn complex commands. With a GUI, the user instructs the operating system by using a mouse to point and click icons that are displayed on the screen. Microsoft Windows, first released in 1985, was originally designed as a GUI for DOS, which uses the command-line approach. In order to communicate with the computer, DOS users must type commands or instructions at the command prompt, and then the command-line interpreter executes those commands. The term "DOS" can refer to any operating system, but it is frequently used as a synonym for Microsoft Disk Operating System (MS-DOS). DOS has limited use with modern computer systems and applications because it does not support multiple users or multitasking. Some of the other operating systems, including Windows, can also execute DOS-based applications. Today, most DOS systems have been replaced by more user-friendly systems that use a GUI.

Windows 3.1 was released in 1991. By then, Windows had gained in market share. Microsoft released Windows 95 in August 1995. It was so well marketed and in such high demand that people bought the operating system, even if they didn't own a home computer. With each new release, from Windows 98 to Window 2000 to Windows XP, Microsoft gained popularity. Today, almost every new personal computer comes preloaded with the Windows operating system. Windows can be run on practically any brand of personal computers. It is estimated that 90 percent of personal computers run the Windows operating system. The remaining 10 percent run the Macintosh operating system.

UNIX is a multi-user, multitasking operating system, and was designed to be a small, flexible system used by computer programmers. Since UNIX was designed to be used by programmers, it is not considered to be very user-friendly for the average person. However, graphical user interfaces have been developed for UNIX to help alleviate the ease-of-use issue.

Linux is a UNIX variant that runs on several different hardware platforms. Linus Torvalds, a student at the University of Helsinki in Finland, initially created it as a hobby. The kernel, at the heart of all Linux systems, is developed and released under the General Public License (GNU), and its source code is freely available to everyone. There are now hundreds of companies, organizations, and individuals that have released their own versions of operating systems based on the Linux kernel.

Because of its functionality, adaptability, and robustness, Linux is able to compete against the Unix and Microsoft operating systems. IBM, Hewlett-Packard, and other computer giants have embraced Linux and support its ongoing development. More than a decade after its initial release, Linux is being adopted worldwide mainly as a server platform. More and more people are starting to use Linux as a home and office desktop operating system. The operating system can also be incorporated directly into microchips in a process called "embedding." Many appliances and devices are now starting to use operating systems in this way.

SEE ALSO: Computer Networks; Computer Security; Computer-Integrated Manufacturing; Data Processing and Data Management; Management Information Systems

Rhoda L. Wilburn

FURTHER READING:

Coustan, Dave, and Curt Franklin. *How Operating Systems Work.* How Stuff Works, Inc., 2005. Available from <http://computer.howstuffworks.com/operating-system.htm>.

What is Linux? Linux Online. Available from <http://www.linux.org>.

OPERATIONS MANAGEMENT

One may generally consider that there are three distinct areas inherent in any business: marketing, finance, and operations; all other business disciplines fit somewhere under one or more of these areas. For example, finance could include investing, real estate, insurance or banking. While management is considered an academic discipline unto itself it is actually a part of all three areas: financial management, marketing management, and operations management. Operations management is the area concerned with the efficiency and effectiveness of the operation in support and development of the firm's strategic goals. Other areas of concern to operations management include the design and operations of systems to provide goods and services. To put it succinctly, operations management is the planning, scheduling, and control of the activities that transform inputs (raw materials and labor) into outputs (finished goods and services). A set of recognized and well-developed concepts, tools, and techniques belong within the framework considered operations management. While the term operations management conjures up views of manufacturing environments, many of these concepts have been applied in service settings, with some of them actually developed specifically for service organizations.

Operations management is also an academic field of study that focuses on the effective planning, scheduling, use, and control of a manufacturing or service firm and their operations. The field is a synthesis of concepts derived from design engineering, industrial engineering, management information systems, quality management, production management, inventory management, accounting, and other functions.

The field of operations management has been gaining increased recognition over the last two decades. One major reason for this is public awareness of the success of Japanese manufacturers and the perception that the quality of many Japanese products is superior to that of American manufacturers. As a result, many businesses have come to realize that the operations function is just as important to their firm as finance and marketing. In concert with this, firms now realize that in order to effectively compete in a global market they must have an operations strategy to support the mission of the firm and its overall corporate strategy.

Another reason for greater awareness of operations management is the increased application of operations management concepts and techniques to service operations. Finally, operations management concepts are being applied to other functional areas such as marketing and human resources. The term *marketing/operations interface* is often used.

HISTORY OF OPERATIONS MANAGEMENT

Until the end of the 18th century, agriculture was the predominant industry in every country. The advent of the steam engine and Eli Whitney's concept of standardized parts paved the way for the Industrial Revolution with its large manufacturing facilities powered by steam or water. A number of countries (the United States included) evolved from an agricultural economy to an industrial economy. But for a time, manufacturing was more of an art than a science. This changed with the introduction of Frederick W. Taylor's systematic approach to scientific management at the beginning of the twentieth century. The introduction of Taylor's method of scientific management and Henry Ford's moving assembly line brought the world into an age where management was predominantly centered around the production of goods.

In the late 1950s and early 1960s scholars moved from writing about industrial engineering and operations research into writing about production management. Production management had itself become a professional field as well as an academic discipline. As the U.S. economy evolved into a service economy and operations techniques began to be incorporated into services the term *production/operations management* came into use. Today, services are such a pervasive part of our life that the term *operations management* is used almost exclusively.

WHAT DO OPERATIONS MANAGERS DO?

At the strategic level (long term), operations managers are responsible for or associated with making decisions about product development (what shall we make?), process and layout decisions (how shall we make it?), site location (where will we make it?), and capacity (how much do we need?).

At the tactical level (intermediate term), operations management addresses the issues relevant to efficiently scheduling material and labor within the constraints of the firm's strategy and making aggregate planning decisions. Operations managers have a hand in deciding employee levels (how many workers do we need and when do we need them?), inventory levels (when should we have materials delivered and should we use a chase strategy or a level strategy?), and capacity (how many shifts do we need? Do we need to work overtime or subcontract some work?).

At the operational level, operations management is concerned with lower-level (daily/weekly/monthly) planning and control. Operations managers and their subordinates must make decisions regarding scheduling (what should we process and when should we process it?), sequencing (in what order should we process the orders?), loading (what order to we put on

what machine?), and work assignments (to whom do we assign individual machines or processes?).

Today's operations manager must have knowledge of advanced operations technology and technical knowledge relevant to his/her industry, as well as interpersonal skills and knowledge of other functional areas within the firm. Operations managers must also have the ability to communicate effectively, to motivate other people, manage projects, and work on multidisciplinary teams. Sunil Chopra, William Lovejoy, and Candace Yano describe the scope of operations management as encompassing these multi-disciplinary areas:

- Supply Chains—management of all aspects of providing goods to a consumer from extraction of raw materials to end-of-life disposal.
- Operations Management/Marketing Interface—determining what customers' value prior to product development.
- Operations Management/Finance Interface—Capital equipment and inventories comprise a sizable portion of many firms' assets.
- Service Operations—Coping with inherent service characteristics such as simultaneous delivery/consumption, performance measurements, etc.
- Operations Strategy—Consistent and aligned with firm's other functional strategies.
- Process Design and Improvements—Managing the innovation process.

Mark Davis, Nicolas Aquilano and Richard Chase (1999) have suggested that the major issues for operations management today are:

- reducing the development and manufacturing time for new goods and services
- achieving and sustaining high quality while controlling cost
- integrating new technologies and control systems into existing processes
- obtaining, training, and keeping qualified workers and managers
- working effectively with other functions of the business to accomplish the goals of the firm
- integrating production and service activities at multiple sites in decentralized organizations
- working effectively with suppliers at being user-friendly for customers
- working effectively with new partners formed by strategic alliances

As one can see, all these are critical issues to any firm. No longer is operations management considered subservient to marketing and finance; rather, it is a legitimate functional area within most organizations. Also, operations management can no longer focus on isolated tasks and processes but must be one of the architects of the firm's overall business model.

SEE ALSO: Operations Strategy; Product Design; Production Planning and Scheduling; Product-Process Matrix; Service Operations; Supply Chain Management

R. Anthony Inman

FURTHER READING:

Anupindi, Ravi, Sunil Chopra, Sudhakar D. Deshmukh, Jan A. Van Mieghem, and Eitan Zemel. *Managing Business Process Flows: Principles of Operations Management.* Upper Saddle River, NJ: Pearson Prentice Hall, 2006.

Davis, Mark M., Nicholas J. Aquilano, and Richard B. Chase. *Fundamentals of Operations Management.* 3rd ed. Boston: Irwin McGraw-Hill, 1999.

Finch, Byron. *Operations Now.* 2nd ed., Boston: McGraw-Hill Irwin, 2006.

Rainbird, Mark. "A Framework for Operations Management: The Value Chain." *International Journal of Operations and Production Management* 34, no. 3/4 (2004): 337–345.

Raturi, Amitabh, and James R. Evans. *Principles of Operations Management.* Mason, OH: Thomson Southwestern, 2005.

OPERATIONS SCHEDULING

OPERATIONS SCHEDULING

Scheduling pertains to establishing both the timing and use of resources within an organization. Under the operations function (both manufacturing and services), scheduling relates to use of equipment and facilities, the scheduling of human activities, and receipt of materials.

While issues relating to facility location and plant and equipment acquisition are considered long term and aggregate planning is considered intermediate term, operations scheduling is considered to be a short-term issue. As such, in the decision-making hierarchy, scheduling is usually the final step in the transformation process before the actual output (e.g., finished goods) is produced. Consequently, scheduling decisions are made within the constraints established by these longer-term decisions. Generally, scheduling objectives deals with tradeoffs among conflicting goals for efficient utilization of labor and equipment, lead time, inventory levels, and processing times.

Byron Finch notes that effective scheduling has recently increased in importance. This increase is due in part to the popularity of lean manufacturing and just-in-time. The resulting drop in inventory levels and subsequent increased replenishment frequency has greatly increased the probability of the occurrence of stockouts. In addition, the Internet has increased pressure to schedule effectively. "Business to customer" (B2C) and "business to business" (B2B) relationships have drastically reduced the time needed to compare prices, check product availability, make the purchase, etc. Such instantaneous transactions have increased the expectations of customers, thereby, making effective scheduling a key to customer satisfaction. It is noteworthy that there are over 100 software scheduling packages that can perform schedule evaluation, schedule generation, and automated scheduling. However, their results can often be improved through a human scheduler's judgment and experience.

There are two general approaches to scheduling: forward scheduling and backward scheduling. As long as the concepts are applied properly, the choice of methods is not significant. In fact, if process lead times (move, queue and setup times) add to the job lead time and process time is assumed to occur at the end of process time, then forward scheduling and backward scheduling yield the same result. With forward scheduling, the scheduler selects a planned order release date and schedules all activities from this point forward in time.

With backward scheduling, the scheduler begins with a planned receipt date or due date and moves backward in time, according to the required processing times, until he or she reaches the point where the order will be released.

Of course there are other variables to consider other than due dates or shipping dates. Other factors which directly impact the scheduling process include: the types of jobs to be processed and the different resources that can process each, process routings, processing times, setup times, changeover times, resource availability, number of shifts, downtime, and planned maintenance.

LOADING

Loading involves assigning jobs to work centers and to various machines in the work centers. If a job can be processed on only one machine, no difficulty is presented. However, if a job can be loaded on multiple work centers or machines, and there are multiple jobs to process, the assignment process becomes more complicated. The scheduler needs some way to assign jobs to the centers in such a way that processing and setups are minimized along with idle time and throughput time.

Two approaches are used for loading work centers: infinite loading and finite loading. With infinite loading jobs are assigned to work centers without regard for capacity of the work center. Priority rules are appropriate for use under the infinite loading approach. Jobs are loaded at work centers according to the chosen priority rule. This is known as vertical loading.

Finite loading projects the actual start and stop times of each job at each work center. Finite loading considers the capacity of each work center and compares the processing time so that process time does not exceed capacity. With finite loading the scheduler loads the job that has the highest priority on all work centers it will require. Then the job with the next highest priority is loaded on all required work centers, and so on. This process is referred to as horizontal loading. The scheduler using finite loading can then project the number of hours each work center will operate. A drawback of horizontal loading is that jobs may be kept waiting at a work center, even though the work center is idle. This happens when a higher priority job is expected to arrive shortly. The work center is kept idle so that it will be ready to process the higher priority job as soon as it arrives. With vertical loading the work center would be fully loaded. Of course, this would mean that a higher priority job would then have to wait to be processed since the work center was already busy. The scheduler will have to weigh the relative costs of keeping higher priority jobs waiting, the cost of idle work centers, the number of jobs and work centers, and the potential for disruptions, new jobs and cancellations.

If the firm has limited capacity (e.g., already running three shifts), finite loading would be appropriate since it reflects an upper limit on capacity. If infinite loading is used, capacity may have to be increased through overtime, subcontracting, or expansion, or work may have to be shifted to other periods or machines.

SEQUENCING

Sequencing is concerned with determining the order in which jobs are processed. Not only must the order be determined for processing jobs at work centers but also for work processed at individual work stations. When work centers are heavily loaded and lengthy jobs are involved, the situation can become complicated. The order of processing can be crucial when it comes to the cost of waiting to be processed and the cost of idle time at work centers.

There are a number of priority rules or heuristics that can be used to select the order of jobs waiting for processing. Some well known ones are presented in a list adapted from Vollmann, Berry, Whybark, and Jacobs (2005):

- Random (R). Pick any job in the queue with equal probability. This rule is often used as a benchmark for other rules.
- First come/first served (FC/FS). This rule is sometimes deemed to be fair since jobs are processed in the order in which they arrive.
- Shortest processing time (SPT). The job with the shortest processing time requirement goes first. This rule tends to reduce work-in-process inventory, average throughput time, and average job lateness.
- Earliest due date (EDD). The job with the earliest due date goes first. This seems to work well if the firm performance is judged by job lateness.
- Critical ratio (CR). To use this rule one must calculate a priority index using the formula (due date–now)/(lead time remaining). This rule is widely used in practice.
- Least work remaining (LWR). An extension of SPT, this rule dictates that work be scheduled according to the processing time remaining before the job is considered to be complete. The less work remaining in a job, the earlier it is in the production schedule.
- Fewest operations remaining (FOR). This rule is another variant of SPT; it sequences jobs based on the number of successive operations remaining until the job is considered complete. The fewer operations that remain, the earlier the job is scheduled.
- Slack time (ST). This rule is a variant of EDD; it utilizes a variable known as slack. Slack is computed by subtracting the sum of setup and processing times from the time remaining until the job's due date. Jobs are run in order of the smallest amount of slack.
- Slack time per operation (ST/O). This is a variant of ST. The slack time is divided by the number of operations remaining until the job is complete with the smallest values being scheduled first.
- Next queue (NQ). NQ is based on machine utilization. The idea is to consider queues (waiting lines) at each of the succeeding work centers at which the jobs will go. One then selects the job for processing that is going to the smallest queue, measured either in hours or jobs.
- Least setup (LSU). This rule maximizes utilization. The process calls for scheduling first the job that minimizes changeover time on a given machine.

These rules assume that setup time and setup cost are independent of the processing sequence. However, this is not always the case. Jobs that require similar setups can reduce setup times if sequenced back to back. In addition to this assumption, the priority rules also assume that setup time and processing times are deterministic and not variable, there will be no interruptions in processing, the set of jobs is known, no new jobs arrive after processing begins, and no jobs are canceled. While little of this is true in practice, it does make the scheduling problem manageable.

GANTT CHARTS

Gantt charts are named for Henry Gantt, a management pioneer of the early 1900s. He proposed the use of a visual aid for loading and scheduling. Appropriately, this visual aid is known as a Gantt chart. This Gantt chart is used to organize and clarify actual or intended use of resources within a time framework. Generally, time is represented horizontally with scheduled resources listed vertically. Managers are able to use the Gantt chart to make trial-and-error schedules to get some sense of the impact of different arrangements.

There are a number of different types of Gantt charts, but the most common ones, and the ones most appropriate to our discussion, are the load chart and schedule chart. A load chart displays the loading and idle times for machines or departments; this shows when certain jobs are scheduled to start and finish and where idle time can be expected. This can help the scheduler redo loading assignments for better utilization of the work centers. A schedule chart is used to monitor job progress. On this type of Gantt chart, the vertical axis shows the orders or jobs in progress while the horizontal axis represents time. A quick glance at the chart reveals which jobs are on schedule and which jobs are on time.

Gantt charts are the most widely used scheduling tools. However, they do have some limitations. The chart must be repeatedly updated to keep it current. Also, the chart does not directly reveal costs of alternate loadings nor does it consider that processing times may vary among work centers.

SCHEDULING SERVICE OPERATIONS

The scheduling of services often encounters problems not seen in manufacturing. Much of this is due to the nature of service, i.e., the intangibility of services and the inability to inventory or store services and the fact that demand for services is usually random. Random demand makes the scheduling of labor extremely difficult as seen in restaurants, movie theaters, and amusement parks. Since customers don't like to wait, labor

must be scheduled so that customer wait is minimized. This sometimes requires the use of queuing theory or waiting line theory. Queuing theory uses estimate arrival rates and service rates to calculate an optimum staffing plan. In addition, flexibility can often be built into the service operation through the use of casual labor, on-call employees, and cross-training.

Scheduling of services can also be complicated when it is necessary to coordinate and schedule more than one resource. For example, when hospitals schedule surgery, not only is the scheduling of surgeons involved but also the scheduling of operating room facilities, support staff, and special equipment. Along with the scheduling of classes, universities must also schedule faculty, classrooms, labs, audiovisual and computer equipment, and students. To further complicate matters, cancellations are also common and can add further disruption and confusion to the scheduling process.

Instead of scheduling labor, service firms frequently try to facilitate their service operations by scheduling demand. This is done through the use of appointment systems and reservations.

SEE ALSO: Aggregate Planning; Capacity Planning; Operations Management; Product-Process Matrix

R. Anthony Inman

FURTHER READING:

Finch, Byron. *Operations Now: Profitability, Processes, Performance.* Boston: McGraw-Hill Irwin, 2006.

Hurtubise, Stephanie, Claude Olivier, and Ali Gharbi. "Planning Tools for Managing the Supply Chain." *Computers & Industrial Engineering* 46 (2004): 763–779.

Kreipl, Stephan and Michael Pinedo. "Planning and Scheduling in Supply Chains: An Overview of Issues in Practice." *Production and Operations Management* 13, no. 1 (2004): 77–92.

Raturi, Amitabh S., and James R. Evans. *Principles of Operations Management.* Mason, OH: Thomson South-Western, 2005.

Stevenson, William J. *Production and Operations Management.* 8th ed. Boston: Irwin/McGraw-Hill, 2005.

Vollmann, Thomas E., William L. Berry, D. Clay Whybark, and F. Robert Jacobs. *Manufacturing Planning and Control for Supply Chain Management.* 5th ed. Boston: McGraw-Hill Irwin, 2005.

OPERATIONS STRATEGY

After collectively considering the products and services demanded by customers, strengths and weaknesses of competitors, the environment, and the firm's own strengths, weaknesses, cultures, and resources, proficient firms can formulate their vision as expressed through the mission statement. This statement expresses the organization's values and aspirations; basically its reason or purpose for existence. Based on this mission statement the firm will formulate its business strategy. This business strategy is a long-term plan for accomplishing the mission set forth in the mission statement. Each function within the business can then derive its own strategy in support of the firm's overall business strategy (financial strategy, marketing strategy, and operations strategy).

Operations strategy is the collective concrete actions chosen, mandated, or stimulated by corporate strategy. It is, of course, implemented within the operations function. This operations strategy binds the various operations decisions and actions into a cohesive consistent response to competitive forces by linking firm policies, programs, systems, and actions into a systematic response to the competitive priorities chosen and communicated by the corporate or business strategy. In simpler terms, the operations strategy specifies how the firm will employ its operations capabilities to support the business strategy.

Operations strategy has a long-term concern for how to best determine and develop the firm's major operations resources so that there is a high degree of compatibility between these resources and the business strategy. Very broad questions are addressed regarding how major resources should be configured in order to achieve the firm's corporate objectives. Some of the issues of relevance include long-term decisions regarding capacity, location, processes, technology, and timing.

The achievement of world-class status through operations requires that operations be integrated with the other functions at the corporate level. In broad terms, an operation has two important roles it can play in strengthening the firm's overall strategy. One option is to provide processes that give the firm a distinct advantage in the marketplace. Operations will provide a marketing edge through distinct, unique technology developments in processes that competitors cannot match.

The second role that operations can play is to provide coordinated support for the essential ways in which the firm's products win orders over their competitors, also known as distinctive competencies. The firm's operations strategy must be conducive to developing a set of policies in both process choice and infrastructure design (controls, procedures, systems, etc.) that are consistent with the firm's distinctive competency. Most firms share access to the same processes and technology, so they usually differ little in these areas. What is different is the degree to which operations matches its processes and infrastructure to its distinctive competencies.

KEY SUCCESS FACTORS

Industries have characteristics or strategic elements that affect their ability to prosper in the marketplace (i.e., attributes, resources, competencies, or capabilities). The ones that most affect a firm's competitive abilities are called key success factors (KSFs). These KSFs are actually what the firm must be competent at doing or concentrating on achieving in order to be competitively and financially successful; they could be called prerequisites for success. In order to determine their own KSFs, a firm must determine a basis for customer choice. In other words, how do customers differentiate between competitors offering the same or similar products or services and how will the firm distinguish itself from these competitors? Once this is determined, the firm has to decide what resources and competitive capabilities it needs in order to compete successfully, and what will it take to achieve a sustainable competitive advantage. These KSFs can be related to technology, operations, distribution, marketing, or to certain skills or organizational capability. For example, the firm may derive advantages from superior ability to transform material or information (technology or operations), to quickly master new technologies and bring processes online (technology or organizational capability), or to quickly design and introduce new products, service a broad range of products, customize products or services on demand, or provide short lead times (skills).

The set of KSFs that are delegated totally or substantially to the operations function has been termed the *manufacturing mission.* It represents what top management expects from operations in terms of its strategic contribution. All decisions made relative to system design, planning, control and supervision must aim at accomplishing the manufacturing mission. As such, the manufacturing mission is the principal driver of the operations function and gives it its reason for existence. All world-class manufacturers have an explicit, formal manufacturing mission.

From the manufacturing mission the operations function derives its distinctive competencies (also called competitive priorities or competitive weapons). Distinctive competence is defined as the characteristic of a given product/service or its producing firm that causes the buyer to purchase it rather than the similar product/service of a competitor. It is generally accepted that the distinctive competencies are cost/price, quality, flexibility, and service/time. Various experts include other competencies, such as location, but these can usually be categorized within one of the generally accepted four. Some experts also feel that innovation is quickly becoming a fifth distinctive competency, if it hasn't already. It should be noted that a firm's position on the product-process matrix is a controlling factor for the manufacturing mission and the firm's competitive priority or priorities.

DISTINCTIVE COMPETENCIES

Details relative to each distinctive competency are provided, along with the implications of each and some examples.

PRICE/COST. A firm competing on a price/cost basis is able to provide consumers with an in-demand product at a price that is competitively lower than that offered by firms producing the same or similar good/service. In order to compete on a price basis, the firm must be able to produce the product at a lesser cost or be willing to accept a smaller profit margin. Firms with this competency are generally in a position to mass produce the product or service, thereby giving the firm economies of scale that drive the production cost per unit down considerably. Commodity items are mass-produced at such volume that they utilize a continuous process, thus deriving tremendous economies of scale and very low prices Consumers purchasing commodity-type products are usually not greatly aware of brand difference, and will buy strictly on the basis of price; e.g., as long as it is a major brand of gasoline and location is not a factor, consumers will opt for the lowest price. Wal-Mart is able to offer low prices by accepting a lower profit margin per unit sold. Their tremendous volume more than makes up for the lower profit margin.

QUALITY. David Garvin lists eight dimensions of quality as follows:

- Performance. Performance refers to a product's primary operating characteristics. For an automobile this could mean fast acceleration, easy handling, a smooth ride or good gas mileage. For a television it could mean bright color, clarity, sound quality or number of channels it can receive. For a service this could merely mean attention to details or prompt service.
- Conformance. Conformance is the degree to which a product's design and operating characteristics meet predetermined standards. When a manufacturer utilizing coils of steel receives a shipment from the mill, it checks the width of the coil, the gauge (thickness) of the steel, the weight of the coil, and puts a sample on a Rockwell hardness tester to check to ensure that the specified hardness has been provided. Receiving inspection will also check to see if specified characteristics are met (e.g., hot-rolled, pickled, and oiled). Services may have conformance requirements when it comes to repair, processing, accuracy, timeliness, and errors.
- Features. Features are the bells and whistles of a product or service. In other words, characteristics that supplement the basic function

of the product or service. Desirable, but not absolutely necessary, features on a VCR include four heads, slow-motion capability, stereo or surround sound, split screens or inset screens, and 365-day programming ability. Service examples include free drinks on an airline flight or free delivery of flowers.

- Durability. Durability is defined as mean time until replacement. In other words, how long does the product last before it is worn out or has to be replaced because repair is impossible? For some items, such as light bulbs, repair is impossible and replacement is the only available option. Durability may be had by use of longer life materials or improved technology processes in manufacturing. One would expect home appliances such as refrigerators, washer and dryers, and vacuum cleaners to last for many years. One would also hope that a product that represents a significant investment, such as an automobile, would have durability as a primary characteristic of quality.
- Reliability. Reliability refers to a product's mean time until failure or between failures. In other words, the time until a product breaks down and has to be repaired, but not replaced. This is an important feature for products that have expensive downtime and maintenance. Businesses depend on this characteristic for items such as delivery trucks and vans, farm equipment and copy machines since their failure could conceivably shut down the business altogether.
- Serviceability. Serviceability is defined by speed, courtesy, competence and ease of repair. This is can be an extremely important characteristic as witnessed by the proliferation of toll-free hot lines for customer service. A number of years ago, a major television manufacturer advertised that its product had its "works in a box." This meant that the television set was assembled out of modular units. Whenever there were problems with the set, a repairman making a house call simply had to replace the problem module, making the product easily and quickly serviceable.
- Aesthetics. A product's looks, feel, smell, sound, or taste are its aesthetic qualities. Since these characteristics are strictly subjective and captive to preference, it is virtually impossible to please everyone on this dimension.
- Perceived Quality. Perceived quality is usually inferred from various tangible and intangible aspects of the product. Many consumers assume products made in Japan are inherently of high quality due to the reputation of Japanese manufacturers, whereas 50 years ago, the perception was the complete opposite. Other characteristics such as high price or pleasing aesthetics may imply quality.

Firms competing on this basis offer products or services that are superior to the competition on one or more of the eight dimensions. Obviously, it would be undesirable if not impossible for firms to compete on all eight dimensions of quality at once. This would be prohibitively expensive, and there are some limitations imposed by trade-offs that must be made due to the nature of the product. For example, a firm may sacrifice reliability in order to achieve maximum speed.

SERVICE. Service can be defined in a number of ways. Superior service can be characterized by the term customer service or it could mean rapid delivery, on-time delivery, or convenient location.

FLEXIBILITY. Firms may compete on their ability to provide either flexibility of the product or volume. Firms that can easily accept engineering changes (changes in the product) offer a strategic advantage to their customers. This can also apply to services. A number of years ago, a well-known fast food restaurant advertised "hold the pickles, hold the lettuce, special orders don't upset us," which meant that ordering a nonstandardized version of the product would not slow down the delivery process. Also, some firms are able to absorb wide fluctuations in volume allowing customers with erratic demand the luxury of not holding excessive inventories in anticipation of change in demand.

TRADEOFFS. Firms usually focus on one distinctive competency (rarely more than two). For some competencies there are tradeoffs involved. An automobile manufacturer producing a product that is considered to be of high quality (leather seats, real wood trim, and an outstanding service package) will not be able to compete on a cost/price basis as the cost of manufacture prohibits it. An automotive parts house would like to keep their customers happy by offering the lowest prices possible. However, if the automotive parts house also wants to be able to fill almost every single order from walk-in customers, it must maintain an extensive inventory. The expense of this inventory could preclude the parts house from offering prices competitive with other similar firms not choosing to provide this level of service. Therefore, one parts house is competing on the basis of service (but not cost/price) while the other is competing of the basis of cost/price (but not service). The customer may have to wait a few days to get the desired part; if the customer cannot wait, he or she can pay more and purchase the part immediately from the competitor.

ORDER WINNERS/QUALIFIERS

Operations strategist and author Terry Hill introduced the terms qualifier and order winner (1989). A qualifier is a competitive characteristic a firm or product must be able to exhibit to be a viable competitor in the marketplace. An order winner is a competitive characteristic of a product or service that causes a customer to choose this firm's product or service rather than that of a competitor (distinctive competence). For example, say a consumer in the market for a new automobile has a predetermined level of quality that the automobile must possess before being considered for purchase. The consumer has narrowed his or her choice down to five models of automobile that all meet this minimum quality requirement. From this point the consumer, with all else being equal, will probably purchase the automobile that he or she can get for the least cost. Therefore, quality is the qualifier (must be present to be considered) and cost/price is the order winner (basis for the final choice).

THE NEED FOR AN OPERATIONS STRATEGY

In too many instances, a firm's operations function is not geared to the business's corporate objectives. While the system itself may be good, it is not designed to meet the firm's needs. Rather, operations is seen as a neutral force, concerned solely with efficiency, and has little place within the corporate consciousness. Steven C. Wheelwright and Robert H. Hayes described four generic roles that manufacturing can play within a company, from a strategic perspective. While they specifically discuss the manufacturing function, the term operations can be substituted with no loss in relevance. These generic roles are labeled stages 1 to 4, as explained below.

Stage 1 firms are said to be internally neutral, meaning that the operations function is regarded as being incapable of influencing competitive success. Management, thereby, seeks only to minimize any negative impact that operations may have on the firm. One might say that operations maintain a reactive mode. When strategic issues involving operations arise, the firm usually calls in outside experts.

Stage 2 firms are said to be externally neutral, meaning they seek parity with competitors (neutrality) by following standard industry practices. Capital investments in new equipment and facilities are seen as the most effective means of gaining competitive advantage.

Stage 3 firms are labeled internally supportive, that is, operations' contribution to the firm is dictated by the overall business strategy but operations has no input into the overall strategy. Stage 3 firms do, however, formulate and pursue a formal operations strategy.

Stage 4 firms are at the most progressive stage of operations development. These firms are said to be externally supportive. Stage 4 firms expect operations to make an important contribution to the competitive success of the organization. An operation is actually involved in major marketing and engineering decisions. They give sufficient credibility and influence to operations so that its full potential is realized. Firms within Stage 4 are known for their overall manufacturing capability.

Since the bulk of many, if not all, firms have the bulk of their labor force and assets tied to the operations function, it makes sense for most firms to strive for a position in Stage 3 or Stage 4. Firms can, of course, evolve from one stage to the next with few, if any, skipping a stage. In fact, most outstanding firms are in Stage 3, as Stage 4 is extremely difficult to reach.

The need for an operations strategy that reflects and supports the corporate strategy is not only crucial for the success of the corporate strategy but also because many decisions are structural in nature. In other words, the results are not easily changed. The firm could be locked into a number of operations decisions, which could take years to change if the need arose. These could range from process investment decisions to human resource management practices. Too often, marketing-led strategies leave operations to resolve the resulting issues from their unilateral view of what is best for the business as a whole. If corporate management cannot fully appreciate the issues and consequences of relegating operations to a tactical status it could find itself needing to make structural changes that are costly, time consuming, and much too late to make the competitive impact necessary to compete effectively.

Firms that fail to fully exploit the strategic power of operations will be hampered in their competitive abilities and vulnerable to attack from those competitors who do exploit their operations strategy. To do this effectively, operations must be involved throughout the whole of the corporate strategy. Corporate executives have tended to assume that strategy has only to do with marketing initiatives. They erroneously make the assumption that operation's role is strictly to respond to marketing changes rather than make inputs into them. Secondly, corporate executives assume that operations have the flexibility to respond positively to changing demands. These assumptions place unrealistic demands upon the operations function. A recent article by Michael A. Lewis in the *International Journal of Operations and Production Management* warns firms a practical operations strategy is iterative and will require market compromise. While corporate management perceives corporate improvement as coming through broad decisions concerning new markets, takeovers, and so on, it overlooks

the idea that building blocks of corporate success can be found in the creative and effective use of operations strategy to support the marketing requirement within a well-conceived corporate strategy.

Operations management's attention must increasingly be toward strategy. The balance and direction of its activity should reflect its impact on the firm's performance toward achieving its goals through its strategy, and on the performance of operations itself, recognizing that both need to be done well. Linda Nielsen-Englyst recommends a four-phase process for formulating and updating operations strategy: learning, reviewing, aligning, and redirecting. Phase one is a learning stage where alternatives to the intended strategy are evaluated in practice. Phase two involves reviewing alternatives over time, allowing ideas to grow and mature. Phase three, the alignment stage, is an analytical process where the firm attempts to identify and document financial rationale for changing the intended strategy. Finally, in the redirecting phase, the firm tests its ideas in practice through local initiatives.

SEE ALSO: Mission and Vision Statements; Operations Management; Order-Winning and Order-Qualifying Criteria; Quality and Total Quality Management; Strategy Formulation

R. Anthony Inman

FURTHER READING:

Garvin, David A. "Competing on the Eight Dimensions of Quality." *Harvard Business Review,* November-December 1987, 101–109.

Hill, Terry. *Manufacturing Strategy: Text and Cases 3rd ed.* Homewood, IL: Irwin, 2000.

Lewis, Michael A., "Analysing Organisational Competence: Implications for the Management of Operations," International Journal of Operations and Production Management, Vol. 23, No. 7, 2003, 731–756.

Neilslen-Englyst, Linda, "Operations Strategy Formation—A Continuous Process," Integrated Manufacturing Systems, Vol. 14, No. 8, 2003, 677–685.

Wheelwright, Steven C., and Robert H. Hayes. "Competing Through Manufacturing." *Harvard Business Review,* January-February 1985, 99–109.

OPPORTUNITY COST

An opportunity cost is defined as the value of a forgone activity or alternative when another item or activity is chosen. Opportunity cost comes into play in any decision that involves a tradeoff between two or more options. It is expressed as the relative cost of one alternative in terms of the next-best alternative. Opportunity cost is an important economic concept that finds application in a wide range of business decisions.

Opportunity costs are often overlooked in decision making. For example, to define the costs of a college education, a student would probably include such costs as tuition, housing, and books. These expenses are examples of accounting or monetary costs of college, but they by no means provide an all-inclusive list of costs. There are many opportunity costs that have been ignored: (1) wages that could have been earned during the time spent attending class, (2) the value of four years' job experience given up to go to school, (3) the value of any activities missed in order to allocate time to studying, and (4) the value of items that could have purchased with tuition money or the interest the money could have earned over four years.

These opportunity costs may have significant value even though they may not have a specific monetary value. The decision maker must often subjectively estimate Opportunity costs. If all options were purely financial, the value of all costs would be concrete, such as in the example of a mutual fund investment. If a person invests $10,000 in Mutual Fund ABC for one year, then he forgoes the returns that could have been made on that same $10,000 if it was placed in stock XYZ. If returns were expected to be 17 percent on the stock, then the investor has an opportunity cost of $1,700. The mutual fund may only expect returns of 10 percent ($1,000), so the difference between the two is $700.

This seems easy to evaluate, but what is actually the opportunity cost of placing the money into stock XYZ? The opportunity cost may also include the peace of mind for the investor having his money invested in a professionally managed fund or the sleep lost after watching his stock fall 15 percent in the first market correction while the mutual fund's losses were minimal. The values of these aspects of opportunity cost are not so easy to quantify. It should also be noted that an alternative is only an opportunity cost if it is a realistic option at that time. If it is not a feasible option, it is not an opportunity cost.

Opportunity-cost evaluation has many practical business applications, because opportunity costs will exist as long as resource scarcity exists. The value of the next-best alternative should be considered when choosing among production possibilities, calculating the cost of capital, analyzing comparative advantages, and even choosing which product to buy or how to spend time. According to Kroll, there are numerous real-world lessons about opportunity costs that managers should learn:

1. Even though they do not appear on a balance sheet or income statement, opportunity costs

are real. By choosing between two courses of action, you assume the cost of the option not taken.

2. Because opportunity costs frequently relate to future events, they are often difficult to quantify.
3. Most people will overlook opportunity costs.

Because most finance managers operate on a set budget with predetermined targets, many businesses easily pass over opportunities for growth. Most financial decisions are made without the consultation of operational managers. As a result, operational managers are often convinced by finance departments to avoid pursuing value-maximizing opportunities, assuming that the budget simply will not allow it. Instead, workers slave to achieve target production goals and avoid any changes that might hurt their short-term performance, for which they may be continually evaluated.

People incur opportunity costs with every decision that is made. When you decided to read this article, you gave up all other uses of this time. You may have given up a few minutes of your favorite television program or a phone call to a friend, or you may have even forgone the opportunity to invest or earn money. All possible costs should be considered when making financial or economic decisions, not simply those that can be concretely measured in terms of dollars or rates of return.

SEE ALSO: Balance Sheets; Economics; Strategic Planning Failure

Dena Waggoner
Revised by Laurie Collier Hillstrom

FURTHER READING:

Internet Center for Management and Business Administration. "Opportunity Cost." NetMBA.com. Available from <http://www.netmba.com/econ/micro/cost/opportunity>

Kroll, Karen. "Costly Omission." *Industry Week,* 6 July 1998, 20.

"Opportunities Lost Because 'There Isn't the Budget'?" *Management Accounting,* June 1998, 7.

Sikora, Martin. "Trying to Recoup the Cost of Lost Opportunities." *Mergers and Acquisitions Journal,* March 2000.

ORDER-QUALIFYING CRITERIA

SEE: Order-Winning and Order-Qualifying Criteria

ORDER-WINNING AND ORDER-QUALIFYING CRITERIA

The terms "order winners" and "order qualifiers" were coined by Terry Hill, professor at the London Business School, and refer to the process of how internal operational capabilities are converted to criteria that may lead to competitive advantage and market success. In his writings, Hill emphasized the interactions and cooperation between operations and marketing. The operations people are responsible for providing the order-winning and order-qualifying criteria—identified by marketing—that enable products to win orders in the marketplace. This process starts with the corporate strategy and ends with the criteria that either keeps the company in the running (i.e., order qualifiers) or wins the customer's business.

COMPETITIVE ADVANTAGE AND COMPETITIVE PRIORITIES

Many factors shape and form the operations strategy of a corporation, for example, the ever increasing need for globalizing products and operations and thus reducing the unit cost, creating a technology leadership position, introducing new inventions, taking advantage of mass customization, using supplier partnering, and looking for strategic sourcing solutions. All of these factors require an external or market-based orientation; these are the changes that take place in the external environment of the company.

Traditionally, strategic decisions were thought of as "big decisions" made by general managers. However, big strategic decisions may not be the only source of competitive advantage for the firm. Jay Barney wrote, "Recent work on lean manufacturing suggests that it is the simultaneous combination of several factors that enables a manufacturing facility to be both very high quality and very low cost. This complicated system of numerous interrelated, mutually supporting small decisions is difficult to describe, and even more difficult to imitate, and thus a source of sustained competitive advantage." Barney contrasted big and small decisions further, "Recognizing that small decisions may be more important for understanding competitive advantages than big decisions suggests that the study of strategy implementation—the process by which big decisions are translated into operational reality—may be more important for understanding competitive advantage than the study of strategy formulation."

The strategy expressed as a combination of a few big and hundreds of small decisions leads to setting up competitive priorities for improving operational practices through investments in various programs. These competitive priorities place different and diverse demands

on manufacturing. These demands, sometimes called manufacturing tasks, can be organized into three distinctly different groups: product-related demands, delivery-related demands, and cost demands.

The emphasis given to these priorities and the state of the organization determine the nature and level of investments deemed necessary to implement the operations strategy. These investments in operational practices are expected to lead to better operational performance, as measured and evaluated internally using indicators like reject rates in the manufacturing process, production schedule fulfillment, and others. Through investments firms create and acquire resources that can isolate them from negative market influences and can serve as a source of competitive advantage for them. These investments can be made in tangible assets (e.g., machinery and capital equipment) and intangible assets (e.g., brand names and the skills of individual employees).

A distinction has to be made between investments aimed at creating resources and those aimed at creating capabilities. Few resources on their own are productive. Productive activity requires the cooperation and coordination of teams of resources. An operational capability is the capacity for a team of resources to perform some task or activity.

While resources are the source of a firm's capabilities, capabilities are the main source of its competitive advantage. Capabilities are not evaluated in themselves, and they cannot be thought of as absolute values. They have to be evaluated relative to the capabilities of competitors. This is the reason for distinguishing between competitiveness dimensions (like the 3 Ps from the marketing mix: price, place, and product) and capability-based dimensions (like cost-time-quality measures). They show the two sides of the same coin: the internal capabilities and their evaluation in the market.

ORDER QUALIFIERS AND ORDER WINNERS

Terry Hill argues that the criteria required in the marketplace (and identified by marketing) can be divided into two groups: order qualifiers and order winners. An order qualifier is a characteristic of a product or service that is required in order for the product/service to even be considered by a customer. An order winner is a characteristic that will win the bid or customer's purchase. Therefore, firms must provide the qualifiers in order to get into or stay in a market. To provide qualifiers, they need only to be as good as their competitors. Failure to do so may result in lost sales. However, to provide order winners, firms must be better than their competitors. It is important to note that order qualifiers are not less important than order winners; they are just different.

Firms must also exercise some caution when making decisions based on order winners and qualifiers. Take, for example, a firm producing a high quality product (where high quality is the order-winning criteria). If the cost of producing at such a high level of quality forces the cost of the product to exceed a certain price level (which is an order-qualifying criteria), the end result may be lost sales, thereby making "quality" an order-losing attribute.

Order winners and qualifiers are both market-specific and time-specific. They work in different combinations in different ways on different markets and with different customers. While, some general trends exist across markets, these may not be stable over time. For example, in the late 1990s delivery speed and product customization were frequent order winners, while product quality and price, which previously were frequent order winners, tended to be order qualifiers. Hence, firms need to develop different strategies to support different marketing needs, and these strategies will change over time. Also, since customers' stated needs do not always reflect their buying habits, Hill recommends that firms study how customers behave, not what they say.

When a firm's perception of order winners and qualifiers matches the customer's perception of the same, there exists a "fit" between the two perspectives. When a fit exists one would expect a positive sales performance. Unfortunately, research by Sven Horte and Hakan Ylinenpaa, published in the *International Journal of Operations and Production Management,* found that for many firms a substantial gap existed between managers' and customers' opinions on why they did business together. The researchers found that favorable sales performance resulted when there was a good fit between a firm's perception of the strengths of a product and customer perception of the product. Conversely, when firms with high opinions about their competitive strengths had customers who did not share this opinion, sales performance was negative.

PRODUCT LIFE CYCLE

Over time product sales follow a pattern called the product life cycle. The different stages of the product life cycle also influence a product's set of order winners and order qualifiers. The length of and the sales at each stage of the cycle, as well as the overall length of the life cycle, vary from product to product and depend on such factors as the rate of technological change, the amount of competition in the industry, and customer preferences.

In the early portion of a product's life, product design is critical. A product's early users are almost always more interested in product performance than in price. This stage is characterized by a large number of product innovations. A considerable amount of

product design is undertaken to make the product more useful and desirable for its users. Abernathy referred to this early phase of product technology as the search for dominant design. Dominant designs are those that "make a market," such as Ford's Model T car, the DC-3 airplane, and the IBM PC. At this stage, the production process is most likely to be a job shop or close to a job shop.

As the dominant design gets more accepted, cost reduction becomes increasingly important. Thus, process innovation—geared primarily toward lowering costs, increasing yield, and improving throughput time—becomes more important. Changes become less radical as the product, the process, and the organization become more standardized. The production process moves closer to the continuous flow end of the process spectrum. When this happens, both the product and the process become increasingly vulnerable to the introduction of new offerings of similar function (i.e., substitute products) by other producers. Then, the company has to decide when and how to abandon the product and process that they perfected and in which they invested so much.

As the product moves through its life cycle, the requirements for the product and for the production process change. During the early part of the life cycle a production facility with high flexibility (i.e., a job shop) can generate order winners such as customization. For a mature product a dedicated facility (i.e., a flow shop) can produce high quality and low cost, which are the order winners for many, but not all, mature products.

Terry Hill noted that different product characteristics require different production processes, and without communication between marketing, which identifies the order winners and qualifiers, and operations, which develops the operational capabilities to deliver these characteristics, market success cannot be achieved. Hill developed a tool—product profiling—to ascertain a certain level of fit between process choices and the order-winning criteria of the products. The purpose of profiling is to provide comparison between product characteristics required in the market and the process characteristics used to manufacture the products and make the necessary adjustments.

SEE ALSO: Competitive Advantage; Operations Strategy; Product Life Cycle and Industry Life Cycle

Gyula Vastag
Revised by R. Anthony Inman

FURTHER READING:

Barney, Jay. "Organizational Culture: Can It Be a Source of Sustained Competitive Advantage?" *Academy of Management Review* 11 (1986): 656–65.

Barney, Jay. "Firm Resources and Sustained Competitive Advantage." *Journal of Management* 17 (1991): 99–120.

Hill, Terry. *Manufacturing Strategy: Text and Cases.* 3rd ed. Boston: Irwin McGraw-Hill, 2000.

Horte, Sven Ake, and Hakan Ylinenpaa. "The Firm's and Its Customers' Views on Order-Winning Criteria." *International Journal of Operations and Production Management* 17, no. 10 (1997): 1006–1019.

Vastag, G., and Ram Narasimhan. "An Investigation of Causal Relationships Among Manufacturing Strategic Intent, Practices and Performance." In *Performance Measurement.* eds. A.D. Neely and D.B. Waggoner. Cambridge, UK: Centre for Business Performance, 1998: 679–86.

ORGANIC ORGANIZATIONS

The term "organic" suggests that, like living things, organizations change their structures, roles, and processes to respond and adapt to their environments. Burns and Stalker noted in *The Management of Innovation* that organic structures are appropriate in unstable, turbulent, unpredictable environments and for non-routine tasks and technologies. For organizations coping with such uncertainty, finding appropriate, effective, and timely responses to environmental challenges is of critical importance. Organic organizations are characterized by:

- decentralization
- flexible, broadly defined jobs
- interdependence among employees and units
- multi-directional communication
- employee initiative
- relatively few and broadly defined rules, regulations, procedures, and processes
- employee participation in problem solving and decision making, often interactively and in groups

In organic organizations, the emphasis is on effectiveness, problem solving, responsiveness, flexibility, adaptability, creativity, and innovation. Such an organization is able to respond in a timely manner to environmental change because employees are empowered to be creative, to experiment, and to suggest new ideas. The process of innovation is triggered by employees throughout the organization in a "bottom-up" manner. The following four sections explain how these characteristics fit together in a cohesive organizational structure that allows for flexibility and ongoing change.

MEETING CHALLENGES

An unstable external environment increases the uncertainty and complexity with which an organization must contend. An organization is continually confronted with a variety of new and unexpected problems and opportunities, of which the nature and relevant factors are initially unclear and for which appropriate responses are not immediately obvious. Further, since the environment changes rapidly, responses to today's problems and opportunities may need to be modified or may even be inappropriate or irrelevant to tomorrow's challenges. In short, the organization cannot keep doing the same old things in the same old ways. Under conditions of uncertainty and complexity, the organization must design its structures and processes to be flexible and responsive to changes in customer desires, technology, governmental regulations, and economic conditions.

FLEXIBILITY AND SHARED AUTHORITY

The need for flexibility and responsiveness leads to the decentralization of decision-making authority in organic organizations. As a result, rules, regulations, procedures, and policies tend to be few, are defined broadly rather than precisely, loosely rather than rigidly, and are often informal rather than written. Employees are allowed to exercise a great deal of discretion. The authority to identify problems and opportunities and to devise responses is delegated to those best able to respond, regardless of their position, unit, or level in the organization. Emphasis is placed more on individual and group control than on managerial, hierarchical control. Top-level managers in organic organizations are more concerned with coordination and integration as opposed to passing directives down a vertical hierarchy, which is a common task of top-level managers in mechanistic organizations.

The need for flexibility and responsiveness also affects how work is designed and performed in organic organizations. Jobs are not clearly or precisely defined in these organizations. Positions, roles, job descriptions, and standard operating procedures are broad and generalized rather than specific and specialized. Employees accept general responsibility for getting things done, but the manner in which they accomplish their tasks is dictated more by autonomous or semi-autonomous teams than by standard operating procedures. Because the work of organic organizations is often interdependent, specific tasks and responsibilities vary from one situation to another and are refined through direct interaction and mutual adjustment among employees and work units. Too much direction from top-level management may hinder rather than assist the accomplishment of tasks.

A key issue in organic organizations is determining who has the knowledge, perspective, experience, expertise, or skills required to identify opportunities or find solutions to problems. Rather than assuming that top management is the fountainhead of all knowledge and wisdom, organic organizations assume that various people in the organization may have crucial insights or capabilities. Thus, communication is multidirectional, decentralized, and informal rather than hierarchical and formalized. In order to facilitate the sharing of information and ideas, employees are frequently empowered to communicate across traditional organizational boundaries regardless of position or level or unit.

Going one step further, pharmaceutical firms, for example, may collaborate across corporations and with academic researchers to conduct basic research leading to new drug development. Jack Welch, former CEO of General Electric, referred to this type of company as a "boundaryless organization." Coordination and integration with multiple constituencies beyond traditional organizational boundaries is a necessary component for success, especially in multinational organizations.

Diversity of information and perspectives is often the key to the development of creative responses to vague, complex problems and opportunities. Thus, in organic organizations, much work is done in groups composed of employees with different backgrounds and from different levels, units, or functional areas. Such teams are among the main coordination mechanisms in organic organizations.

THE HUMAN ELEMENT

Human needs and dynamics play an important role in organic organizations. The empowerment and participation of employees is motivational because it meets the human need for autonomy, responsibility, challenge, esteem, social interaction, and personal development. Furthermore, this empowerment and participation helps the organization develop and capitalize on its intellectual capital, which is becoming increasingly valued by many organizations. By emphasizing initiative, direct interaction, open communication, and the creation of teams composed of various members of the organization, organic organizations are able to utilize their internal diversity to foster innovative responses to environmental challenges and changes.

MIXING STYLES

The organic organization is not entirely without hierarchy or formalized rules, regulations, procedures, and processes. Indeed, structural parameters, even if loosely or broadly defined, are necessary to prevent the chaos that would result from absolute decentralization (i.e., where everyone in the organization is completely

free to decide what they want to do or not do). As an example of such structural parameters, while employees of Minnesota Mining and Manufacturing (3M) are encouraged to take the initiative in suggesting new products and seeking support from others in the organization, new product teams must still meet specific financial measures at each stage of product development. Nonetheless, the real control is found in constant interaction among peers and the normative rules that develop informally among them.

It is not always necessary for an entire organization to be organic. Some units, such as research and development departments, may benefit from an organic structure because they face an unstable environment. Units that have a more stable environment, such as routine, administrative departments, may favor a mechanistic structure. Some units may borrow from both models. Customer service departments, for example, can build flexibility into responding to exceptional circumstances while maintaining standardized protocols for more typical situations.

The structures of organic organizations are informal, fluid, and constantly changing to identify and develop responses to new problems and opportunities. Authority and responsibility shifts from one situation to another. Groups are established, complete their work, and disband, and a single employee may belong to several temporary teams at the same time. In organic organizations there is diminished emphasis on superior-subordinate roles in favor of dispersed initiative. Roles, tasks, and responsibilities are not limited by rigid, vertical boundaries of hierarchy for decision-making, communication, coordination, and control. Relations and interactions between personnel and units continually change, and managers and other employees must figure out which relations and interactions will be most effective for each particular problem or opportunity.

SEE ALSO: Effectiveness and Efficiency; Mechanistic Organizations; Organization Theory

Durward Hofler
Revised by Scott B. Droege

FURTHER READING:

Berry, L. "The Collaborative Organization: Leadership Lessons from Mayo Clinic." *Organizational Dynamics* 33, no. 3 (2004): 228–42.

Burns, T., and G.M. Stalker. *The Management of Innovation.* London: Tavistock, 1961.

Cardinal, Laura B., Sim B. Sitkin, and Chris P. Long. "Balancing and Rebalancing in the Creation and Evolution of Organizational Control." *Organization Science* 15, no. 4 (2004): 411–32.

Gooderham, P.N., and O. Nordhaug. *International Management: Cross-Boundary Challenges.* Malden, MA: Blackwell Publishing, 2004.

Hansen, M.T., and N. Nohria. "How to Build Collaborative Advantage." *MIT Sloan Management Review* 46, no. 1 (2004): 22–31.

Pearce, C.L. "The Future of Leadership: Combining Vertical and Shared Leadership to Transform Knowledge Work." *Academy of Management Executive* 18, no. 1 (2004): 47–58.

ORGANIZATION THEORY

Organization theory is a broad field with roots in sociology. Anthropologists, philosophists, and political scientists have contributed greatly to the field. Organization theory as a topic for managers, as opposed to scholars, has come about fairly recently. For example, political scientists trace many ideas back to Ancient Rome or even before. Philosophers reach even farther back in time, and anthropologists have been interested in organization in terms of how groups arrange social systems and status systems as long as there has been a field of anthropology.

Although it is difficult to pinpoint when managers became interested in theories of organization, some suggest it was around the 1940s, when the writings of the German sociologist and engineer, Max Weber, were translated into English. Although Weber's lifework was spent trying to understand why capitalism arose first in Western Europe rather than in Asia, American managers lifted Weber's notion of bureaucracy out of these studies to explain then-modern forms of organizations that coincided with what Weber had described among Western European organizations. These organizations had reduced the influence of patriarchal styles of management to systems in which job positions, rather than the people in those positions, provided the source of authority.

Phillip Selznick became well known for studying goal conflict and power struggles during the U.S. government's subsidy of the Tennessee Valley Authority, which was an effort to put unemployed Americans to work producing electricity for the Tennessee Valley area. In the 1950s Herbert Simon studied how managers make decisions when information is complex but incomplete. The 1960s brought about research elaborating why the closed-system mentality of organizations—the idea that organizations have little reciprocal interaction with their environments—was not accurate. The result was a shift to viewing organizations as open systems that are intertwined with their environments in such a way that reciprocal interdependence is created. Managers began to realize that society has a profound effect on organizations, as organizations also have a profound effect on society.

Taken in total, then, organization theory as a management topic of interest was born out of non-management research. Bureaucracy, authority, goal conflict, power, managerial decision-making, and interaction between organizations and their environments are all topics of concern among today's organization theorists, but none of these ideas arose from management research.

Management research has borrowed from these various fields to attempt to answer two questions that are of specific interest to managers: Why do organizations exist and how do they function? With respect to the first question, it seems reasonable to argue that organizations exist to provide society with a level of goods and services that would otherwise be unattainable. With respect to the second, how organizations function, organizations combine human skills, knowledge, technology, and material resources to produce goods and services.

The broadest variant of organization theory looks at the relationship between organizations and their social and natural environments, as originated by open-system theorists. One branch of Western moral philosophy conceives of organizations as having a social contract with society, whereby they are granted legitimacy for the purpose of serving the social good. This constructive purpose includes the production of goods and services and their fair allocation. Yet organizations can also cause negative social outcomes. Negative externalities include the social problems associated with monopolies, unsafe products, and the unfair treatment of employees, as well as the ecological problems posed by industrial accidents and industry-related pollution of the natural environment.

Because of the existence of negative externalities, organization theory is influenced by the concept of social control that can be found in political science, economics, and sociology. Social control refers to the laws, regulations, and social customs that are meant to minimize the negative impacts of organizational activities. Because organization theorists address social control, they also examine the nature of the relationship between organizations and their regulatory agencies.

The anthropological view derives from the knowledge that standards of social control reflect the underlying assumptions, values, and beliefs of cultures. The restraints or expectations placed on organizations, therefore, can vary across societies. The stakeholder model of organizations is useful for demonstrating this form of cultural relativism. The stakeholder model depicts an organization as surrounded by a variety of constituent groups, such as customers, social activists, regulators, the media, stockholders, and regulatory agencies.

Stakeholder expectations, in turn, can depend upon cultural affiliations. For example, employees in the United States tend to expect more active participation in the work contract than do employees in Japan. Thus, a Japanese firm with operations in the United States may face employment laws and employee views of justice and fairness that differ from those of the home country. When the scope of organization theory is widened to include international issues such as the activities of multinational corporations in host environments, the impact of cultural relativism must be acknowledged.

Although organization theory never loses sight of the importance of the organizational-societal interface (and this is one distinguishing feature between organization theory and organization behavior), it also deals with what goes on inside organizations. Weber's classical theory of bureaucracy, for example, was followed by research on the more informal aspects of organizational life. This line of inquiry is strongly influenced by the insight that organizational activity can involve less-than-rational processes that yield unexpected consequences, including the negative externalities mentioned above. Hence, although organizations ideally exist as tools for constructive social purposes, these purposes can be subverted by the constraints on rational decision processes within organizations.

Contemporary theorists use many metaphors to guide their investigations into the suboptimal and even non-rational decisions enacted in organizations. These metaphors include those that suggest organizations are systems of power and political intrigue, miniature cultures, chaos, temples, theaters, machines, families, and jungles. These metaphors arise through shared meaning that has been socially constructed and generally agreed upon, thus subconsciously institutionalizing the specific, agreed-upon metaphor for certain organizations.

Organization theorists are interested in why organizations exist and how these social systems function. This interest has yielded a body of research on the organizational-societal relationship and the formal and informal aspects of organizational life, yet there is no single answer to either of these root issues.

SEE ALSO: Mechanistic Organizations; Organic Organizations; Organizational Analysis and Planning

Diane L. Swanson
Revised by Scott B. Droege

FURTHER READING:

Brown-Johnson, N., and S.B. Droege. "Reflections on the Generalization of Agency Theory: Cross-cultural Considerations." *Human Resource Management Review* 14, no. 3 (2004): 325–35.

Vázquez, X.H. "Allocating Decision Rights on the Shop Floor: A Perspective from Transaction Cost Economics and Organization Theory." *Organization Science* 15, no. 4 (2004): 463–81.

Zajac, E.J., and Westphal, J.D. "The Social Construction of Market Value: Institutionalization and Learning Perspectives on Stock Market Reactions." *American Sociological Review* 69, no. 3 (2004): 433–58.

ORGANIZATIONAL ANALYSIS AND PLANNING

Organizational analysis and planning focuses on cultivating and maintaining an efficient workforce through the design and structure of an organization, as well as the relationships and behavior of individuals within organizations. Specifically, organizational analysis is concerned with developing models and theories that accurately capture the functioning and development of organizations and that account for the ways in which organizations respond to and bring about changes. Organizational planning, on the other hand, involves designing an organization's structure and dividing up the responsibilities of an organization. The goals of organizational analysis and planning typically have been to determine the best way to view and organize a company in order to manage it successfully and to bring about greater efficiency.

MODELS OF ORGANIZATIONAL ANALYSIS

One of the basic techniques of organizational analysis is modeling—developing models of organizations that delineate the way they function and evolve in order to identify the best way of managing each one. Modeling enables managers to determine the crucial variables in particular circumstances so they can experiment with different combinations of variables to achieve their desired results. For example, managers can determine the best combination of technology and organizational structure for their company by using organizational models.

Organizational models typically focus on behavior, structure, or technology. In consideration of these variables, four general models of organizational analysis exist: the rational (also called the classical model), the natural system (also called the participative model), the sociotechnical, and the cognitive model.

RATIONAL MODEL. A pioneer of the rational model of organization was Frederick Taylor, who was influential near the start of the twentieth century. Taylor's background in engineering prompted his organizational analysis on efficiency. In Taylor's view, there was one best way—the most efficient way—to perform a task. Scientific management sprang from his work, with resultant time and motion studies in which tasks were timed and employee motions were gauged for efficiency. The best way to perform a task, in Taylor's view, was the way that accomplished the task in the least amount of time. He extended this view from employees to management, suggesting that nearly all organizational tasks could become more efficient if scientific principles were applied.

This was at the dawn of the introduction of the automobile to America. Although many Western European nations began manufacturing automobiles before the early 1900s, production efficiencies still had a long way to go. Applying scientific management principles helped Ford Motor Company develop the first American, mass-produced automobile. Frederick Taylor, then, was correct. Scientific management did work, but it was not without problems. The main problem was that it ignored the boredom that repetitive tasks created for workers. Workers became simply replaceable parts in the organizational machine.

In addition, the rational model of organization presupposes that decisions about an organization's structure are reached because of the rational assessment of an organization's needs, goals, and external influences. And like Taylor's scientific management, this is true in some situations, but is not comprehensive enough to tell the whole story of how needs, goals and external influences affect organizational analysis and planning.

The rational model assumes that deviations from rationality result from errors in judgment and calculation as well as from ignorance. This model treats organizations as mechanical groups because it conceives of the organization as having structure of different parts, and all of these parts can be modified and manipulated in order to improve the efficiency of the entire organization. Furthermore, individual parts of the organization are viewed as modifiable through deliberate effort. Finally, this model sees the long-term development of the organization as modifiable and controllable through planned modification in order to accomplish definite goals.

The rational model is still pervasive among managers and corresponds to the pyramidal organizational structure, in which top managers are at the apex and employees are at the bottom. Managers possess the authority in this model, defining and assigning tasks to the employees, who are charged with completing the tasks. They must begin by giving employees clear and detailed instructions. After that, managers must evaluate employee performance and distribute rewards and punishments based on the way employees performed their tasks.

Managers assume that worker motivation is directly correlated with economic rewards and punishments meted out by the managers. Motivation, from a rational perspective, simply involves increasing pay or threatening workers with various punishments. Hence, according to this model, managers rely

on pay and related forms of compensation to motivate workers to complete their tasks efficiently in order to achieve company goals.

The problem with this assumption is that there are many motivators other than money, there can be many ways to perform a given task, and there are many organizational goals that are not rational. The rational model is thus a starting point for thinking about organizational analysis, but certainly not encompassing enough to provide a complete picture.

NATURAL SYSTEM MODEL. In contrast to the rational model, the natural system model views organizations holistically, that is, as systems. The natural system model sees an organization as not only striving to accomplish its own goals, but also other important goals. An organizational structure is regarded as an institution in its own right that has needs of its own. Hence, according to this model, an organization seeks to maintain a balance of its various needs and goals, which may restrict the way it pursues other goals.

Unlike the rational model of organization, the natural system model sees the modification of an organization as unplanned and adaptive reactions to unstable conditions that threaten the balance of the organization as an entire system. The way an organization responds to problems is characterized as a defense mechanism and as being influenced by the common values ensconced in the members of the organization. This model concentrates on threats to an organization's equilibrium, that is, on events and activities with the potential of disrupting an organization's balance.

When deviations from organizational plans and goals occur, they are seen not as the product of error or ignorance, but as the result of limitations brought about by an organization's social structure. This model generally is based on the concept of organizations as organisms in which all the parts are interconnected and interdependent. Consequently, changes in one part of an organization are thought to have an impact on other parts of the organization, and so planned modification of the organization is difficult.

In practical terms, the natural system model strives to balance the needs of all the members of the organization as well as other stakeholders, such as customers, shareholders, and suppliers. This model holds that organizations function best when members belong to at least one effective work group (department, committee, or staff group), thereby contributing to the goals of organizations. Members who belong to more than one work group help link the different units of the organization together and facilitate communication and the exchange of information throughout the organization.

The natural system model views change as affecting the entire organization, not just individuals or individual units. Consequently, managers cannot change just one small part of an organization; rather, they must change the whole organization. As a result, planning for change must be comprehensive and systematic. Theoretically, the natural system model helps prevent conflicts in that changes take place only with the involvement of each member of the organization. Therefore, commitment to change is greatly increased and conflict over change is limited.

SOCIOTECHNICAL MODEL

Because of the limitations of the previous models of organization, theorists have developed other models to capture the essence and functioning of modern organizations. The sociotechnical model does not rely on the mechanical and biological analogies of the rational and natural system models. Instead, the sociotechnical model views organizations as having a greater ability to modify their form and structure. Nevertheless, like the natural system model, the sociotechnical model sees organizations as evolving. An organization changes when the expectations of its members change as a result of their collaboration with other members and the exchange of information.

This model views organizations as systems that interact with their environments. Through the course of this interaction, organizational behavior is affected by human, social, technological, and organizational inputs. These inputs are all interdependent, thus a change in one causes a change in the others. The basic tenets of the sociotechnical model include the belief that behavior in organizations can have a number of causes, that organizations are systems, and that informal social systems are different from formal social systems.

An organization's main task is accomplished through the process of inputs being converted into outputs. The organization is designed around these tasks. Similarly each unit of the organization is designed around its specific subtask. The sociotechnical model assumes that an organization's effectiveness is determined by its design to perform its main task. Organizations have differentiated, yet integrated, units based on three primary factors: technology (including techniques, skills, and materials), geographic location, and time (work shifts). According to this model, if an organization is effectively designed around its main task and if its units are differentiated and integrated effectively, then the number of conflicts will be reduced.

COGNITIVE MODEL

The cognitive model of organization consists of three primary components: cognition, the decision-making or problem-solving process, and an organizational setting. Cognition refers to the information-processing units of an

organization and its organizational units. The decision-making or problem-solving component is a series of steps, operations, and procedures that an organizational unit uses to make decisions or solve problems. The organizational setting component is the arrangement of the organization, that is, the way tasks are distributed and the way processes are coordinated.

Although the rational model of organization focuses on clarifying and assigning tasks, it does not address the other aspects of organizations. In particular, it provides little in terms of the ways organizations solve problems once tasks are clarified and assigned. The cognitive model moves beyond this level of organizational analysis by focusing on the processes through which organizations assign specific activities and times for the activities to be performed.

The cognitive model focuses on the decision-making process of an organization. An organization makes decisions in accordance with its objectives and based on available information. Since this model views individuals as having the capacity to do only a few things at a time, the organization functions as the combination of these limited capacities and facilitates the overall completion of a number of complex tasks, which are broken down into a series of subtasks so that individuals can perform them. These subtasks are the areas of specialization within an organization. Specialization, in turn, brings about the flow of specific information to and from specialized units.

This model provides several key insights into the workings of organizations. It conceives of an organization as a process that develops from the interaction of human cognition, organizational structure, and the types of decisions that need to be made. Because of these characteristics, the cognitive model focuses on the development and adaptation of organizations in different circumstances. Furthermore, this model accounts for the way in which specialization affects organizational behavior and coordination.

In conclusion, because each different organization model has its advantages and disadvantages, managers must decide which one (or ones) best captures the workings of their company by evaluating the assumptions and key processes of each, as well as by determining which one can solve the kinds of problems they need to solve.

TYPES OF ORGANIZATIONAL PLANNING STRUCTURES

Organizational planning involves designing an organization's structure to maximize efficiency. This includes dividing a company up into different units, departments, and teams. Prior to this division, managers must consider a company's goals and business obstacles as well as alternative company structures. Business goals may include, for example, increasing the flow of information, promoting teamwork, and reducing redundancy. Next, managers must consider the different organizational structures and select the one that holds the greatest potential for eliminating problems with the current corporate structure or for bringing about the desired structural environment. The selection may be made by taking different organizational models into consideration, as well.

Managers and executives generally divide an organization into different units based on one of the following six criteria:

FUNCTION. A manufacturing firm typically includes functional units such as engineering, production, finance, sales, and personnel. These different functions are controlled by managers who head each function. In this organizational structure, each function primarily focuses on its core tasks (e.g., production or finance).

PRODUCT. Large, diversified companies may find it advantageous to divide their tasks based on product groups, such as foodstuffs, farm chemicals, and pharmaceuticals. This organizational structure has the benefit of enabling each business unit to produce desired results. However, it can lead to high administrative costs and redundancy.

CUSTOMERS. Companies may be divided into different units based on target customers. For example, a book publisher may be organized by retail bookstores, mail-order book stores, online book stores, and school system tier, such as elementary, middle school, high school, and higher education.

GEOGRAPHIC LOCATION. Many sales and service companies use geographic location as the basis for creating departments within the organization. This organizational structure calls for members of each group to concentrate on particular locations for which they are responsible.

PROCESS. Some companies are organized by process. Process organization is common in manufacturing and clerical companies. For example, natural gas companies have different units for exploration, production, and distribution. This type of organizational structure enables each unit to have its own specialists.

MATRIX. Matrix organizational structures include not only general functional units like production, sales, and finance, but also product or geographic units. Company executives frequently oversee the product units directly. The product units, in turn, collaborate with and coordinate the functional units. By adopting the matrix arrangement, companies attempt to reap the benefits of the functional and the product or geographic structures, while bypassing the inefficient and redundant aspects of the product structure. A company with

a matrix organizational structure has functional units such as development, production, and sales matched in a matrix by product or geographic location.

Company executives and managers must strive to select the organizational structure that best suits their fields of business, that offers the optimal amount of control, specialization, and cooperation, and that facilitates key business activities while also taking into consideration concerns for efficiency and effectiveness.

SEE ALSO: Organizational Chart; Organizational Development; Organizational Structure

Karl Heil
Revised by Scott B. Droege

FURTHER READING:

French, W., C.H. Bell, and R.A. Zawacki. *Organization Development and Transformation: Managing Effective Change,* 6th ed. McGraw-Hill, 2005.

Goodman, P.S., and D.M. Rousseau. "Organizational Change that Produces Results: The Linkage Approach." *Academy of Management Executive* 18, no. 3 (2004): 7–20.

Roberts, John. *The Modern Firm: Organizational Design for Performance and Growth.* Oxford University Press, 2004.

Wall, S.J. "The Protean Organization: Learning to Love Change." *Organizational Dynamics* 34, no. 1 (2004): 37–46.

ORGANIZATIONAL BEHAVIOR

Organizational behavior is a misnomer. It is not the study of how organizations behave, but rather the study of individual behavior in an organizational setting. This includes the study of how individuals behave alone, as well as how individuals behave in groups.

The purpose of organizational behavior is to gain a greater understanding of those factors that influence individual and group dynamics in an organizational setting so that individuals and the groups and organizations to which they belong may become more efficient and effective. The field also includes the analysis of organizational factors that may have an influence upon individual and group behavior. Much of organizational behavior research is ultimately aimed at providing human resource management professionals with the information and tools they need to select, train, and retain employees in a fashion that yields maximum benefit for the individual employee as well as for the organization.

Organizational behavior is a relatively new, interdisciplinary field of study. Although it draws most heavily from the psychological and sociological sciences, it also looks to other scientific fields of study for insights. One of the main reasons for this interdisciplinary approach is because the field of organizational behavior involves multiple levels of analysis, which are necessary to understand behavior within organizations because people do not act in isolation. That is, workers influence their environment and are also influenced by their environment.

INDIVIDUAL LEVEL OF ANALYSIS

At the individual level of analysis, organizational behavior involves the study of learning, perception, creativity, motivation, personality, turnover, task performance, cooperative behavior, deviant behavior, ethics, and cognition. At this level of analysis, organizational behavior draws heavily upon psychology, engineering, and medicine.

GROUP LEVEL OF ANALYSIS

At the group level of analysis, organizational behavior involves the study of group dynamics, intra- and intergroup conflict and cohesion, leadership, power, norms, interpersonal communication, networks, and roles. At this level of analysis, organizational behavior draws upon the sociological and socio-psychological sciences.

ORGANIZATION LEVEL OF ANALYSIS

At the organization level of analysis, organizational behavior involves the study of topics such as organizational culture, organizational structure, cultural diversity, inter-organizational cooperation and conflict, change, technology, and external environmental forces. At this level of analysis, organizational behavior draws upon anthropology and political science.

Other fields of study that are of interest to organizational behavior are ergonomics, statistics, and psychometrics.

A number of important trends in the study of organizational behavior are the focus of research efforts. First, a variety of research studies have examined topics at the group level of analysis rather than exclusively at the individual level of analysis. For example, while empowerment has largely been investigated as an individual-level motivation construct, researchers have begun to study team empowerment as a means of understanding differences in group performance. Similar research has focused on elevating the level of analysis for personality characteristics and cooperative behavior from the individual level to the group level.

Another research trend is an increasing focus on personality as a factor in individual- and group-level

performance. This stems from the movement toward more organic organization designs, increased supervisory span of control, and more autonomous work designs. All of these factors serve to increase the role that personality plays as a determinant of outcomes such as stress, cooperative or deviant behavior, and performance.

Personality traits that are related to flexibility, stress hardiness, and personal initiative are also the subject of research. Examples of these personality traits include a tendency toward individualism or collectivism, self-monitoring, openness to experience, and a proactive personality. Forms of behavior that are constructive and change-oriented in nature are also studied. These forms of behavior are proactive in nature and act to improve situations for the individual, group, or organization. Examples of these behaviors include issue selling, taking initiative, constructive change-oriented communication, innovation, and proactive socialization.

Other topics of interest in the field of organizational behavior include the extent to which theories of behavior are culturally bound, unethical decision-making, self-management and self-leadership, and work/family conflict.

SEE ALSO: Motivation and Motivation Theory; Organic Organizations; Organizational Culture; Organizational Development

Jerry Bryan Fuller

ORGANIZATIONAL CHART

An organizational chart is a pictorial representation of a company's structure and reporting relationships. This chart can provide a great deal of information and may help organizational members understand the overall structure of the organization and its strategy. This entry describes how organizational charts are constructed, including the software that can be used to create them; what information the organizational chart provides; the benefits of making the chart available inside and outside of the organization; and the circumstances under which a chart is likely to change.

CONSTRUCTING AN ORGANIZATIONAL CHART

All organizational charts have similar elements that allow them to be easily interpreted and understood by people inside and outside of the organization. Charts consist of shapes and lines that represent work units and their hierarchy. See Figure 1 for an example of an organizational chart.

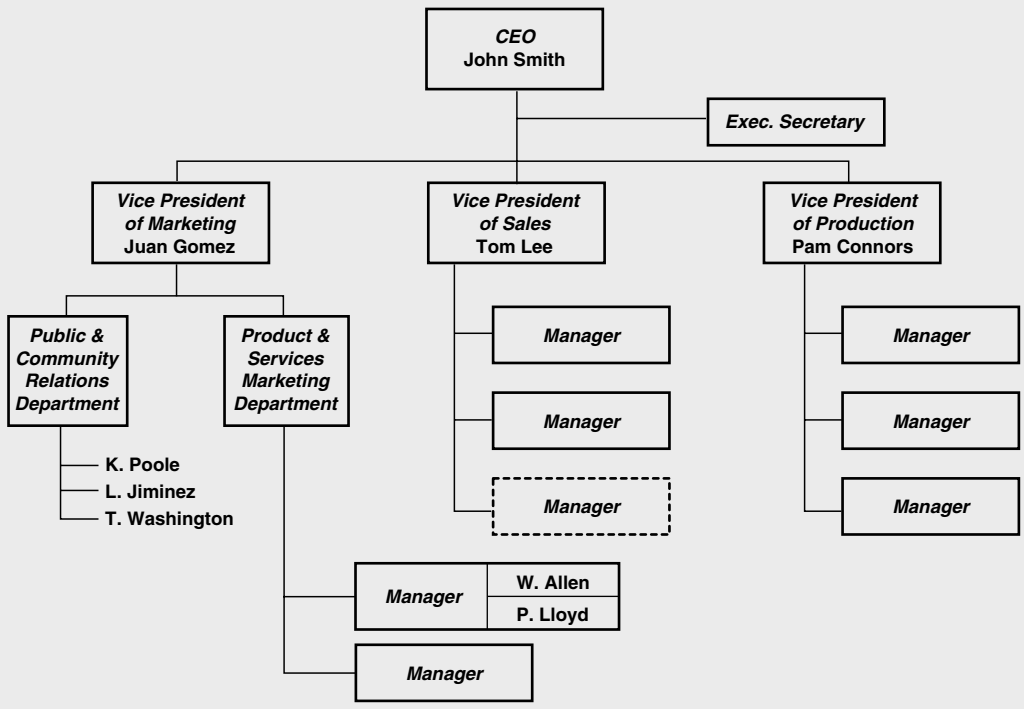
The basic building block of an organizational chart is the rectangle, which can represent a person or a work unit (e.g., a department). For example, as shown in figure 1, the CEO position has a separate rectangle that denotes one person, but the entire Public and Community Relations Department is also represented by one rectangle. If the outline of the rectangle is dashed, this means that a position is open and must be filled, as with one of the manager positions. If a rectangle is divided, and two or more names are in it, this may indicate job sharing or that multiple people are responsible for the outcomes associated with this position. In the figure, W. Allen and P. Lloyd are comanagers in one area of the Production and Services Marketing Department, where they have a job sharing arrangement and each works part-time hours.

The boxes may contain as much or as little information as the organization prefers. They may include a job title, an employee's name, an employee's department, or even information such as job tenure, education, or salary. Alternatively, a chart may be created without rectangles, with names or titles standing alone. The three employees in the Public and Community Relations Department are listed with their names not in rectangles. This often is done to save space on the chart.

Rectangles on an organizational chart are linked with solid or dashed lines. A solid line indicates a formal, direct relationship and a dashed line indicates that one employee or department advises another or has some other sort of indirect relationship. Note that all but one of the reporting relationships in figure 1 are formal. L. Jiminez has a dashed line to the Product and Services Marketing Department, which means that she sometimes will work for that department or will report to that department's manager. When lines represent a tree structure—when two or more rectangles are linked to another with multiple lines—this indicates that several individuals or departments report to one supervisor. For instance, the tree structure represents the relationship between the CEO and the three top managers who report to the CEO. Finally, a rectangle that is attached horizontally outside of the vertical hierarchy typically indicates an assistant or staff person. In the example, this is represented by the executive secretary to the CEO.

While organizational charts can be created by hand, most are created using computer software. Although it may be labor intensive, organizational charts can be created using drawing tools in a word processing program. Microsoft's PowerPoint presentation software allows for the creation of organizational charts, although there is little space available to create large charts. Specific software exists for creating

Figure 1
Sample Organizational Chart



larger, more complex charts, and there are many different packages available for purchase. Some examples are OrgPlus5, ConceptDraw V, SmartDraw, and Abra OrgChart. These software programs allow for quick and easy chart creation with point-and-click menus and automatic resizing and alignment. Many of these software programs also allow one to easily download charts into a word processing document, a presentation, or a Web site. Other features available in these programs include the ability to insert employee photographs, as well as information from other human resources computer programs, directly into charts.

INFORMATION IN THE ORGANIZATIONAL CHART

The organizational chart provides a great deal of information about the organization as a whole and the interaction of its parts. From a chart, one can see the organization's structure, its hierarchy, the degree to which it is centralized or decentralized, and its chain of command. Each of these is summarized below.

ORGANIZATIONAL STRUCTURE. First, organizational charts detail an organization's structure. It may be functional, in which work units are divided based on what they do and named after those functions (e.g., research and development, marketing, sales, etc.). The structure may be divisional, based on product, customers served, or geographic location. Finally, an organizational chart may represent a matrix structure, in which work units are organized by both function and division.

ORGANIZATIONAL HIERARCHY AND CENTRALIZATION. In addition to outlining the type of organizational structure, the organizational chart also indicates the number of management levels, whether the organizational structure is tall or flat, and the span of control at each level. Tall organizations have many levels of middle management and small spans of control. Each manager supervises and directs few employees, and the chain of command has many managers. Conversely, a flat organization has fewer management levels and larger spans of control. Because managers supervise more employees, employees tend to have more autonomy and discretion in their jobs.

Organizational hierarchy and the number of management levels often indicates the degree of centralization within an organization. Centralized organizations are those in which most of the decision making occurs by a few people at the top of the hierarchy. This typically creates a top-down management structure, in which top-level managers strongly control the direction

of the workplace through their decisions and supervision. Conversely, an organization with a decentralized structure allows greater decision-making and authority at lower organizational levels. Highly decentralized companies may have units that operate nearly independently of one another. The degree of hierarchy on an organization's chart normally will help one to determine the degree of centralization or decentralization within its structure. Typically, the taller the organization, the more centralized it is; flatter organizations generally require more decentralization, because managers each have broader spans of control and cannot direct and closely supervise so many people. Additionally, as previously described, the organization's structure may indicate the degree of centralization. Functional structures tend to be more centralized than do divisional structures.

CHAIN OF COMMAND. The vertical and horizontal lines connecting the rectangles on an organizational chart indicate reporting relationships and chain of command. That is, they indicate which employees are directly responsible for the supervision of others and who has ultimate accountability for a group of employees.

AVAILABILITY OF THE ORGANIZATIONAL CHART

Many companies make their organizational chart available to their employees and to the public. The members of the public who may have an interest in a company's organizational chart include company shareholders, investors, distributors and suppliers, customers, potential job applicants, and even community members.

Employees typically have access to the organizational chart through materials provided by the organization (e.g., the employee handbook) or through a company Web site. Providing the organizational chart to employees allows them to see the structure of the organization and to better understand the entirety of the organization and how their position or work unit fits into it. Additionally, the observable chain of command can help an employee to understand to whom they are accountable. This may aid the company in diagnosing organizational problems by being able to pinpoint accountability.

Many organizations now make their organizational charts available for viewing by the general public, either online or in corporate literature for shareholders and prospective employees. By providing this information, these external stakeholders and other interested parties may gain a better understanding of the organization. The chart may give them a sense of the organization's operations, workforce, or even its strategy.

CHANGES TO THE ORGANIZATIONAL CHART

There are a number of reasons that an organizational chart might change since the chart must reflect any alterations to the organizational structure. The structure may change due to a company's growth, decline, or restructuring.

GROWTH OR DECLINE. All organizations progress through a life cycle of growth, maturity, and decline, and in each stage the organizational structure is likely to be different. In the growth stage, the company is expanding rapidly, gaining customers and market share. Growth will occur when a company is just beginning and products and services are gaining a foothold. It may also occur when an organization develops a new product or expands into new markets, perhaps in other countries. With growth, the organizational chart will change. Levels of management may be added, along with new departments.

In maturity, an organization is no longer growing at a rapid rate and is stable in its production and sales. The organization may introduce minor changes to a product or service, but there are unlikely to be major changes to its structure.

In the decline stage, the organization is losing ground in the marketplace. It may be that its products or services are becoming obsolete or that its competitors are taking over the market. In decline, the organization may shed levels of management or positions in all divisions. Additionally, it may outsource work in some areas and thus remove those departments from its structure. Or, as certain products or services are dropped from the organization, the work units needed for these products and services also may be eliminated. Thus, in the decline stage the organizational chart is likely to be streamlined or shrunken.

RESTRUCTURING. Restructuring occurs when an organization reduces its workforce by eliminating large numbers of management and line employees. Restructuring typically occurs when information technology can be used to achieve the same productivity outcomes with fewer people. With restructuring, management levels may be eliminated entirely, or entire departments may be removed. This particularly is true if outsourcing accompanies the restructuring.

SEE ALSO: Management Levels; Organizational Structure

Marcia J. Simmering

FURTHER READING:

DuBrin, Andrew J. *Essentials of Management.* 7th ed. Cincinnati, OH: Thomson/South-Western, 2004.

Jones, Gareth R., and Jennifer M.George. *Contemporary Management.* 4th ed. New York: McGraw-Hill/Irwin, 2006.

Rue, Leslie W., and Lloyd L. Byars. *Management: Skills and Application.* 10th ed. New York: McGraw-Hill/Irwin, 2003.

Williams, Chuck. *Management.* 3rd ed. Mason, OH: Thomson/South-Western, 2005.

ORGANIZATIONAL CULTURE

As people work together to accomplish goals, groups develop into organizations. As goals become more specific and longer-term, and work more specialized, organizations become both more formal and institutionalized. Organizations tend to take on a life of their own and widely held beliefs, values, and practices develop, differentiating one organization from another and often affecting the organization's success or failure. In the early 1980s, management scholars began attempting to describe these belief systems, which they referred to as organizational or corporate cultures.

Interest in organizational cultures was further created by William Ouchi's 1981 best-seller, *Theory Z: How American Business Can Meet the Japanese Challenge.* Ouchi considered organizational culture to be a key determinant of organizational effectiveness. In 1982 two other best-sellers, Terrance Deal and Allan Kennedy's *Corporate Cultures: The Rites and Rituals of Corporate Life and Thomas Peters and Robert Waterman's In Search of Excellence,* supported the idea that excellent companies tended to have strong cultures.

An organizational culture is defined as the shared assumptions, values, and beliefs that guide the actions of its members. Organizational culture tends to be shaped by the founders' values, the industry and business environment, the national culture, and the senior leaders' vision and behavior. There are many dimensions or characteristics of organizational culture that have been defined. For example, a research study conducted by J.A. Chatman and K.A. Jehn in 1994, identified seven primary characteristics that define an organization's culture: innovation, stability (maintaining the status quo versus growth), people orientation, outcome orientation, easygoingness, detail orientation, and team orientation.

Large organizations usually have a dominant culture that is shared by the majority of the organization and subcultures represented by groups of individuals with unique values or beliefs that may or may not be consistent with the dominant culture. Subcultures that reject the dominant culture are called countercultures. Strong organizational cultures are those where the core values of the dominant culture are strongly believed by the great majority of organizational members. A strong culture tends to increase behavior consistency and reduce turnover. However, strong cultures may be less adaptive to change, may create barriers to diversity, and may create barriers to successful acquisitions and mergers.

CULTURAL FIT BETWEEN ORGANIZATION AND MEMBERS

There are many practices within an organization that tend to keep a culture alive and measure the cultural fit between the organization and its employees. Many of the human resource practices such as selection, performance appraisal, training, and career development reinforce the organization's culture. Organizational beliefs also tend to influence the work norms, communication practices, and philosophical stances of employees. Organizations use a process called socialization to adapt new employees to the organization's culture. If employees do not adapt well, they feel increasing pressure from supervisors and from coworkers who are better acculturated. They might stay and fight, stay and become isolated, or leave the organization, voluntarily or involuntarily, and look for a different organization whose culture they fit better.

In contrast, employees who understand and share the organization's values have a better basis for making choices that match the firm's goals. Many organizations compete through innovation. When most employees understand and support the organization's expectations, less time is spent explaining, instructing, and building consensus before trying something innovative. Moreover, the error level will be lower in most cases. Employees who are well acculturated also find their work more meaningful: They are part of, and contributing to, something larger than themselves. Thus, a good cultural fit between employees and the organization contributes to employee retention, organizational productivity, and profit.

MEANS OF CONVEYING CULTURE

Organizations often convey cultural values explicitly by means of mission statements or corporate credos, or to a lesser extent through slogans, logos, or advertising campaigns. Leaders and managers also show what the organization values by what they say and do, what they reward, who they make allies, and how they motivate compliance. Other elements of culture appear tacitly in symbols and symbolic behavior: For instance, meeting protocols, greeting behavior, allocation and use of space, and status symbols are a few areas where organizational norms often develop. Culture can regulate social norms as well as work or task norms.

The new-employee orientation typically offered by organizations conveys selected cultural elements of which management is both aware and proud. Some cultural elements might be initially unpalatable, however, and some others might be hard to put into words. For instance, an orientation would rarely say outright that the culture rewards neglect of one's personal life and demands a 60-hour work week, although these expectations are not unknown in corporate life. Perceptive new employees learn about tacit cultural elements through observation and through questioning trusted employees or mentors. This is not one-time learning; employees must continue to watch for signs that the rules are changing.

These organizational rules include explicit policy statements, but also a much larger and less evident set of unwritten organizational expectations. Attentive employees figure them out sooner than others. They listen to the metaphors, images, and sayings that are common in the organization. They watch, for example, the consequences of others' mistakes to reach conclusions about appropriate behavior.

Organizations also communicate values and rules through displayed artifacts. For example, in some organizations, the CEO's office displays many symbols of wealth, such as expensive original art or antiques. In others, the CEO's workspace is very Spartan and differs little from that of other executives and higher-level managers. In the former case, a manager with other sources of income might be able to afford similar status symbols but would be unwise to display them since this might be perceived as competing with the CEO. In the latter case, display of personal wealth by people in general would probably be counter to organizational values.

Even the way a physical plant is laid out communicates cultural messages: Is it an open area where everyone can see everyone? Are there cubicles? Are there private offices? Is it easy or difficult to move and communicate between functional areas? Have ergonomics and convenience been considered or ignored? Are there adequate neutral spaces for people to meet to make decisions and solve problems? Do the break rooms and lunch rooms invite or discourage use?

SOME COMPONENTS OF CULTURE

The idea that organizations have cultures came originally from ethnography, the study and description of human social cultures. Researchers in organizational culture have borrowed some of that language. Individuals in societies took on specific "roles," such as ruler, priest, historian, or teacher. In organizations, similar roles emerge. The historian or storyteller, for instance, is usually a longtime employee who narrates inspirational stories about the company's early years or its evolution. Embodied in the stories are many of the core values that permeate the organization. This "organizational folklore" includes oft-repeated stories about the founder, a long-term CEO, a dramatic firing, or an individual who rose through the ranks very quickly owing to some attribute highly valued by the firm. The stars of an organization are comparable to a social culture's heroes. An organization's success stories yield "role models" for the ambitious.

Organizations develop "rites and rituals" comparable to traditional activities within an ethnic culture. Whereas some organizations might emphasize award ceremonies, others might de-emphasize explicit recognition and affiliation behaviors. Still others might foster "management by walking around," whereby managers spend frequent one-on-one time away from their desks giving praise or criticism to individuals. As another example, lunch with the president might be a longstanding tradition, although the amount of actual communication will vary from organization to organization according to unwritten rules about who talks to whom.

Although all organizations have both formal and informal communication networks, organizational culture strongly affects the content, reliability, and influence of the informal network or "grapevine." When information through formal channels is scarce, the grapevine carries heavier traffic. Leaders aware of culture's importance try to find ways to tap and monitor the grapevine and sometimes use the grapevine by adding information to it.

CULTURE CHANGE

An organization's culture is composed of relatively stable characteristics that are based on deeply held values that are reinforced by many organizational practices. However, an organizational culture can be changed. Cultural changes are most likely to occur when there is a dramatic setback such as a financial crisis or when there is a turnover in top leadership. Also, younger and smaller organizations and organizations with a weak culture are more amenable to change.

Deliberate and major culture change occurs by executive fiat, by implementation of a plan, or a combination of these means. When leadership changes or when existing leadership commits to change, employees learn that the old assumptions which they were comfortable are no longer safe. After a merger or acquisition, for example, "how we do things here" will change, sometimes quickly and radically. A wise leadership team implements a planned culture-change process. The process usually consists of a series of two-way communications that elicit the prevailing assumptions, reassure employees that the changes can benefit them, introduce (sometimes gradually) the new vision, and work to gain employees' commitment

and support. Leaders also must model the new culture for others and change the organization's structure and management practices to support the new culture. If the leaders skip the process or do an inadequate job, employees at all levels experience stress, confusion, and anger. When change is introduced so as not to arouse fear and resentment, however, transition may be relatively smooth.

A 1992 research study by J.P. Kotter and J.L. Heskett showed that long-term financial performance was highest for organizations with an adaptive culture. One example of when organizations must adapt their culture is when organizations become multinational. With the increase in global organizations, it has become clear that national cultures impinge on organizational cultures. Besides language differences, employees bring to the job many radically different assumptions about such aspects as the dignity of work, the proper relationship between employee and supervisor, the value of initiative, the treatment of unwelcome information, and the voicing of complaints. Organizations with international customers, and even more, those with global operations have needed to learn how to adapt to a multicultural environment. Failure to adapt jeopardizes an organization's chance of success abroad.

To summarize, organizational culture is the shared assumptions, beliefs and values held by most members of an organization. Culture is conveyed in both explicit and implicit ways. Newcomers to an organization must quickly assimilate a great deal about the culture. Veteran employees must remain aware of cultural change too, especially when the leadership changes. A strong culture that is aligned with the organization's strategic context and is adaptive to environmental changes can enhance an organization's long-term financial performance.

SEE ALSO: International Cultural Differences

Jeanette W. Gilsdorf
Revised by Dr. Fraya Wagner-Marsh

FURTHER READING:

Chatman, J.A. and K.A. Jehn. "Assessing the relationship between industry characteristics and organizational culture: How different can you be?." *Academy of Management Journal* 37 (1994): 522–553.

David, Stanley M. *Managing Corporate Culture.* Cambridge, MA: Ballinger Pub. Co., 1984.

Deal, Terrence E., and Allan A. Kennedy. *Corporate Cultures: The Rites and Rituals of Corporate Life.* Reading, MA: Addison-Wesley, 1982.

Frost, Peter J., Larry F. Moore, Meryl R. Louis, Craig C. Lundberg, and Joanne Martin, eds. *Organizational Culture.* Beverly Hills, CA: Sage, 1985.

Graf, Alan B. "Building Corporate Cultures." *Chief Executive,* March 2005, 18.

Hofstede, Geert. *Cultures and Organizations: Software of the Mind.* New York: McGraw-Hill, 1991.

Kilman, Ralph H., M.J. Saxton, and Roy Serpa, eds. *Gaining Control of the Corporate Culture.* San Francisco: Jossey-Bass, 1985.

Kotter, J.P. and J.L. Heskett. *Corporate Culture and Performance.* New York: Free Press, 1992.

LaRue, Bruce, and Robert R. Ivany. "Transform Your Culture." *Executive Excellence,* December 2004, 14–15.

LeFranc, Fred. "A Dynamic Culture Can Make a Franchise System Successful." *Franchising World,* February 2005, 75–77.

Oden, Howard W. *Managing Corporate Culture, Innovation, and Intrapreneurship.* Westport, CT: Quorum Books, 1997.

Ouchi, William G. "Theory Z: How American Business Can Meet the Japanese Challenge." Reading, MA: Addison-Wesley Publishing, 1982.

Panico, C. Richard. "Culture's Competitive Advantage." *Global Cosmetic Industry* 172, no. 12 (December 2004): 58–60.

Peters, Thomas J., and Robert H. Waterman, Jr. *In Search of Excellence: Lessons from America's Best Run Companies.* New York: Harper & Row, 1982.

Schein, Edgar H. *Organizational Culture and Leadership: A Dynamic View.* San Francisco: Jossey-Bass, 1995.

Schneider, Benjamin, ed. *Organizational Climate and Culture.* San Francisco: Jossey-Bass, 1990.

Weick, Karl E. *Sensemaking in Organizations.* Thousand Oaks, CA: Sage, 1995.

Wright, Gordon. "Realigning the Culture." *Building Design & Construction* 46, no. 1 (January 2005): 26–34.

ORGANIZATIONAL DEVELOPMENT

Organizational development is an ongoing, systematic process to implement effective change in an organization. Organizational development is known as both a field of applied behavioral science focused on understanding and managing organizational change and as a field of scientific study and inquiry. It is interdisciplinary in nature and draws on sociology, psychology, and theories of motivation, learning, and personality.

HISTORY OF ORGANIZATIONAL DEVELOPMENT

In the late 1960s organizational development was implemented in organizations via consultants, but was relatively unknown as a theory of practice and had no common definition among its practitioners. Richard Beckhard, an authority on organizational development and change management, defined

organizational development as "an effort, planned, organization-wide, and managed from the top, to increase organization effectiveness and health through planned interventions in the organization's processes, using behavioral-science knowledge" (Beckhard 1969).

Throughout the 1970s and 1980s organizational development became a more established field with courses and programs being offered in business, education, and administration curricula. In the 1990s and 2000s organizational development continued to grow and evolve and its influences could be seen in theories and strategies such as total quality management (TQM), team building, job enrichment, and reengineering.

RATIONALE AND IMPLEMENTATION

Organizational development takes into consideration how the organization and its constituents or employees function together. Does the organization meet the needs of its employees? Do the employees work effectively to make the organization a success? How can the symbiotic relationship between employee satisfaction and organizational success be optimized? Organizational development places emphasis on the human factors and data inherent in the organization-employee relationship. Organizational development strategies can be used to help employees become more committed and more adaptable, which ultimately improves the organization as a whole.

The organizational development process is initiated when there is a need, gap, or dissatisfaction within the organization, either at the upper management level or within the employee body. Ideally, the process involves the organization in its entirety, with evidenced support from upper management and engagement in the effort by all members from each level of the organization.

To launch the process, consultants with experience in organizational development and change management are often utilized. These consultants may be internal to the company or external, with the cautionary understanding that internal consultants might be too entrenched in the existing company environment to effectively coordinate and enforce the action plans and solutions required for successful change.

Data analysis through task forces, interviews, and questionnaires can illuminate likely causes for disconnects throughout an organization. These gaps can then be analyzed, an action plan formed, and solutions employed. This is by no means a linear process, nor is it a brief one. Feedback from all constituents should be elicited throughout the process and used to make adjustments to the action plan as necessary. Constant monitoring during the entire implementation effort is important for its success and acceptance.

THE FUTURE OF ORGANIZATIONAL DEVELOPMENT

There are contradictory opinions about the status and future prospects of organizational development. Is it a theory whose time has come and gone? Does its basis in behavioral science, a "soft" science, make it unappealing? What are the challenges for the future?

An article by Bunker, Alban, and Lewicki proposes six areas that could revitalize the field of organizational development in the future: virtual teams, conflict resolution, work group effectiveness, social network analysis, trust, and intractable conflict. These authors suggest that focusing on these areas will help bridge the gap between research theory (i.e., academics) and practice (i.e., consultants). Getting these two groups to communicate with each other will benefit both groups and promote organizational development efforts.

In a survey conducted by Church, Waclawski, and Berr, twenty individuals involved in the study and practice of organizational development were questioned about their perspectives and predictions on the future of the field. The most in-demand services, according to those polled, are:

- executive coaching and development
- team building and team effectiveness
- facilitating strategic organizational change
- systemic integration
- diversity and multiculturalism.

They list the daily challenges in the field as the need for speed, resistance to change, interpersonal skills and awareness, and differentiating organizational development, which refers to the variety of definitions of organizational development among practitioners and how this impacts consultants, clients, and the clients' needs.

The opinions on the future direction of the field vary among its practitioners. Nevertheless, the continuing interest in and value of optimizing an organization's needs and goals with the needs, wants, and personal satisfaction of its employees indicate that organizational development will continue to be relevant to and vital for organizational reform in the future, either in its present form or through evolution into other theories and practices.

SEE ALSO: Organization Theory; Organizational Learning; Quality and Total Quality Management; Teams and Teamwork

Monica C. Turner

FURTHER READING:

Beckhard, Richard. *Organization Development: Strategies and Models.* Reading, MA: Addison-Wesley, 1969.

Brown, D.R., and D.F. Harvey. *An Experiential Approach to Organization Development.* Upper Saddle River, NJ: Pearson Prentice Hall, 2004.

Bunker, B.B., B.T. Alban, and R.J. Lewicki. "Ideas in Currency and OD Practice: Has the Well Gone Dry?" *Journal of Applied Behavioral Science* 40, no. 4 (December 2004): 403–22.

Burke, W.W. "Internal Organization Development Practitioners: Where Do They Belong?" *Journal of Applied Behavioral Science* 40, no. 4 (December 2004): 423–31.

Cummings, T.G., and C.G. Worley. *Organization Development and Change.* 8th ed. Mason, OH: Thomson/South-Western, 2005.

French, W.L., C. Bell, and R.A. Zawacki. *Organization Development and Transformation: Managing Effective Change.* 6th ed. New York: McGraw-Hill/Irwin, 2005.

Massarik, F., and M. Pei-Carpenter. *Organization Development and Consulting: Perspectives and Foundations.* San Francisco: Pfeiffer, 2002.

Shifo, R. "OD in Ten Words or Less: Adding Lightness to the Definitions of Organizational Development." *Organizational Development Journal* 22, no. 3 (Fall 2004): 74–85.

Waclawski, J., and A.H. Church. *Organization Development: A Data-driven Approach to Organizational Change.* San Francisco: Jossey-Bass, 2002.

Wheatley, M., R. Tannenbaum, P.Y. Griffin, and K. Quade. *Organization Development at Work: Conversations on the Values, Applications, and Future of OD.* San Francisco: Pfeiffer, 2003.

ORGANIZATIONAL LEARNING

The importance of learning in organizations has been recognized since the early twentieth century. Organizational learning was implicitly applied by Henry Ford in developing the Model T. This work demonstrated the existence of learning curves, whereby the time and cost needed to assemble products decreased by a constant percentage—usually 20 to 30 percent—for every doubling of output.

The phenomenon of learning curves, also called experience curves, progress curves, or learning by doing, became very popular in the 1960s and 1970s. At that time, many managers were held up to (and fired for not reaching) the 80 percent mark, meaning, with each doubling of output, costs were expected to decrease to 80 percent of the prior cost level. This overly simplistic view of learning curves resulted in disgruntlement with them in the 1980s.

Modern scholars realize that, although the learning curve is present in many organizations, there is great variation in the slope of those learning curves. The disparity in organizational learning rates clearly indicates that productivity rates are not guaranteed to improve as experience increases. Other factors are at play.

The goal of much research on organizational learning is to determine which characteristics of an organization cause it to be able to continually learn and adapt to new circumstances. Those that are able to do so are called "learning organizations" because they are uniquely capable of improving themselves by learning from experience. Peter Senge popularized the concept of the learning organization in his 1993 book *The Fifth Discipline,* and he identified the following as its core ingredients:

1. Mental models—everyone sets aside old ways of thinking.
2. Personal mastery—everyone becomes self-aware and open to others.
3. Systems thinking—everyone learns how the whole organization works.
4. Shared vision—everyone understands and agrees to a plan of action.
5. Team learning—everyone works together to accomplish the plan.

Organizations that meet Senge's criteria offer work settings in which members develop their abilities to learn and are encouraged and helped to make that learning continuously available to everyone else. These organizations have value-driven organizational cultures that emphasize information sharing, teamwork, empowerment, participation, and learning. Importantly, the leaders of learning organizations set an example for others by embracing change and communicating enthusiasm for solving problems and growing with new opportunities. Jack Welch, formerly the CEO of General Electric, communicated his enthusiasm for the learning organization when he stated in General Electric's 1999 annual report that this was the company's only competitive advantage.

The imperative for improved learning derives from the emerging global, knowledge-based economy, which focuses on collective, entrepreneurial learning to create continual innovations in products, processes, and services. It is driven by the continuing growth of new technological knowledge. This, in turn, leads to newly definable markets for this knowledge and to changing organizational and network structures, thus enabling organizations to apply new technology in both old and new markets.

SEE ALSO: Knowledge Management; Organizational Culture; Trends in Organizational Change

Michael J.C. Martin
Revised by Rebecca J. Bennett

FURTHER READING:

Argote, Linda. *Organizational Learning: Creating, Retaining & Transferring Knowledge.* The Netherlands: Kluwer Academic Publishing, 1999.

Argyris, C., and D. Schon. *Organizational Learning II.* London: Addison-Wesley, 1996.

Garvin, David A. "Building a Learning Organization." *Harvard Business Review* 71 (1993).

Kline, Peter, and Bernard Saunders. *Ten Steps to a Learning Organization.* Green River Books, 1997.

Senge, Peter M. *The Fifth Discipline: The Art and Practice of Learning Organization.* London: Century Business, 1993.

ORGANIZATIONAL STRUCTURE

Organizational structure refers to the way that an organization arranges people and jobs so that its work can be performed and its goals can be met. When a work group is very small and face-to-face communication is frequent, formal structure may be unnecessary, but in a larger organization decisions have to be made about the delegation of various tasks. Thus, procedures are established that assign responsibilities for various functions. It is these decisions that determine the organizational structure.

In an organization of any size or complexity, employees' responsibilities typically are defined by what they do, who they report to, and for managers, who reports to them. Over time these definitions are assigned to positions in the organization rather than to specific individuals. The relationships among these positions are illustrated graphically in an organizational chart (see Figures 1a and 1b). The best organizational structure for any organization depends on many factors including the work it does; its size in terms of employees, revenue, and the geographic dispersion of its facilities; and the range of its businesses (the degree to which it is diversified across markets).

There are multiple structural variations that organizations can take on, but there are a few basic principles that apply and a small number of common patterns. The following sections explain these patterns and provide the historical context from which some of them arose. The first section addresses organizational structure in the twentieth century. The second section provides additional details of traditional, vertically-arranged organizational structures. This is followed by descriptions of several alternate organizational structures including those arranged by product, function, and geographical or product markets. Next is a discussion of combination structures, or matrix organizations. The discussion concludes by addressing emerging and potential future organizational structures.

ORGANIZATIONAL STRUCTURE DURING THE TWENTIETH CENTURY

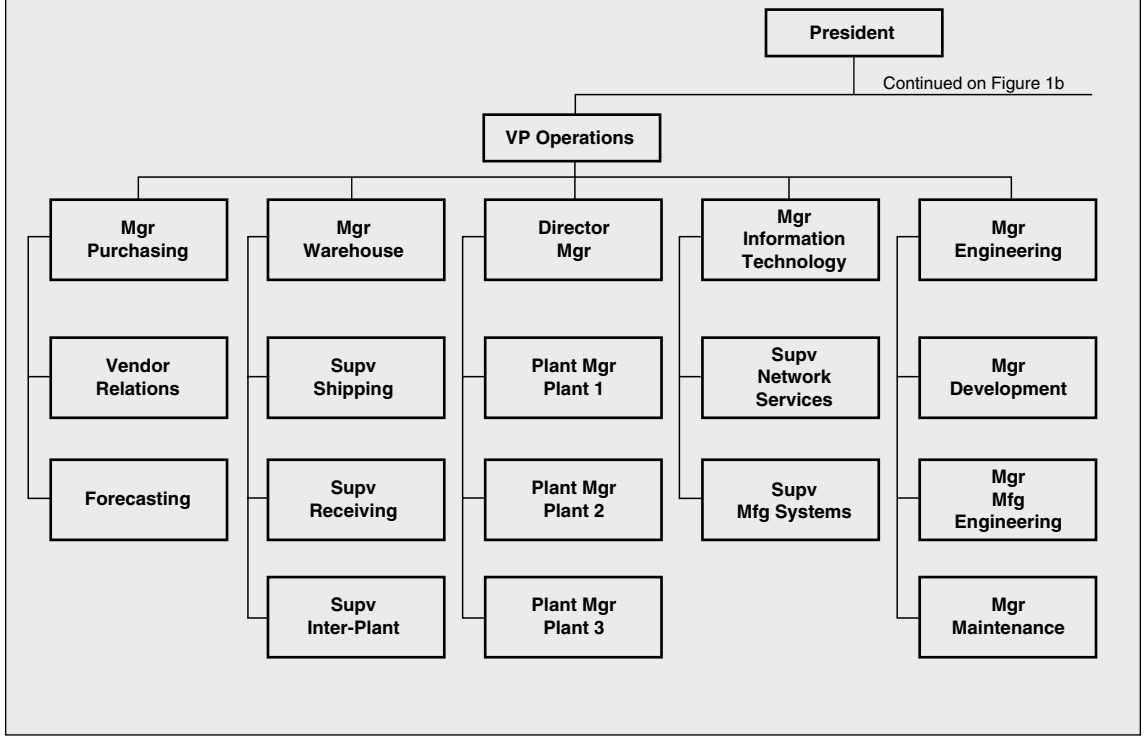
Understanding the historical context from which some of today's organizational structures have developed helps to explain why some structures are the way they are. For instance, why are the old, but still operational steel mills such as U.S. Steel and Bethlehem Steel structured using vertical hierarchies? Why are newer steel mini-mills such as Chaparral Steel structured more horizontally, capitalizing on the innovativeness of their employees? Part of the reason, as this section discusses, is that organizational structure has a certain inertia—the idea borrowed from physics and chemistry that something in motion tends to continue on that same path. Changing an organization's structure is a daunting managerial task, and the immensity of such a project is at least partly responsible for why organizational structures change infrequently.

At the beginning of the twentieth century the United States business sector was thriving. Industry was shifting from job-shop manufacturing to mass production, and thinkers like Frederick Taylor in the United States and Henri Fayol in France studied the new systems and developed principles to determine how to structure organizations for the greatest efficiency and productivity, which in their view was very much like a machine. Even before this, German sociologist and engineer Max Weber had concluded that when societies embrace capitalism, bureaucracy is the inevitable result. Yet, because his writings were not translated into English until 1949, Weber's work had little influence on American management practice until the middle of the twentieth century.

Management thought during this period was influenced by Weber's ideas of bureaucracy, where power is ascribed to positions rather than to the individuals holding those positions. It also was influenced by Taylor's scientific management, or the "one best way" to accomplish a task using scientifically-determined studies of time and motion. Also influential were Fayol's ideas of invoking unity within the chain-of-command, authority, discipline, task specialization, and other aspects of organizational power and job separation. This created the context for vertically-structured organizations characterized by distinct job classifications and top-down authority structures, or what became known as the traditional or classical organizational structure.

Job specialization, a hierarchical reporting structure through a tightly-knit chain-of-command, and the subordination of individual interests to the superordinate goals of the organization combined to result in organizations arranged by functional departments with order and discipline maintained by rules, regulations, and standard operating procedures. This classical view, or bureaucratic structure, of organizations was the dominant pattern as small organizations grew increasingly larger during the economic boom that occurred from the 1900s until the Great Depression of the 1930s. Henry Ford's plants were typical of this

Figure 1a
Organizational Structure



growth, as the emerging Ford Motor Company grew into the largest U.S. automaker by the 1920s.

The Great Depression temporarily stifled U.S. economic growth, but organizations that survived emerged with their vertically-oriented, bureaucratic structures intact as public attention shifted to World War II. Postwar rebuilding reignited economic growth, powering organizations that survived the Great Depression toward increasing size in terms of sales revenue, employees, and geographic dispersion. Along with increasing growth, however, came increasing complexity. Problems in U.S. business structures became apparent and new ideas began to appear. Studies of employee motivation raised questions about the traditional model. The "one best way" to do a job gradually disappeared as the dominant logic. It was replaced by concerns that traditional organizational structures might prevent, rather than help, promote creativity and innovation—both of which were necessary as the century wore on and pressures to compete globally mounted.

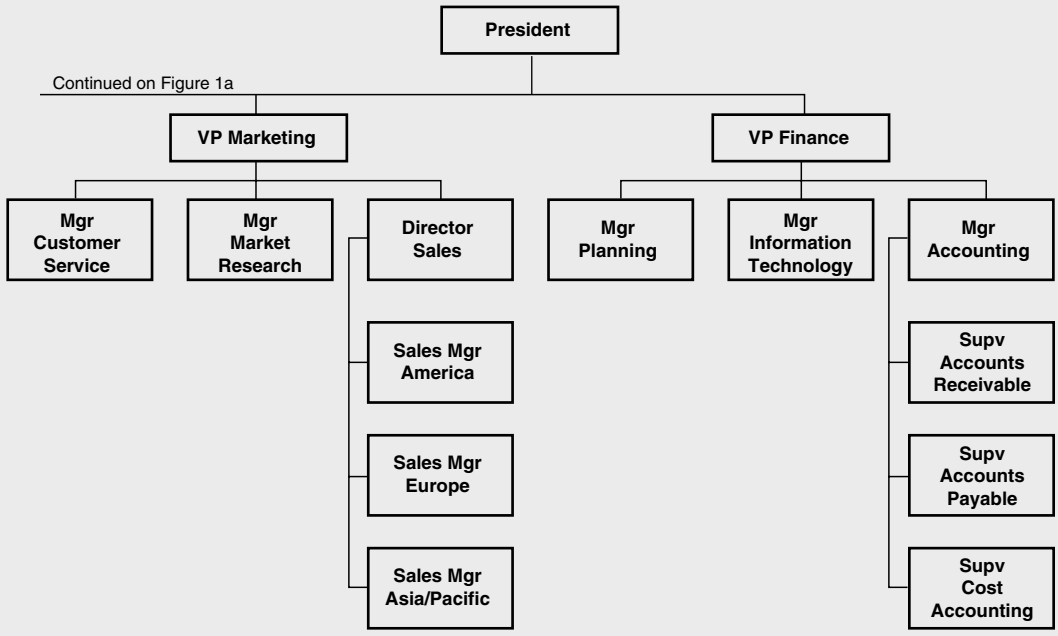
TRADITIONAL ORGANIZATIONAL STRUCTURE

While the previous section explained the emergence of the traditional organizational structure, this section provides additional detail regarding how this affected the practice of management. The structure of every organization is unique in some respects, but all organizational structures develop or are consciously designed to enable the organization to accomplish its work. Typically, the structure of an organization evolves as the organization grows and changes over time.

Researchers generally identify four basic decisions that managers have to make as they develop an organizational structure, although they may not be explicitly aware of these decisions. First, the organization's work must be divided into specific jobs. This is referred to as the division of labor. Second, unless the organization is very small, the jobs must be grouped in some way, which is called departmentalization. Third, the number of people and jobs that are to be grouped together must be decided. This is related to the number of people that are to be managed by one person, or the span of control—the number of employees reporting to a single manager. Fourth, the way decision-making authority is to be distributed must be determined.

In making each of these design decisions, a range of choices are possible. At one end of the spectrum, jobs are highly specialized with employees performing a narrow range of activities, while at the other end of the spectrum employees perform a variety of tasks. In

Figure 1b
Organizational Structure



traditional bureaucratic structures, there is a tendency to increase task specialization as the organization grows larger. In grouping jobs into departments, the manager must decide the basis on which to group them. The most common basis, at least until the last few decades, was by function. For example, all accounting jobs in the organization can be grouped into an accounting department, all engineers can be grouped into an engineering department, and so on. The size of the groupings also can range from small to large depending on the number of people the managers supervise. The degree to which authority is distributed throughout the organization can vary as well, but traditionally structured organizations typically vest final decision-making authority by those highest in the vertically structured hierarchy. Even as pressures to include employees in decision-making increased during the 1950s and 1960s, final decisions usually were made by top management. The traditional model of organizational structure is thus characterized by high job specialization, functional departments, narrow spans of control, and centralized authority. Such a structure has been referred to as traditional, classical, bureaucratic, formal, mechanistic, or command and control. A structure formed by choices at the opposite end of the spectrum for each design decision is called unstructured, informal, or organic.

The traditional model of organizational structure is easily represented in a graphical form by an organizational chart. It is a hierarchical or pyramidal structure with a president or other executive at the top, a small number of vice presidents or senior managers under the president, and several layers of management below this, with the majority of employees at the bottom of the pyramid. The number of management layers depends largely on the size of the organization. The jobs in the traditional organizational structure usually are grouped by function into departments such as accounting, sales, human resources, and so. Figures 1a and 1b illustrate such an organization grouped by functional areas of operations, marketing and finance.

BASIS FOR DEPARTMENTALIZATION

As noted in the previous section, many organizations group jobs in various ways in different parts of the organization, but the basis that is used at the highest level plays a fundamental role in shaping the organization. There are four commonly used bases.

FUNCTIONAL DEPARTMENTALIZATION. Every organization of a given type must perform certain jobs in order do its work. For example, key functions of a manufacturing company include production, purchasing, marketing, accounting, and personnel. The functions of a hospital include surgery, psychiatry, nursing,

housekeeping, and billing. Using such functions as the basis for structuring the organization may, in some instances, have the advantage of efficiency. Grouping jobs that require the same knowledge, skills, and resources allows them to be done efficiently and promotes the development of greater expertise. A disadvantage of functional groupings is that people with the same skills and knowledge may develop a narrow departmental focus and have difficulty appreciating any other view of what is important to the organization; in this case, organizational goals may be sacrificed in favor of departmental goals. In addition, coordination of work across functional boundaries can become a difficult management challenge, especially as the organization grows in size and spreads to multiple geographical locations.

GEOGRAPHIC DEPARTMENTALIZATION. Organizations that are spread over a wide area may find advantages in organizing along geographic lines so that all the activities performed in a region are managed together. In a large organization, simple physical separation makes centralized coordination more difficult. Also, important characteristics of a region may make it advantageous to promote a local focus. For example, marketing a product in Western Europe may have different requirements than marketing the same product in Southeast Asia. Companies that market products globally sometimes adopt a geographic structure. In addition, experience gained in a regional division is often excellent training for management at higher levels.

PRODUCT DEPARTMENTALIZATION. Large, diversified companies are often organized according to product. All the activities necessary to produce and market a product or group of similar products are grouped together. In such an arrangement, the top manager of the product group typically has considerable autonomy over the operation. The advantage of this type of structure is that the personnel in the group can focus on the particular needs of their product line and become experts in its development, production, and distribution. A disadvantage, at least in terms of larger organizations, is the duplication of resources. Each product group requires most of the functional areas such as finance, marketing, production, and other functions. The top leadership of the organization must decide how much redundancy it can afford.

CUSTOMER/MARKET DEPARTMENTALIZATION. An organization may find it advantageous to organize according to the types of customers it serves. For example, a distribution company that sells to consumers, government clients, large businesses, and small businesses may decide to base its primary divisions on these different markets. Its personnel can then become proficient in meeting the needs of these different customers. In the same way, an organization that provides services such as accounting or consulting may group its personnel according to these types of customers. Figure 2 depicts an organization grouped by customers and markets.

Figure 2
Customer/Market Organization

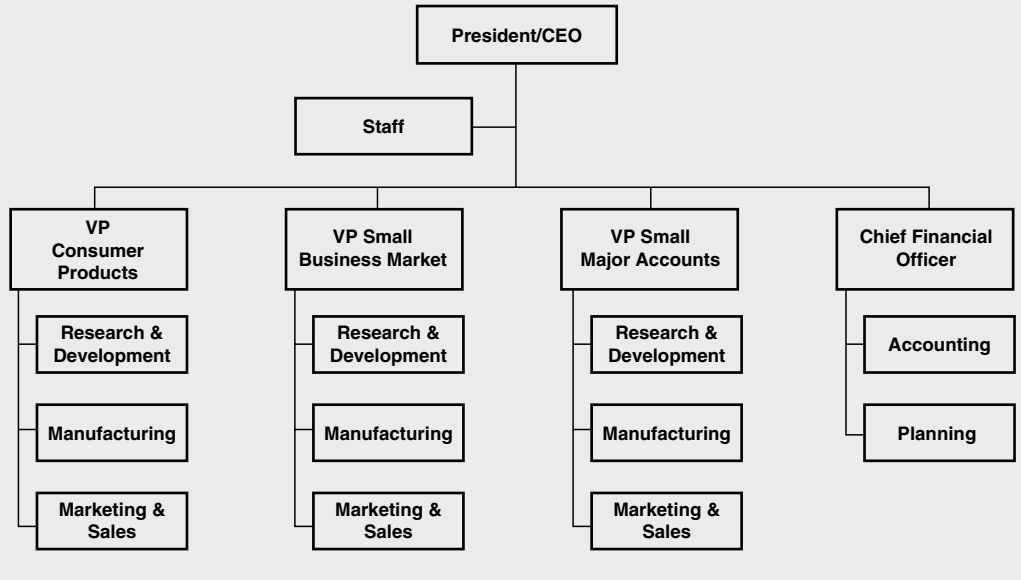
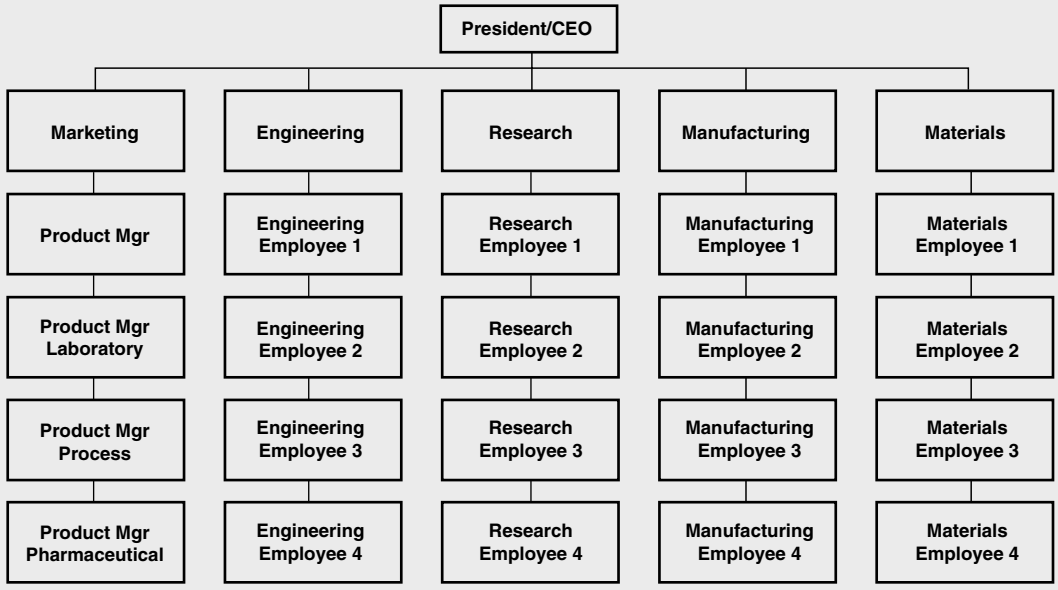


Figure 3
Matrix Structure



MATRIX ORGANIZATIONAL STRUCTURE

Some organizations find that none of the aforementioned structures meet their needs. One approach that attempts to overcome the inadequacies is the matrix structure, which is the combination of two or more different structures. Functional departmentalization commonly is combined with product groups on a project basis. For example, a product group wants to develop a new addition to its line; for this project, it obtains personnel from functional departments such as research, engineering, production, and marketing. These personnel then work under the manager of the product group for the duration of the project, which can vary greatly. These personnel are responsible to two managers (as shown in Figure 3).

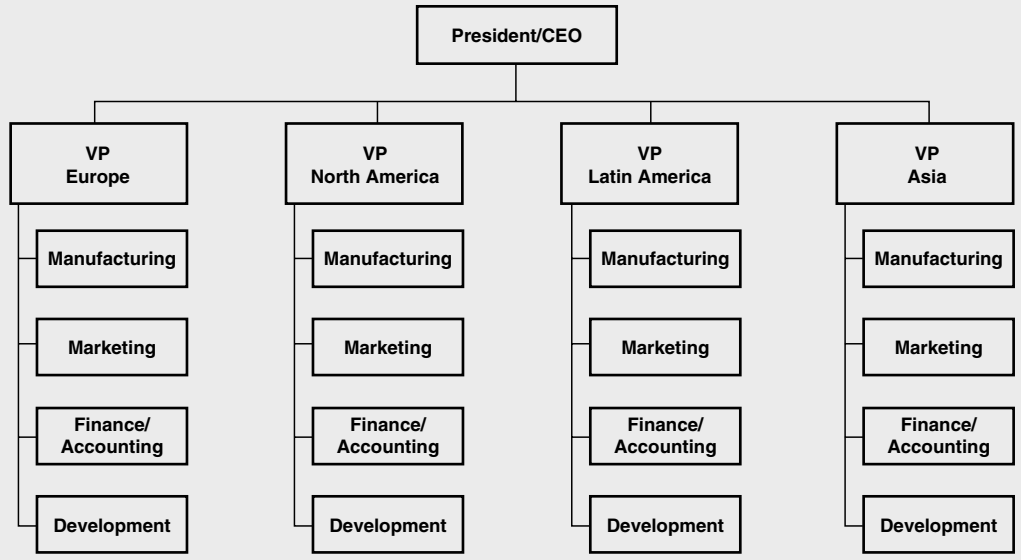
One advantage of a matrix structure is that it facilitates the use of highly specialized staff and equipment. Rather than duplicating functions as would be done in a simple product department structure, resources are shared as needed. In some cases, highly specialized staff may divide their time among more than one project. In addition, maintaining functional departments promotes functional expertise, while at the same time working in project groups with experts from other functions fosters cross-fertilization of ideas.

The disadvantages of a matrix organization arise from the dual reporting structure. The organization's top management must take particular care to establish proper procedures for the development of projects and to keep communication channels clear so that potential conflicts do not arise and hinder organizational functioning. In theory at least, top management is responsible for arbitrating such conflicts, but in practice power struggles between the functional and product manager can prevent successful implementation of matrix structural arrangements. Besides the product/function matrix, other bases can be related in a matrix. Large multinational corporations that use a matrix structure most commonly combine product groups with geographic units. Product managers have global responsibility for the development, manufacturing, and distribution of their own product or service line, while managers of geographic regions have responsibility for the success of the business in their regions.

STRATEGIC BUSINESS UNITS

As corporations become very large they often restructure as a means of revitalizing the organization. Growth of a business often is accompanied by a growth in bureaucracy, as positions are created to facilitate developing needs or opportunities. Continued changes in the organization or in the external business environment may make this bureaucracy a hindrance rather than a help, not simply because of the size or complexity of the organization but also because of a sluggish bureaucratic way of thinking. One approach to encourage new ways of thinking and acting is to reorganize parts of the company into largely autonomous groups,

Figure 4
SBU Structure



called strategic business units (SBUs). Such units generally are set up like separate companies, with full profit and loss responsibility invested in the top management of the unit—often the president of the unit and/or a senior vice president of the larger corporation. This manager is responsible to the top management of the corporation. This arrangement can be seen as taking any of the aforementioned departmentalization schemes one step further. The SBUs might be based on product lines, geographic markets, or other differentiating factors. Figure 4 depicts SBUs organized by geographic area.

EMERGING TRENDS IN ORGANIZATIONAL STRUCTURE

Except for the matrix organization, all the structures described above focus on the vertical organization; that is, who reports to whom, who has responsibility and authority for what parts of the organization, and so on. Such vertical integration is sometimes necessary, but may be a hindrance in rapidly changing environments. A detailed organizational chart of a large corporation structured on the traditional model would show many layers of managers; decision making flows vertically up and down the layers, but mostly downward. In general terms, this is an issue of interdependence.

In any organization, the different people and functions do not operate completely independently. To a greater or lesser degree, all parts of the organization need each other. Important developments in organizational design in the last few decades of the twentieth century and the early part of the twenty-first century have been attempts to understand the nature of interdependence and improve the functioning of organizations in respect to this factor. One approach is to flatten the organization, to develop the horizontal connections and de-emphasize vertical reporting relationships. At times, this involves simply eliminating layers of middle management. For example, some Japanese companies—even very large manufacturing firms—have only four levels of management: top management, plant management, department management, and section management. Some U.S. companies also have drastically reduced the number of managers as part of a downsizing strategy; not just to reduce salary expense, but also to streamline the organization in order to improve communication and decision making.

In a virtual sense, technology is another means of flattening the organization. The use of computer networks and software designed to facilitate group work within an organization can speed communications and decision making. Even more effective is the use of intranets to make company information readily accessible throughout the organization. The rapid rise of such technology has made virtual organizations and boundarlyless organizations possible, where managers, technicians, suppliers, distributors, and customers connect digitally rather than physically.

A different perspective on the issue of interdependence can be seen by comparing the organic model of organization with the mechanistic model.

The traditional, mechanistic structure is characterized as highly complex because of its emphasis on job specialization, highly formalized emphasis on definite procedures and protocols, and centralized authority and accountability. Yet, despite the advantages of coordination that these structures present, they may hinder tasks that are interdependent. In contrast, the organic model of organization is relatively simple because it de-emphasizes job specialization, is relatively informal, and decentralizes authority. Decision-making and goal-setting processes are shared at all levels, and communication ideally flows more freely throughout the organization.

A common way that modern business organizations move toward the organic model is by the implementation of various kinds of teams. Some organizations establish self-directed work teams as the basic production group. Examples include production cells in a manufacturing firm or customer service teams in an insurance company. At other organizational levels, cross-functional teams may be established, either on an ad hoc basis (e.g., for problem solving) or on a permanent basis as the regular means of conducting the organization's work. Aid Association for Lutherans is a large insurance organization that has adopted the self-directed work team approach. Part of the impetus toward the organic model is the belief that this kind of structure is more effective for employee motivation. Various studies have suggested that steps such as expanding the scope of jobs, involving workers in problem solving and planning, and fostering open communications bring greater job satisfaction and better performance.

Saturn Corporation, a subsidiary of General Motors (GM), emphasizes horizontal organization. It was started with a "clean sheet of paper," with the intention to learn and incorporate the best in business practices in order to be a successful U.S. auto manufacturer. The organizational structure that it adopted is described as a set of nested circles, rather than a pyramid. At the center is the self-directed production cell, called a Work Unit. These teams make most, if not all, decisions that affect only team members. Several such teams make up a wider circle called a Work Unit Module. Representatives from each team form the decision circle of the module, which makes decisions affecting more than one team or other modules. A number of modules form a Business Team, of which there are three in manufacturing. Leaders from the modules form the decision circle of the Business Team. Representatives of each Business Team form the Manufacturing Action Council, which oversees manufacturing. At all levels, decision making is done on a consensus basis, at least in theory. The president of Saturn, finally, reports to GM headquarters.

THE FUTURE

Industry consolidation—creating huge global corporations through joint ventures, mergers, alliances, and other kinds of interorganizational cooperative efforts—has become increasingly important in the twenty-first century. Among organizations of all sizes, concepts such as agile manufacturing, just-in-time inventory management, and ambidextrous organizations are impacting managers' thinking about their organizational structure. Indeed, few leaders were likely to blindly implement the traditional hierarchical structure common in the first half of the century. The first half of the twentieth century was dominated by the one-size-fits-all traditional structure. The early twenty-first century has been dominated by the thinking that changing organizational structures, while still a monumental managerial challenge, can be a necessary condition for competitive success.

SEE ALSO: Line-and-Staff Organizations; Organizational Chart; Organizational Development

Howard Distelzweig
Revised by Scott B. Droege

FURTHER READING:

Brews, Peter J., and Christopher L. Tucci. "Exploring the Structural Effects of Internetworking." *Strategic Management Journal* 25, no. 5 (2004): 429–452.

Hansen, Morten T., and Nitin Nohria. "How to Build Collaborative Advantage." *MIT Sloan Management Review* 46, no. 1 (2004): 22–31.

Lumpkin, G.T., and Gregory G. Dess. "E-Business Strategies and Internet Business Models: How the Internet Adds Value." *Organizational Dynamics* 33, no. 2 (2004): 161–173.

O'Reilly, Charles A., III, and Michael L. Tushman. "The Ambidextrous Organization." *Harvard Business Review* 82, no. 4 (2004): 74–82.

Ticoll, David. "Get Self-Organized." *Harvard Business Review* 82, no. 9 (2004): 18–20.

ORGANIZING

Organizing is the managerial function of arranging people and resources to work toward a goal. The purposes of organizing include but are not limited to determining the tasks to be performed in order to achieve objectives, dividing tasks into specific jobs, grouping jobs into departments, specifying reporting and authority relationships, delegating the authority necessary for task accomplishment, and allocating and deploying resources in a coordinated fashion.

Henri Fayol first identified organizing as a function of management in his classic monograph *General and Industrial Administration.* This book was published in France in 1916 but was not translated into English until the 1920s, and it was not published in the United States until 1949. Fayol's monograph has had a profound effect on the teaching and practice of management in the years since. Early "principles of management" texts published in the 1950s generally were organized around management functions, including organizing, as are most basic management texts in the late 1990s.

Organizing plays a central role in the management process. Once plans are created the manager's task is to see that they are carried out. Given a clear mission, core values, objectives, and strategy, the role of organizing is to begin the process of implementation by clarifying jobs and working relationships. It identifies who is to do what, who is in charge of whom, and how different people and parts of the organization relate to and work with one another. All of this, of course, can be done in different ways. The strategic leadership challenge is to choose the best organizational form to fit the strategy and other situational demands.

ORGANIZING DECISIONS

When organizing, managers must make decisions about the division of labor and work specialization, departmentalization, chain of command, span of management, centralization, and formalization. Collectively, these decisions are often called organizational design.

DIVISION OF LABOR OR SPECIALIZATION. More than two centuries ago Adam Smith concluded that division of labor contributes to increased productivity and efficiency by allowing workers to specialize and become proficient at a specific task. This principle, coupled with technological advances, made possible the tremendous productivity of industrial companies during most of the twentieth century. By the 1940s most manufacturing jobs in developed nations were highly specialized, with workers performing specific, standardized, and repetitive tasks. This resulted in reduced staffing, training, and compensation costs, since highly skilled workers were often not necessary. In addition, since employees were doing the same task repetitively, they tended to become very good at it.

Despite the improvements in productivity made possible by the division of labor, managers must be aware of the negative aspects of specialization: fatigue, stress, boredom, low quality products, absenteeism, and turnover. Such problems have led to programs geared toward job enlargement and job enrichment.

DEPARTMENTALIZATION. After the work to be completed is organized into identifiable jobs through a process of dividing labor, jobs are then combined into logical sections or departments. Doing so allows for effective coordination of effort. There are many ways to departmentalize, each of which has important advantages and disadvantages. One of the most common forms is functional departmentalization, which involves grouping similar jobs into a common department, such as accounting, sales, human resources, and engineering. Another form is product departmentalization, which involves organizing around an enterprise's various product lines. Other ways of departmentalizing include organizing by customer and by geographic territory. In practice, most large companies use a hybrid form of departmentalization, which means they combine one or more of the above methods to form their organizational structure.

CHAIN OF COMMAND. The chain of command is a line of authority extending from the top to the bottom of the organizational structure. Classic principles of organizing emphasize that one must be aware of the need to define the extent of managers' responsibility and authority by specifying their place in the chain of command. Another principle of organizing related to the chain of command is called the unity of command, which states that a person should have only one superior to whom he or she must report.

SPAN OF MANAGEMENT. The span of management, often called the span of control, is the number of individuals who are directly responsible to a particular manager. A classic principle of organizing suggests that there are definite limits to the number of subordinates one manager can supervise effectively. When organizing, managers must keep these limits in mind. Wide spans of management lead to flatter organizational structures with fewer layers of management, and are thus considered more efficient. However, if spans become too wide managers may not be able to provide adequate direction to subordinates. Narrow spans of management lead to tall organizational structures with many layers of management. Although narrower spans of management allow for closer supervision of subordinates they have many drawbacks, including cost, communication problems, and difficulty in developing the initiative and autonomy of subordinates.

In general, the trend is toward wider spans of management, with an accompanying decrease in management hierarchy. Technological advances in information processing and communication have made wider spans of management more feasible.

DEGREE OF CENTRALIZATION. Another organizing decision is the degree of centralization in the organizational structure. If decision-making authority in an organization is highly centralized, then most major decisions are made at the upper levels of the structure. Conversely, if decision-making authority is decentralized, important decisions are often made at lower

levels of the hierarchy. The degree of centralization that is appropriate for a given organization depends upon many factors, including the nature of the environmental conditions that face the enterprise, the characteristics and abilities of lower-level employees, and the size of the enterprise. Many organizations are favoring a greater degree of decentralization of their decision-making authority.

FORMALIZATION. The degree of formalization in an enterprise refers to the degree to which there are standardized rules and procedures governing the activities of employees. A company with a high degree of formalization is characterized by detailed job descriptions and clearly defined policies and procedures covering a wide variety of employee behaviors. Conversely, a company with a low level of formalization is characterized by non-structured jobs and fewer explicit policies and procedures.

As companies grow larger, a certain amount of formalization is inevitable. Employees require some direction in their job responsibilities and in the procedures required for consistency within the organization's production schema. When organizing, however, managers should be aware of the costs of excessive formalization, which may include stifling employee creativity and innovation as well as slowing the organization's responsiveness to critical issues and problems.

FACTORS AFFECTING ORGANIZING DECISIONS

There is no standard formula for the best way to organize an enterprise. Several factors have been shown to influence organizing decisions. Among the most important of these factors are strategy, size, environmental conditions, and technology.

STRATEGY. Managers organize in order to achieve the objectives of the enterprise for which they work. Thus, the strategy of the enterprise affects organizing decisions. Changes in strategy frequently necessitate changes in the way the enterprise is organized.

SIZE. Small enterprises tend to exhibit less formalization, centralization, and complexity in their organizational structure. Nevertheless, enterprises of the same size may be organized quite differently because of differences in strategy, environmental conditions, and technology.

ENVIRONMENTAL CONDITIONS. The key factor in the external environment that is relevant to organizing is uncertainty. Some enterprises face competitive environments that change rapidly and are quite complex, while others face relatively stable conditions. Generally, turbulent environments call for organizing decisions that lead to less formalization and centralization in the organizational structure.

TECHNOLOGY. The processes by which an enterprise transforms inputs into outputs may also affect organizing decisions. Some research suggests that organizing decisions that lead to high degrees of formalization, centralization, and work specialization are more appropriate for routine technologies and that the converse is true for non-routine technologies.

SEE ALSO: Management Functions; Organizational Chart; Organizational Structure

Tim Barnett

Revised by Rebecca J. Bennett

FURTHER READING:

Fayol, Henri. *General and Industrial Administration.* London: Sir Issac Pitman & Sons, Ltd., 1949.

Robbins, Stephen P., and Mary Coulter. *Management.* 10th ed. Upper Saddle River, NJ: Prentice Hall, 2003.

Schermerhorn, J. *Management.* 8th ed. John Wiley & Sons, 2004.

OUTSOURCING AND OFFSHORING

Outsourcing refers to a firm's practice of paying another firm to perform a function or produce a product that could be done or made in-house by the paying firm. It usually involves more information exchange, coordination, and trust than a mere vendor relationship, since a certain amount of management control is transferred to the supplier. Products and services can be outsourced domestically or to a foreign company. Outsourcing is increasingly associated with firms located overseas, where salaries are markedly lower.

Offshoring refers to business processes—as opposed to product production—being relocated to a lower-cost location, usually overseas. Related practices are near-sourcing and out-tasking. Near-sourcing is the relocation of business processes to lower-cost locations that are in close proximity to the United States, specifically in Mexico or Canada. Out-tasking means turning over a narrowly-defined segment of a business to another firm, on an annual basis or shorter, with continued direct or indirect management and decision making functions retained by the client.

Outsourcing and offshoring began in the 1960s and 70s with the transfer of physical manufacturing processes to lower-cost areas. For example, some U.S. companies shifted production to factories in Mexico that were part of a *maquiladora* system. Offshoring of physical products then moved to other low-cost locations such as China, India, the Philippines, and Eastern Europe.

Despite increased transportation, dock, duty, and broker costs and loss of supply chain speed, firms found that a 30 to 50 percent reduction in labor costs more than compensated for these increases.

The information technology revolution has made location much less important since inputs and outputs can be transmitted digitally. This has facilitated the offshoring of many white-collar functions. For example, the computer manufacturer Dell has outsourced its technical support for residential customers. When customers dial the number for technical support they are connected with technicians in India. With the costs of establishing sufficient bandwidth, compatible software connections, and video hookups decreasing rapidly, more employers may embrace the opportunity to replace employees located in the United States with lower-cost workers overseas.

Some analysts foresee a new global division of labor emerging. They propose that the West will focus on the highest levels of product creation, the part that entails artistry, creativity, and empathy with the customer, and the jobs involving turning these concepts into actual products and services will be sent overseas. However, outsourcing is also used for the process of innovation. Some American firms feel that their current spending on research and development is not yielding a sufficient return, so they are turning to "original design manufacturers" (ODMs). These ODMs completely design products that are then sold to firms such as Dell, Motorola and Philips, who tweak them to their own specifications and label them with their own brand names. Approximately 30 percent of digital cameras, 65 percent of MP3 players, and 70 percent of personal digital assistants (PDAs) are produced by ODMs.

Outsourcing and offshoring have caused considerable controversy in the United States, as the country has lost jobs to foreign nations. Forrester Research predicts that 3.3 million white-collar jobs and $136 billion in wages will shift from the United States to lower-wage countries by the year 2015. Despite possible backlash, some feel that outsourcing and offshoring are beneficial to the United States. Nineteenth-century economist David Ricardo proposed that the nation losing jobs will eventually recover its economic loss by developing worldwide markets for its products and services. Outsourcing can also enable firms to spend more time and resources on their core competencies, leading to more innovative goods and services to be sold globally.

SEE ALSO: International Business; International Management; International Management; Technology Management; Technology Transfer

R. Anthony Inman

FURTHER READING:

"40 Risks Purchasing Pros Must Address for Outsourcing Success." *Supplier Selection & Management Report,* March 2005, 406.

Economic Policy Institute. "EPI Issue Guide: Offshoring." Available from <http://www.epinet.org/>.

Engardio, Pete, and Bruce Einhorn. "Outsourcing Innovation." *Business Week* Online, 21 March 2005. Available from <http://www.businessweek.com/magazine/content/5_12/b39225601.htm>.

LaLonde, Bud. "From Outsourcing to 'Offshoring'-Part 1." *Supply Chain Management Review* 8, no. 2 (2004): 6–7.

Michel, Roberto. "Sorting Out Offshoring Versus Outsourcing." *MSI* 22, no. 1 (2004): 2.

P

PARTICIPATIVE MANAGEMENT

Participative (or participatory) management, otherwise known as employee involvement or participative decision making, encourages the involvement of stakeholders at all levels of an organization in the analysis of problems, development of strategies, and implementation of solutions. Employees are invited to share in the decision-making process of the firm by participating in activities such as setting goals, determining work schedules, and making suggestions. Other forms of participative management include increasing the responsibility of employees (job enrichment); forming self-managed teams, quality circles, or quality-of-work-life committees; and soliciting survey feedback. Participative management, however, involves more than allowing employees to take part in making decisions. It also involves management treating the ideas and suggestions of employees with consideration and respect. The most extensive form of participative management is direct employee ownership of a company.

Four processes influence participation. These processes create employee involvement as they are pushed down to the lowest levels in an organization. The farther down these processes move, the higher the level of involvement by employees. The four processes include:

1. Information sharing, which is concerned with keeping employees informed about the economic status of the company.
2. Training, which involves raising the skill levels of employees and offering development opportunities that allow them to apply new skills to make effective decisions regarding the organization as a whole.
3. Employee decision making, which can take many forms, from determining work schedules to deciding on budgets or processes.
4. Rewards, which should be tied to suggestions and ideas as well as performance.

BENEFITS OF PARTICIPATIVE MANAGEMENT

A participative management style offers various benefits at all levels of the organization. By creating a sense of ownership in the company, participative management instills a sense of pride and motivates employees to increase productivity in order to achieve their goals. Employees who participate in the decisions of the company feel like they are a part of a team with a common goal, and find their sense of self-esteem and creative fulfillment heightened.

Managers who use a participative style find that employees are more receptive to change than in situations in which they have no voice. Changes are implemented more effectively when employees have input and make contributions to decisions. Participation keeps employees informed of upcoming events so they will be aware of potential changes. The organization can then place itself in a proactive mode instead of a reactive one, as managers are able to quickly identify areas of concern and turn to employees for solutions.

Participation helps employees gain a wider view of the organization. Through training, development opportunities, and information sharing, employees can acquire the conceptual skills needed to become effective managers or top executives. It also increases the commitment of employees to the organization and the decisions they make.

Creativity and innovation are two important benefits of participative management. By allowing a diverse group of employees to have input into decisions, the organization benefits from the synergy that comes from a wider choice of options. When all employees, instead of just managers or executives, are given the opportunity to participate, the chances are increased that a valid and unique idea will be suggested.

REQUIREMENTS OF PARTICIPATIVE MANAGEMENT

A common misconception by managers is that participative management involves simply asking employees to participate or make suggestions. Effective programs involve more than just a suggestion box. In order for participative management to work, several issues must be resolved and several requirements must be met. First, managers must be willing to relinquish some control to their workers; managers must feel secure in their position in order for participation to be successful. Often managers do not realize that employees' respect for them will increase instead of decrease when they implement a participative management style.

The success of participative management depends on careful planning and a slow, phased approach. Changing employees' ideas about management takes time, as does any successful attempt at a total cultural change from a democratic or autocratic style of management to a participative style. Long-term employees may resist changes, not believing they will last. In order for participation to be effective, managers must be genuine and honest in implementing the program. Many employees will need to consistently see proof that their ideas will be accepted or at least seriously considered. The employees must be able to trust their managers and feel they are respected.

Successful participation requires managers to approach employee involvement with an open mind. They must be open to new ideas and alternatives in order for participative management to work. It is important to remember that although the manager may not agree with every idea or suggestion an employee makes, how those ideas are received is critical to the success of participative management.

Employees must also be willing to participate and share their ideas. Participative management does not work with employees who are passive or simply do not care. Many times employees do not have the skills or information necessary to make good suggestions or decisions. In this case it is important to provide them with information or training so they can make informed choices. Encouragement should be offered in order to accustom employees to the participative approach. One way to help employees engage in the decision-making process is by knowing their individual strengths and capitalizing on them. By guiding employees toward areas in which they are knowledgeable, a manager can help to ensure their success.

Before expecting employees to make valuable contributions, managers should provide them with the criteria that their input must meet. This will aid in discarding ideas or suggestions that cannot be implemented, are not feasible, or are too expensive. Managers should also give employees time to think about ideas or alternative decisions. Employees often do not do their most creative thinking on the spot.

Another important element for implementing a successful participative management style is the visible integration of employees' suggestions into the final decision or implementation. Employees need to know that they have made a contribution. Offering employees a choice in the final decision is important because it increases their commitment, motivation, and job satisfaction. Sometimes even just presenting several alternatives and allowing employees to choose from them is as effective as if they thought of the alternatives themselves. If the employees' first choice is not feasible, management might ask for an alternative rather than rejecting the employee input. When an idea or decision is not acceptable, managers should provide an explanation. If management repeatedly strikes down employee ideas without implementing them, employees will begin to distrust management, thus halting participation. The key is to build employee confidence so their ideas and decisions become more creative and sound.

CONCERNS

Participative management is not a magic cure for all that ails an organization. Managers should carefully weigh the pros and the cons before implementing this style of management. Managers must realize that changes will not take effect overnight and will require consistency and patience before employees will begin to see that management is serious about employee involvement. Participative management is probably the most difficult style of management to practice. It is challenging not only for managers but for employees as well.

While it is important that management allows employees to participate in decision making and encourages involvement in the organization's direction, managers must be cognizant of the potential for employees to spend more time formulating suggestions and less time completing their work. Upper-level management will not support a participative management program if they believe employees are not meeting their daily or weekly goals. Some suggestions for overcoming this potential problem are to set aside a particular time each week for workers to meet with management in order to share their ideas, or to allow them to work on their ideas during less busy times of

the day or week. Another idea that works for some managers is to allow employees to set up individual appointments to discuss ideas or suggestions.

Managers should remember that participative management is not always the appropriate way to handle a given situation. Employees often respect a manager that uses his or her authority and makes decisions when it is necessary. There are times when, as a manager, it is important to be in charge, make a decision, and then accept the responsibility for the choices made. For example, participative management is probably not appropriate when disciplinary action is needed.

When managers look upon their own jobs as a privilege instead of as a responsibility, they will fail at making participative management work. They will be less willing to turn over some of the decision-making responsibility to subordinates. Another reason that participative management fails is that managers do not realize it is not the same as delegating or simply shifting responsibility. Participation alone has no value; it is only an effective tool if it is used to solve problems and meet goals. Some managers believe that inviting employees to join in meetings and form committees will create a successful participative management program. However, these measures are only successful when employees' ideas are accepted by management and implemented.

The larger the organization, the more difficult it becomes to institute a participative management style. Large organizations have more layers and levels, which complicate effective communication and make it difficult to register the opinions and suggestions of a diverse group of employees and managers. Critics argue that unions are often more effective than participative management in responding to employee needs because union efforts can cut through bureaucratic organizations more quickly.

Participative management programs can be threatened by office politics. Due to hidden agendas and peer pressure, employees may keep their opinions to themselves and refuse to tell a manager if they feel an idea will not work. Managers also play a part in politics when they implement participative management programs to impress their own bosses but have no intention of seeing them through.

Many companies have experienced the positive effects of participative management. Employees are more committed and experience more job satisfaction when they are allowed to participate in decision making. Organizations have reported that productivity improved significantly when managers used a participative style. Participative management is not an easy management style to implement. It presents various challenges and does not succeed overnight. Managers will be more successful if they remember that it will take time and careful planning before they will see results. Starting with small projects that encourage and reward participation is one way to get employees to believe that management is sincere and trustworthy.

SEE ALSO: Empowerment; Human Resource Management; Management Styles; Motivation and Motivation Theory; Synergy; Teams and Teamwork

Amy McMillan

Revised by Debbie D. DuFrene

FURTHER READING:

Coleman, P.T. "Implicit Theories of Organizational Power and Priming Effects on Managerial Power-Sharing Decisions: An Experimental Study." *Journal of Applied Social Psychology* 34, no. 2 (2004): 297–321.

Coye, R.W., and J.A. Belohlav. "An Exploratory Analysis of Employee Participation." *Group and Organization Management* 20, no. 1 (1995): 4–17.

Greenfield, W.M. "Decision Making and Employee Engagement." *Employment Relations Today* 31, no. 2 (2004): 13–24.

Kaner, S., and L. Lind. *Facilitator's Guide to Participatory Decision-making.* Gabriola Island, BC, Canada: New Society Publishers, 1996.

Keef, L. "Generating Quality Interaction." *Occupational Health & Safety* 73, no. 5 (2004): 30–31.

McCoy, T.J. *Creating an Open Book Organization: Where Employees Think and Act Like Business Partners.* New York: Amacom, 1996.

Robbins, S.P. *Essentials of Organizational Behavior.* 8th ed. Upper Saddle River, NJ: Prentice Hall, 2005.

Sumukadas, N., and R. Sawhney. "Workforce Agility through Employee Involvement." *IIE Transactions* 36, no. 10 (2004): 1011–1021.

Vanderburg, D. "The Story of Semco: The Company that Humanized Work." *Bulletin of Science, Technology & Society* 24, no. 5 (2004): 430–34.

Weiss, W.H. "Improving Employee Performance: Major Supervisory Responsibility." *Supervision,* October 1998, 6–8.

PATENTS AND TRADEMARKS

Trademarks and patents, along with copyrights, constitute the major forms of legal protection for what is commonly referred to as intellectual property. Although the rights in these three kinds of intellectual property protection are somewhat similar, trademarks, patents, and copyrights differ in what they protect. Patents protect inventions, while trademarks protect words, phrases, symbols, and designs. Copyrights protect original artistic, musical, and literary works, including software.

PATENTS

A patent is a grant of a property right by the United States government, through the Patent and Trademark Office, to the inventor of an invention. The term of this property right is twenty years from the date the patent is granted, as long as the holder of the patent pays maintenance fees. A patent is not a grant of a right to make, manufacture, use, or sell the invention; rather it secures the right to exclude others from making, manufacturing, using, or selling the invention for the duration of the patent.

A patented invention is no guarantee of future commercial success. Statistically, although millions of patents have been granted, the number of successful inventions is minuscule. One avenue of commercialization open to a patentee is licensing his or her patent to a company, or a number of companies, provided he or she is able to locate a firm that is willing to risk investing in a wholly untried product or process. Upon licensing the patent, however, the patent holder cannot demand that royalties from the product continue beyond the stipulated 20-year patent period, nor can the patentee set the product's price or determine its use.

CREATION OF PATENT RIGHTS

The power to grant rights in patents arises from Article I, section 8 of the United States Constitution, which provides that "Congress shall have power . . . to promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." The first patent law was passed in 1790, and the current law governing patents was enacted in 1952 and became effective 1 January 1953. Since the first statute, over five million patents have been granted. The current statute sets forth the subject matters for which patents may be granted and the conditions under which a patent will be issued. It also established the Patent and Trademark Office.

Under the law, anyone who "invents or discovers any new and useful process, machine, manufacture or composition of matter, or any new and useful improvements thereof, may obtain a patent." Courts have interpreted this language to include nearly anything that could be fabricated, although they have not allowed methods of doing business or printed matter, such as books, to be patented. An invention must meet the test of being new under the standards in the law before a patent will be granted. The subject matter of an invention must be sufficiently different from what has been described in a printed publication of some sort anywhere in the world, or sold in this country, before the date of the application for the patent. In addition, the invention must go beyond what would seem a commonsense or obvious advancement, even to a practitioner or expert in the field. Finally, an invention must be determined "useful" before a patent will issue; this requirement, however, is interpreted very broadly.

Only the inventor may apply for a patent, with two exceptions: (1) if the inventor has died before applying for a patent, the inventor's estate may do so, and (2) if the inventor is insane, the inventor's guardian may apply for the patent.

An inventor applies for a patent by sending to the Commissioner of Patents and Trademarks, at the Patent and Trademark Office, a written specification, which is a description of the invention and of the process in which the invention is made and used. The specification must contain one or more claims about the subject matter that the applicant believes constitute an invention. The specification must be accompanied by a sworn oath or declaration by the inventor that he or she is the original and first inventor of the subject matter of the application. The application must also include drawings, where necessary, and the appropriate filing fee, which the patent statute and rules have established.

THE PATENT AND TRADEMARK OFFICE

The Patent and Trademark Office carries out the patent laws by examining the applications to determine if the inventor is entitled to a patent. The office publishes the specifications and drawings of all patents on the day they are issued. It records assignments of any patents to entities other than the inventors. It maintains a search room for the public to look at issued patents and the office's records.

TRADEMARKS

A trademark is a word, name, phrase, symbol, or design, or a combination of these elements, that identifies and distinguishes the source of goods or services. The term also encompasses service marks. Service marks are the same as trademarks except that they identify and distinguish the source of a service rather than a product. Trademark rights are used to prevent others from making, promoting, or selling goods or services which have a name, symbol, or design that is confusingly similar to that of the trademark. It does not, however, prevent others from making or selling the same goods or services, as long as it is under a different, non confusing mark.

CREATION OF TRADEMARK RIGHTS

There are two distinct types of rights in a trademark or service mark: the right to use the mark and the right to register the mark. These rights arise either from using the mark in actual commerce or from filing an application for registration of the mark with the Patent and Trademark Office.

The registration of marks is controlled under the Trademark Act of 1946; the Trademark Rules, 37 C.F.R. Part 2; and the *Trademark Manual of Examining Procedure.* The act covers not only trademarks and service marks, but also certification marks, collective trademarks, and collective membership marks.

The first party who either uses a mark in the course of commerce or business or files an application for registration with the Patent and Trademark Office usually has the right to register that mark. A party can use a mark, or establish rights in it, without filing an application for registration. The registration, however, creates a presumption that the party who has registered the mark is the owner of the mark for the goods and services set forth in the registration application, and therefore has the right to use the mark anywhere in the country. This presumption can become important when two parties unintentionally begin using similar marks and become involved in a lawsuit over who has the sole right to use the mark. The Patent and Trademark Office does not determine this, rather it is the decision of a court, which has the power to issue an injunction to stop a party from using a mark and to award damages for a party's improper use of another's mark.

Similarly, the owner of a mark may use the trademark (™) or service mark (℠) designation with the mark to make it clear that the owner is claiming rights in the product or service so designated. The ™ and ℠ designation may be used without the owner having registered the mark with the Patent and Trademark Office. If it is registered, however, the owner may use the registration symbol (®) with the mark.

Rights embodied in a trademark, unlike those of a copyright or a patent, can last for an indefinite period if the owner of the mark continuously uses the mark for its products or services. Federal registrations last for ten years, but between the fifth and sixth year after the date of the initial registration, the person who registered the mark must file an affidavit with information about the mark and ownership. If the registrant does not file this affidavit, the registration is cancelled. After the initial registration period, the mark can be renewed for successive ten-year terms. Registration of a mark with the Patent and Trademark Office provides protection from others using the mark in the United States and its territories, but does not extend to its use in other countries.

PATENTS AND TRADEMARKS IN THE INTERNET AGE

The growth of Internet technology has affected patent and trademark protection in a number of different ways. For instance, the Internet has made it significantly easier for individuals and companies to conduct searches of patent and trademark databases, whether they are looking to patent an invention or license someone else's invention. The global reach of the Internet has also spurred efforts to harmonize international patent and trademark protection, which may eventually offer firms greater protection in worldwide markets. In other ways, however, the Internet has made it more difficult for owners to protect their intellectual property rights. The widespread availability of intellectual property in digital form has led to illegal copying of technology, software, music, and other protected materials.

In the early 2000s, a growing number of technology companies began launching intellectual property licensing programs in order to turn their accumulated patent bases into revenue. These firms conducted inventories of their patents and identified technologies that were outside the core business yet still offered some potential for development. They then sought to license these technologies to other firms. IP licensing has proven quite lucrative for a number of large technology firms. IBM, for example, earns over one billion dollars per year from its IP licensing program.

SEE ALSO: Entrepreneurship; Intellectual Property Rights; Licensing and Licensing Agreements

Cindy Rhodes Rhode
Revised by Laurie Hillstrom

FURTHER READING:

Ambrogi, Robert J. "The Top Internet Sites for Patents, Trademarks." *Palm Beach Daily Business Review,* 24 March 2004.

Brown, Marc E. "New Kinds of Protection for Intellectual Property." *Electronic Business,* 1 April 2003.

Geffken, Carl. "Protecting Your Intellectual Property: Understanding Your Rights Regarding Patents, Copyrights, and Trademarks Is Vital in Protecting Your Company's Offerings across the Globe." *Global Cosmetic Industry* (January 2004).

O'Haver, R. Russ. "Management Intangibles: Capitalizing on Your IP Assets." *Journal of Internet Law* (December 2003).

U.S. Patent and Trademark Office. "General Information Concerning Patents." January 2005. Available from <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

U.S. Small Business Administration. "Protecting Your Ideas." Available from <http://www.sba.gov/starting_business/startup/ideas.html>.

PERFORMANCE APPRAISALS

SEE: Employee Evaluation and Performance Appraisals

PERFORMANCE MEASUREMENT

PERFORMANCE MEASUREMENT

Improvement in individual, group, or organizational performance cannot occur unless there is some way of getting performance feedback. Feedback is having the outcomes of work communicated to the employee, work group, or company. For an individual employee, performance measures create a link between their own behavior and the organization's goals. For the organization or its work unit's performance measurement is the link between decisions and organizational goals.

It has been said that before you can improve something, you have to be able to measure it, which implies that what you want to improve can somehow be quantified. Additionally, it has also been said that improvement in performance can result just from measuring it. Whether or not this is true, measurement is the first step in improvement. But while measuring is the process of quantification, its effect is to stimulate positive action. Managers should be aware that almost all measures have negative consequences if they are used incorrectly or in the wrong situation. Managers have to study the environmental conditions and analyze these potential negative consequences before adopting performance measures.

TYPES OF PERFORMANCE MEASURES

Performance measures can be grouped into two basic types: those that relate to results (outputs or outcomes such as competitiveness or financial performance) and those that focus on the determinants of the results (inputs such as quality, flexibility, resource utilization, and innovation). This suggests that performance measurement frameworks can be built around the concepts of results and determinants.

Measures of performance of a business usually embrace five fundamental, but interlinking areas:

1. Money, usually measured as profit
2. Output/input relationships or productivity
3. Customer emphasis such as quality
4. Innovation and adaptation to change
5. Human resources

Within the operations area, standard individual performance measures could be productivity measures, quality measures, inventory measures, lead-time measures, preventive maintenance, performance to schedule, and utilization. Specific measures could include:

1. Cost of quality: measured as budgeted versus actual.
2. Variances: measured as standard absorbed cost versus actual expenses.
3. Period expenses: measured as budgeted versus actual expenses.
4. Safety: measured on some common scale such as number of hours without an accident.
5. Profit contribution: measured in dollars or some common scale.
6. Inventory turnover: measured as actual versus budgeted turnover.

While financial measures of performance are often used to gauge organizational performance, some firms have experienced negative consequences from relying solely on these measures. Traditional financial measures are better at measuring the consequences of yesterday's actions than at projecting tomorrow's performance. Therefore, it is better that managers not rely on one set of measures to provide a clear performance target. Many firms still rely on measures of cost and efficiency, when at times such indicators as time, quality, and service would be more appropriate measures. To be effective, performance yardsticks should continuously evolve in order to properly assess performance and focus resources on continuous improvement and motivating personnel. In order to incorporate various types of performance measures some firm's develop performance measurement frameworks. These frameworks appear in the literature and vary from Kaplan and Norton's balanced scorecard to Fitzgerald's framework of results and determinants.

Kaplan and Norton's balanced scorecard approach operates from the perspective that more than financial data is needed to measure performance and that nonfinancial data should be included to adequately assess performance. They suggest that any performance measurement framework should allow managers to ask the following questions:

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

However, the balanced scorecard is flawed as it does not allow for one of the most important questions of all:

- What are our competitors doing? (the competitor perspective)

Keegan proposed a similar, but lesser known, performance measurement framework titled the "performance matrix." The performance matrix is more flexible, as it is able to integrate different dimensions

of performance, and employs generic terms such as internal, external, cost, and noncost.

DESIGNING THE PERFORMANCE MEASUREMENT SYSTEM

A number of suggestions have been offered by various experts on the subject of designing performance measurement systems. Below is a list of suggestions derived from a number of these experts. Some of these apply to all measures and some apply to a limited number of a firm's measures. A firm's performance measures should:

- Be simple and easy to use.
- Have a clear purpose.
- Provide fast feedback.
- Cover all the appropriate elements (internal, external, financial and nonfinancial).
- Relate to performance improvement, not just monitoring.
- Reinforce the firm's strategy.
- Relate to both long-term and short-term objectives of the organization.
- Match the firm's organization culture.
- Not conflict with one another.
- Be integrated both horizontally and vertically in the corporate structure.
- Be consistent with the firm's existing recognition and reward system.
- Focus on what is important to customers.
- Focus on what the competition is doing.
- Lead to identification and elimination of waste.
- Help accelerate organizational learning.
- Help build a consensus for change when customer expectations shift or strategies and priorities call for the organization to behave differently.
- Evaluate groups not individuals for performance to schedule.
- Establish specific numeric standards for most goals.
- Be available for constant review.

Other recommendations for organizations that are developing performance measures include:

1. Data collection and methods of calculating the performance measure must be clearly defined.
2. Objective performance criteria are preferable to subjective ones.
3. Recognize that measures may vary between locations; avoid a "one size fits all" mentality.

Wisner and Fawcett provide a nine-step process for developing a performance measurement system:

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

Finally, it is important that the performance measurement systems used by managers be continually reviewed and revised as the environment and economy changes. Failure to make the necessary modifications can inhibit the ability of the organization to be an effective and efficient global competitor.

SEE ALSO: Balanced Scorecard; Employee Evaluation and Performance Appraisals; Human Resource Management; Quality and Total Quality Management

R. Anthony Inman
Revised by Marcia Simmering

FURTHER READING:

Boyd, Lynn H., and James F. Cox, III. "A Cause-and-Effect Approach to Analyzing Performance Measures." *Production and Inventory Management Journal* 38, no. 3 (1997): 25–32.

Denton, D. Keith. "Effective Measurement Involves Asking the Right Questions." *Production and Inventory Management Journal* (1995): 65–67.

Gunasekaran, A., H. James Williams, and Ronald E. McGaughey. "Performance Measurement and Costing System in New Enterprise." *Technovation* 25, no. 5 (May 2005): 523.

Hinton, Matthew, and David Barnes. "Towards a Framework for Evaluating the Business Process Performance of E-Business Investments." *International Journal of Business Performance Management* 7, no. 1 (2005): 87.

Kaplan, R.S., and D.P. Norton. "The Balanced Scorecard-Measures That Drive Performance." *Harvard Business Review,* January-February 1992, 71–79.

Keegan, D.P., R.G. Eiler, and C.R. Jones. "Are Your Performance Measures Obsolete?" *Management Accounting,* June 1989, 38–43.

Robson, Ian. "Implementing a Performance Measurement System Capable of Creating a Culture of High Performance." *International Journal of Productivity and Performance Management* 54, no. 1-2 (2005): 137–145.

Tangen, Stefan. "Performance Measurement: From Philosophy to Practice." *International Journal of Productivity and Performance Management* 53, no. 8 (2004): 726.

Vokurka, Robert, and Gene Fliedner. "Measuring Operating Performance: A Specific Case Study." *Production and Inventory Management Journal* 36, no. 1 (1995): 38–43.

Wisner, J.D., and S.E. Fawcett. "Link Firm Strategy to Operating Decisions through Performance Measurement." *Production and Inventory Management Journal* 32, no. 3 (1991): 5–11.

PERSONALITY AND PERSONALITY TESTS

Personality is a set of enduring traits and characteristics that relate to a person's emotions, motivations, interpersonal interactions, and attitudes. Personality is different from ability. Whereas personality may dictate attitudes towards situations or people, attitudes are transient and personality is enduring.

Personality is meaningful to management, because employees' personalities may dictate how well they perform their jobs. Personality may indicate how hard a person will work, how organized they are, how well they will interact with others, and how creative they are.

In recent years, more organizations have been using self-reporting personality tests to identify personality traits as part of their hiring or management development processes. Employers recognize that experience, education, and intelligence may not be the only indicators of who the best hire might be. Additionally, understanding one's own personality characteristics may improve one's ability to develop as an employee and manager. Therefore, it is important to understand the different facets of personality and the ways in which they can be measured.

Research into the human personality has been conducted for many decades, and much of this work has focused on defining personality and understanding how many dimensions of personality there are. One primary area of agreement about personality is that it is a trait. That is, personality is enduring and unlikely to change substantially in one's adult life.

Because personality is a trait, this also means that a person is likely to behave similarly in a variety of situations. This does not mean that a person cannot or will not adapt to a change in circumstances (e.g., behavior at work versus behavior in social situations), but that, on average, a person demonstrates similar personality across all situations and may behave differently from those with dissimilar personality characteristics.

A major debate in the area of personality research is where personality originates, which is often described as the "nature vs. nurture" argument. Researchers who believe that individuals are born with a personality that is determined by genetics and remains unchanged regardless of environment, subscribe to the "nature" theory of the origin of personality. The "nurture" perspective is that personality is not determined by genetics, but rather by a host of environmental forces and personal experiences, such as geography, socio-economic status, and parental upbringing. Most scholars now agree that personality is determined by a combination of both genetics and environment, and that neither is solely responsible for personality.

There are a number of different ways in which personality has been categorized, and different opinions exist about the number of dimensions of personality. Early tests of personality were developed to diagnose mental illness, and while some of these tests were used in employment settings, their acceptability and applicability were questionable. However, there are now tests specifically for use in normal adult populations, each of which is based on different conceptions of the dimensionality of personality.

MINNESOTA MULTIPHASIC PERSONALITY INVENTORY AND CALIFORNIA PSYCHOLOGICAL INVENTORY

Some of the earlier tests used to assess the personality of job applicants and employees were the Minnesota Multiphasic Personality Inventory (MMPI) and the California Psychological Inventory (CPI), which is based on the MMPI.

The MMPI was developed for psychological clinical profiling and includes ten clinical scales. While some of these scales may be applicable to predicting job performance in a selection tool, others are not. Additionally, the items used in the MMPI may be off-putting to job applicants. However, before the availability of personality tests commercially available for

use in a business setting, organizations often used the MMPI to assess the personality characteristics of applicants and employees.

Using the psychological basis of the MMPI, the CPI was created to assess the personality of normal adult populations. It assesses seventeen different dimensions of performance, including dominance, responsibility, empathy, and sociability. The CPI is much more appropriate for business settings than the MMPI, but was not created for use in business hiring.

FIVE-FACTOR MODEL

A different conception of personality is captured in the Sixteen Personality Factor Questionnaire, also called the 16 PF. It yields scores of sixteen different personality traits, including dominance, vigilance, and emotional stability. These sixteen factors can be combined to express five "global factors" of personality. These five global factors are often called the Big Five or the Five-Factor Model.

Most researchers agree that while more than five dimensions of personality are present in human beings, nearly all of them can be subsumed within five: emotional stability, conscientiousness, agreeableness, extraversion, and openness to experience. They are summarized in Table 1.

EMOTIONAL STABILITY. Emotional stability (also called neuroticism, when scored oppositely) involves a person's ability to remain stable and balanced. A person who is high in emotional stability is even-tempered, calm, and somewhat resistant to stress. A person who is low in emotional stability tends to be moody, depressed, and very susceptible to stress. In most professions, a person who is high in emotional stability is preferred. Employees with low emotional stability are more likely to be distracted from work by stress, deadlines, or situations in their personal lives, whereas those with high levels of this trait are more able to control their emotions and feelings at work.

CONSCIENTIOUSNESS. Conscientiousness is a person's ability to be dependable, organized, punctual, and to persist in the face of setbacks. Research indicates that conscientiousness is the personality characteristic that is most related to job performance across a variety of jobs. Thus, in nearly every situation, a person who is high in conscientiousness will be better suited to perform a job. Individuals who are low in conscientiousness do not give much attention to detail, are likely to overlook deadlines, or may lose important documents. Additionally, individuals low in conscientiousness are more likely to give up when faced with challenges or difficulties in their work, whereas employees with high conscientiousness will continue to persist.

AGREEABLENESS. Agreeableness, when high, indicates that a person is warm, friendly, and tactful. Low agreeableness is demonstrated when employees are cold, abrasive, and unfriendly. Preference on whether an employee high in agreeableness or low in agreeableness is somewhat dependent on the type of job.

In general, a person with high agreeableness can be easier to work with, because they tend to be easier to

Table 1

Personality Factor	Characteristics of Individuals High in Factor	Characteristics of People Low in Factor
Emotional Stability	• Calm • Resistant to stress • Secure • Stable	• Anxious • Depressed • Insecure • Susceptible to stress
Conscientiousness	• Dependable • Organized • Persevering • Punctual	• Disorganized • Easily discouraged • Unpredictable • Unreliable
Agreeableness	• Amiable • Cooperative • Flexible • Trusting	• Aloof • Contrary • Suspicious • Unfriendly
Extraversion	• Active • Assertive • Excitable • Sociable	• Apprehensive • Dull • Shy • Timid
Openness to Experience	• Creative • Curious • Insightful • Intellectual	• Bored • Intolerant • Routine-oriented • Uninterested

talk to and interact with in a group setting. And, in some jobs, being highly agreeable is an advantage, such as in sales, or in other jobs that require patient and friendly interactions with people. However, there are some jobs in which being too warm and friendly can be a detriment, such as a collections agent; and in these jobs, being low in agreeableness could be advantageous.

EXTRAVERSION. Extraversion is how outgoing and social a person is. Someone high in extraversion enjoys crowds, social gatherings, and working in groups. A person low in extraversion is more comfortable working on his or her own and is less gregarious. As with agreeableness, the level of extraversion that is desired in an employee is dependent on the job. In jobs that involve interacting with others, such as sales, teaching, or public relations, high extraversion may be helpful. However, if a job requires independent work and solitude, such as computer programming, having a person high in extraversion may be difficult, and thus a person lower in extraversion would be preferred.

OPENNESS TO EXPERIENCE. Openness to experience refers to how open-minded a person is. An individual who is high in openness to experience is curious, imaginative, open-minded, and enjoys trying new things. People who are low in openness to experience are routine-oriented, close-minded, literal, and prefer not to try new things.

As with agreeableness and extraversion, the degree to which an employee is benefited by openness depends on the job. High openness is important in jobs that require creativity and flexibility; you would definitely prefer to have high openness in advertising or research positions. However, some jobs reward routine work, and in those jobs in which creativity is not needed or desired, a person low in openness may find these jobs more rewarding.

In summary, high emotional stability and conscientiousness are desirable in nearly all jobs, and the level of agreeableness, extraversion, and openness to experience are dependent on the job duties and requirements. While personality can relate to how well a person performs a job, it is not the only characteristic upon which a hiring decision should be made. Ideally, a person's education, experience, and intelligence should be evaluated for a position, with personality being part of the criteria considered.

REVISED NEO PERSONALITY INVENTORY

In addition to the 16 PF instrument, the Revised NEO Personality Inventory (NEO PI-R), developed by Costa and McCrae, assesses the five personality dimensions of the Five-Factor Model and thirty additional traits used to create the scores on these dimensions. For instance, to determine scores on the Neuroticism (i.e., Emotional Stability) scale, the following facets are measured: anxiety, angry hostility, depression, self-consciousness, impulsiveness, and vulnerability. This NEO PI-R was developed specifically for use in business settings.

MYERS-BRIGGS TYPE INDICATOR

The Myers-Briggs Type Indicator (MBTI) is a very popular test, primarily used in organizations to develop managers and build teams. It is very different from the other personality tests. Rather than tapping the Big Five personality characteristics, the MBTI is based on the work of Jung and addresses four areas of personality to create sixteen distinct types.

The four areas of personality are perception (sensing vs. intuiting), judgment (thinking vs. feeling), extraversion (extraversion vs. introversion), and orientation towards the outer world (perceiving vs. judging). The scores along these four dimensions can be combined to create sixteen different "types." The scores on each dimension represent the strength of dimension; so a person might be "sensing, thinking, introverted, and perceiving" and very strong in sensing, but somewhat less strong in thinking.

While the other personality inventories are often used as a selection tool in the organization, the MBTI is best used for career development, counseling, and team selection. Another difference between the MBTI and other personality tests is that strengths on the different dimensions are all seen as valuable. So, a person who is strong in "thinking" is seen as just as skilled an employee as one who is strong in "feeling," but is believed to be more suited to different types of tasks and duties. Contrast this with the NEO-PI: on that instrument, a low score on some dimensions, like conscientiousness, would be undesirable to an organization.

While the Myers-Briggs Type Indicator is used in many organizations and is very popular among employers and employees, there is not as much empirical evidence of its validity compared to other personality inventories. Thus, it is typically not recommended as a tool for employee selection, but rather is best suited for employee and managerial development and team-building.

USING PERSONALITY TESTS FOR SELECTION

When employers first began to learn about personality and the impact that it could have on job performance, they did not have specific employment tests to measure personality. Therefore, many turned to psychologists and existing personality tests (e.g., the MMPI) to determine the characteristics of job applicants. Unfortunately, the purpose of some of these tests was to diagnose mental illness or psychological

disorders, and although they could provide some information related to personality, the test items were likely to seem strange and intrusive to job applicants.

Furthermore, because the tests were not written in an employment context, the information that they provided typically went beyond what was needed to make an informed hiring decision. For these reasons, many managers had negative experiences with personality testing in the workplace and thought it to be inappropriate and useless.

However, there are now tests designed specifically for business hiring needs. These tests tap into the Big Five personality characteristics and are written in such a way as to not offend the average job applicant. Therefore, human resources departments should investigate which tests are available and most appropriate to their company before adopting personality testing.

To use a personality test for selection, its reliability, validity, and acceptability must be evaluated.

RELIABILITY. Reliability, or the degree to which a test measures some characteristic consistently, is a necessary requirement for a selection test. If a test does not measure consistently, then it cannot be valid; thus, assessing the reliability of personality tests is crucial for accurate selection. In general, most commercial personality tests have demonstrated high reliability.

Reliability can be assessed in several different ways. The test-retest method of assessing reliability involves giving one group the same test twice and statistically evaluating the consistency of scores. Because personality tests are intended to measure stable, enduring personality traits, the test-retest reliability of these tests should be high.

The equivalent measures method of determining reliability involves creating two tests that evaluate the same content domains, giving them to the same group, and statistically comparing the scores of each individual. If the two tests truly are equal in content, then high reliability will be indicated by very similar scores on both tests.

Finally, internal consistency is one of the most used measures of reliability. An assessment of internal consistency only requires one version of a test and one sample of people; the test is then broken into two parts, and the consistency of responses on the two parts is determined. A well-known form of the internal consistency approach, called coefficient alpha, averages the correlations between all possible splits of a test, and therefore results in a highly accurate assessment of reliability.

VALIDITY. The validity, or accuracy, of personality tests has been measured in a number of research studies and can be assessed in two main ways: content validity and criterion-related validity. Additionally, meta-analysis has been used to understand the validity of personality tests.

Content validity is an assessment of the degree to which the items on a test capture the domain of interest. This assessment is made by subject matter experts, such as trained psychologists or expert managers. While content validity is an important assessment of the usefulness of a selection test, criterion-related validity provides empirical evidence as to a test's accuracy.

Criterion-related validity indicates how well a test predicts job performance, and it can be evaluated concurrently or predictably. In a concurrent criterion-related validity study of a personality test, job incumbents are given the personality test, and their job performance is measured at the same time. A correlation between test scores and job performance indicates the level of validity of the new test.

With predictive criterion-related validity, job applicants are given the new personality test, but it is not used when making the hiring decisions. After a certain time period, the scores on the personality test are correlated with job performance scores of the new employees to determine the validity of the test. While concurrent validity studies are often preferred because they can be done quickly, the motivation of current employees to do well on these tests may not be high, or at least not as high as the motivation of job applicants.

With predictive validity, the benefit occurs with the use of actual job applicants; however, the time lag involved is often a major drawback.

In both cases, a big concern is range restriction; that is, because the full range of scores on the test is not evaluated (since not all applicants are hired and, presumably, current employees would have high scores on the personality test), the actual validity of a test may be underestimated.

Meta-analysis is a statistical technique that can be used to further explore the validity of selection tests. Meta-analysis combines individual research studies to indicate an overall average validity for most jobs; using this, the general validity of selection tests can be estimated. Based on information from meta-analysis, most personality tests have low to moderate validity, as compared to other selection methods such as intelligence tests, work samples, and structured interviews. However, they are still useful for hiring in many jobs because the information they provide is unique.

Intelligence tests and work samples cannot indicate a person's level of different personality traits, and although structured interview questions may be written to capture some elements of personality, such as conscientiousness, or agreeableness, typically, a personality test will provide information above and beyond other employment tests. Therefore, the inclusion of a validated personality test may increase the overall validity of the selection battery for certain jobs.

There are three major threats to the validity of personality tests: faking, socially desirable responding, and careless responding. While all occur for different reasons, the effects of these types of responses can reduce the validity of personality tests.

Faking occurs when a job applicant purposely attempts to score more positively than he or she would if answering items truthfully. Because many personality inventories include response choices that are easily seen as more desirable than others, applicants may be able to deliberately misrepresent themselves to look more favorable, or "fake good."

Although most personality tests include instructions that request that applicants answer truthfully, they may choose not to follow these instructions. There are no firm conclusions on the amount of faking that occurs, or its effect on test scores, but many researchers argue that when faking occurs, it is unlikely to skew test appreciably.

Socially desirable responding is similar to faking in that the applicant answers items falsely in order to look better; however, unlike faking, socially desirable responding is not deliberate. These unconscious and unintended responses are chosen in order to conform with social norms. For instance, an applicant may overestimate his punctuality or organization skills on a personality test because these are skills that the employer wants. However, this decision would not be conscious, but instead would represent a generous view of one's own habits.

Response carelessness occurs when an applicant does not pay careful enough attention to the items on the test and therefore responds incorrectly. This occurs when the applicant has poor reading skills, is in a hurry, is bored, or is not motivated to take the test. Careless responses can harm the reliability and the validity of the test because they lack consistency and accuracy.

To avoid these problems, many personality inventories now include scales to detect faking, socially desirable responding, and response carelessness from which scores can be used to adjust the scores on the other scales. Thus, most published personality inventories have the means to avoid and/or correct for these threats to validity.

ACCEPTABILITY. Acceptability is an assessment made by job applicants. Their reaction to taking the personality test may have an influence on their motivation to take the test, their continuation in the hiring process, or their opinions about the company. For example, if a job applicant is asked a number of questions on a personality test that she believes to be invasive and too personal, she may be offended and therefore not accept a job offer. She may then complain to friends about the company's selection tests—reducing the number of people who might have applied for jobs with the organization.

Any of these outcomes are likely to hurt recruitment and selection efforts, and thus, only tests with high levels of acceptability should be used.

Understanding personality can be useful in the workplace. There are many commercial personality tests available that can be used for selection. Many of these are high in reliability and have low to moderate validity. Many tests are written specifically for business settings and are likely to be deemed acceptable by job applicants.

Research supports the use of tests based on the Five-Factor Model of personality for selection. The Myers-Briggs Type Indicator, a very popular inventory, can be useful for development and team-building in the organization.

SEE ALSO: Employee Screening and Selection; Employment Law and Compliance; Human Resource Management; Leadership Theories and Studies; Management Styles

Marcia J. Simmering

FURTHER READING:

Anastasi, Anne, and Susana Urbina. *Psychological Testing.* Upper Saddle River, NJ: Prentice Hall, 1997.

Barrick, Murray R., and Michael K. Mount. "The Big Five Personality Dimensions and Job Performance: A Meta Analysis." *Personnel Psychology* 44 (1991): 1–26.

Gardner, William L., and Mark J. Martinko. "Using the Myers-Briggs Type Indicator to Study Managers: A Literature Review and Research Agenda." *Journal of Management* 22, no. 1 (1996): 45–83.

McCrae, Robert R., and Paul T. Costa, Jr. "Validation of the Five-Factor Model of Personality Across Instruments and Observers." *Journal of Personality and Social Psychology* 52, no. 1 (1987): 81–90.

McFarland, Lynn A., and Ann Marie Ryan. "Variance in Faking Across Noncognitive Measures." *Journal of Applied Psychology* 85, no. 5 (2000): 812–821.

Schneider, Benjamin, and D. Brent Smith. *Personality and Organizations.* Mahwah, NJ: Lawrence Erlbaum Associates, 2004.

PIONEERS OF MANAGEMENT

The study of management as a discipline is relatively new, especially when compared with other scientific disciplines. Yet, to truly understand current management thought, it is necessary to examine the historical links. It is best to consider not only management pioneers' management theories, but also the

contextual and environmental factors that helped to clarify the developmental process behind the theories. Therefore, management pioneers may be easily placed along a historical timeline.

Using the work of Daniel Wren as a guide, the following categories are employed: (1) early management thought; (2) the scientific management era; (3) the social man era; and (4) the modern era.

EARLY MANAGEMENT THOUGHT: THE ECONOMIC FACET

Adam Smith and James Watt have been identified as the two men most responsible for destroying the old England and launching the world toward industrialization. Adam Smith brought about the revolution in economic thought and James Watt's steam engine provided cheaper power that revolutionized English commerce and industry. In doing so, they also laid the foundation for modern notions of business management theory and practice.

ADAM SMITH. Adam Smith (1723–1790) was a Scottish political economist. His *Wealth of Nations,* published in 1776, established the "classical school" and with its publication, he became the father of "liberal economics." Smith argued that market and competition should be the regulators of economic activity and that tariff policies were destructive. The specialization of labor was the mainstay of Smith's market system. According to Smith, division of labor provided managers with the greatest opportunity for increased productivity.

JAMES WATT AND MATTHEW BOULTON. James Watt (1736–1819), aided by Matthew Boulton (1728–1809), and building on the work of his predecessors, developed his first workable steam engine in 1765. Together the partners founded the engineering firm of Boulton, Watt, and Sons.

Recognized as Watt's greatest breakthrough, in 1971 he developed a steam engine with rotary, rather than the traditional up-and-down, movement. This made the engine more adaptable to factory uses as the engine replacing water wheel power for grinding grain, driving textile machines, and operating bellows for iron works.

Steam power lowered production costs, lowered prices, and expanded markets. In 1800 the sons of Boulton and Watts took over the management of the company and instituted one of the first complete applications of scientific management. In this plant there is evidence of market research, including machine layout study involving workflow, production standards, cost accounting, employee training, employee incentives, and employee welfare programs.

EARLY MANAGEMENT THOUGHT: MANAGEMENT PIONEERS IN THE FACTORY SYSTEM

The division of labor, combined with the advances in technology, provided the economic rationale for the factory system. However, the factory system brought new problems for owners, managers, and society. Four management pioneers proposed solutions for coping with the pressures of the new large-scale industrial organizations. They were Robert Owens, Charles Babbage, Andrew Ure, and Charles Dupin.

ROBERT OWENS. Robert Owens (1771–1858) was a successful Scottish entrepreneur and a utopian socialist who sowed the first seeds of concern for the workers. He was repulsed by the working conditions and poor treatment of the workers in the factories across Scotland. Owen became a reformer. He reduced the use of child labor and used moral persuasion rather than corporal punishment in his factories. He chided his fellow factory owners for treating their equipment better than they treated their workers.

Owen deplored the evils of the division of labor and in his ideal system believed each man would do a number of different jobs switching easily from one job to another. Additionally, Owen hated the modern factory system, so he decided to revolutionize it. In 1813 he proposed a factory bill to prohibit employment of children under the age of ten and to limit hours for all children to $10^1/_2$ hours per day with no night work. The bill became law six years later, but was limited to cotton mills, reduced the age limit to nine, and included no provision for inspections; therefore, the law had little impact.

Feeling frustrated in his attempts to reform Britain, Owen traveled to America in 1824. He continued on to New Harmony, Indiana, where he had purchased a large plot of land. New Harmony was the first and most famous of sixteen U.S.-based Owenite communities appearing between 1825 and 1829. None, however, lasted more than a few years as full-fledged socialist communities.

CHARLES BABBAGE. Charles Babbage (1792–1871) is known as the patron saint of operations research and management science. Babbage's scientific inventions included a mechanical calculator (his "difference engine"), a versatile computer (his "analytical engine"), and a punch-card machine. His projects never became a commercial reality; however, Babbage is considered the originator of the concepts behind the present day computer.

Babbage's most successful book, *On the Economy of Machinery and Manufacturers,* described the tools and machinery used in English factories. It discussed the economic principles of manufacturing, and analyzed

the operations; the skills used and suggested improved practices.

Babbage believed in the benefits of division of labor and was an advocate of profit sharing. He developed a method of observing manufacturing that is the same approach utilized today by operations analysts and consultants analyzing manufacturing operations.

ANDREW URE AND CHARLES DUPIN. Andrew Ure (1778–1857) and Charles Dupin (1784–1873) were early industrial educators. Ure provided academic training at Anderson's College in Glasgow for managers in the early factory system. He published a text in 1835 that dealt mainly with the technical problems of manufacturing in the textile industry, but also dealt with problems of managing.

Obviously pro-management, Ure advocated an "automatic plan" to provide harmony and to keep any individual worker from stopping production. He was a defender of the factory system and believed workers must recognize the benefits of mechanization and not resist its introduction.

Dupin was a French engineer and professor who pioneered industrial education in France. He is credited with having a great influence on the writings of Henri Fayol. Dupin published *Discours sur le Sort Des Ouvriers,* translated Discourse on the Condition of the Workers, in 1831. This manuscript included concepts such as time study and the need to balance workloads after introducing division of labor. He wrote of the need for workers to receive concise instructions and the need to discover and publish the best way to perform work with the least amount of worker energy.

THE SCIENTIFIC MANAGEMENT ERA

Since management relied heavily on engineers for advice in the new factories, it is not surprising that associations of engineers were some of the first to examine and write about management problems. The American Society of Mechanical Engineers (ASME) was founded in 1880 and was one of the first proponents of the search for scientific management.

HENRY TOWNE. Henry Towne, president of the Yale and Towne Manufacturing Company, began applying systematic management practices as early as 1870. In 1866 he wrote a paper, *The Engineer as an Economist,* that suggested that ASME become a clearinghouse for information on managerial practices, since there was no management association.

Towne also published several papers and a book, *Evolution of Industrial Management,* on the use of "gain sharing" to increase worker productivity. In his last book Towne contrasted the status of scientific management in 1886 and in 1921, noting the establishment of industrial management courses, and crediting Frederick Taylor as the apostle of the scientific movement.

FREDERICK A. HALSEY. Frederick A. Halsey was another engineer who wrote papers presented to ASME outlining his ideas about wages. He attacked the evils of profit sharing and proposed a special "premium plan" for paying workers based on time saved. Halsey proposed incentives based on past production records, including a guaranteed minimum wage and a premium for not doing work. Halsey's plan, along with Taylor's ideas on piece rates, had a major influence in the United States and Great Britain on the design of pay schemes.

HENRY METCALFE. Another early application of the scientific principles of management occurred when Captain Henry Metcalfe developed a system of controls that he applied to the management of the Frankford Arsenal. In 1885, Metcalfe published *The Cost of Manufactures and the Administration of Workshops, Public and Private.* This book is considered a pioneer work in the area of management science.

DANIEL McCALLUM. Unlike many industries, the railroad industry forced managers to develop special ways of managing a labor force that was dispersed over a wide geographical area. Daniel McCallum (1815–1878) became general superintendent of the Erie Railroad in 1854. He developed principles of management that included discipline, division of labor, detailed job descriptions, promotion and pay based on merit, frequent and accurate reporting of worker performance, and a clearly defined chain of command.

McCallum also designed a formal organizational chart and a sophisticated information management system using the telegraph. His system and rules, however, ran afoul of the militant union and he resigned after a six-month strike. Later, McCallum successfully ran the Northern railroads during the Civil War. He also served as a management consultant for several railroads after the war.

FREDERICK TAYLOR. Probably the most famous management pioneer of all is Frederick W. Taylor (1856–1915), the father of scientific management. Taylor rose from common laborer to chief engineer in six years, and completed a home study course to earn a degree in mechanical engineering in 1883.

In trying to overcome soldiering by the workers, Taylor began a scientific study of what workers ought to be able to produce. This study led to the beginnings of scientific management. Taylor used time studies to break tasks down into elementary movements, and designed complementary piece-rate incentive systems.

Taylor believed management's responsibility was in knowing what you want workers to do and then seeing that they do it in the best and cheapest way.

He developed many new concepts such as functional authority. In other words, Taylor proposed that all authority was based on knowledge, not position. He wrote *Shop Management* in 1903, became the president of the American Society of Mechanical Engineers in 1906, and was a widely traveled lecturer, lecturing at Harvard from 1909 to 1914.

In 1911, Taylor published *Principles of Scientific Management* in 1911. Its contents would become widely accepted by managers worldwide. The book described the theory of scientific management. Scientific management was defined as methods aimed at determining the one best way for a job to be done.

During this same period organized labor waged an all-out war on Taylorism resulting in a congressional investigation. In February of 1912, however, the committee reported finding no evidence to support abuses of workers or any need for remedial legislation. Taylor did not neglect the human side of work, as often suggested. He simply emphasized the individual worker not the group. Taylor called for a revolution that would fuse the interests of labor and management into a mutually rewarding whole.

HENRY GANTT. Henry Gantt (1861–1919) worked with Taylor at the Midvale Steel Company and was considered a Taylor disciple. Gantt felt the foreman should teach the workers to be industrious and cooperative which, in turn, would facilitate the acquisition of all other knowledge.

Gantt also designed graphic aids for management called Gantt charts using horizontal bars to plan and control work. Similar to Taylor, Gantt called for the scientific study of tasks, movements, working conditions, and worker cooperation. He also focused on the connection between the involvement of management and financial interests.

FRANK GILBRETH. Frank Gilbreth (1868–1924) and Lillian Gilbreth (1878–1972) were a husband and wife team that brought many significant contributions, as well as color, to scientific management. Frank began working at age seventeen as an apprentice bricklayer, and later became a chief superintendent and independent contractor. Frank's early work parallels Taylor's and, in later years, Frank formed his own management consulting company, which was closely associated with scientific management methods.

Frank Gilbreth published a series of books describing the best way of laying bricks, handling materials, training apprentices, and improving methods while lowering costs and paying higher wages.

In 1907, Frank Gilbreth met Frederick Taylor and soon became one of Taylor's most devoted advocates. Frank turned his attention away from construction, and extended his interest in motion study (similar to Taylor's time study) to the general field of management.

In order to supplement the human eye, Gilbreth used motion picture cameras, lights, and clocks calibrated in fractions of minutes to create "micromotion" study. Gilbreth also developed a list of seventeen basic motions he called "therbligs" (Gilbreth spelled backwards) to help analyze any worker movement. Unfortunately, the partnership of Frank and Lillian came to an end in 1924 when Frank died of a heart attack. Lillian continued their work through motion study seminars and consulting, later becoming a professor of management at Purdue University (1935–1948).

LILLIAN GILBRETH. Dr. Lillian Gilbreth, known as the first lady of management, played an important role in Frank's research and made many contributions of her own. Lillian pursued a degree in psychology, and in addition to her marriage and family of twelve, she assisted Frank with his work. Lillian's thesis-turned-book, *The Psychology of Management,* is one of the earliest contributions to understanding the human side of management.

Lillian faced many incidents of discrimination during her life, including the fact that her book could only be published if her initials were used so readers would not know she was a woman. Dr. Gilbreth's work was always more management than psychology. Her work illustrated concern for the worker and attempted to show how scientific management would benefit the individual worker, as well as the organization. Lillian wrote about reduction of worker fatigue, how to retool for disabled veteran workers returning to the workplace, and how to apply principles of scientific management to the home.

HARRINGTON EMERSON. Harrington Emerson (1853–1931) was educated in Germany and symbolized a new breed of "efficiency engineers" who were bringing new methods of time and cost savings to American industry. Emerson practiced his system as general manager of the Burlington Railroad, but saw the need for applications of his system in other industries.

The Engineering Magazine published a series of articles by Emerson in 1908 and 1909 that were later issued as a single volume. To Emerson, organization was one of the greatest problems that led to inefficiency. Emerson embraced the general staff concept where each firm was to have a chief of staff and four major sub groupings of staff under him: one for employees, one for machines, one for materials, and one for methods. Staff advice was available to all levels and focused on planning.

Emerson made other contributions in the areas of cost accounting and in setting standards for judging workers and shop efficiency. In 1913, Emerson published *Twelve Principles of Efficiency.* This publication became a landmark in the history of management thought. Harrington Emerson achieved renown in his time and his legacy lives on today.

MORRIS COOKE. While Taylor, the Gilbreths, Gantt, and Emerson were working with industrial enterprises, Morris Cooke (1872–1960) was extending the gospel of efficiency in non-industrial organizations. Cooke focused his attention on educational and municipal organizations.

Cooke conducted a study of administration in educational organizations funded by the Carnegie Foundation for the Advancement of Teaching. The resulting study was a bombshell in the academic world. Cooke's findings included, among other things, widespread use of inbreeding (hiring your own graduates), inefficient committee management, autonomous departments working against university coordination, and pay based on tenure.

In 1911, Cooke was selected as director of public works and brought scientific management to the governance of Philadelphia. In four years he saved the city over $1 million in garbage collection costs alone. Cooke wrote *Our Cities Awake* (1918) to put forth his case for using scientific management for better-managed municipalities.

Cooke became a close friend of Samuel Gompers, president of the American Federation of Labor, and tried to bring labor and management together in a time when they were becoming more antagonistic.

HUGO MUNSTERBERG. While the efficiency engineers studied mechanical efficiency, the industrial psychologists studied human efficiency, with the same goal in mind of improving productivity. The father of industrial psychology was Hugo Munsterberg (1863–1916). In 1892, Munsterberg established his psychological laboratory at Harvard, which was to become the foundation stone in the industrial psychology movement.

Munsterberg published *Psychology and Industrial Efficiency* (1913), which included theories directly related to Taylor's scientific management. The book contained three parts. Part one, the "best possible man," was a study of the demand jobs made on people, and the importance of finding people whose mental capabilities made them well-matched for the work. Part two, the "best possible work," described the psychological conditions under which the greatest output might be obtained from every worker. Part three, the "best possible effect," examined the necessity of creating the influences on human needs that were desirable for the interests of business.

Munsterberg's proposals were based on his own evidence from studies involving telephone operators, trolley drivers, and naval officers.

WALTER DILL SCOTT. Walter Dill Scott (1869–1955) taught at Northwestern University from 1901 to 1920 and then served as president of the university for nineteen years. Scott was interested in employee attitudes and motivation in production and devised a system, adopted by the army, for classifying personnel and testing officer candidates. In fact, he was awarded the Distinguished Service Medal for his work.

From March 1910 till October 1911, Scott wrote a series of articles entitled *The Psychology of Business* later published in *System* magazine. These articles were based on actual business cases and represented one of the earliest applications of the principles of psychology to motivation and productivity in industry.

THE EMERGENCE OF ADMINISTRATIVE THEORY

HENRI FAYOL. Two contributors to the administrative theory of management are Henri Fayol (1841–1925) and Max Weber (1864–1920). Both wrote during the scientific management era in America, but neither was accorded the full measure of his contribution until some decades after his death.

Fayol was trained as a mining engineer and became the managing director of a coal-mining and iron foundry combine. From his own experience, he formulated and wrote papers about his ideas of administrative theory as early as 1900. His first mention of the "elements" of administration came in a book published in 1916. However, America was not thoroughly exposed to Fayol's theory until the book was translated in 1949 and entitled *General and Industrial Management.*

Fayol identified the major elements or functions of management as planning, organization, command, coordination, and control. Planning and organization received the majority of his attention in his writings. Fayol believed that management could be taught, that managerial ability was sorely needed as one moved up the ladder, and that management was a separate activity applicable to all types of undertakings.

Fayol's fourteen principles of management included: division of labor, authority, discipline, unity of command, unity of direction, subordination of individual interests to the general interest, remuneration, centralization, scalar chain, order, equity, stability of tenure of personnel, initiative, and *espirit de corps* (morale).

MAX WEBER. The work of Max Weber (1864–1920) runs chronologically parallel to that of Fayol and Taylor. Weber was a German intellectual with interests in sociology, religion, economics, and political science. He was a professor, editor, government consultant, and author. Weber used the concept of "bureaucracy" as an ideal organizational arrangement for the administration of large-scale organizations. His work was not translated into English until 1947.

Weber's concept of the best administrative system was actually similar to Taylor's. Some of Weber's essential elements included division of labor, and chain of command. He also believed that selection should be

based on technical qualifications, officials'/managers' appointments should be based on qualifications, managers should not be owners, and impersonal and uniform rules should be applied.

PETER DRUCKER. Peter Drucker (b. 1909) made an enduring contribution to understanding the role of manager in a business society. Unlike the previous Fayolian process texts, Drucker developed three broader managerial functions: (1) managing a business; (2) managing managers; and (3) managing workers and work. He proposed that in every decision the manager must put economic considerations first. Drucker recognized that there may be other non-economic consequences of managerial decision, but that the emphasis should still be placed on economic performance.

THE SOCIAL MANERA

The behavioral school of management thought began late in the scientific management era, but did not achieve large-scale recognition until the 1930s. The real catalyst for the emergence of the behavioral school was a series of research studies conducted at the Hawthorne plant of Western Electric between 1924 and 1932. This research became known as the Hawthorne experiments.

ELTON MAYO AND THE HAWTHORNE STUDIES. Elton Mayo (1880–1949) joined the Harvard faculty in 1926 as associate professor of industrial research, and two years later was asked to work with Western Electric, as part of the Harvard research group, to continue the Hawthorne studies.

Mayo was intrigued by the initial results of the early illumination studies that showed output had increased upon changes in illumination—either brighter or darker—but no one knew why. Mayo believed the increased output came from a change in mental attitude in the group as the workers developed into a social unit.

Other experiments included the piecework experiment, the interviewing program, and the bank wiring room experiments. From these experiments the Mayoists concluded that employees have social needs as well as physical needs, and managers need a mix of managerial skills that include human relations skills.

MARY PARKER FOLLETT. Another contributor to the behavioral school of thought was Mary Parker Follett. Follett (1868–1933) was trained in philosophy and political science, and became interested in vocational guidance and the emerging field of social psychology. She had an international reputation as a political philosopher and in 1924 published *Creative Experience,* a book that was widely read by businessmen of the day.

Follett advocated a business philosophy that embraced integration as a way to reduce conflict without compromise or domination. She also proposed the "law of the situation," where parties agree to take their orders from the situation instead from an individual.

Another facet of her philosophy focused on coordination as a fundamental principle of organization. Follett believed the primary leadership task was to define the purpose of the organization and integrate that purpose with individual and group purposes. In other words, she thought that organizations should be based on a group ethic rather than individualism. Thus, managers and employees should view themselves as partners rather than adversaries.

CHESTER BARNARD. Chester Barnard (1886–1961) was a self-made scholar who attended Harvard on a scholarship, but never graduated because he lacked a laboratory science course. He joined the AT&T system in 1909 and became the president of New Jersey Bell in 1927.

Barnard's best known work, *The Functions of the Executive* (1938), was a collection of eight lectures in which he described a theory of organizations in order to stimulate others to examine the nature of cooperative systems. Looking at the disparity between personal and organizational motives, Barnard described an "effective-efficient" dichotomy.

According to Barnard, effectiveness deals with goal achievement, and efficiency is the degree to which individual motives are satisfied. He viewed formal organizations as integrated systems where cooperation, common purpose, and communication are universal elements, whereas the informal organization provides communication, cohesiveness and maintenance of feelings of self-worth. Barnard also developed the "acceptance theory of authority" based on his idea that bosses only have authority if subordinates accept that authority.

THE MODERN ERA: TOTAL QUALITY MANAGEMENT

A quality revolution swept through the business sector during the latter part of the twentieth century. The universal term used to describe this phenomenon was "total quality management" or TQM. This revolution was led by a small group of quality gurus, the most well-known were W. Edwards Deming (1900–1993) and Joseph Juran (b. 1904).

W. EDWARDS DEMING. Deming, an American, is considered to be the father of quality control in Japan. In fact, Deming suggested that most quality problems are not the fault of employees, but the system. He emphasized the importance of improving quality by suggesting a five-step chain reaction. This theory proposes that when quality is improved, (1) costs decrease because of less rework, fewer mistakes, fewer delays, and better use of time and materials; (2) productivity

Table 1
Deming's 14 Points

1. Create consistency of purpose toward the improvement of product and service, and communicate this goal to all employees.
2. Adopt the new philosophy of quality throughout all levels with the organization.
3. Cease dependence on inspection to achieve quality; understand that quality comes from improving processes.
4. No longer select suppliers based solely on price. Move towards developing a long-term relationship with a single supplier.
5. Processes, products, and services should be improved constantly; reducing waste.
6. Institute extensive on-the-job training.
7. Improve supervision.
8. Drive out fear of expressing ideas and concerns.
9. Break down barriers between departments. People should be encouraged to work together as a team.
10. Eliminate slogans and targets for the workforce.
11. Eliminate work quotas on the factory floor.
12. Remove barriers that rob workers of their right to pride of workmanship.
13. Institute a program of education and self-improvement.
14. Make sure to put everyone in the company to work to accomplish the transformation.

improves; (3) market share increases with better quality and prices; (4) the company increases profitability and stays in business; and (5) the number of jobs increases. Deming developed a 14-point plan to summarize his teachings on quality improvement. These fourteen points are listed in Table 1.

JOSEPH M. JURAN. Joseph Juran's experience led him to conclude that more than 80 percent of all quality defects are caused by factors within management's control. He referred to this as the "Pareto principle." From this theory, he developed a management trilogy that included quality planning, control, and improvement. Juran suggested that an area be selected which has experience chronic quality problems. It should be analyzed, and then a solution is generated and finally implemented.

The quality work of Joseph Juran and W. Edwards Deming changed the way people looked at business.

THE MODERN ERA: CONTEMPORARY MANAGEMENT HISTORIANS

The following group of individuals have proven themselves to be great teachers and intellectual leaders in matters of fundamental concern to management history. Their leadership and research have contributed greatly to our understanding of the evolution of management.

ARTHUR BEDEIAN. Arthur Bedeian, a management professor at Louisiana State University, is a management historian with universal interests. He has written on a variety of management-related topics, many of which fall within the area of management history. Bedeian has made several significant contributions to management history. These include his research into specific areas of inquiry such as scientific management and his bibliographic investigations and memoriams. However, perhaps his most important contribution to the field is his editorship of the four volumes of the *Management Laureates: A Collection of Autobiographical Essays.*

ALFRED BOLTON. Alfred Bolton was born in Canada in 1926. At the age of fifty-four, he began work on his doctorate at Nova University. It was during this time that he developed an interest in management history. His most significant contribution to the body of management history knowledge is his work with Ron Greenwood regarding the Hawthorne study participants. The work resulting from this collaborative effort has provided a unique glimpse into the groundbreaking experiments at Western Electric.

DANIEL WREN. Daniel Wren (b. 1932) is considered one of the leading authorities on the history of management thought. He is one of the most prolific writers in this field. His textbook, *The Evolution of Management Thought,* focuses on describing management history by providing a conceptual framework for understanding the evolution of management. Both his research and teaching in this area have led many to consider Wren as one of the management history gurus of the twentieth century.

SEE ALSO: Management Thought; Quality and Total Quality Management; Quality Gurus

Fraya Wagner-Marsh
Revised by Patricia A. Lanier

FURTHER READING:

Deming, W. Edwards. *Out of the Crisis.* Cambridge, MA: Massachusetts Institute of Technology, 2000.

Duncan, W. Jack. *Great Ideas in Management: Lessons from the Founders and Foundations of Managerial Practice.* San Francisco, CA: Jossey-Bass, 1989.

Gazell, J.A. "Drucker on Effective Public Management." *Journal of Management History* 6, no. 1 (2000): 48–62.

Gibson, Jane Whitney, Richard M. Hodgetts, and Jorge M. Herrer. "Management History Gurus of the 1990s: Their Lives, Their Contributions." *Journal of Management History* 5, no. 6 (1999): 380–397.

Lewis, P.S., S. H. Goodman, and P.M. Fandt. *Management: Challenges for Tomorrow's Leaders.* Cincinnati, OH: Thompson South-Western, 2005.

Robbins, Stephen R., and David A. DeCenzo. *Fundamentals of Management.* Upper Saddle River, NJ: Pearson Prentice Hall, 2004.

Spigener, J.B. "What Would Deming Say?" *Quality Progress* 34, no. 3 (2001): 61–64.

Wrege, Charles D., Ronald G. Greenwood, and R. Greenwood. "A New Method Of Discovering Primary Management History: Two Examples Where 'Little Things Mean A Lot.'" *Journal of Management History* 3, no. 1 (1997): 59–92.

Wren, Daniel A. *The Evolution of Management Thought.* New York, NY: John Wiley & Sons, 2004.

Wren, Daniel A., Arthur G. Bedeian, and J.D. Breeze. "The Foundations of Henri Fayol's Administrative Theory." *Management Decision* 40, no. 9 (2002): 906–918.

Wren, Daniel A., and Ronald G. Greenwood. *Management Innovators.* New York, NY: Oxford University Press, 1998.

PLANNING

Planning is the management function that involves setting goals and deciding how to best achieve them. Setting goals and developing plans helps the organization to move in a focused direction while operating in an efficient and effective manner. Long-range planning essentially is the same as strategic planning; both processes evaluate where the organization is and where it hopes to be at some future point. Strategies or plans are then developed for moving the organization closer to its goals. Long-range plans usually pertain to goals that are expected to be met five or more years in the future.

People often confuse the role of planning and scheduling. They are different methodologies and utilize a different set of tools. Planning takes a futuristic view and sets anticipated timelines, while scheduling focuses on an organization's day-to-day activities. For example, most enterprise resource planning (ERP) systems are good at the planning function, but are very poor at the scheduling function. A tool like finite capacity scheduling (FCS) is necessary to facilitate the daily tracking of material and labor movements.

LONG-RANGE PLANNING AND STRATEGIC MANAGEMENT

Since the purpose of strategic management is the development of effective long-range plans, the concepts often are used interchangeably. The traditional process models of strategic management involve planning organizational missions; assessing relationships between the organization and its environment; and identifying, evaluating, and implementing strategic alternatives that enable the organization to fulfill its mission.

One product of the long-range planning process is the development of corporate-level strategies. Corporate strategies represent the organization's long-term direction. Issues addressed as part of corporate strategic planning include questions of diversification, acquisition, divestment, and formulation of business ventures. Corporate strategies deal with plans for the entire organization and change relatively infrequently, with most remaining in place for five or more years.

Long-range plans usually are less specific than other types of plans, making it more difficult to evaluate the progress of their fulfillment. Since corporate plans may involve developing a research-intensive new product or moving into an international market, which may take years to complete, measuring their success is rarely easy. Traditional measures of profitability and sales may not be practical in evaluating such plans.

Top management and the board of directors are the primary decision makers in long-range planning. Top management often is the only level of management with the information needed to assess organization-wide strengths and weaknesses. In addition, top management typically is alone in having the authority to allocate resources toward moving the organization in new and innovative directions.

WHY ENGAGE IN LONG-RANGE PLANNING?

Research has found that firms engaged in strategic planning outperform firms that do not follow this approach. Managers also appear to believe that strategic planning leads to success, as the number of firms using strategic planning has increased in recent years. Because planning helps organizations to consider environmental changes and develop alternative responses, long-range planning seems particularly useful for firms operating in dynamic environments.

A review of studies regarding long-range and strategic planning and performance allows a number of generalizations to be made about how long-range planning can contribute to organizational performance.

1. Long-range plans provide a theme for the organization. This theme is useful in formulating and evaluating objectives, plans, and policies. If a proposed objective or policy is not consistent with the existing theme, it can be changed to better fit the organization's strategies.
2. Planning aids in the anticipation of major strategic issues. It enhances the ability of a firm to recognize environmental changes and begin courses of action to prevent potential problems. Rewarding employees for recognizing and responding to environmental changes sensitizes employees to the need for planning.
3. Planning assists in the allocation of discretionary resources; future costs and returns from various alternatives can be more easily anticipated. Strategies also reflect priorities resulting from multiple objectives and business-unit interdependencies.
4. Plans guide and integrate diverse administrative and operating activities. The relationship between productivity and rewards is clarified through strategic planning, guiding employees along the path to the desired rewards. Strategies also provide for the integration of objectives, avoiding the tendency for subunit objectives to take precedence over organizational objectives.
5. Long-range planning is useful for developing prospective general managers. Strategic planning exposes middle managers to the types of problems and issues they will have to face when they become general managers. Participation in strategic planning also helps middle managers to see how their specialties fit into the total organization.
6. Plans enable organizations to communicate with groups in the environment. Plans incorporate the unique features of the product or company that differentiate it from its competitors. Branding communicates to the public an image of product attributes (e.g., price, quality, and style). Similarly, dividend policies make a difference in the attractiveness of a stock to blue-chip, growth, and speculative investors.

THE STRATEGIC MANAGEMENT/ LONG-RANGE PLANNING PROCESS

The first basic step in long-range planning is the definition of the organization's mission. Essentially, the mission is what differentiates the organization from others providing similar goods or services. Strategies are developed from mission statements to aid the organization in operationalizing its mission.

Long-range planning primarily is the responsibility of boards of directors, top management, and corporate planning staffs. Strategic decision makers are responsible for identifying and interpreting relevant information about the business environment. Thus, a key part of strategic management involves identifying threats and opportunities stemming from the external environment and evaluating their probable impact on the organization.

Environmental analysis, another key component of long range-planning, identifies issues to be considered when evaluating an organization's environment. The environment consists of two sets of factors. These include the macro-environment, consisting of factors with the potential to affect many businesses or business segments, and the task environment, with elements more likely to relate to an individual organization. Industry analysis is an especially important part of analyzing the specific environment of an organization.

Internal characteristics of an organization must be thoroughly identified and accounted for in order to effect long-term planning. Internal factors can represent either strengths or weaknesses. Internal strengths provide a basis upon which strategies can be built. Internal weaknesses represent either current or potential problem areas that may need to be corrected or minimized by appropriate strategies. Internal planning issues commonly involve the functional areas of finance, marketing, human resource management, research and development, operations/production, and top management.

Once the organization's mission is determined and its internal and external strengths and weaknesses are identified, it is possible to consider alternative strategies that provide the organization with the potential to fulfill its mission. This process essentially involves the identification, evaluation, and selection of the most appropriate alternative strategies. Strategic alternatives include strategies designed to help the organization grow faster, maintain its existing growth rate, reduce its scope of operations, or a combination of these alternatives. Corporate grand strategies are evaluated later in this discussion.

Strategy implementation is another important part of long-range planning. Once a strategic plan has been selected, it must be operationalized. This requires the strategy to be implemented within the existing organizational structure, or the modification of the structure so that it is consistent with the strategy. Implementing a strategy also requires integration with the organization's human component.

A final element of long-range planning is strategic control, which evaluates the organization's current performance and compares this performance to its mission. Strategic control essentially brings the strategic

management process full circle in terms of comparing actual results to intended or desired results.

CORPORATE-LEVEL PLANS

Corporate-level plans are most closely associated with translating organizational mission statements into action. In a multi-industry or multiproduct organization, managers must juggle the individual businesses to be managed so that the overall corporate mission is fulfilled. These individual businesses may represent operating divisions, groups of divisions, or separate legal business entities. Corporate-level plans primarily are concerned with:

1. Scope of operations. What businesses should we be in?
2. Resource allocation. Which businesses represent our future? Which businesses should be targeted for termination?
3. Strategic fit. How can the firm's businesses be integrated to foster the greatest organizational good?
4. Performance. Are businesses contributing to the organization's overall financial picture as expected, in accordance with their potential? The business must look beyond financial performance to evaluate the number and mix of business units. Has the firm been able to achieve a competitive advantage in the past? Will it be able to maintain or achieve a competitive advantage in each business in the future?
5. Organizational structure. Do the organizational components fit together? Do they communicate? Are responsibilities clearly identified and accountabilities established?

CORPORATE PORTFOLIO ANALYSIS

The Boston Consulting Group (BCG) Model is a relatively simple technique for helping managers to assess the performance of various business segments and develop appropriate strategies for each investment within the corporate portfolio.

The BCG Model classifies business unit performance on the basis of the unit's relative market share and the rate of market growth. Products and their respective strategies fall into one of four quadrants. The typical starting point for a new business is as a *question mark.* If the product is new, it has no market share but the predicted growth rate is good. What typically happens is that management is faced with a number of these types of products, but with too few resources to develop all of them. Thus, long-range planners must determine which of the products to attempt to develop into commercially viable products and which ones to drop from consideration. Question marks are cash users in the organization. Early in their life, they contribute no revenues and require expenditures for market research, test marketing, and advertising to build consumer awareness.

If the correct decision is made and the product selected achieves a high market share, it becomes a *star* in the BCG Model. Star products have high market share in a high growth market. Stars generate large cash flows for the business, but also require large infusions of money to sustain their growth. Stars often are the targets of large expenditures for advertising and research and development in order to improve the product and to enable it to establish a dominant industry position.

Cash cows are business units that have high market share in a low-growth market. These often are products in the maturity stage of the product life cycle. They usually are well-established products with wide consumer acceptance and high sales revenues. Cash cows generate large profits for the organization because revenues are high and expenditures are low. There is little the company can do to increase product sales. The plan for such products is to invest little money into maintaining them, and to divert the large profits generated into products with more long-term earnings potentials (i.e., question marks and stars).

Dogs are businesses with low market share in low-growth markets. These often are cash cows that have lost their market share or are question marks the company has elected not to develop. The recommended strategy for these businesses is to dispose of them for whatever revenue they will generate and reinvest the money in more attractive businesses (question marks or stars).

CORPORATE GRAND STRATEGIES

Corporate strategies can be classified into three groups or types. Collectively known as grand strategies, these involve efforts to expand business operations (growth strategies), maintain the status quo (stability strategies), or decrease the scope of business operations (retrenchment strategies).

GROWTH STRATEGIES. Growth strategies are designed to expand an organization's performance, usually as measured by sales, profits, product mix, or market coverage. Typical growth strategies involve one or more of the following:

1. Concentration strategy, in which the firm attempts to achieve greater market penetration by becoming very efficient at servicing its market with a limited product line.
2. Vertical integration strategy, in which the firm attempts to expand the scope of its current

operations by undertaking business activities formerly performed by one of its suppliers (backward integration) or by undertaking business activities performed by a business in its distribution channel.

3. Diversification strategy, in which the firm moves into different markets or adds different products to its mix. If the products or markets are related to its existing operations, the strategy is called *concentric diversification.* If the expansion is in products and markets unrelated to the existing business, the diversification is called *conglomerate.*

STABILITY STRATEGIES. When firms are satisfied with their current rate of growth and profits, they may decide to employ a stability strategy. This strategy basically extends existing advertising, production, and other strategies. Such strategies typically are found in small businesses in relatively stable environments. The business owners often are making a comfortable income operating a business that they know, and see no need to make the psychological and financial investment that would be required to undertake a growth strategy.

RETRENCHMENT STRATEGIES. Retrenchment strategies involve a reduction in the scope of a corporation's activities. The variables to be considered in such a strategy primarily involve the degree of reduction. Retrenchment strategies can be subdivided into the following:

1. Turnaround strategy, in which firms undertake a temporary reduction in operations in an effort to make the business stronger and more viable in the future. These moves are popularly called downsizing or rightsizing. The hope is that a temporary belt tightening will allow the firm to pursue a growth strategy at some future point.
2. Divestment, in which a firm elects to spin off, shut down, or sell a portion of its business. This strategy would commonly be used with a business unit identified as a dog by the BCG Model. Typically, a poor performing unit is sold to another company and the money is reinvested in a business with greater potential.
3. Liquidation strategy, which is the most extreme form of retrenchment. Liquidation involves the selling or closing of the entire business operation, usually when there is no future for the business. Employees are released, buildings and equipment are sold, and customers no longer have access to the product. This generally is viewed as a strategy of last resort, and is one that most managers work hard to avoid.

The purpose of an organization is its role as defined by those who maintain authority over it. How the organization elects to fulfill this role constitutes its plan. Mission statements differentiate the organization from other organizations providing similar goods or services. Objectives are the intermediate goals or targets to be completed as the organization fulfills its mission. Plans outline how a firm intends to achieve its mission. Policies provide guidelines or parameters within which decisions are made so that decisions are integrated with other decisions and activities.

SEE ALSO: Forecasting; Government-University-Industry Partnerships; Strategic Planning Tools; Strategy Formulation; Strategy in the Global Environment; Strategy Levels

Joe G. Thomas

Revised by Gerhard Plenert

FURTHER READING:

Plenert, Gerhard. *The eManager: Value Chain Management in an eCommerce World.* Dublin, Ireland: Blackhall Publishing Ltd., 2001.

———. *International Operations Management.* Copenhagen, Denmark: Copenhagen Business School Press, 2002.

Plenert, Gerhard Johannes, and Bill Kirchmier. *Finite Capacity Scheduling: Management, Selection, and Implementation.* New York: John Wiley & Sons Inc., 2000.

POISON PILL STRATEGIES

Poison pill strategies are defensive tactics that allow companies to thwart hostile takeover bids from other companies. Many companies may find themselves unprepared when facing such bids. By adopting a poison pill strategy, a company can be somewhat reassured that acquiring companies will approach its board of directors, not the shareholders. Poison pill strategies are also known as shareholders' protection rights plans.

HISTORY

During the late 1950s and early 1960s, several large corporations began acquiring other companies to diversify their operations. Diversification allowed them to offset their losses in a failing industry with profits from other unrelated, successful industries. Such phenomena caused concerns about the potential of conglomerates to concentrate excessive economic power in the hands of a few corporations. This led to the passage of the Williams Act in 1968, which required the

acquiring company to fully disclose the terms of an impending acquisition and to allow a period for competing offers for the target company to be made. By the late 1970s, the pace of acquisition nearly came to a halt. In 1982, however, the U.S. Supreme Court passed a landmark ruling in the case of *Edgar v. MITE Corp.* that invalidated the basis for anti-takeover laws in thirty-seven states. Furthermore, under the Reagan administration, the U.S. Department of Justice followed a lax policy towards enforcing anti-takeover laws. No longer able to shelter themselves against unfriendly takeover bids, many companies opted to devise anti-takeover strategies. At that time there was a significant increase in poison pill adoptions. However, in light of recent corporate scandals and an overall perception of poor corporate ethics poison pills began to show a decline between 2002 to 2004.

TYPES OF POISON PILL STRATEGIES

"FLIP-OVER" RIGHTS PLAN. Most poison pill strategies involve some form of discrimination against the acquiring company. The most commonly used strategy is called the "flip over" or the shareholder rights plan. Under this strategy, the holders of common stock of a company receive one right for each share held, which allows them an option to buy more shares in the company. The rights have a set expiration date and do not carry voting power. They are worthless at the time of the offering because the exercise price is set well above the going market price of common shares. A shareholder cannot sell these rights independently as they trade together with the shares. When a suitor company makes an unwelcome bid, the rights begin trading separately from the shares. If the takeover bid is successful, the shareholder rights may be exercised to purchase shares at a discount of as much as fifty percent from the going market price. All the shareholders except the acquirer can exercise their rights to purchase shares at discount. This results in a significant dilution in the share holdings of the acquirer, possibly placing the control of the firm in jeopardy. The attempted takeover bid becomes expensive. If the takeover bid is abandoned, the company might redeem the rights, usually at five cents per share.

"FLIP-IN" RIGHTS PLAN. A variation of the flip over is the "flip-in" plan. The plan allows the rights holder to purchase shares in the target company at a discount upon the mere accumulation of a specified percentage of stock by a potential acquirer. For example, the rights become exercisable to purchase the target company's common stock at 50 percent discount from market price in the event the acquirer purchases more than, say, 30 percent ownership in the target company. The acquirer is precluded from exercising flip-in rights. This strategy allows more power than the "flip-over" rights plan and, therefore, has become a common form of poison pill adopted by many U.S. corporations.

POISON DEBT. The target company issues debt securities on certain stipulated terms and conditions in order to discourage a hostile takeover bid. Examples include covenants that severely restrict the company's ability to sell assets, an increase in the interest rates, an acceleration of the maturity date, a conversion of debt to equity at favorable rates, and rights to buy notes at a substantial premium to the prevailing market price at the time of the takeover bid.

"PUT RIGHTS" PLAN. Under this plan, the target company issues rights to its stockholders in the form of a dividend. When an acquirer purchases a specified percentage ownership in the target company, the target shareholders, excluding the acquirer, are entitled to sell their common stock back to the company for a specified sum of cash, debt securities, preferred stock, or some combination thereof. This form of poison pill strategy is rarely used by the U.S. corporations.

VOTING POISON PILL PLAN. This poison pill strategy is designed to dilute the controlling power of the acquirer. Under this plan, the target company issues a dividend of securities, conferring special voting privileges to its stockholders. For example, the target company might issue shares that do not have special voting privileges at the outset. When a potential hostile bid occurs, the stockholders, other than the acquiring party, receive super voting privileges. Alternately, the target company's stockholders might receive securities with voting rights that increase in value over period.

EXAMPLES OF RIGHTS PLANS. On 5 November 1998, Motorola, Inc. adopted a new rights plan to replace an existing plan. Under the plan, one right attaches to each existing share of common stock. If a person or group acquires a ten percent stake, all other right holders will be entitled to purchase the company's stock at a fifty percent discount. Motorola may redeem the new rights at one cent per right at any time before a person or group takes a ten percent stake.

On 13 October 1998, Baldwin Piano & Organ Company announced a shareholder rights plan by declaring a dividend of one stock purchase right for each share of common stock owned. Unlike rights plans adopted by other companies, Baldwin's innovative plan would permit a qualified offer to go forward without the board's approval. A qualified offer must be all cash, made to all shareholders, contain a firm financing commitment, and a fairness opinion from an investment bank. A qualified offer must result in the acquirer gaining at least seventy-percent of Baldwin's then outstanding shares.

In late 2004 PeopleSoft management attempted to use a poison pill that would be triggered when twenty percent of the company was acquired however shareholder interest in accepting the takeover by Oracle Corp. led to an eventual merger of the two companies.

Cisco had implemented a poison pill plan triggered when an individual or group acquired more than fifteen percent of the company. The plan was set to expire in 2008 however, in March 2005 Cisco decided to end the shareholder rights' program citing revision of its corporate governance procedures.

THE NET EFFECTS OF POISON PILL STRATEGIES

The net effect of a poison pill strategy is to make it prohibitively expensive for an acquirer to buy the control of a company. The underlying assumption is that the board will always act in the best interest of the shareholders, a view that is explicitly rejected by agency theorists. Agency theorists have argued that the practice of allowing management to adopt poison pill strategy has reduced the number of potential offers and actual takeovers. In doing so, they have protected incumbent management at the expense of shareholders. It is argued that poison pills have the effect of perpetuating inefficiencies and poor management that ultimately is reflected in lower stock values.

Boards of directors invariably argue that poison pill strategies have exactly the opposite effect on stock values. They help maintain their independent decision making power to run their companies in the best interests of the shareholders. Poison pill strategies also provide bargaining strength to the board in order to extract the most value for the stock from a potential acquirer.

While there are merits to the arguments on both sides, an efficient allocation of resources through merger and acquisition activities can only enhance shareholders' wealth no matter how hostile the tender offers of corporate raiders. Many of the defensive tactics of management should be opposed by the shareholders as they might cause a loss of their wealth, although other defensive actions-for example, by soliciting competitive bids-can increase their wealth.

SEE ALSO: Diversification Strategy; Leveraged Buyouts; Mergers and Acquisitions

Ramesh C. Garg
Revised by Hal P. Kirkwood, Jr.

FURTHER READING:

Dolbeck, A. "Hard to Swallow: Poison Pills on the Decline." *Weekly Corporate Growth Report,* 22 March 2004, 1–3.

Lowry, J.P. "Poison Pills in U.S. Corporations-A Re-examination." *Journal of Business Law,* May 1992, 337–341.

Simon, C.E., and J.M. Bryan. *Corporate Anti-Takeover Defenses: The Poison Pill Device.* St. Paul, MN: Thomson West., 2004.

Velasco, J. "The Enduring Illegitimacy of the Poison Pill" *Journal of Corporation Law* 27, no. 3 (Spring 2002): 381–423.

POKA-YOKE

Poka-yoke is a technique for avoiding simple human error in the workplace. Also known as mistake-proofing, goof-proofing, and fail-safe work methods, poka-yoke is simply a system designed to prevent inadvertent errors made by workers performing a process. The idea is to take over repetitive tasks that rely on memory or vigilance and guard against any lapses in focus. Poka-yoke can be seen as one of the three common components of Zero Defect Quality Control performed by Japanese companies (source inspection and feedback are the other two).

Dr. Shigeo Shingo, a renowned authority on quality control and efficiency, originally developed the mistake-proofing idea. Realizing its value as an effective quality control technique, he formalized its use in Japanese manufacturing as the poka-yoke system. One hundred percent inspections catch unacceptable products but do nothing to improve the process. Shingo was emphatic that the purpose of this system be to improve the process not sort out defective parts.

Today, this concept is in wide use in Japan. Toyota Motor Corporation, whose production system Shingo helped design, averages twelve poka-yoke devices per machine in their manufacturing plants, thus validating the concept as beneficial to industry. Patel, Dale, and Shaw, in the article "Set-Up Time Reduction and Mistake Proofing Methods: An Examination in Precision" list the potential benefits as:

- elimination of set-up errors and improved quality
- decreased set-up times with associated reduction in production time and improved production capacity
- simplified and improved housekeeping
- increased safety
- lower costs
- lower skill requirements
- increased production flexibility
- improved operator attitudes.

In a *Quality* magazine article, Melissa Larson provides interesting details about benefits resulting from the implementation of poka-yoke systems at the Supply Support Activity (SSA) at Fort Carson, Colorado, a military retail supply operation of the U.S. Army.

Inventory, receipt, and batch processing all improved quantifiably. Location survey accuracy was approximately sixty-five percent prior to implementation. After implementing the use of the bar-code readers location accuracy increased to ninety-eight percent.

Inventory adjustments averaged $3000 a month. Inventory adjustments dropped to an average of $250 per month.

The rate of incorrect receipt closures to the supplier had been ninety percent. This rate dropped to zero percent. Batch processing was also significantly improved. Traditionally, the SSA had approximately fifteen to twenty batch processing failures per month, and a myriad of system file failures due to operators performing the process out of proper sequence. Since the poka-yoke implementations, there have been zero batch process failures.

Catalog update improvements also resulted. The error rate was twenty-two percent but dropped to zero percent. Original request processing time was 12.5 days, but with the new request processing time is 1.6 days. Actual dollars invested in these activities totaled less than $1000.

TYPES OF POKA-YOKES

Poka-yoke is based on prediction and detection. That is, recognizing that a defect is about to occur or recognizing that a defect has occurred. Consequently, there are two basic types of poka-yoke systems. The control poka-yoke does not allow a process to begin or continue after an error has occurred. It takes the response to a specific type of error out of the hands of the operator. For example, a fixture on a machine may be equipped with a sensing device that will not allow the process to continue unless the part is properly inserted. A 3.5-inch floppy disk will not work if inserted backwards or upside down. As a matter of fact, it won't fit into the drive at all unless properly inserted. A second type of poka-yoke provides some type of warning when an error occurs. This does not prevent the error, but immediately stops the process when an error is detected. This type of poka-yoke is useful for mass production environments with rapid processing as the device prevents mass production of scrapped material. For environments where large losses of time or resources do not result, a warning poka-yoke is warranted. All that is needed is a way to ensure that the error is investigated and corrected in a timely manner.

Poka-yokes can be as simple as a steel pin on a fixture that keeps incorrectly placed parts from fitting properly, or they can be as complex as a fuzzy logic neural network used to automatically detect tool breakage and immediately stop the machine. Surprisingly, the simple low-cost devices tend to be in the majority. Regardless of degree of simplicity, all poka-yokes fall into one of three categories: contact methods, fixed-value methods, and motion-step methods. Each is briefly discussed.

CONTACT METHODS. Contact methods are based on some type of sensing device which detects abnormalities in the product's shape or dimension and responds accordingly. Interference pins, notches with matching locator pins, limit switches and proximity switches are sometimes used to ensure that a part is positioned correctly before work occurs. Asymmetric parts with matching work fixtures can also alleviate incorrect positioning. If orientation is not critical, symmetrical designs can then be used to prevent defects.

Contact methods are useful in situations which encourage mistakes. Such situations involve rapid repetition, infrequent production, or environmental problems such as poor lighting, high or low heat, excess humidity, dust, noise, or anything which distracts a worker. Paul Dvorak, in "Poka-Yoke Designs Make Assemblies Mistakeproof," an article appearing in *Machine Design,* recommends that the maintenance engineer investigate at least four areas for potential problems that require contact method solutions:

1. Look for where the product will fail if parts are assembled incorrectly.
2. Look for small features critical to proper assembly.
3. Beware of relying on subtle differences to determine top from bottom or front from back, especially if the parts are painted dark colors.
4. Beware of designs so complicated that they confuse inexperienced operators.

FIXED-VALUE METHODS. Fixed-value methods are used in processes where the same activity is repeated several times, such as tightening of bolts. This method frequently involves very simple techniques, such as methods that allow operators to easily track how often this activity has been performed. Dvorak gives the example of an operator who is responsible for tightening down six bolts on a product. Before passing the product on, the tightening process is performed a fixed number of times (six). A simple poka-yoke device would incorporate the use of a wrench dipped in diluted paint. Since untightened bolts will not have paint on them, the operator can easily see if he or she has performed the process the required number of times. A second example (from Dvorak) would be the use of packaged material in the exact (fixed) quantities needed to complete the process. If the bolts were stored in containers of six, the operator could easily see when the process was still incomplete as the box would still contain one or more bolts.

MOTION-STEP METHOD. The motion-step method is useful for processes requiring several different activities performed in sequence by a single operator. This is similar to the fixed-value situation in that the operator is responsible for multiple activities but instead of performing the same activity multiple times the operator performs different activities. First, each step in the

Table 1

Examples of Poka-Yokes

	Contact Type	Warning Type
Contact Method	A steel pin on a fixture keeps incorrectly placed parts from fitting properly.	A device on a drill counts the number of holes drilled in a work piece; a buzzer sounds if the work piece is removed before the correct number of holes have been drilled.
Fixed-value Type	Light sensors determine if each crayon is present in each box; if a crayon is missing, the machines will stop automatically.	Bolts are tightened with a wrench dipped in paint. Bolts with no paint on them are still untightened.
Motion-Step Method	A simple proximity switch opens after all components are loaded in the proper order.	A device detects when each component is removed from a dispenser; if a component is not removed, the device alerts the assembler before he can move on to another unit.

process is identified by the specific motions needed to complete it. Then devices are created to detect whether each motion is performed and then alert the operator when a step is skipped. An assembly process could utilize a device that senses when all required components are present at the start of the process for each unit. The devices could then detect when each component is removed from its dispenser, If a component is not removed, the sensing device alerts the assembler before he/she can move on to another unit.

SELF CHECKS

Poka-yoke devices which provide the fastest possible feedback about defects and allow workers to assess the quality of their own work are referred to as self-checks. Self-checks can be used to allow workers to rapidly identify slips or work errors such as incomplete or omitted operations and to verify the existence or absence of an attribute. For example, at Brigham and Women's Hospital, a computer system is used to check and process doctors' prescriptions.

EXAMPLES. A number of "real world" applications are presented in the business and engineering literature. Below are a list of examples of poka-yoke applications. James R. Evans and William M. Lindsay present these examples in their book *The Management and Control of Quality:*

- Color-coding a wiring template to assist the worker.
- Installing a device on a drill to count the number of holes drilled in a work piece; a buzzer sounds if the work piece is removed before the correct number of holes has been drilled.
- Cassette covers were frequently scratched when the screwdriver slipped out of the screw slot and slid against the plastic covers. The screw design was changed as shown in Table 1 to prevent the screwdriver from slipping.
- A metal roller is used to laminate two surfaces bonded with hot melted glue. The glue tended to stick to the roller and cause defects in the laminate surface. An investigation showed that if the roller were dampened the glue would not stick. A secondary roller was added to dampen the steel roller during the process, preventing the glue from sticking.
- One production step at Motorola involves putting alphabetic characters on a keyboard, then checking to make sure each key is placed correctly. A group of workers designed a clear template with the letters positioned slightly off center. By holding the template over the keyboard, assemblers can quickly spot mistakes.

John Grout presented these examples in "Mistake-Proofing Production," an article written for *Production and Inventory Management Journal:*

- Trinity Industries Railcar Division workers created a layout jig to avoid having to use a tape measure and chalk to position subassemblies on each car individually. The jig has tops that allow it to be quickly positioned correctly on the car's chassis. Each component that is to be attached to the car has a corresponding cutout on the jig. The jig eliminates two modes of worker error. It eliminates incorrect measurements and inaccurate positioning of parts. It also eliminates the worker vigilance required to ensure all of the components are attached. Omitted parts are made very obvious because an empty space exists on the layout jig. Without the jig, there would be no indication that anything is missing. Once parts are spot welded in place the jig is lifted

off and welding is completed. Not only is dependence on worker vigilance reduced, cost savings result from the simplified, accelerated process.

- Binney and Smith, maker of Crayola Crayons, uses light sensors to determine if each crayon is present in each box of crayons they produce. If a crayon is missing, the machines will stop automatically. Producing complete boxes of crayons right the first time is the preferred outcome.
- A mail-order computer company has designed its boxes and packing material to avoid mistakes. The inner flaps of the box bottom have a large brightly colored warning to "Stop! Open the other side." When the correct side is opened, a book titled "Setting Up Your Computer" is on top of the packing material. The sequence of the book matches the arrangement of the contents of the box. Each instruction involves the next item from the box.
- Airplane lavatory lights come on only when the door lock is engaged. This keeps customers from failing to lock the door.
- John Deere produced a gearbox that was assembled without oil, mounted on a machine, and required replacement after factor tests. A team streamlined production with a simple proximity switch that opens after all components were loaded into an assembly fixture. The switch prevents workers from using air wrenches to tighten bolts on the assembly until they cycle an oil gun into the gearbox. After filling the gearbox a solenoid releases the interlock sending air to the wrench. Then workers can tighten cover bolts and send the box to the next station.
- The electrical connectors in one machine control formerly used only three-pin connectors to join each in a series. Labels instructed assemblers which boards went where and which connectors should be joined. But in the field, assemblers connecting and disconnecting them wear or bend the pins, which meant putting on a new plug. Soon the label was gone. The simple solution involved three, four and five-pin connectors that cannot join others and demand a single assembly sequence.
- Ficarra's solution to labels that come off is to machine them into parts, especially when the function is to determine the correct orientation.
- On Varian machines, assemblers are guided by small machined-in pictures that cannot wear off.

SERVICE APPLICATIONS

Poka-yoke can also be applied to service-based organizations. The following is summarized from the paper "Using Poka-Yoke Concepts to Improve a Military Retail Supply System," which was printed in *Production and Inventory Management Journal.*

While manufacturing typically only considers errors made by the producer, service industries must consider errors from both the server and the customer. Additionally, service organizations interface in many different ways to transfer a service to the customer. Because of the possibility that service errors can be created by both the customer and the server, service poka-yokes are grouped into two categories: fail-safing the server and fail-safing the customer.

SERVER POKA-YOKES

There are three types poka-yoke systems that can be used to fail-safe the server: task poka-yokes, treatment poka-yokes, and tangible poka-yokes.

TASK POKA-YOKES. Task poka-yokes focus on server tasks and common mistakes servers make while performing the service/task for the customer. A good example of a control-oriented, task poka-yoke is the coin return machine used in may fast-food restaurants. The coin portion of a customer's change from payment is returned automatically through these machines. This takes the control out of the hands of the cash register operator, eliminating errors and speeding up the processing of customers.

TREATMENT POKA-YOKES. Treatment poka-yokes focus on the social interaction between the customer and the server (i.e., eye contact, greeting). By mistake-proofing/standardizing what servers say and do to customers, managers can reasonably ensure that customers receive proper, fair and consistent treatment. Burger King utilized warning-oriented, treatment poka-yokes by placing "cue cards" at the service point ensuring that servers know what to say the minute they interface with the customer.

TANGIBLE POKA-YOKES. Tangible poka-yokes attempt to improve the tangible, physical impression and experience for the customer in addition to the direct task of the server (i.e., dirty office, unkempt server, sloppy documents). Motorola uses a control-oriented poka-yoke in the legal department by having a second lawyer inspect all legal work for spelling, presentation, and arithmetic. In this way, the legal department is ensuring that the "tangibles" of the service are satisfactory in addition to the task of the service (legal work).

CUSTOMER POKA-YOKES

Fail-safeing the customer also consists of three of poka-yoke systems: preparation poka-yokes, encounter poka-yokes, and resolution poka-yokes.

PREPARATION POKA-YOKES. Preparation poka-yokes attempt to fully prepare the customer before they even enter the service. An example of a warning-oriented, preparation poka-yoke is the notice a university sends to each student prior to registration for the next semester detailing the courses he needs to finish his degree. This system could be converted to a control system by having an automated registration process which would not allow students to sign up for classes out of sequence or until all prerequisites are met.

ENCOUNTER POKA-YOKES. Encounter poka-yokes attempt to fail-safe a customer at a service who may misunderstand, ignore, or forget the nature of the service or their role in it. A good example of a control-oriented, encounter poka-yoke is the use of concrete curbing at an oil& lube shop that directs customers so that they do not/cannot pull the wrong way into the station. This system also assists in the selection process so that customers are not served out of order.

RESOLUTION POKA-YOKES. Resolution poka-yokes attempt to remind customers of the value of their input to the continuous improvement of a service. A hotel which uses an automated check-out system through the television in each room could attach a few questions to the check-out process to ensure the customer provides feedback on key issues. This would be a control-oriented resolution poka-yoke. Obviously, one of the keys to the success of any customer-oriented poka-yoke is to obtain willing customer participation.

BARRIERS TO IMPLEMENTATION AND RECOMMENDATIONS

Patel, Dale and Shaw note that there are a number of barriers a firm may face when implementing poka-yoke devices within their system. These include:

- Difficulty in accepting change
- Justification of the investment
- Using inappropriate and ineffective methods
- Time requirements
- Difficulty encountered as a result of continuous process

Stewart and Grout, in an article entitled "The Human Side of Mistake-Proofing," make the following recommendations for the implementation of poka-yoke devices:

1. The outcome of the process or routine must be known in advance so as to have a standard for comparison.
2. The process must be stable, i.e., outcomes are not changing.
3. There must be an ability to create a break between cause and effect in the process so as to provide an opportunity to insert a poka-yoke.
4. Environments requiring substantial operator skill are prime locations for poka-yoke devices.
5. Environments where training or turnover cost is high are prime locations for poka-yoke devices.
6. Environments with frequent interruptions and distractions are prime locations for poka-yoke devices.
7. Environments with a consistent set of mixed products are prime locations fopoka-yoke devices.
8. The beginning of any process where there are multiple other possible processes that could be initiated are a prime location for poka-yoke devices.
9. Locations in the process with similarly positioned or configured parts, controls or tools are prime locations for poka-yoke devices.
10. Any point in the process requiring replacement or orientation of parts in order to prevent mispositioning is a prime location for poka-yoke devices.
11. Any point in the process where adjustments are made for machine or process setups is a prime location for poka-yoke devices.

John Grout attributed defects to three sources: variance, mistakes, and complexity. Complexity requires techniques which simplify the process while managing variance can be accomplished by utilizing statistical process control (SPC). However, if quality problems are the result of mistakes, poka-yoke devices are the appropriate technique to use. In this case, poka-yoke provide an even more effective quality improvement tool than SPC. Other poka-yoke benefits include reduced training costs and the advantage of freeing workers' time and minds for more creative and value-adding activities.

Circumstances where poka-yoke is not the appropriate response are situations involving high speed production, situations where X-bar ($\bar{X}$) & R charts are effective, and use in destructive testing. Other situations, however, provide opportunities for simple, inexpensive, and fail-safe devices to improve performance. Grout relates the example of Lucent Technologies, which reported that half of their 3,300 mistake-proof devices cost less than $100. However, they estimate a

net savings of $8.4 million or about $2,545 per device. Poka-yoke is a most impressive and powerful tool.

SEE ALSO: Japanese Management; Quality and Total Quality Management

R. Anthony Inman

FURTHER READING:

Dvorak, Paul. "Poka-Yoke Designs Make Assemblies Mistake-proof." *Machine Design,* 10 March 1998, 181–184.

Evans, James R., and William M. Lindsay. *The Management and Control of Quality.* South-Western Publishing, 2004.

Ghinato, Paulo. "Quality Control Methods: Towards Modern Approaches Through Well Established Principles." *Total Quality Management* 9, no. 6 (August 1998).

Grout, John R. "Mistake-Proofing Production." *Production and Inventory Management Journal* 38, no. 3 (3rd Quarter 1997): 33–37.

Larson, Melissa, "Drill Template Illustrates 'Poka-Yoke.'" *Quality* 10, no. 6 (June 1998).

Patel, S., B.G. Dale and P. Shaw. "Set-up Time Reduction and Mistake Proofing Methods: An Examination in Precision Component Manufacturing." *The TQM Magazine* 13, no. 3 (2001): 175–179.

Snell, Todd, and J. Brian Atwater. "Using Poka-Yoke Concepts to Improve a Military Retail Supply System." *Production and Inventory Management Journal* 37, no. 4 (1996).

Stewart, Douglas M., and John R. Grout. "The Human Side of Mistake-Proofing." *Production and Operations Management* 10, no. 4 (2001): 440–459.

Stewart, Douglas M. and Steven A. Melnyk. "Effective Process Improvement: Developing Poka-Yoke Processes." *Production and Inventory Management Journal* 41, no. 4 (2000): 48–55.

POPULAR PRESS MANAGEMENT BOOKS

The past several decades have witnessed a profusion of management books published in the popular press, many becoming best sellers. This trend began during economic hard times when managers were searching for some easy-to-understand cures for their organizations' financial woes. While the economy greatly improved during the 1990s, managers continue to look for new insights that might help them improve their own or their organizations' fortunes. When the economy slowed in the early part of the twenty-first century, managers again began searching for the golden elixir that would save their jobs.

Despite their enormous sales, popular management books must weather a rather severe image problem. They are quite often perceived as hastily assembled tracts attempting to capitalize on a hot (and usually short-lived) management fad, borne of managers' frazzled attempts to overcome obstacles and challenges that do not generalize well for a wide audience, but which hide these faults behind hyperbolic and trendy word spinning. Typically relying as much on their style as on their substance, popular management books are criticized for lacking both empirical and rational justification, assuming factors that one would be ill-advised to assume, and excessively simplifying very complex problems. Lastly, critics skeptically eye the sheer volume of such books, along with the frequency with which new ones arrive in bookstores before sliding into the background, typically just in time for a new generation of popular books to detail the next fad.

On the other hand, fads do indeed become fads for a reason; some observers emphasize that fads (and the books that extol them) need not be dismissed out of hand. In fact, it is those managers and organizations that are able to spot and expediently capitalize on fads while they are useful that end up excelling over time. Moreover, due to the recognizability and popularity of fads, organizations can utilize the hype surrounding them as a springboard to more general and useful organizational learning and management techniques. In other words, a fool will follow a popular management book to the letter simply because the fad it details is hot; a successful manager will utilize fads for what they are worth, no more and no less, and will avoid inflating the wisdom (or lack thereof) of a popular management book. A confluence of the best and most useful elements of fads past can result in increased quality, productivity, and profitability. The important thing is for managers and organizations to remain focused on their actual concerns-what does the organization do? what elements or techniques are and are not appropriate to its goals? and so on. Simply hammering a useless fad into an organization not suited to it, of course, can be disastrous.

Since a systematic analysis of popular-press management books would be an endless odyssey, what follows are brief summaries of six quite popular titles. The purpose is not so much to critically examine the books, since the criticisms, like the books themselves, do not generalize reliably; rather, the more modest goal is to lay the foundation for what a reader can expect from popular-press management books, from which one can deduce the degree of usefulness therein for one's own purposes.

COMPETITIVE ADVANTAGE THROUGH PEOPLE

Stanford professor Jeffrey Pfeffer in his book *Competitive Advantage Through People* has described the potential impact of human resource management

practices on competitive advantage. Based on his study of popular and academic business literature and interviews with people from a wide range of the business community, Pfeffer identified 16 human resource management practices that, in his opinion, can enhance a firm's competitive advantage:

1. *Employment security.* A guarantee of employment stating that no employee will be laid off for lack of work.
2. *Selectivity in recruiting.* Carefully selecting the right employees in the right way.
3. *High wages.* Wages that are higher than required by the market (i.e., than those paid by competitors).
4. *Incentive pay.* Allowing employees who are responsible for enhanced levels of performance and profitability to share in the benefits.
5. *Employee ownership.* Giving the employees ownership interests in the organization by providing them with such things as shares of company stock and profit-sharing programs.
6. *Information sharing.* Providing employees with information about operations, productivity, and profitability.
7. *Participation and empowerment.* Encouraging the decentralization of decision making, broader worker participation, empowerment in controlling their own work process.
8. *Teams and job redesign.* The use of interdisciplinary teams that coordinate and monitor their own work.
9. *Training and skill development.* Providing workers with the skills necessary to do their jobs.
10. *Cross-utilization and cross-training.* Train people to perform several different tasks.
11. *Symbolic egalitarianism.* Equality of treatment among employees established by such actions as eliminating executive dining rooms and reserved parking spaces.
12. *Wage compression.* Reducing the size of the pay differences among employees.
13. *Promotion from within.* Filling job vacancies by promoting employees from jobs at lower organizational levels.
14. *Long-term perspective.* The organization must realize that achieving competitive advantage through the workforce takes time to accomplish, and thus a long-term perspective is needed.
15. *Measurement of practices.* Organizations should measure such things as employee attitudes, the success of various programs and initiative, and employee performance levels.
16. *Overarching philosophy.* An underlying management philosophy that connects the various individual practices into a coherent whole.

THE ONE MINUTE MANAGER

Written by Kenneth Blanchard and Spencer Johnson, *The One Minute Manager* warns managers of the perils of treating employees too harshly or too softly. In the first instance, the employer wins; in the latter, the employee wins. The ideal is to manage employees in a way that both parities win. This aim can be accomplished if managers use three techniques: goal setting, positive reinforcement, and verbal reprimand, each of which can be implemented within one minute.

The use of one-minute goals helps clarify the employees' specific responsibilities and lets them know performance standards to which they will be held. The manager should then frequently review the employees' goal achievements to ensure they remain on target. Moreover, managers should focus their time on catching their employees doing something right, rather than something wrong. Immediate praise should accompany these behaviors. Finally, when seen doing something wrong, employees should receive immediate feedback, indicating exactly what was done wrong and how the manager feels about it. Following the reprimand, the manager should praise the individual as a person, thus establishing a clear separation between the person and the problem behavior.

WHO MOVED MY CHEESE?

Written by Spencer Johnson, M.D., *Who Moved My Cheese?* is a simple parable that reveals profound truths about change. It is an amazing and enlightening story of four characters that live in a "Maze" and look for "Cheese" to nourish them and make them happy. Two mice are named Sniff and Scurry—nonanalytical and nonjudgmental, they just want cheese and are willing to do whatever it takes to get it. Hem and Haw are "little people," mouse-size humans who have an entirely different relationship with cheese. It's not just sustenance to them; it's their self-image. Their lives and belief systems are built around the cheese they've found.

Most of us reading the story will see the cheese as something related to our livelihoods—our jobs, our career paths, the industries we work in—although it can stand for anything, from health to relationships. In the story, the characters are faced with unexpected change. Eventually, one of them deals with it successfully, and

writes what he has learned from his experience on the maze walls. When the reader sees the "handwriting on the wall," he or she can discover for him or herself how to deal with change more effectively. One of the most eloquent of the wall sayings is "what would you do if you weren't afraid?" The point of the story is that we have to be alert to changes in the cheese, and be prepared to go running off in search of new sources of cheese when the cheese we have runs out.

GUNG HO!

Blanchard (*The One Minute Manager,* 1984), along with co-author Bowles (*Raving Fans,* Morrow, 1993), recounts an organizational turnaround based on three Native American lessons. This inspirational story of business leaders Peggy Sinclair and Andy Longclaw uses allegory to explain fundamental techniques to boost enthusiasm and performance.

Meet Peggy Sinclair, the newly promoted factory manager who was sent to the worst plant in the thirty-two owned by the company with the expectation to shut it down in 6 months. And Andy Longclaw, who is pointed out to her the first day, in spite of his area's remarkable performance, as a "troublemaker" by one of her executive staff. Sinclair Longclaw patiently shows Sinclair Native American principles that help turn Walton Works #2 from the worst in the company to a workplace recognized by the White House as one of the nation's finest workplaces. Those three important principles are:

1. "The Spirit of the Squirrel" teaches a lesson of the power of worthwhile work.
2. "The Way of the Beaver" showcases empowerment.
3. "The Gift of the Goose" shows the exponential factor of motivation.

GOOD TO GREAT

Jim Collins' book, *Good to Great,* is based on extensive research on a set of companies that moved from mediocre performance to great results and sustained those results for at least fifteen years. (The good-to-great companies generated cumulative stock returns that beat the general stock market by an average of seven times in fifteen years.)

The research team contrasted the good-to-great companies with a carefully selected set of comparison companies that failed to make the leap from good to great. What was different? Why did one set of companies become truly great performers while the other set remained only good? The team spent five years analyzing the histories of all twenty-eight companies in the study. After 15,000 hours of digging through mountains of data, Collins and his team discovered the key determinants of greatness—why some companies make the leap and others don't. The findings of the Good to Great study:

1. Level 5 Leaders: During the transition years, all of the companies were led by humble individuals who channel their ego needs away from themselves and into the larger goal of building a great company. It is not that Level 5 leaders have no ego or self-interest. Indeed, they are incredibly ambitious—but their ambition is first and foremost for the institution, not themselves. Ten out of eleven of those profiled came up from inside the company whereas the mediocre comparison companies turned to outsiders six times more often.
2. First Who Then What: The good-to-great leaders began the transformation by first getting the right people on the bus (and the wrong people off the bus) and then figured out where to drive it. The comparison companies frequently followed the "genius with a thousand helpers" model where the leader sets a vision and then enlists a crew of highly capable "helpers" to make the vision happen. This model fails when the genius departs.
3. Confront the Brutal Facts (Yet Never Lose Faith): Create a culture where people have a tremendous opportunity to be heard, and, ultimately, for the truth to be heard. Leadership begins with getting people to confront the brutal facts and to act on the implications. Retain absolute faith that you can and will prevail in the end, regardless of the difficulties.
4. Hedgehog Concept: See what is essential and ignore the rest. Hedgehog companies understand what they can be the best at, what they can feel passionate about and that is what they focus on.
5. A Culture of Discipline: Good-to-great firms have a high ethic of responsibility and a high culture of discipline. Get disciplined people to engage in discipline thought and take disciplined action.
6. Technology Accelerators: Good-to-great companies avoid technology fads and yet they become pioneers in the application of carefully selected, relevant technologies.
7. The Flywheel and the Doom Loop: Good-to-great companies follow a pattern of buildup leading to breakthrough. They accumulate successes and use the cumulative

consistent momentum to push them yet further out in front. There is no dramatic, revolutionary event.

PRIMAL LEADERSHIP

Business leaders who maintain that emotions are best kept out of the work environment do so at their organization's peril. Bestselling author Daniel Goleman's theories on emotional intelligence (EI) have radically altered common understanding of what "being smart" entails, and in *Primal Leadership,* he and his coauthors present the case for cultivating emotionally intelligent leaders. Since the actions of the leader apparently account for up to seventy percent of employees' perception of the climate of their organization, Goleman and his team emphasize the importance of developing what they term "resonant leadership." Focusing on the four domains of emotional intelligence—self-awareness, self-management, social awareness, and relationship management—they explore what contributes to and detracts from resonant leadership, and how the development of these four EI competencies spawns different leadership styles. The best leaders maintain a style repertoire, switching easily between "visionary," "coaching," "affiliative," and "democratic," and making rare use of less effective "pace-setting" and "commanding" styles. The authors' discussion of these methods is informed by research on the workplace climates engendered by the leadership styles of more than 3,870 executives. Indeed, the experiences of leaders in a wide range of work environments lend real-life examples to much of the advice Goleman et al. offer, from developing the motivation to change and creating an improvement plan based on learning rather than performance outcomes, to experimenting with new behaviors and nurturing supportive relationships that encourage change and growth. The book's final section takes the personal process of developing resonant leadership and applies it to the entire organizational culture.

SEE ALSO: Management Styles; The Art and Science of Management

Lawrence S. Kleiman
Revised by Rebecca Bennett

FURTHER READING:

Blanchard, K., and S. Bowles. *Gung Ho!* Morrow, 1998.

Blanchard, K., and S. Johnson. *The One-Minute Manager.* New York: Morrow, 1982.

Collins, J. *Good to Great.* Harper Business, 2001.

Goleman, D., R. Boyatzis, and A. McKee. *Primal Leadership.* Harvard Business School Press, 2002.

Johnson, S., M.D. *Who Moved My Cheese?* Putnam, 1998.

Pfeffer, J. *Competitive Advantage Through People.* Boston: Harvard Business School Press, 1994.

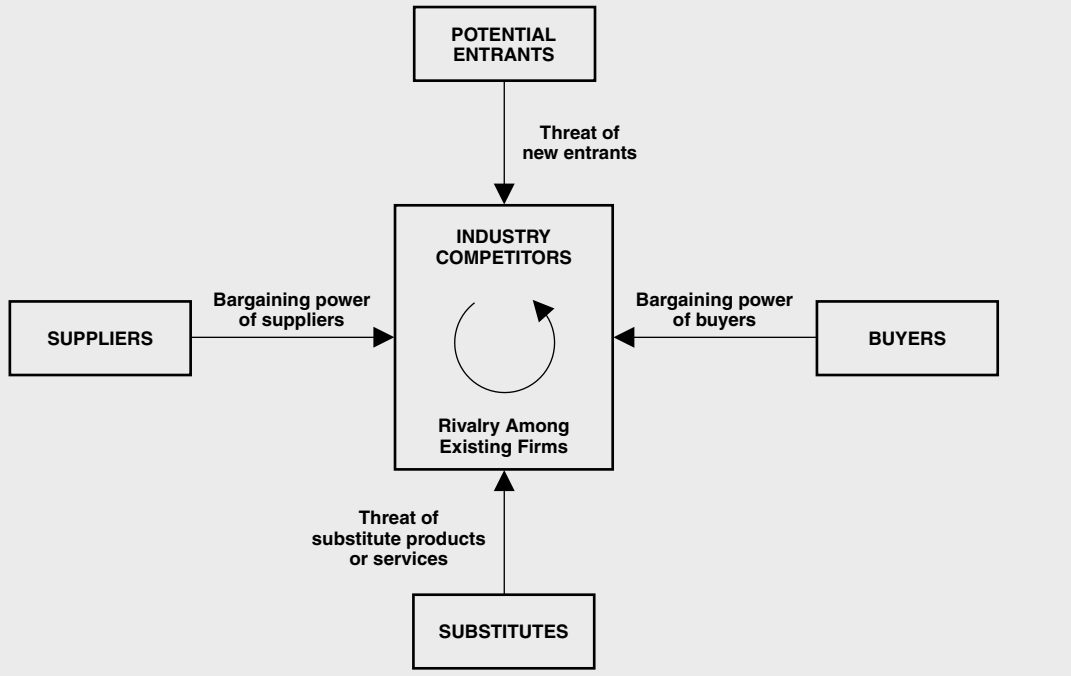
PORTER'S 5-FORCES MODEL

A means of providing corporations with an analysis of their competition and determining strategy, Porter's five-forces model looks at the strength of five distinct competitive forces, which, when taken together, determine long-term profitability and competition. Porter's work has had a greater influence on business strategy than any other theory in the last half of the twentieth century, and his more recent work may have a similar impact on global competition.

Michigan native Michael Porter was born in 1947, was educated at Princeton, and earned an MBA (1971) and Ph.D. (1973) from Harvard. He was promoted to full professor at Harvard at age 34 and is currently C. Roland Christensen Professor of Business Administration at the Harvard Business School. He has published numerous books and articles, the first *Interbrand Choice, Strategy and Bilateral Market Power,* appearing in 1976. His best known and most widely used and referenced books are *Competitive Strategy* (1980) and *Competitive Advantage* (1985). *Competitive Strategy* revolutionized contemporary approaches to business strategy through application of the five-forces model. In *Competitive Advantage,* Porter further developed his strategy concepts to include the creation of a sustainable advantage. His other model, the value chain model, centers on product added value. Porter's work is widely read by business strategists around the world as well as business students. Any MBA student recognizes his name as one of the icons of business literature. The Strategic Management Society named Porter the most important living strategist in 1998, and Kevin Coyne of the consulting firm McKinsey and Co. called Porter "the single most important strategist working today, and maybe of all time."

The five-forces model was developed in Porter's 1980 book, *Competitive Strategy: Techniques for Analyzing Industries and Competitors.* To Porter, the classic means of developing a strategy—a formula for competition, goals, and policies to achieve those goals—was antiquated and in need of revision. Porter was searching for a solution between the two schools of prevailing thought-the Harvard Business School's urging firms to adjust to a unique set of changing circumstances and that of the Boston Consulting Group, based on the experience curve, whereby the more a company knows about the existing market, the more its strategy can be directed to increase its share of the market.

Figure 1



Porter applied microeconomic principles to business strategy and analyzed the strategic requirements of industrial sectors, not just specific companies. The five forces are competitive factors which determine industry competition and include: suppliers, rivalry within an industry, substitute products, customers or buyers, and new entrants (see Figure 1).

Although the strength of each force can vary from industry to industry, the forces, when considered together, determine long-term profitability within the specific industrial sector. The strength of each force is a separate function of the industry structure, which Porter defines as "the underlying economic and technical characteristics of an industry." Collectively, the five forces affect prices, necessary investment for competitiveness, market share, potential profits, profit margins, and industry volume. The key to the success of an industry, and thus the key to the model, is analyzing the changing dynamics and continuous flux between and within the five forces. Porter's model depends on the concept of power within the relationships of the five forces.

THE FIVE FORCES

INDUSTRY COMPETITORS. Rivalries naturally develop between companies competing in the same market. Competitors use means such as advertising, introducing new products, more attractive customer service and warranties, and price competition to enhance their standing and market share in a specific industry. To Porter, the intensity of this rivalry is the result of factors like equally balanced companies, slow growth within an industry, high fixed costs, lack of product differentiation, overcapacity and price-cutting, diverse competitors, high-stakes investment, and the high risk of industry exit. There are also market entry barriers.

PRESSURE FROM SUBSTITUTE PRODUCTS. Substitute products are the natural result of industry competition, but they place a limit on profitability within the industry. A substitute product involves the search for a product that can do the same function as the product the industry already produces. Porter uses the example of security brokers, who increasingly face substitutes in the form of real estate, money-market funds, and insurance. Substitute products take on added importance as their availability increases.

BARGAINING POWER OF SUPPLIERS. Suppliers have a great deal of influence over an industry as they affect price increases and product quality. A supplier group exerts even more power over an industry if it is dominated by a few companies, there are no substitute products, the industry is not an important consumer for the suppliers, their product is essential to the industry, the supplier differs costs, and forward integration potential of the supplier group exists. Labor supply can also influence the position of the suppliers. These factors are generally out of the control of the industry or company but strategy can alter the power of suppliers.

BARGAINING POWER OF BUYERS. The buyer's power is significant in that buyers can force prices down, demand higher quality products or services, and, in

essence, play competitors against one another, all resulting in potential loss of industry profits. Buyers exercise more power when they are large-volume buyers, the product is a significant aspect of the buyer's costs or purchases, the products are standard within an industry, there are few changing or switching costs, the buyers earn low profits, potential for backward integration of the buyer group exists, the product is not essential to the buyer's product, and the buyer has full disclosure about supply, demand, prices, and costs. The bargaining position of buyers changes with time and a company's (and industry's) competitive strategy.

POTENTIAL ENTRANTS. Threats of new entrants into an industry depends largely on barriers to entry. Porter identifies six major barriers to entry:

- Economies of scale, or decline in unit costs of the product, which force the entrant to enter on a large scale and risk a strong reaction from firms already in the industry, or accepting a disadvantage of costs if entering on a small scale.
- Product differentiation, or brand identification and customer loyalty.
- Capital requirements for entry; the investment of large capital, after all, presents a significant risk.
- Switching costs, or the cost the buyer has to absorb to switch from one supplier to another.
- Access to distribution channels. New entrants have to establish their distribution in a market with established distribution channels to secure a space for their product.
- Cost disadvantages independent of scale, whereby established companies already have product technology, access to raw materials, favorable sites, advantages in the form of government subsidies, and experience.

New entrants can also expect a barrier in the form of government policy through federal and state regulations and licensing. New firms can expect retaliation from existing companies and also face changing barriers related to technology, strategic planning within the industry, and manpower and expertise problems. The entry deterring price or the existence of a prevailing price structure presents an additional challenge to a firm entering an established industry.

In summary, Porter's five-forces models concentrates on five structural industry features that comprise the competitive environment, and hence profitability, of an industry. Applying the model means, to be profitable, the firm has to find and establish itself in an industry so that the company can react to the forces of competition in a favorable manner. For Porter, *Competitive Strategy* is not a book for academics but a blueprint for practitioners-a tool for managers to analyze competition in an industry in order to anticipate and prepare for changes in the industry, new competitors and market shifts, and to enhance their firm's overall industry standing.

Throughout the relevant sections of *Competitive Strategy,* Porter uses numerous industry examples to illustrate his theory. Since those examples are now over twenty years old, changes in technology and other industrial shifts and trends have made them somewhat obsolete. Although immediate praise for the book and the five-forces model was exhaustive, critiques of Porter have appeared in business literature. Porter's model does not, for example, consider nonmarket changes, such as events in the political arena that impact an industry. Furthermore, Porter's model has come under fire for what critics see as his under-evaluation of government regulation and antitrust violations. Overall, criticisms of the model find their nexus in the lack of consideration by Porter of rapidly changing industry dynamics. In virtually all instances, critics also present alternatives to Porter's model.

Yet, in a *Fortune* interview in early 1999, Porter responded to the challenges, saying he welcomed the "fertile intellectual debate" that stemmed from his work. He admitted he had ignored writing about strategy in recent years but emphasized his desire to reenter the fray discussing his work and addressing questions about the model, its application, and the confusion about what really constitutes strategy. Porter's *The Competitive Advantage of Nations* (1990) and the more recent *On Competition* (1998) demonstrate his desire to further stimulate discussion in the business and academic worlds.

SEE ALSO: Competitive Advantage; Generic Competitive Strategies; Product Life Cycle and Industry Life Cycle; Strategy Formulation

Boyd Childress

Revised by Hal P. Kirkwood, Jr.

FURTHER READING:

Competitive Advantage: Creating and Sustaining Superior Performance. New York: Free Press, 1998.

Competitive Strategy: Techniques for Analyzing Industries and Competitors. New York: Free Press, 1998.

Mahon, J. F., and R.A. McGowan. "Modeling Industry Political Dynamics." *Business and Society* 37, no. 4 (1998, December): 390–413.

Porter, M.E. *Michael Porter on Competition.* Boston, MA: Harvard Business School Press, 1998.

"Professor Porter Ph.D.: Management Theorists." *Economist, 333* (1994, October): 75.

Siaw, I. and A. Yu. "An Analysis of the Impact of the Internet on Competition in the Banking Industry, Using Porter's Five

Forces Model". International Journal of Management 21, no. 4 (2004, December): 514–524.

Slater, S. F. and E.M.A. Olson. "Fresh Look at Industry and Market Analysis." *Business Horizons* 45. no. 1, (2002, January/February): 15–23.

Surowiecki, J. "The Return of Michael Porter." *Fortune* 139, no. 2 (1999, February): 135–138.

PRICING POLICY AND STRATEGY

Managers should start setting prices during the development stage as part of strategic pricing to avoid launching products or services that cannot sustain profitable prices in the market. This approach to pricing enables companies to either fit costs to prices or scrap products or services that cannot be generated cost-effectively. Through systematic pricing policies and strategies, companies can reap greater profits and increase or defend their market shares. Setting prices is one of the principal tasks of marketing and finance managers in that the price of a product or service often plays a significant role in that product's or service's success, not to mention in a company's profitability. Generally, pricing policy refers how a company sets the prices of its products and services based on costs, value, demand, and competition. Pricing strategy, on the other hand, refers to how a company uses pricing to achieve its strategic goals, such as offering lower prices to increase sales volume or higher prices to decrease backlog. Despite some degree of difference, pricing policy and strategy tend to overlap, and the different policies and strategies are not necessarily mutually exclusive.

After establishing the bases for their prices, managers can begin developing pricing strategies by determining company pricing goals, such as increasing short-term and long-term profits, stabilizing prices, increasing cash flow, and warding off competition. Managers also must take into account current market conditions when developing pricing strategies to ensure that the prices they choose fit market conditions. In addition, effective pricing strategy involves considering customers, costs, competition, and different market segments.

Pricing strategy entails more than reacting to market conditions, such as reducing pricing because competitors have reduced their prices. Instead, it encompasses more thorough planning and consideration of customers, competitors, and company goals. Furthermore, pricing strategies tend to vary depending on whether a company is a new entrant into a market or an established firm. New entrants sometimes offer products at low cost to attract market share, while incumbents' reactions vary. Incumbents that fear the new entrant will challenge the incumbents' customer base may match prices or go even lower than the new entrant to protect its market share. If incumbents do not view the new entrant as a serious threat, incumbents may simply resort to increased advertising aimed at enhancing customer loyalty, but have no change in price in efforts to keep the new entrant from stealing away customers.

The following sections explain various ways companies develop pricing policy and strategy. First, cost-based pricing is considered. This is followed by the second topic of value-based pricing. Third, demand-based pricing is addressed followed by competition-based pricing. After this, several strategies for new and established pricing strategies are explained.

COST-BASED PRICING

The traditional pricing policy can be summarized by the formula:

Cost + Fixed profit percentage = Selling price.

Cost-based pricing involves the determination of all fixed and variable costs associated with a product or service. After the total costs attributable to the product or service have been determined, managers add a desired profit margin to each unit such as a 5 or 10 percent markup. The goal of the cost-oriented approach is to cover all costs incurred in producing or delivering products or services and to achieve a targeted level of profit.

By itself, this method is simple and straightforward, requiring only that managers study financial and accounting records to determine prices. This pricing approach does not involve examining the market or considering the competition and other factors that might have an impact on pricing. Cost-oriented pricing also is popular because it is an age-old practice that uses internal information that managers can obtain easily. In addition, a company can defend its prices based on costs, and demonstrate that its prices cover costs plus a markup for profit.

However, critics contend that the cost-oriented strategy fails to provide a company with an effective pricing policy. One problem with the cost-plus strategy is that determining a unit's cost before its price is difficult in many industries because unit costs may vary depending on volume. As a result, many business analysts have criticized this method, arguing that it is no longer appropriate for modern market conditions. Cost-based pricing generally leads to high prices in weak markets and low prices in strong markets, thereby impeding profitability because these prices are the exact opposites of what strategic prices would be if market conditions were taken into consideration.

While managers must consider costs when developing a pricing policy and strategy, costs alone should not determine prices. Many managers of industrial goods and service companies sell their products and services at incremental cost, and make their substantial profits from their best customers and from short-notice deliveries. When considering costs, managers should ask what costs they can afford to pay, taking into account the prices the market allows, and still allow for a profit on the sale. In addition, managers must consider production costs in order to determine what goods to produce and in what amounts. Nevertheless, pricing generally involves determining what prices customers can afford before determining what amount of products to produce. By bearing in mind the prices they can charge and the costs they can afford to pay, managers can determine whether their costs enable them to compete in the low-cost market, where customers are concerned primarily with price, or whether they must compete in the premium-price market, in which customers are primarily concerned with quality and features.

VALUE-BASED PRICING

Value pricers adhere to the thinking that the optimal selling price is a reflection of a product or service's perceived value by customers, not just the company's costs to produce or provide a product or service. The value of a product or service is derived from customer needs, preferences, expectations, and financial resources as well as from competitors' offerings. Consequently, this approach calls for managers to query customers and research the market to determine how much they value a product or service. In addition, managers must compare their products or services with those of their competitors to identify their value advantages and disadvantages.

Yet, value-based pricing is not just creating customer satisfaction or making sales because customer satisfaction may be achieved through discounting alone, a pricing strategy that could also lead to greater sales. However, discounting may not necessarily lead to profitability. Value pricing involves setting prices to increase profitability by tapping into more of a product or service's value attributes. This approach to pricing also depends heavily on strong advertising, especially for new products or services, in order to communicate the value of products or services to customers and to motivate customers to pay more if necessary for the value provided by these products or services.

DEMAND-BASED PRICING

Managers adopting demand-based pricing policies are, like value pricers, not fully concerned with costs. Instead, they concentrate on the behavior and characteristics of customers and the quality and characteristics of their products or services. Demand-oriented pricing focuses on the level of demand for a product or service, not on the cost of materials, labor, and so forth.

According to this pricing policy, managers try to determine the amount of products or services they can sell at different prices. Managers need demand schedules in order to determine prices based on demand. Using demand schedules, managers can figure out which production and sales levels would be the most profitable. To determine the most profitable production and sales levels, managers examine production and marketing costs estimates at different sales levels. The prices are determined by considering the cost estimates at different sales levels and expected revenues from sales volumes associated with projected prices.

The success of this strategy depends on the reliability of demand estimates. Hence, the crucial obstacle managers face with this approach is accurately gauging demand, which requires extensive knowledge of the manifold market factors that may have an impact on the number of products sold. Two common options managers have for obtaining accurate estimates are enlisting the help from either sales representatives or market experts. Managers frequently ask sales representatives to estimate increases or decreases in demand stemming from specific increases or decreases in a product or service's price, since sales representatives generally are attuned to market trends and customer demands. Alternatively, managers can seek the assistance of experts such as market researchers or consultants to provide estimates of sales levels at various unit prices.

COMPETITION-BASED PRICING

With a competition-based pricing policy, a company sets its prices by determining what other companies competing in the market charge. A company begins developing competition-based prices by identifying its present competitors. Next, a company assesses its own product or service. After this step, a company sets it prices higher than, lower than, or on par with the competitors based on the advantages and disadvantages of a company's product or service as well as on the expected response by competitors to the set price. This last consideration-the response of competitors-is an important part of competition-based pricing, especially in markets with only a few competitors. In such a market, if one competitor lowers its price, the others will most likely lower theirs as well.

This pricing policy allows companies to set prices quickly with relatively little effort, since it does not require as accurate market data as the demand pricing. Competitive pricing also makes distributors more receptive to a company's products because they are priced within the range the distributor already handles. Furthermore, this pricing policy enables companies to

select from a variety of different pricing strategies to achieve their strategic goals. In other words, companies can choose to mark their prices above, below, or on par with their competitors' prices and thereby influence customer perceptions of their products. For example, if a Company A sets its prices above those of its competitors, the higher price could suggest that Company A's products or services are superior in quality. Harley Davidson used this with great success. Although Harley-Davidson uses many of the same parts suppliers as Honda, Kawasaki, Yamaha, and Honda, they price well above the competitive price of these competitors. Harley's high prices combined with its customer loyalty and mystique help overcome buyer resistance to higher prices. Production efficiencies over the last two decades, however, have made quality among motorcycle producers about equal, but pricing above the market signals quality to buyers, whether or not they get the quality premium they pay for.

STRATEGIES FOR NEW AND ESTABLISHED PRODUCTS

Product pricing strategies frequently depend on the stage a product or service is in its life cycle; that is, new products often require different pricing strategies than established products or mature products.

NEW PRODUCT PRICING STRATEGY. Entrants often rely on pricing strategies that allow them to capture market share quickly. When there are several competitors in a market, entrants usually use lower pricing to change consumer spending habits and acquire market share. To appeal to customers effectively, entrants generally implement a simple or transparent pricing structure, which enables customers to compare prices easily and understand that the entrants have lower prices than established incumbent companies.

Complex pricing arrangements, however, prevent lower pricing from being a successful strategy in that customers cannot readily compare prices with hidden and contingent costs. The long-distance telephone market illustrates this point; large corporations have lengthy telephone bills that include numerous contingent costs, which depend on location, use, and service features. Consequently, competitors in the corporate long-distance telephone service market do not use lower pricing as the primary pricing strategy, as they do in the consumer and small-business markets, where telephone billing is much simpler.

Another example is the computer industry. Dell, Fujitsu, HP, and many others personal computer makers offer bundles of products that make it more difficult for consumers to sort out the true differences among these competitors. For example, consumers purchasing an HP computer from the retailer, Best Buy, will have not only the computer itself, but also six months of "free" Internet access bundled into the price. Comparing the absolute value of each personal computer become more difficult as an increasing number of other products such as Quicken, Adobe's Photoshop Elements, and other software are sold together with the purchase. For Macintosh users or for those who might consider switching from a personal computer to a Macintosh, Apple announced in 2005 that it would begin selling the Mac Mini, a Macintosh that, as with PC makers, bundles its iLife® software into the mix. By extending its brand to non-premium price tiers, Apple will compete head-to-head with established firms. And although the Mac Mini is at a low price point, starting at $499, it will be difficult for consumers to directly compare the bundled products of PCs directly with the bundled products of Apple's Mac Mini. The complexity of these comparisons is what can make such new product pricing successful.

ESTABLISHED PRODUCT PRICING STRATEGY. Sometimes established companies need not adjust their prices at all in response to entrants and their lower prices, because customers frequently are willing to pay more for the products or services of an established company to avoid perceived risks associated with switching products or services.

However, when established companies do not have this advantage, they must implement other pricing strategies to preserve their market share and profits. When entrants are involved, established companies sometimes attempt to hide their actual prices by embedding them in complex prices. This tactic makes it difficult for customers to compare prices, which is advantageous to established companies competing with entrants that have lower prices. In addition, established companies also may use a more complex pricing plan, such as a two-part pricing tactic. This tactic especially benefits companies with significant market power. Local telephone companies, for example, use this strategy, charging both fixed and per-minute charges.

MARKET SEGMENTATION

Because all customers do not have the same needs, expectations, and financial resources, managers can improve their pricing strategies by segmenting markets. Successful segmentation comes about when managers determine what motivates particular markets and what differences exist in the market when taken as a whole. For example, some customers may be motivated largely by price, while others are motivated by functionality and utility. The idea behind segmentation is to divide a large group into a set of smaller groups that share significant characteristics such as age, income, geographic location, lifestyle, and so on. By dividing a market into two or more segments, a company can devise a pricing scheme that will appeal to the motivations of each of the different

market segments or it can decide to target only particular segments of the market that best correspond to its products or services and their prices.

Managers can use market segmentation strategically to price products or services in order to attain company objectives. Companies can set prices differently for different segments based on factors such as location, time of sale, quantity of sale, product design, and a number of others, depending on the way companies divide up the market. By doing so, companies can increase their profits, market share, cash flow, and so forth.

SEE ALSO: Product Design; Product Life Cycle and Industry Life Cycle; Product-Process Matrix; Strategy Formulation

Karl Heil
Revised by Scott B. Droege

FURTHER READING:

Kardes, F.R., M.L. Cronley, J.J. Kellaris, and S.S. Posavac. "The Role of Selective Information Processing in Price-Quality Inference." *Journal of Consumer Research* 31, no. 2 (2004): 368–375.

Meyvis, T. and C. Janiszewski. "When Are Broader Brands Stronger Brands? An Accessibility Perspective on the Success of Brand Extensions." *Journal of Consumer Research* 31, no. 2 (2004): 346–358.

Potter, D. "Confronting Low-End Competition." *MIT Sloan Management Review* 45, no. 4 (2004): 73–79.

Smagalla, D. "Does Promotion Pricing Grow Future Business?" *MIT Sloan Management Review* 45, no. 4 (2004): 9.

PROBLEM SOLVING

A managerial problem can be described as the gap between a given current state of affairs and a future desired state. Problem solving may then be thought of as the process of analyzing the situation and developing a solution to bridge the gap. While it is widely recognized that different diagnostic techniques are appropriate in different situations, problem solving as a formal analytical framework applies to all but the simplest managerial problems. The framework is analogous to the scientific method used in chemistry, astronomy, and the other physical sciences. In both cases, the purpose underlying the analytic process is to minimize the influence of the investigator's personal biases, maximize the likelihood of an accurate result, and facilitate communication among affected parties.

Problem solving was popularized by W. Edwards Deming and the expansion of the total quality management movement in the 1980s. While Deming described what he called the Shewhart cycle, the technique is more commonly known as the Deming Wheel or simply as the PDCA cycle. Regardless of the name, a problem solver is urged to follow a step-by-step approach to problem solving-plan, do, check, act (hence the PDCA acronym).

In the planning stage, a manager develops a working hypothesis about why a given problem exists and then develops a proposed solution to the problem. The second step is to implement, or do, the proposed remedy. Next, the manager studies or checks the result of the action taken. The focus of this review is to determine whether the proposed solution achieved the desired result-was the problem solved? The fourth step then depends upon the interpretation of the check on results. If the problem was solved, the manager acts to institutionalize the proposed solution. This might mean establishing controls or changing policy manuals to ensure that the new way of doing business continues. However, if the check indicates that the problem was not solved or was only partially corrected, the manager acts by initiating a new cycle. Indeed, the technique is represented as a cycle based on the belief that many problems are never fully solved. For example, suppose that the problem in a given manufacturing facility is determined to be that labor productivity is too low. A change in processing methods may be found to successfully increase labor productivity. However, this does not preclude additional increases in labor productivity. Therefore, the PDCA cycle suggests that managers should pursue a course of continuous improvement activity.

The problem-solving framework can be used in a wide variety of business situations, including both large-scale management-change initiatives and routine improvement or corrective activity. Indeed, management consultants may be thought of as professional problem solvers. By relying on the proven problem-solving framework, external consultants are often able to overcome their lack of specific industry experience or knowledge of an organization's internal dynamics to provide meaningful analysis and suggestions for improvement. To more fully explore the issues presented by problem solving, the four-step PDCA cycle is expanded to a nine-step framework in the next section.

Perhaps the only generalizable caveat regarding problem solving is to guard against overuse of the framework. For example, Florida Power & Light became well known for their problem-solving ability in the late 1980s. One of their most successful initiatives was to institute an aggressive tree-trimming program to anticipate and prevent power failure due to downed limbs falling on electrical lines during storms. They were so successful that

they integrated the problem-solving framework into their day-to-day managerial decision making and organizational culture. While this resulted in well reasoned decisions, it also meant that implementing even simple changes like moving a filing cabinet closer to the people using it required an overly bureaucratic approval process. This phenomenon is commonly referred to as paralysis of analysis. Therefore, managers should remain aware of the costs in both time and resources associated with the problem-solving framework. Accordingly, the nine-step framework described below is offered as a suggested guide to problem solving. Managers should feel free to simplify the framework as appropriate given their particular situation.

THE PROBLEM-SOLVING FRAMEWORK

PROBLEM IDENTIFICATION. Although business problems in the form of a broken piece of machinery or an irate customer are readily apparent, many problems present themselves in a more subtle fashion. For example, if a firm's overall sales are increasing, but its percentage of market share is declining, there is no attention-grabbing incident to indicate that a problem exists. However, the problem-solving framework is still helpful in analyzing the current state of affairs and developing a management intervention to guide the firm toward the future desired state. Therefore, a solid approach to problem solving begins with a solid approach to problem identification. Whatever techniques are used, a firm's approach to problem identification should address three common identification shortfalls. First and most obviously, the firm wants to avoid being blindsided. Many problems develop over time; however, unless the firm is paying attention, warning signals may go unheeded until it is too late to effectively respond. A second common error of problem identification is not appropriating properly. This means that although a firm recognizes that an issue exists, they do not recognize the significance of the problem and fail to dedicate sufficient resources to its solution. It can be argued that not prioritizing properly has kept many traditional retail firms from responding effectively to emerging internet-based competitors. Finally, a third common error in problem identification is overreaction-the Chicken Little syndrome. Just as every falling acorn does not indicate that the sky is falling, neither does every customer complaint indicates that a crisis exists. Therefore, a firm's problem identification methods should strive to present an accurate assessment of the problems and opportunities facing the firm.

While no specific problem-identification technique will be appropriate for every situation, there are several techniques that are widely applicable. Two of the most useful techniques are statistical process control (SPC) and benchmarking. SPC is commonly used in the repetitive manufacturing industries, but can also prove useful in any stable production or service-delivery setting. A well formulated SPC program serves to inform managers when their operational processes are performing as expected and when something unexpected is introducing variation in process outputs. A simplified version of SPC is to examine performance outliers-those instances when performance was unusually poor or unusually good. It is believed that determining what went wrong, or conversely what went right, may inspire process or product modifications. Competitive benchmarking allows managers to keep tabs on their competition and thereby gauge their customers' evolving expectations. For instance, benchmarking might involve reverse engineering-disassembling a competitor's product-to study its design features and estimate the competitor's manufacturing costs. Texas Nameplate Company, Inc., a 1998 Malcolm Baldrige National Quality Award winner, uses competitive benchmarking by periodically ordering products from their competitors to compare their delivery-time performance.

Additional listening and problem identification techniques include the time-tested management-by-walking-around, revamped with a Japanese influence as going to gemba. The technique suggests that managers go to where the action is-to the production floor, point of delivery, or even to the customer's facilities to directly observe how things are done and how the product is used. Other methods include active solicitation of customer complaints and feedback. Bennigan's Restaurants offer a five-dollar credit toward future purchases to randomly selected customers who respond to telephone surveys on their satisfaction with their most recent restaurant visit. Granite Rock Company, a 1992 Baldrige Award winner, goes even farther by allowing customers to choose not to pay for any item that fails to meet their expectations. All that Granite Rock asks in return is an explanation of why the product was unsatisfactory.

PROBLEM VERIFICATION. The amount of resources that should be dedicated to verification will vary greatly depending upon how the problem itself is manifested. If the problem is straightforward and well-defined, only a cursory level of verification may be appropriate. However, many business problems are complex and ill defined. These situations may be similar to the case of a physician who is confronted with a patient that has self-diagnosed his medical condition. While considering the patient's claim, the doctor will conduct her own analysis to verify the diagnosis. Similarly, the need for verification is especially important when a manager is asked to step in and solve a problem that has been identified by someone else. The introduction of the manager's fresh perspective and the possibility of a hidden agenda on the part of the individual who initially identified the issue under consideration suggests that a "trust, but verify" approach

may be prudent. Otherwise, the manager may eventually discover she has expended a great deal of time and effort pursuing a solution to the wrong problem.

In the case of particularly ambiguous problems, McKinsey & Company, a management-consulting group, uses a technique they call Forces at Work. In this analysis, McKinsey's consultants review the external pressures on the client firm arising from suppliers, customers, competitors, regulators, technology shifts, and substitute products. They then attempt to document the direction and magnitude of any changes in the various pressures on the firm. In addition, they review any internal changes, such as shifts in labor relations or changes in production technology. Finally, they look at how the various factors are impacting the way the firm designs, manufactures, distributes, sells, and services its products. Essentially, McKinsey attempts to create comprehensive before-and-after snapshots of their client's business environment. Focusing on the differences between the two, they hope to identify and clarify the nature of the challenges facing the firm.

PROBLEM DEFINITION. The next step in problem solving is to formally define the problem to be addressed. This is a negotiation between the individuals tasked with solving the problem and the individuals who oversee their work. Essentially, the parties need to come to an agreement on what a solution to the problem will look like. Are the overseers anticipating an implementation plan, a fully operational production line, a recommendation for capital investment, or a new product design? What metrics are considered important-cycle time, material costs, market share, scrap rates, or warranty costs? Complex problems may be broken down into mutually exclusive and collectively exhaustive components, allowing each piece to be addressed separately. The negotiation should recognize that the scope of the problem that is defined will drive the resource requirements of the problem solvers. The more focused the problem definition, the fewer resources necessary to generate a solution. Finally, the time frame for problem analysis should also be established. Many business problems require an expedited or emergency response. This may mean that the problem solvers need to generate a temporary or interim solution to the problem before they can fully explore the underlying causes of the problem. Ensuring that the overseers recognize the limitations inherent in an interim solution serves to preserve the credibility of the problem solvers.

ROOT-CAUSE ANALYSIS. Now that the problem has been formally defined, the next step is for the problem solvers to attempt to identify the causes of the problem. The ultimate goal is to uncover the root cause or causes of the problem. The root cause is defined as that condition or event that, if corrected or eliminated, would prevent the problem from occurring. However, the problem solver should focus on potential root causes they are within the realm of potential control. For example, finding that a particular weight of motor oil is insufficient to protect an engine from overheating readily leads to an actionable plan for improvement. Finding that the root cause of a problem is gravity does not.

A common technique for generating potential root causes is the cause-and-effect diagram (also known as the fishbone or Ishikawa diagram). Using the diagram as a brainstorming tool, problem solvers traditionally review how the characteristics or operation of raw materials, labor inputs, equipment, physical environment, and management policies might cause the identified problem. Each branch of the diagram then becomes a statement of a causal hypothesis. For example, one branch of the diagram might suggest that low salaries are leading to high employee turnover, which in turn results in inexperienced operators running the machinery, which leads to a high scrap rate and ultimately higher material costs. This analysis suggests that to address the problem of high material costs, the firm may have to address the root cause of insufficient salaries.

Collection and examination of data may also lead the problem solver toward causal hypotheses. Check sheets, scatter plots, Pareto diagrams, data stratification, and a number of other graphical and statistical tools can aid problem solvers as they look for relationships between the problems identified and various input variables. Patterns in the data, changes in a variable over time, or comparisons to similar systems may all be useful in developing working theories about why something is happening. The problem solver should also consider the possibility of multiple causes or interaction effects. Perhaps the problem manifests only when a specific event occurs and certain conditions are met-the temperature is above 85 degrees or the ambient humidity is abnormally low.

Once the problem solver has identified the likely root causes of the problem, an examination of the available evidence should be used to confirm or disconfirm which potential causes actually are present and impacting the performance under consideration. This might entail developing an experiment where the candidate cause is controlled to determine whether its manipulation influences the presence of the problem. At this stage of the analysis, the problem solver should remain open to disconfirming evidence. Many elegant theories fail to achieve the necessary confirmation when put to the test. At this stage of the analysis it is also common for the problem solver to discover simple, easily implemented actions that will solve all or part of the problem. If this occurs, then clearly the problem solver should grasp the opportunity to "pick the low hanging fruit." Even if only a small component of the problem is solved, these interim wins serve to build momentum and add credibility to the problem-solving process.

ALTERNATIVE GENERATION. Once the root causes of the problem have been identified, the problem solver can concentrate on developing approaches to prevent, eliminate, or control them. This is a creative process. The problem solver should feel free to challenge assumptions about how business was conducted in the past. At times, an effective approach is to generalize the relationship between the cause and the problem. Then the problem solver can look for similar relationships between other cause and effects that might provide insight on how to address the issues at hand. In general, it is useful to attempt to generate multiple candidate solutions. By keeping the creative process going, even after a viable solution is proposed, the problem solver retains the possibility of identifying a more effective or less expensive solution to the problem.

EVALUATION OF ALTERNATIVES. Assuming that the problem was well defined, evaluation of the effectiveness of alternative solutions should be relatively straightforward. The issue is simply to what extent each alternative alleviates the problem. Using the metrics previously identified as important for judging success, the various alternatives can generally be directly compared. However, in addition to simply measuring the end result, the problem solvers may also want to consider the resources necessary to implement each solution. Organizations are made up of real people, with real strengths and weaknesses. A given solution may require competencies or access to finite resources that simply do not exist in the organization. In addition, there may be political considerations within the organization that influence the desirability of one alternative over another. Therefore, the problem solver may want to consider both the tangible and intangible benefits and costs of each alternative.

IMPLEMENTATION. A very common problem-solving failure is for firms to stop once the plan of action is developed. Regardless of how good the plan is, it is useless unless it is implemented. Therefore, once a specific course of action has been approved, it should continue to receive the necessary attention and support to achieve success. The work should be broken down into tasks that can be assigned and managed. Specific milestones with target dates for completion should be established. Traditional project management techniques, such as the critical path method (CPM) or the program evaluation and review technique (PERT) are very useful to oversee implementation efforts.

POST-IMPLEMENTATION REVIEW. Another common failure is for firms to simply move on after a solution has been implemented. At a minimum, a post-implementation evaluation of whether or not the problem has been solved should be conducted. If appropriate and using the metrics that were established earlier, this process should again be relatively straightforward-were the expected results achieved? The review can also determine whether additional improvement activities are justified. As the PDCA cycle suggests, some problems are never solved, they are only diminished. If the issue at hand is of that nature, then initiating a new cycle of problem-solving activity may be appropriate.

A secondary consideration for the post-implementation review is a debriefing of the problem solvers themselves. By its very nature, problem solving often presents managers with novel situations. As a consequence, the problem-solving environment is generally rich in learning opportunities. To the extent that such learning can be captured and shared throughout the organization, the management capital of the firm can be enhanced. In addition, a debriefing may also provide valuable insights into the firm's problem-solving process itself. Given the firm's unique competitive environment, knowing what worked and what did not may help focus future problem-solving initiatives.

INSTITUTIONALIZATION AND CONTROL. The final step in problem solving is to institutionalize the results of the initiative. It is natural for any system to degrade over time. Therefore, any changes made as a result of the problem-solving effort should be locked in before they are lost. This might entail amending policy manuals, establishing new control metrics, or even rewriting job descriptions. In addition, the firm should also consider whether the problem addressed in the initiative at hand is an isolated incident or whether the solution can be leveraged throughout the organization. Frequently, similar problems are present in other departments or other geographic locations. If this is the case, institutionalization might involve transferring the newly developed practices to these new settings.

SEE ALSO: Project Management

Daniel R. Heiser
Revised by Badie N. Farah

FURTHER READING:

Deming, W. Edwards. *Out of the Crisis.* Cambridge: Massachusetts Institute of Technology, Center for Advanced Engineering Study, 1992.

Ketola, Jeanne and Kathy Roberts. *Correct! Prevent! Improve!: Driving Improvement Through Problem Solving and Corrective and Preventive Action.* Milwaukee: ASQ Quality Press, 2003.

National Institute of Standards and Technology. "Award Recipients." Malcolm Baldrige National Quality Award Program, 1999. Available from <www.quality.nist.gov>.

Rasiel, Ethan M. *The McKinsey Mind: Using the Techniques of the World's Top Strategic Consultants to Help You and Your Business.* New York: McGraw-Hill, 2001.

———. *The McKinsey Way—Understanding and Implementing the Problem-Solving Tools and Management Techniques of the World's Top Strategic Consulting Firm.* New York: McGraw-Hill, 1999.

Smith, Gerald F. *Quality Problem Solving.* Milwaukee: ASQ Quality Press, 1998.

PROCESS MANAGEMENT

Process management is a concept that integrates quality/performance excellence into the strategic management of organizations. It is Category 6.0 of the Malcolm Baldrige National Quality Award. Process management includes (1) process design or engineering, which is the invention of new processes; (2) process definition, which requires the description of existing processes; (3) process documentation; (4) process analysis and control; and (5) process improvement.

Process design and definition include describing what must be done and how it is to be accomplished. After defining a process, it must be documented using a flowchart, a process map, or even a simple checklist. Until the process is described and documented, one cannot be assured that a process is in place. At that point, the process can be analyzed and improved.

There are many process analysis tools, including cause-and-effect diagrams, statistical process control, and trend analyses. Process improvement may result from gradual, continuous improvement or a dramatic reinvention or reengineering of the process.

HISTORICAL PERSPECTIVE

Process management can trace its roots back to the early days of industrial engineering and quality management (quality control and quality engineering). The earliest focus was on streamlining factory processes to increase productivity. However, process management concepts are now used in all types of organizations to improve process baselines (safety, quality, cycle time, productivity, on-time delivery, etc.), as well as to improve financial and operational results.

In 1911, Frederick Taylor published *The Principles of Scientific Management.* Some of his ideas are the predecessors for modern industrial engineering tools and concepts that are used to reduce cycle time and/or improve productivity. Frank and Lillian Gilbreth also used time and motion studies to improve processes and to increase productivity by evaluating how much time it took to do each task within a process, and the best way to do each task (the motions involved). Their work and personal lives were publicized in the book, *Cheaper by the Dozen.*

One of the world's leading experts on improving the manufacturing process, Shigeo Shingo, created with Taiichi Ohno, many of the features of just-in-time (JIT) manufacturing methods, systems, and processes that constitute the Toyota Production System. Much of Shingo's work is documented in books he has written, such as *A Study of the Toyota Production System From An Industrial Engineering Viewpoint* (1989).

Experts in the field of quality developed many process-management concepts and tools:

1. Dr. W. Edwards Deming (1900–1993) is famous for his work in Japan in the 1950s and for theories such as his Fourteen Points and Plan-Do-Check-Act (PDCA) Cycle (also referred to as the Shewhart Cycle). He also refined and publicized other concepts and tools, including statistical process control. Many of Dr. Deming's theories are contained in his book, *Out of the Crisis.*
2. Dr. Joseph Juran (b.1904) also worked with the Japanese beginning in the 1950s. Some of his theories supporting process management are Juran's Trilogy (process planning, process control, and process improvement); Big Q (the quality department is responsible for quality) vs. Little Q (everyone is responsible for quality); and the Quality Planning Roadmap. Juran's books include *Juran's Quality Control Handbook* and *A History of Managing for Quality.*
3. Dr. Kaoru Ishikawa, author of *Guide to Quality Control,* invented the cause-and-effect diagram and taught people involved in teams (quality circles) to ask what caused each effect.
4. Dr. Walter Shewhart, a statistician who worked at Western Electric, Bell Laboratories and who used statistics to explain process variability, first published his theories in his book *Economic Control of Quality of Manufactured Product* (1931).

PROCESS THINKING

Examples of simple, essential questions in process thinking are:

1. What is a process?
2. Who are the internal and external customers of a process?
3. Who are the process owners?
4. Who improves processes-process owners, customers, suppliers?
5. How do you improve processes?
6. What might not add value for customers?
7. What role does measurement play?

WHAT IS A PROCESS?

A process is a series of connected steps or actions with a beginning and an end that can be replicated. Organizations should be viewed as a set or hierarchy

of processes that produce outputs of value to a customer, as well as a set of functions such as engineering, manufacturing, accounting, and marketing.

The most successful organizations are managed from a horizontal (process) perspective, as well as from a vertical (function) perspective. Understanding an organization from the process perspective will cause changes in the way one thinks about people and processes as depicted in Figure 1.

Figure 1

Functional Focus	Cross-Funcitonal (Process) Focus
Employees are the problem.	The process is the problem.
Measure individuals.	Measure process results.
Motivate people.	Remove process barriers and constraints.
Who made this error?	What caused the error?
Evaluate employees.	Evaluate the process.
Vertical organizations.	Cross-functional (horizontal) organizations.

Examples of processes in various organizations are included in the following list. Please note that many of the processes could be found in all the various organization types.

1. University
   - Teaching Students
   - Paying for Classes
2. Hospital
   - Emergency Care
   - Payroll
3. Factory
   - Purchasing Material
   - Training Workers
4. Federal Agency
   - Procurement
   - Hiring New Employees
5. Retail Store
   - Selling Products
   - Employee Scheduling
6. Bank
   - Opening New Accounts
   - Statement Distribution
7. Church
   - Recruiting Members
   - Maintaining Facilities
8. Restaurant
   - Preparing Meals
   - Advertising
9. Construction
   - Budgeting
   - Managing Subcontractors
10. Not for Profit
    - Distribution of Funds
    - Employee Recruitment

A process involves the steps or stages by which inputs such as people, materials, methods, machines, and environment are transformed into outputs (products and services).

WHO ARE THE CUSTOMERS OF A PROCESS?

Because a transformation process exists to satisfy customer requirements, process owners need to understand who their customers are, what they want, and how to provide what they want. The customers of a process are the people who require the products and services that are the result of the process or one phase of the process. They are classified as: (1) external customers-people who ultimately use the products and/or services (process outputs or work results) of an organization; and (2) internal customers—the owners of the next phases in the process who must wait for the delivery of a product or service before completing work.

External and internal customers must be satisfied if organizations are to experience the highest levels of success. Individuals and teams must understand their roles as suppliers to internal and external customers if customer satisfaction is to be a reality. At the same time, individuals and teams must act as internal customers who communicate requirements to internal suppliers.

CUSTOMER/SUPPLIER RELATIONSHIPS. Concepts relating to customer/supplier relationships and satisfaction are as follows:

- Customers (internal and external) have a right to expect quality products and services.
- Every member of an organization has an internal customer—the next phase in the process.
- If each team member treats other team members like valuable customers, relationships

and work results (individual and team performance) will improve.

- The customer determines if the product or service is what he or she ordered and if it has the value expected and promised by the supplier.

Individuals and team members should ask internal customers and suppliers, "How am I doing?" and "What did you expect compared to what I gave you?" The answer will assist in improving processes, products, services, and relationships.

Basically, customers want to be their suppliers' first priority. They want (and deserve) perfect products and services delivered on or ahead of schedule at the lowest possible cost. They expect suppliers to be in the improvement mode of operation so that the customers are assured of paying a competitive price.

Perfection is the aspiration, level-improvement is the goal. Whatever today's standard is, tomorrow's customers will require more. It is the responsibility of the supplier to remain on a journey toward perfection; to determine current baselines for important customer requirements such as safety, quality, schedule, and cost; and to determine what process and relationship improvements are necessary to improve those baselines.

RELATIONSHIPS AMONG QUALITY, SCHEDULE, AND COST. One of the things that must be done when evaluating and improving processes is to establish process baselines. The baselines for quality, schedule, and cost are so interwoven that it is difficult to measure and improve one of them without considering the other. This is as it should be since customers want the highest quality products and services on or ahead of schedule and at the lowest possible price.

If you improve the quality of processes and relationships, you can expect other baselines (e.g., quality, schedule, and cost) to improve. While quality, schedule, and cost are measured as separate baselines, long-term improvement is interdependent and process focused.

Customers expect speed of delivery as well as quality. Therefore, objectives of process management are customer satisfaction and retention through the improvement of quality and cycle time. In order to satisfy and retain external customers, suppliers should:

1. Be competitive based on speed as well as quality.
2. Provide real-time information to internal and external customers.
3. Design and streamline processes so that they are free of defects, constraints, and activities that do not add value for the customer.
4. Eliminate procrastination.
5. Change paradigms based on sequential decision making to paradigms that include concurrent decision making, as well as concurrent engineering.
6. Empower workers to dismantle time-wasting bureaucracy.

WHO ARE THE PROCESS OWNERS?

The process owners (the people who actually do the jobs) are the most knowledgeable about the processes by which they accomplish their work. Therefore, if process evaluation and improvement becomes an integral part of daily work, safety improvement, defect prevention, and cycle-time reduction can become a reality. Process owners are those empowered to do work, improve how they do the work, and accept accountability as process owners.

PROCESS EVALUATION AND IMPROVEMENT. An essential concept in process management is that all processes have improvement potential. If organizations only focus on current processes, current problems, and doing the things that are currently done, they may eventually encounter a variety of problems, such as:

- They may continue making a product (e.g., buggy whips) long after the market is gone. These perfect products may have no customers.
- They may do everything in a process perfectly, but they may be doing many things that do not need to be done at all (efficient, not effective).
- They may be focusing only on quality, when speed is also important.
- They may miss opportunities to improve products, services, processes, and relationships.

WHO IMPROVES PROCESSES?

People who know the most about processes and who are most capable of evaluating and improving them are process owners—people who are accountable for process output or results. However, feedback from customers and suppliers contributes a great deal to improvement.

Examples of data a customer could provide include (1) whether the product or service meets the customer's needs/expectations; (2) whether there are any defects or discrepancies; and (3) whether the product or service is delivered on-time or early.

Examples of data suppliers could provide are (1) whether the customer's requirements (e.g., purchase orders) were clear and understandable; and (2) whether

Figure 2

Area of Difference	Continuous Improvement	Reengineering
Reason for change	Desire to improve baselines	Compelling (rapid process redesign for survival)
Targets	Small improvement in every process; cumulative effects	Aggressive (e.g., 10 times or more, six sigma, etc.)
Approach	Nonstructured	Structured and disciplined
Scope	Evaluation of all steps in all processes	Broad cross-functional processes
Focus	Parts of a system	Relations in system
Level of change	Incremental and continuous	Order of magnitude
Organizational structure	Vertical or horizontal	Flattened, horizontal
Involvement of executives	Important up-front; support throughout	Intensive long-term involvement
Involvement of all employees	Gradual voluntary involvement	Nonvoluntary
Use of terms	Work teams and cross-functional team	Cross-functional teams
Role of information	Incidental	Cornerstone

customers met lead-time requirements when placing orders.

HOW DO YOU IMPROVE PROCESSES?

Improvement may be gradual and continuous (i.e., kaizen, continuous process improvement), or it may be dramatic process redesign (i.e., process reengineering). The differences between the two are depicted in Figure 2.

Both gradual, continuous improvement and process reengineering should be an integral part of process management and improvement.

The following are some of the things people can do to improve processes:

- Use a structured methodology such as the Golden-Pryor Improvement Checklist.
- Eliminate activities that do not add value for the customer. Ask yourself: "Would the customer want to pay for this activity?" If the answer is no, ask yourself: "Why are we doing this? Is it a federal law? A state law?" If the answer is no, ask yourself: "What benefit do we gain by doing this?" At this point, you are coming close to eliminating the activity.
- Eliminate constraints—things that frustrate employees and slow processes.
- Streamline/simplify processes. It is difficult to document and teach people complex processes.
- Once processes are streamlined, computerize them if feasible.
- Provide leadership in a positive direction. Function as a strategist. Envision and invent the future with streamlined processes and relationships.
- Act empowered; be accountable. As individuals and members of teams, function as process owners and consider process management and improvement an integral part of daily work. Don't say, "They won't let us . . ." Make decisions, not excuses.
- Document and publicize improvements. Success breeds success.
- Continue to monitor and evaluate processes to identify additional opportunities for improvement.
- Ask (and teach others to ask) what, where, why, who, when, and how questions about each step in a process (or job).

PROCESS QUESTIONS.

What:

- is there to do?
- is being done?
- should be done?
- can be done?
- constraints keep us from doing it?

Who:

- does this job?
- should do this job?
- knows how to do it?
- should know how to do it?

Where:

- is this job done?
- should it be done?

• can it be done?

When:

• is this job done?

• should it be done?

• can it be done?

When process-improvement efforts fail, it is generally because people have a deficiency in knowledge—they do not know what actions to take. They should be trained on specific improvement methodologies, and they should be held accountable for documenting improvement results.

Improvement team members generally need a model that provides them common knowledge about what they are required to do individually and as a team, such as the Golden Pryor Improvement Checklist in Figure 3.

WHAT MIGHT NOT ADD VALUE?

The concept of value implies worth; value is something that a customer would expect to pay for, such as labor to design, build, and deliver a product or service. Customers want to pay for perfect products and services delivered on or ahead of schedule at the lowest reasonable cost. They only want to pay for activities that add value to products and services, and to processes and relationships that impact the products and services.

WHAT ROLE DOES MEASUREMENT PLAY?

Organizational leaders are accustomed to measuring things that are important to themselves. They also need to measure items that are important to customers. Improving process results does not require sophisticated measurements. It requires systematic identification and elimination of root causes of problems, process constraints, and activities that do not add value. It is as much continuous learning as it is continuous improvement. Improvement results from learning that is fed back and used as the basis for the next decisions.

Quality products and services are the result of quality processes that exist because of quality people who build quality relationships and streamline processes. Specific measurements must be established for individual phases of a process in addition to the final process output. The following can apply in any organization in any industry:

• Quality—first pass yield, scrap, rework, repair.

Figure 3

Golden Pryor Process Improvement Checklist

I. Determine what work processes you Own and list them. Classify them as critical or ancillary.

II. Describe and flowchart each process.

A. Choose which process to evaluate first.

1. **Identify and list process and decision steps.**
2. **Identify and remove non-value-added steps.**
3. **Identify and remove process constraints for each phrase of the process.**
4. **If flowcharts do not reflect requirements, change the process or change the requirement documents (directives, procedures, etc.)**

B. Using flowcharts, determine the customer and suppliers for each process.

III. Establish quality measurements. Define quality for the output(s) of each process and identify data sources.

IV. Establish time measurements (cycle-time, on-time delivery, etc.)

A. Determine static cycle time (process flow time).

1. **Compute cycle time for sub-processes and total process cycle time.**
2. **Identify slack time/queue time.**
3. **Establish perfect cycle times (no constraints, bottlenecks, or excess queue time).**
4. **Search a second time for non-value-added-activities and eliminate those that still exist. Examples: Redundant Inspection, unnecessary documentation, unnecessary handling, meetings without agendas.**

B. Identify other measurements relating to time and establish process baselines.

V. Establish other baselines and measurements.

A. Safety (e.g., classrooms, discipline problems, acts of violence).
B. Customer satisfaction (e.g., level of satisfaction with products or services and trends).
C. Human resources (hours of training, % multiple skills/job rotations, absenteeism, etc.)

VI. Identify process baselines with greatest improvement potential.

VII. Use TQM/SPC tools to determine system improvement/problem resolution options.

VII. Select best improvement option(s) and implement.

IX. Measure–monitor/track and feedback results to process owners, management, et al. Determine whether process baselines–safety, quality, cycle time are getting better or worse, Analyze the trends, and do root cause analysis.

X. Continue improvement efforts.

XI. Publicize improvements

- Productivity/Use of Time—cycle time, on-time delivery, non-value-added activities, overtime.
- Environmental and Safety—injuries, compliance, ergonomics, discipline problems, incidents of violence.
- People Issues—absenteeism, turnover, morale, grievances, skill levels, stakeholder satisfaction.
- Customer Satisfaction—new and repeat business, customer returns, warranty costs, field service reports/data, involvement.
- Supplier Performance—rating system, quality, capabilities, conformance to requirements.

ESSENTIAL ELEMENTS

This essay focused on process management as it relates to existing processes, not the invention of new processes, products, and services. Process management requires process design (new processes) or definition (existing processes); process documentation; process analysis and control; and process improvement.

Essential elements in process management include: (1) Understanding process thinking, including process ownership; (2) Identifying and satisfying customers' requirements; (3) Establishing process baselines and measurement; (4) Analyzing and improving processes through the use of quality and industrial engineering concepts and tools; and (5) Understanding how to use gradual, continuous process improvement and rapid, dramatic process redesign or reengineering.

Process management is the job of every employee of every organization in every industry.

SEE ALSO: Continuous Improvement; Japanese Management; Managing Change; Product-Process Matrix; Trends in Organizational Change

Mildred Golden Pryor
Revised by Wendy H. Mason

FURTHER READING:

Burlton, Roger. *Business Process Management: Profiting From Process.* Indianapolis, IN: Sams Publishing, May 2001.

Crosby, Philip. *Quality without Tears.* New York: McGraw-Hill, 1984.

Deming, W. Edwards. *The New Economics.* Cambridge, MA: MIT Center for Advanced Engineering Study, 1993.

———. *Out of the Crisis.* Cambridge, MA: MIT Center for Advanced Engineering Study, 1986.

Garvin, David A. *Managing Quality: The Strategic and Competitive Edge.* New York, NY: Free Press, 1988.

Hammer, Michael, and James Champy. *Reengineering the Corporation: A Manifesto for Business Revolution.* New York, NY: HarperCollins Publishers, 1993.

Harrington, H.J. *Business Process Improvement: The Breakthrough Strategy for Total Quality, Productivity, and Competitiveness.* New York, NY: McGraw-Hill, 1991.

———. *The Improvement Process: How America's Leading Companies Improve Quality.* New York, NY: McGraw-Hill, 1987.

Imai, Masaaki. *Kaizen: The Key to Japan's Competitive Success.* New York, NY: McGraw-Hill, 1986.

Ishikawa, Kaoru. *Guide to Quality Control.* Tokyo, Japan: Asian Productivity Organization, 1982.

———. *What Is Total Quality Control?* Englewood Cliffs, NJ: Prentice-Hall, 1985.

Juran, Joseph M. *A History of Managing for Quality.* Milwaukee, WI: ASQ Quality Press, 1995.

Juran, Joseph M., and Frank M. Gryna. *Juran's Quality Control Handbook.* New York, NY: McGraw-Hill, 1988.

———. *Quality Planning and Analysis: From Product Development Through Use.* New York, NY: McGraw-Hill, 1993.

Mizuno, Shigeru. *Management for Quality Improvement: The 7 New QC Tools.* Cambridge, MA: Productivity Press, 1979.

Pryor, Mildred Golden, and Brian D. Cullen. "Learn to Use TQM As Part of Everyday Work." *Industrial Management,* May-June 1993, 10–14.

Pryor, Mildred Golden, and J. Chris White. *Strategic Quality Management.* Dallas, TX: ASQ, Texas Quality EXPO, October 1996.

Pryor, Mildred Golden, J. Chris White, and Leslie A. Toombs. *Strategic Quality Management: A Strategic Systems Approach to Quality.* Houston, TX: Dame Publications, 1998.

Pryor, Mildred Golden, and Leslie A. Toombs. *Total Quality Management.* Commerce, TX: Center for Excellence, 1993.

Pryor, Mildred Golden, and W. Donald Pryor. *Process Reengineering.* Commerce, TX: Center for Excellence, 1994.

Senge, Peter M. *The Fifth Discipline: The Art & Practice of The Learning Organization.* New York, NY: Doubleday/Currency, 1990.

Shingo, Shigeo. *Revolution in Manufacturing: The SMED (Single Minute Exchange of Die) System.* Cambridge, MA: Productivity Press, Inc., 1985.

———. *A Study of the Toyota Production System.* Cambridge, MA: Productivity Press, Inc., 1989.

Smith, Howard, and Peter Fingar. *Business Process Management (BPM): The Third Wave.* Tampa, FL: Meghan-Kiffer Press, 2003.

PROCUREMENT

SEE: Purchasing and Procurement

PRODUCT-PROCESS MATRIX

The product-process matrix is a tool for analyzing the relationship between the product life cycle and the technological life cycle. It was introduced by Robert H. Hayes and Steven C. Wheelwright in two classic management articles published in *Harvard Business Review* in 1979, entitled "Link Manufacturing Process and Product Life Cycles" and "The Dynamics of Process-Product Life Cycles." The authors used this matrix to examine market-manufacturing congruence issues and to facilitate the understanding of the strategic options available to a company. The matrix itself consists of two dimensions, product structure/product life cycle and process structure/process life cycle. The production process used to manufacture a product moves through a series of stages, much like the stages of products and markets, which begins with a highly flexible, high-cost process and progresses toward increasing standardization, mechanization, and automation, culminating in an inflexible but cost-effective process. The process structure/process life cycle dimension describes the process choice (job shop, batch, assembly line, and continuous flow) and process structure (jumbled flow, disconnected line flow, connected line flow and continuous flow) while the product structure/product life cycle describes the four stages of the product life cycle (low volume to high volume) and product structure (low to high standardization). Later writers on the subject sometimes insert an additional stage in the extreme upper-left corner of the matrix: the project.

A company can be characterized as occupying a particular region on the matrix (see accompanying Figure). This region is determined by the firm's stage in the product life cycle and the firm's choice of production process. At the upper left extreme, firms are characterized as process oriented or focused while the lower right extreme holds firms that are said to be product focused. The decision of where a firm locates on the matrix is determined by whether the production system is organized by grouping resources around the process or the product. Note from the figure that the vertices of the matrix result in four distinct types of operations (described by the appropriate process choice) located on the diagonal of the matrix.

PROCESS CHOICES

PROJECT. Projects are briefly included in the discussion since they are sometimes found at the extreme upper-left corner of the matrix (depending on the author). These include large-scale, one-time, unique products such as civil-engineering contracts, aerospace programs, construction, etc. They are also customer-specific and often too large to be moved, which practically dictates that project is the process of choice.

JOB SHOP. If a manufacturer had broken a large cog on an outdated (i.e., replacement parts are no longer available) but still useful machine, she would take the

Product-Process Matrix

Process structure Process life cycle stage ↓	Product structure Product life cycle stage →	Low volume Unique (one of a kind)	Low volume Multiple Products	Higher volume Standardized product	Very high volume Commodity product
	(Project)				
Jumbled flow (job shop)		Job shop			
Disconnected line flow (batch)			Batch		
Connected line flow (assembly line)				Assembly line	
Continuous flow (continuous)					Continuous

broken cog to a machine shop where they would manufacture a new one from scratch. This machine shop (along with tool and die manufacturers) is probably the primary example of manufacturing job shops. A job shop is the producer of unique products; usually this product is of an individual nature and requires that the job shop interpret the customer's design and specifications, which requires a relatively high level of skill and experience. Once the design is specified, one or a small number of skilled employees are assigned to the task and are frequently responsible for deciding how best to carry it out. Generally, resources for processing have limited availability with temporary in-process storage capability needed while jobs wait for subsequent processing. If the product is not a one-time requirement, it is at least characterized by irregular demand with long periods of time between orders. Efficiency is difficult since every output must be treated differently.

In a job shop, the outputs differ significantly in form, structure, materials and/or processing required. Each unique job travels from one functional area to another according to its own unique routing, requiring different operations, using different inputs, and requiring varying amounts of time. This causes the flow of the product through the shop to be jumbled, following no repetitive pattern.

Job shops and batch operations (upper-left quadrant of the matrix) are usually organized around the function of the individual machines. In other words, machinery is grouped according to the purpose it serves or the capabilities it possesses. For example, in a machine shop, hydraulic presses would be grouped in one area of the shop, lathes would be grouped into another area of the shop, screw machines in another area, heat or chemical treatment in still another, and so on (also contributing to the jumbled flow). This is labeled a *process layout.*

In addition to machine shops and tool and die manufacturers, job shops are also appropriate for use in service operations, since the product is customized and frequently requires different operations. Service examples include law offices, medical practices, automobile repair, tailor shops, and so forth.

BATCH. Firms utilizing batch processes provide similar items on a repeat basis, usually in larger volumes than that associated with job shops. Products are sometimes accumulated until a lot can be processed together. When the most effective manufacturing route has been determined, the higher volume and repetition of requirements can make more efficient use of capacity and result in significantly lower costs.

Since the volume is higher than that of the job shop, many processes can be utilized in repetition, creating a much smoother flow of work-in-process throughout the shop. While the flow is smoother, the work-in-process still moves around to the various machine groupings throughout the shop in a somewhat jumbled fashion. This is described as a disconnected line flow or intermittent flow.

Examples of batch processing operations include printing and machine shops that have contracts for higher volumes of a product. Services utilizing batches could be some offices (processing orders in batches), some operations within hospitals, classes within universities (how many classes have only one pupil?), and food preparation.

LINE. When product demand is high enough, the appropriate process is the assembly line. Often, this process (along with continuous; both are in the lower-right quadrant of the matrix) is referred to as mass production. Laborers generally perform the same operations for each production run in a standard and hopefully uninterrupted flow. The assembly line treats all outputs as basically the same. Firms characterized by this process are generally heavily automated, utilizing special-purpose equipment. Frequently, some form of conveyor system connects the various pieces of equipment used. There is usually a fixed set of inputs and outputs, constant throughput time, and a relatively continuous flow of work. Because the product is standardized, the process can be also, following the same path from one operation to the next. Routing, scheduling, and control are facilitated since each individual unit of output does not have to be monitored and controlled. This also means that the manager's span of control can increase and less skilled workers can be utilized.

The product created by the assembly-line process is discrete; that is, it can be visually counted (as opposed to continuous processes which produce a product that is not naturally divisible). Almost everyone can think of an example of assembly-line manufacturing (automobile manufacturing is probably the most obvious). Examples of assembly lines in services are car washes, class registration in universities, and many fast food operations.

Because the work-in-process equipment is organized and sequenced according to the steps involved to produce the product and is frequently connected by some sort of conveyor system, it is characterized as flowing in a line. Even though it may not be a straight line (some firms utilize a U-shaped assembly line) we say that it has a connected line flow. Also, firms in the lower-right quadrant (line and continuous) are classified as having a *product layout.*

Continuous manufacturing involves lot-less production wherein the product flows continuously rather than being divided. A basic material is passed through successive operations (i.e., refining or processing) and eventually emerges as one or more products. This process is used to produce highly standardized outputs in extremely large volumes. The product range is usually

so narrow and highly standardized that it can be characterized as a commodity.

Considerable capital investment is required, so demand for continuous process products must be extremely high. Starting and stopping the process can be prohibitively expensive. As a result, the processes usually run 24 hours a day with minimum downtime (hence, continuous flow). This also allows the firm to spread their enormous fixed cost over as large a base as possible.

The routing of the process is typically fixed. As the material is processed it usually is transferred automatically from one part of the process to the next, frequently with self-monitoring and adjusting. Labor requirements are low and usually involve only monitoring and maintaining the machinery.

Typical examples of industries utilizing the continuous process include gas, chemicals, electricity, ores, rubber, petroleum, cement, paper, and wood. Food manufacture is also a heavy user of continuous processing; especially water, milk, wheat, flour, sugar and spirits.

USING THE MATRIX

The product-process matrix can facilitate the understanding of the strategic options available to a company, particularly with regard to its manufacturing function. A firm may be characterized as occupying a particular region in the matrix, determined by the stages of the product life cycle and its choice of production process(es) for each individual product. By incorporating this dimension into its strategic planning process, the firm encourages more creative thinking about organizational competence and competitive advantage. Also, use of the matrix provides a natural way to involve manufacturing managers in the planning process so they can relate their opportunities and decisions more effectively with those of marketing and of the corporation itself, all the while leading to more informed predictions about changes in industry and the firm's appropriate strategic responses.

Each process choice on the matrix has a unique set of characteristics. Those in the upper-left quadrant of the matrix (job shop and batch) share a number of characteristics, as do those in the lower-right quadrant (assembly line and continuous). Upper-left firms employ highly skilled craftsmen (machinists, printers, tool and die makers, musical instrument craftsmen) and professionals (lawyers, doctors, CPAs, consultants). Hence upper-left firms can be characterized as labor intensive. Since upper-left firms tend to utilize general-purpose equipment, are seldom at 100 percent capacity, and employ workers with a wide range of skills, they can be very flexible. However, there is a difficult trade-off between efficiency and flexibility of operations. Most job shops tend to emphasize flexibility over efficiency. Since efficiency is not a strong point of upper-left firms, neither is low-cost production. Also, the low volume of production does not allow upper-left firms to spread their fixed costs over a wide enough base to provide for reduced costs. Finally, upper-left firms are also more likely to serve local markets.

Lower-right firms require production facilities that are highly specialized, capital intensive, and interrelated (therefore, inflexible). Labor requirements are generally unskilled or semi-skilled at most. Much of the labor requirement deals with merely monitoring and maintaining equipment. Lower-right firms are also more likely to serve national markets and can be vertically integrated.

Hayes and Wheelwright relate three areas affected by the use of the product-process matrix: distinctive competence, management, and organization.

DISTINCTIVE COMPETENCE. Distinctive competence is defined as the resources, skills, and organizational characteristics that give a firm a comparative advantage over its competitors. Simply put, a distinctive competence is the characteristic of a given product that causes the buyer to purchase it rather than the similar product of a competitor. It is generally accepted that the distinctive competencies are cost/price, quality, flexibility and service/time. By using the product-process matrix as a framework, a firm can be more precise about its distinctive competence and can concentrate its attention on a restricted set of process decisions and alternatives and a restricted set of marketing alternatives. In our discussion, we have seen that the broad range of worker skills and the employment of general-purpose equipment give upper-left firms a large degree of flexibility while the highly specialized, high-volume environment of lower-right firms yields very little in the way of flexibility. Therefore, flexibility would be a highly appropriate distinctive competence for an upper-left firm. This is especially true when dealing with the need for flexibility of the product/service produced. Lower-right firms find it very difficult to sidetrack a high-volume operation because of an engineering change in the product. An entire line would have to be shut down while tooling or machinery is altered and large volumes of possibly obsolete work-in-process are accounted for. Upper-left firms, however, would have none of these problems with which to contend. It must be noted though that lower-right firms may possess an advantage regarding flexibility of volume.

Quality may be defined a number ways. If we define quality as reliability, then lower-right firms could claim this as a distinctive competence. Lower-right firms would have the high volume necessary to quickly find and eliminate bugs in their product, yielding more reliability to the end user. However, if we define quality as quality of design (that is, "bells and whistles"—things that embody status, such as leather

seats in an automobile or a handcrafted musical instrument), then quality would be seen as a possible distinctive competence of upper-right firms.

Service may also be defined in more ways than one. If one defines service as face-to-face interaction and personal attention, then upper-left firms could claim service as a distinctive competence. If service is defined as the ability to provide the product in a very short period of time (e.g., overnight), then service as a distinctive competence would belong to lower-right firms.

Finally, remember that high volume, economies of scale, and low cost are characteristics of firms in the lower-right quadrant of the matrix. Upper-left firms produce low volumes (sometimes only one) and cannot take advantage of economies of scale. (Imagine, for instance, what you would have to pay for a handcrafted musical instrument.) Therefore, it is obvious that price or cost competitiveness is within the domain of lower-right firms.

MANAGEMENT. In general, the economics of production processes favor positions along the diagonal of the product-process matrix. That is, firms operating on or close to the diagonal are expected to outperform firms choosing extreme off-diagonal positions. Hayes and Wheelwright provide the example of a firm positioned in the upper-right corner of the matrix. This would appear to be a commodity produced by a job shop, an option that is economically unfeasible. A firm positioned in the lower-left corner would represent a unique one-time product produced by a continuous process, again not a feasible option. Both examples are too far off the diagonal. Firms that find themselves too far off the diagonal invite trouble by impairing their ability to compete effectively. While firms operating in the near vicinity, but not exactly on the diagonal, can be niche players, positions farther away from the diagonal are difficult to justify. Rolls Royce makes automobiles in a job shop environment but they understand the implications involved. Companies off the diagonal must be aware of traps it can fall into and implications presented by their position.

Also, a firm's choice of product-process position places them to the right or left of competitors along the horizontal dimension of the matrix and above or below its competitors along the vertical dimension of the matrix. The strategic implications are obvious. Of course, a firm's position on the matrix may change over time, so the firm must be aware of the implications and maintain the capability to deal with them appropriately. The matrix can provide powerful insights into the consequences of any planned product or process change.

Use of the product-process matrix can also help a firm define its product. Hayes and Wheelwright relate the example of a specialized manufacturer of printed circuit boards who produced a low-volume, customized product using a highly connected assembly-line process. Obviously, this would place them in the lower-left corner of the matrix; not a desirable place to be. This knowledge forced the company to realize that what they were offering was not really circuit boards after all, but design capability. So, in essence, they were mass-producing designs rather than the boards themselves. Hence, they were not far off the diagonal at all.

ORGANIZATION. Firms organize different operating units so that they can specialize on separate portions of the total manufacturing task while still maintaining overall coordination. Most firms will select two or more processes for the products or services they produce. For example, a firm may use a batch process to make components for products, which are constructed on assembly lines. This would be especially true if the work content for component production or the volume needed was not sufficient for the creation of a dedicated line process. Also, firms may need separate facilities for different products or parts, or they may simply separate their production within the same facility. It may even be that a firm can produce the similar products through two different process options. For example, Fender Musical Instruments not only mass produces electric guitars (assembly line) but also offers customized versions of the same product through the Fender Custom Shop (job shop). Again, the matrix provides a valuable framework for diagnostic use in these situations.

OTHER USES OF THE PRODUCT-PROCESS MATRIX

Additional uses of the matrix include:

- Analyzing the product entry and exit.
- Determining the appropriate mix of manufacturing facilities, identifying the key manufacturing objectives for each plant, and monitoring progress on those objectives at the corporate level.
- Reviewing investment decisions for plants and equipment in terms of their consistency with product and process plans.
- Determining the direction and timing of major changes in a company's production processes.
- Evaluating product and market opportunities in light of the company's manufacturing capabilities.
- Selecting an appropriate process and product structure for entry into a new market.

It should be noted that recent empirical research by Sohel Ahmad and Roger G. Schroeder found the proposed relationship between product structure and process structure to be significant but not strong. In general terms,

they found that as the product life cycle changes the process life cycle also shifts in the consistent direction, but not necessarily along the diagonal. Some 60 percent of the firms studied did not fall on the diagonal. The researchers propose that this occurred because new management and technological initiatives have eliminated or minimized some of the inherent trade-offs found on the Product-Process Matrix. They classify these initiatives as processing technology, product design and managerial practice (e.g., TQM and JIT). Therefore, Ahmad and Schroeder recommend that the matrix be conceptualized as having three axes instead of two. They propose an x-axis (product life cycle stages), a y-axis (process life cycle stages), and a z-axis that represents an organization's proactive effort towards adopting and implementing these innovative initiatives. As a firm moves away from the origin along the z-axis, it becomes able to minimize some of the trade-offs seen in the Product-Process Matrix framework.

SEE ALSO: Operations Strategy; Process Management

R. Anthony Inman

FURTHER READING:

Ahmad, Sohel, and Roger G. Schroeder. "Refining the Product-Process Matrix." *International Journal of Operations and Production Management* 22, no. 1 (2002): 103–124.

Anupindi, Ravi, Sunil Chopra, Sudhakar D. Deshmukh, Jan A. Van Mieghem, and Eitan Zemel. *Managing Process Business Flows.* 2nd ed. Upper Saddle River, NJ: Pearson Prentice Hall, 2006.

"The Dynamics of Process-Product Life Cycles." *Harvard Business Review,* March-April 1979, 27–136.

Finch, Byron. *Operations Now.* 2nd ed. Boston: McGraw-Hill Irwin, 2006.

Hayes, Robert, and Steven C. Wheelwright. "Link Manufacturing Process and Product Life Cycles." *Harvard Business Review,* January-February 1979, 133–140.

PRODUCT DESIGN

Product design is cross-functional, knowledge-intensive work that has become increasingly important in today's fast-paced, globally competitive environment. It is a key strategic activity in many firms because new products contribute significantly to sales revenue. When firms are able to develop distinctive products, they have opportunities to command premium pricing. Product design is a critical factor in organizational success because it sets the characteristics, features, and performance of the service or good that consumers demand. The objective of product design is to create a good or service with excellent functional utility and sales appeal at an acceptable cost and within a reasonable time. The product should be produced using high-quality, low-cost materials and methods. It should be produced on equipment that is or will be available when production begins. The resulting product should be competitive with or better than similar products on the market in terms of quality, appearance, performance, service life, and price.

THE INCREASING IMPORTANCE OF PRODUCT DESIGN

Product design is more important than ever because customers are demanding greater product variety and are switching more quickly to products with state-of-the-art technology. The impacts of greater product variety and shorter product life cycles have a multiplicative effect on the number of new products and derivative products that need to be designed. For example, just a few years ago, a firm may have produced four different products and each product may have had a product life cycle of ten years. In this case, the firm must design four new products every ten years. Today, in order to be competitive, this firm may produce eight different products with a life cycle of only five years; this firm must introduce eight new products in five years. That represents sixteen new products in ten years or one product every seven and one-half months. In this fast-paced environment, product design ceases to be an ad hoc, intermittent activity and becomes a regular and routine action. For an organization, delays, problems, and confusion in product design shift from being an annoyance to being life threatening.

PRODUCT DESIGN AND SUPPLY CHAIN MANAGEMENT

Product design can also be an important mechanism for coordinating the activities of key supply chain participants. As organizations outsource the production of sub-assemblies and components, they also may be asking suppliers to participate in product design. As they outsource design capabilities it is essential that they manage and coordinate the flow of information among the supply chain participants. This can be especially important as firms outsource components to two or more suppliers. Now, there may be important design interfaces among two, three, or more suppliers. These interfaces must be properly managed to ensure cost effective and timely designs. Clearly, information and communication technologies become important parts of this effort.

PRODUCT DESIGN: A KEY TO ORGANIZATIONAL SUCCESS

Product design is an essential activity for firms competing in a global environment. Product design drives organizational success because it directly and significantly impacts nearly all of the critical determinants for success. Customers demand greater product variety and are quick to shift to new, innovative, full-featured products. In addition, customers make purchase decisions based on a growing list of factors that are affected by product design. Previously, customers made purchase decisions based primarily on product price and/or quality. While these factors are still important, customers are adding other dimensions such as customizability, order-to-delivery time, product safety, and ease and cost of maintenance. Environmental concerns are expanding to include impacts during production, during the product's operating life, and at the end of its life (recycle-ability). In addition, customers demand greater protection from defective products, which leads to lower product liability losses. Safer and longer lasting products lead to enhanced warrantee provision, which, in turn, impact customer satisfaction and warrantee repair costs.

Programs and activities are being put in place so organizations can cope with these dimensions. Organizations are embracing concepts such as *mass customization, design for manufacturing and assembly, product disposal, quality function deployment, and time-based competition.* They are using technology such as *rapid prototyping* and *computer-aided design* to examine how products function, how much they may cost to produce, and how they may impact the environment. Firms are searching for and implementing new technologies to determine ways to design better products. They are examining legal and ethical issues in product design as well as the impact of product design on the environment.

MASS CUSTOMIZATION

Mass customization is the low-cost, high-quality, large volume delivery of individually customized products. It is the ability to quickly design and produce customized products on a large scale at a cost comparable to non-customized products. Customization, cost effectiveness is the ability to produce highly differentiated products without increasing costs, significantly. Consumers expect to receive customized products at close to mass-production prices. Customization volume effectiveness is the ability to increase product variety without diminishing production volume. As markets become more and more segmented and aggregate demand remains constant or increases, firms must continue to design and produce high volumes across the same fixed asset base. Customization responsiveness is the ability to reduce the time required to deliver customized products and to reorganize design and production processes quickly in response to customer requests. It would be counter-productive to pursue mass customization if a customized product takes too long to produce. Speed in product design and production is an indispensable criterion for evaluating an organization's mass customization capability.

DESIGN FOR MANUFACTURING AND ASSEMBLY

Improving manufacturability is an important goal for product design. A systems approach to product design that was developed by two researchers from England, Geoffrey Boothroyd and Peter Dewhurst, is called design for manufacturability and assembly (DFMA). It can be a powerful tool to improve product quality and lower manufacturing cost. The approach focuses on manufacturing issues during product design. DFMA is implemented through computer software that identifies designs concepts that would be easy to build by focusing on the economic implications of design decisions. These decisions are critical even though design is a small part of the overall cost of a product because design decisions fix 70 to 90 percent of the manufacturing costs. In application, DFMA has had some startling successes. With the DFMA software, Texas Instruments reduced assembly time for an infrared sighting mechanism from 129 minutes to 20 minutes. IBM sliced assembly time for its printers from thirty minutes to three minutes.

Firms are recognizing that the concept behind DFMA can also be extended beyond cost control to design products that are easy to service and maintain. To do this effectively, service and maintenance issues should be considered at the earliest stages of the design. Also, firms will be required to examine disposal during product design as they become liable for recycling the products they make. It can be easier to recycle products if those factors are part of the product design paradigm.

DISPOSAL AND PRODUCT DESIGN

Disposal is becoming an increasingly important part of product design. The European Union is taking the lead by requiring that most of an automobile is recycled by the year 2010. This requirement has a major impact on product design. The most obvious effect is to change the notion that a consumer is the final owner for a product. With this approach, the product returns to the manufacturer to be recycled and the recycling process should begin in product design. Vehicles should be designed so they can be disassembled and recycled easily. The designers should avoid exotic materials that are difficulty to recycle. For example, parts that have plastic and metal fused

together should not be used in applications where they are difficult to separate. The designers should determine which parts will be designed to be refurbished and reused, and which will be designed to be discarded, broken down, and recycled. All this should be done without adding costs or reducing product quality.

QUALITY AND QUALITY FUNCTION DEPLOYMENT

Product design shapes the product's quality. It defines the way that good and service functions. Quality has at least two components. First, the product must be designed to function with a high probability of success, or reliability; that is, it will perform a specific function without failure under given conditions. When product reliability increases, the firm can extend the product's warrantee without increasing customer claims for repairs or returns. Warrantees for complex and expensive items such as appliances are important selling points for customers. Second, quality improves when operating or performance characteristics improve even though reliability does not. The goals of product design should be greater performance, greater reliability, and lower total production and operating costs. Quality and costs should not be viewed as a trade-off because improvements in product and process technologies can enhance quality and lower costs.

Quality function deployment is being used by organizations to translate customer wants into working products. Sometimes referred to as the house of quality, quality function deployment (QFD) is a set of planning and communication routines that focus and coordinate actions and skills within an organization. The foundation of the house of quality is the belief that a product should be designed to reflect customers' desires and tastes. The house of quality is a framework that provides the means for inter-functional planning and communications. Through this framework, people facing different problems and responsibilities can discuss various design priorities.

PROTOTYPING

Engineering and operations combine to develop models of products called prototypes. These may be working models, models reduced in scale, or mock-ups of the products. Where traditional prototype development often takes weeks or months, the technology for rapid prototyping has become available. Some companies are using the same technology that creates virtual reality to develop three-dimensional prototypes. Other firms employ lasers to make prototypes by solidifying plastic in only a few minutes; this process can produce prototypes with complex shapes. Prototyping should increase customer satisfaction and improve design stability, product effectiveness, and the predictability of final product cost and performance.

COMPUTER-AIDED DESIGN

Currently, business managers and engineers perceive computer-aided design (CAD) as a tool to assist engineers in designing goods. CAD uses computer technology and a graphic display to represent physical shapes in the same way that engineering drawings have in the past. It is used in the metalworking industry to display component parts, to illustrate size and shape, to show possible relationships to other parts, and to indicate component deformation under specified loads. After the design has been completed, the engineer can examine many different views or sections of the part and finally send it to a plotter to prepare drawings. This capability greatly reduces engineering time and avoids routine mistakes made in analysis and drawing. It significantly increases productivity and reduces design time, which allows faster delivery.

Applications of CAD systems are not limited to producing goods. While it's true that services do not have physical dimensions, the equipment and facilities used to produce services do. For example, the service stalls in an automotive center or rooms in an emergency medical center have physical characteristics that can be represented by the interactive graphics capabilities of a CAD system.

LEGAL AND ETHICAL ISSUES IN PRODUCT DESIGN

What is the responsibility of an organization and its managers to see that the goods and services they produce do not harm consumers? Legally, it is very clear that organizations are responsible for the design and safe use of their products. Consumers who believe they have been damaged by a poorly designed good or service have legal recourse under both civil and criminal statutes. Often, however, only the most serious and obvious offenses are settled in this way. More difficult ethical issues in product design result when the evidence is not as clear. For example, what responsibilities does a power tool manufacturer have with respect to product safety? Does a power saw manufacturer have the responsibility to design its product so that it is difficult for a child to operate? Suppose a parent is using a power saw and is called away to the telephone for a few minutes. A ten-year old may wander over, press the trigger and be seriously injured. Designing the saw so it has a simple and inexpensive lockout switch that would have to be pressed simultaneously when the trigger is pressed would make it more difficult for the accident to happen. What is the responsibility of the parent? What is the responsibility of the company?

PRODUCT DESIGN AND THE ENVIRONMENT

Organizations consider product design a critical activity to the production of environmentally friendly products. Organizations increasingly recognize that being good corporate citizens increases sales. Fast-food restaurants have begun recycling programs and redesigned packaging materials and systems in response to customer concerns. In other cases, being a good corporate citizen and protecting a company's renewable resources go well together; there are win-win opportunities where an organization can actually design products and processes that cut costs and increase profits by recapturing pollutants and reducing solid waste.

OVERVIEW OF PRODUCT DESIGN PROCESS

Product design time can be reduced by using a team approach and the early involvement of key participants including marketing, research and development, engineering, operations, and suppliers. Early involvement is an approach to managing people and processes. It involves an upstream investment in time that facilitates the identification and solution of downstream problems that would otherwise increase product design and production costs, decrease quality, and delay product introduction.

Time-based competitors are discovering that reducing product design time improves the productivity of product design teams. To reduce time, firms are reorganizing product design from an "over-the-wall" process to a team-based concurrent process. Over-the-wall means to proceed sequentially with the limited exchange of information and ideas. When this approach is used, problems are often discovered late because late-stage participants are excluded from decisions made early in the process. As a result, poor decisions are often made.

Product design is a labor-intensive process that requires the contribution of highly trained specialists. By using teams of specialists, communications are enhanced, wait time between decisions is reduced, and productivity is improved. Participants in this team-based process make better decisions faster because they are building a shared knowledge base that enhances learning and eases decision-making. By sharing development activities, design decisions that involve interdependencies between functional specialists can be made more quickly and more effectively. This reorganized process creates a timely response to customer needs, a more cost-effective product design process, and higher-quality products at an affordable price.

There are several reasons why early involvement and concurrent activities bring about these improvements. First, product design shifts from sequential, with feedback loops that occur whenever a problem is encountered, to concurrent, where problems are recognized early and resolved. The ability to overlap activities reduces product design time. Second, when a team of functional specialists works concurrently on product design, the participants learn from each other and their knowledge base expands. People are better able to anticipate conflicts and can more easily arrive at solutions. As a result, the time it takes to complete an activity should decline. Third, fewer changes later in the process results in faster and less expensive product design. When problems are discovered late, they take more time and money to solve.

Product design requires the expertise and decision-making skills of all parts of the organization. Marketing, engineering, operations, finance, accounting, and information systems all have important roles. Marketing's role is to evaluate consumer needs, determine potential impact of competitive pressure, and measure the external environment. Engineering's role is to shape the product through design, determine the process by which the product will be made, and consider the interface between the product and the people. Operations' role is to ensure that the product can be produced in full-scale production. Finance's role is to develop plans for raising the capital to support the product in full-scale production and to assist in the evaluation of the product's profit potential. Accounting and information systems provide access to information for decision making. Cross-functional teamwork and knowledge sharing are thus keys to success.

SEE ALSO: Computer-Aided Design and Manufacturing; Pricing Policy and Strategy; Product Life Cycle and Industry Life Cycle; Product-Process Matrix; Quality and Total Quality Management; Reverse Supply Chain Logistics; Supply Chain Management

Mark Vonderembse

FURTHER READING:

Corswant, F, and C. Tunälv. "Coordinating Customers and Proactive Suppliers: A Case Study of Supplier Collaboration in Product Development." *Journal of Engineering and Technology Management* 19, no. 3-4 (2002): 249–261.

Droge, C., J. Jayaram, and S. Vickery. "The Ability to Minimize the Timing of New Product Development and Introduction: An Examination of Antecedent Factors in the North American Automobile Supplier Industry." *Journal of Product Innovation Management* 17 (2000): 24–40.

Gerwin, D., and N.J. Barrowman. "An Evaluation of Research on Integrated Product Development." *Management Science* 48, no. 7 (2002): 938–953.

Hong, S.K., and M.J. Schniederjans. "Balancing Concurrent Engineering Environmental Factors for Improved Product Development Performance." *International Journal of Production Research* 38, no. 8 (2000): 1779–1800.

Koufteros, X.A., M. Vonderembse, and J. Jayaram. "Internal and External Integration for Product Development: The Contingency Effects of Uncertainty, Equivocality, and Platform Strategy." *Decisions Sciences* 36, no. 1 (2005): 977–133.

Koufteros, X.A., M. Vonderembse, and W. Doll. "Concurrent Engineering and Its Consequences." *Journal of Operations Management* 19 (2001): 97–115.

Krishnan, V., and K.T. Ulrich. "Product Development Decisions: A Review of the Literature." *Management Science* 47, no. 1 (2001): 1–21.

McDermott, C.M., and G.C. O'Connor. "Managing Radical Innovation: An Overview of Emergent Strategy Issues." *Journal of Product Innovation Management* 19, no. 6 (2002): 424–438.

Meyer, M.H., and A.P. Lehnerd. *The Power of Product Platforms.* New York: The Free Press.

Reinertsen, D.G. *Managing the Design Factory.* New York: The Free Press.

Song, X. M., and M. Montoya-Weiss. "The Effect of Perceived Technological Uncertainty on Japanese New Product Development." *Academy of Management Journal* 44 (2001): 61–80.

Tu, Q., M. Vonderembse, and T.S. Ragu-Nathan. "The Impact of Time-Based Manufacturing Practices on Mass Customization and Value to Customer." *Journal of Operations Management* 19 (2001): 201–217.

Vonderembse, M.A., and G.P. White. *Operations Management: Concepts, Methods, and Strategies.* Danvers, MA: John Wiley & Sons, 2004.

PRODUCT LIFE CYCLE AND INDUSTRY LIFE CYCLE

Recognizing that all living things go through a cycle of birth, growth, maturity, and death, the inspiration for the concepts of product life cycle and industry life cycle comes from biology. The life-cycle concept is an appropriate description of what happens to products and industries over time. When applied to organizations, the product life cycle and industry life cycle contain the four stages of introduction, growth, maturity, and decline.

This concept is much more than an interesting analogy of business and biology. In biology, a living organism's position in its life cycle leads to different courses of action concerning the organism's future. An industry's position and a product's position in their life cycles also lead to very different decisions concerning their futures. Consequently, the life-cycle concept was adopted from biology for use as a strategic planning tool for products and industries.

The following sections define the terms, explain why products have a life cycle, describe the stages of the product life cycle, and examine the strategic implications of the product life cycle.

DEFINITIONS

The life cycle can be used to observe the behavior of many concepts in business. In its classic form, which is described in a later section, it is best applied to products and industries. Used in this form, a product is not individual but a group of similar products. For example, the Chevrolet Malibu, Ford Taurus, and Honda Accord are a product group of mid-sized sedans.

Industry is a much broader classification than product; an industry consists of many similar groups of products. The product groups of mid-size sedan, pickup truck, and sport-utility vehicle all belong to the automobile industry.

Generally, industries have longer life cycles than products. The automobile industry has lasted more than 100 years and shows no signs of declining. However, the large family-sedan appears to be well into the decline stage. After decades of dominance in the automobile industry, only a few large cars, such as Ford's Crown Victoria, are being manufactured.

The life-cycle concept also describes individual brand products, such as the Ford Taurus. However, individual products in a group of products usually have much shorter life cycles, and they do not always follow the classic shape of the product life cycle. They may be introduced and die, and then be reintroduced again at a latter point. For example, the Chevrolet Nova has had more than one life cycle. Consequently, products are defined as groups of similar products, and industries defined as a collection of comparable product groups.

The discussion that follows is applicable to both industries and products. The terms product life cycle and industry life cycle both refer to the four stages of introduction, growth, maturity, and decline. To simplify the discussion, both the product life cycle and industry life cycle will be combined and simply called the product life cycle.

RATIONALE FOR THE PRODUCT LIFE CYCLE

Since products are not living beings, why do they have life cycles? The reason is that society accepts products at different rates, but all go through similar stages of societal acceptance. This acceptance of innovations by societies is called the diffusion of innovations. As society begins to adopt and accept an innovation, the new product grows, eventually reaching maturity. When there is a better alternative to the product or when public preference changes, the products will enter a decline, possibly ending with the death of the product.

The diffusion-of-innovations concept categorizes society by the speed with which the individual members adopt a new product. It classifies people into the five categories of innovators, early adopters, early majority, late majority, and laggards.

INNOVATORS. The first people in a society to adopt a new product are the innovators. These people are risk takers and may be looking for new products to try. They represent only 2.5 percent of the population. Though these people are the first to try a product, they are not usually opinion leaders. Consequently, they do not pass information about the product to the rest of the population.

EARLY ADOPTERS. The early adopters have many opinion leaders in their ranks. They are the first people in the neighborhood to try a new product, and many of them willingly pass the information about the product onto other people. Their experiences can determine whether a product will have a long or short life cycle. They represent about 13.5 percent of the population.

EARLY MAJORITY. Once the early adopters have tried and given their approval to a product, the early majority will begin to follow. Thirty-four percent of the population is in this category. Since they represent such a large percent of the population, the adoption by the early majority causes the new product to enter a period of rapid growth.

LATE MAJORITY. After a significant portion of the population has adopted a product, the late majority will consider its use. These people are not risk takers; they typically wait until they see the product approved by others. They also represent about 34 percent of the population. Once they have adopted the product, the innovators, early adopters, early majority, and late majority represent a total of about 84 percent of the population. By this point, the new product will have reached its maturity.

LAGGARDS. The last category of society to adopt a new product is generally fearful about trying new things. Often, they wait until being forced to adopt because the alternate product is no longer being produced. The laggards represent about 16 percent of the population.

NEW-PRODUCT DEVELOPMENT

Although product development is not usually recognized as a formal stage in the product life cycle, many ideas for long-term product planning are derived from the concepts that are generated through this preliminary process. Product development is defined as a strategy for company growth by offering modified or new products to current market segments. Additionally, product development focuses on turning product concepts into a physical product, while ensuring that that the idea can be turned into a workable product through each stage.

In the product development stage, costs begin to accumulate due to the investment in proposed concepts and ideas. Before introduction, a successful product in the marketplace will go through the following eight distinct stages of new product development: idea generation, idea screening, concept development, marketing strategy, business analysis, product development, test marketing, and commercialization.

Idea generation usually stems from the organization's internal sources (R&D, engineering, marketing). Company employees will brainstorm new ideas to generate viable product concepts. Additionally, a company may also analyze their competition's new product offerings with the intention of differentiating and improving on existing designs.

Ideas are ultimately screened, reducing the number of unrealistic concepts and focusing on realistic, attainable concepts. A single idea is developed into a product concept. Concepts are then tested to measure how appealing the product might be to consumers from the anticipated target market. Testing may range from focus groups to random surveys.

After concept testing, a marketing strategy is needed to define how the product will be positioned in the marketplace. Identifying the product's anticipated target market, financial expectations, distribution channels, and pricing strategy are also determined at this time.

Business analysis, including sales forecasting, determines if the product will be profitable to manufacturer. Many factors are considered when judging the products anticipated profitability. Managers will look at the length of time it takes for the product to be profitable, cost of capital, and other financial considerations when deciding weather to proceed with development. If the concept is approved, a prototype is created from the product concept.

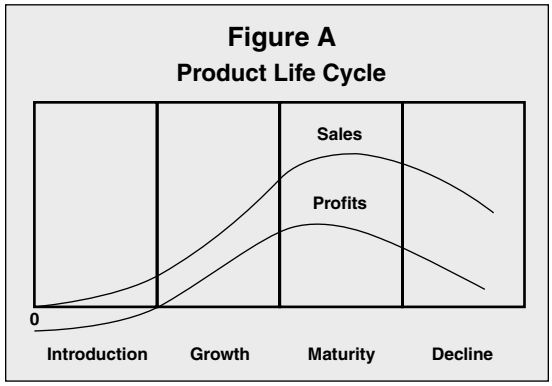
The prototype undergoes rigorous testing to ensure safety and effectiveness of the product. These tests are a good measure for determining whether or not a product is safe and if it should if the designers should move forward with the creation of the product.

Once a successful prototype is developed, companies perform test marketing on the product. Typically, a company will conduct formal research on a product concept to see if the proposed idea has validity with the targeted audience. Again, customer surveys and focus groups are conducted with the intention of testing the product on a sample of the targeted demographic. The testing is then analyzed to measure consumer reaction to the product. Once all the information is available and the company decides to introduce the product, high commercialization costs are incurred.

STAGES OF THE PRODUCT LIFE CYCLE

As stated above, the product life cycle consists of four stages: introduction, growth, maturity, and decline. Figure A illustrates the product life cycle. Determination of a product's stage in its life cycle is not based on age,

but on the relationship of sales, costs, profits, and number of competitors. Each of these stages is described below.



INTRODUCTION. When a new product is introduced to a market, the innovators may be the only people aware of the new product. If the product is a new product class, the innovators may not know what the product uses are. Recalling that the innovators represent only a small percent of the population, the sales of the new product will be low. However, there is an advantage in this situation in that the new product does not yet have any competition. During the introduction stage of a new product, the developer enjoys a monopoly.

Unfortunately, the product monopoly does not usually translate to immediate profits. The product may have been in development for a long time and considerable development costs are still in the recovery phase. Also, an expensive marketing effort may be needed to introduce the product to the public. With low sales and high expenses, the introduction stage of the life cycle is usually a money loser for the company. However, the hope is for the future of the product, and the company usually is more than willing to incur the losses.

GROWTH. As the early adopters begin to try the product, a sale begins to grow and profits usually start to follow. This is a great time for a company introducing a new product because the company still enjoys a monopoly early in the growth stage. The company is reaping all the sales and profits of the new product. When Chrysler introduced the idea of the minivan, they were in this enviable position of having the only minivan on the market.

As the early adopters begin influencing the early majority, sales and profits sore. The competition has also been watching from the new product's inception. Unfortunately for the original firm, the competition has also noticed the new product's success. Although they cannot be the first, the competition races to offer their own products and gain a share of a growing market. Chrysler's minivan did not maintain its monopoly for long; soon, the other major automobile manufacturers offered models to compete with Chrysler. Although total sales and profits continue to grow throughout the growth stage, they are divided among many manufacturers.

MATURITY. By the end of the growth stage of the life cycle, the market is beginning to become very competitive, and this trend continues into the early period of the maturity stage. Besides many more manufacturers offering their products, the producers continue the product-differentiation process begun in the growth stage. The result is a market saturated with many manufacturers offering many models of the product. These manufacturers produce a multitude of models, from desktop computers to notebooks.

With so many companies now in the market, the competition for customers becomes fierce. Although total sales continue to grow during the first part of the maturity stage, the increased competition causes profits to peak at the end of the growth stage and beginning of the maturity stage. Profits then decline during the remainder of the maturity stage. The declining profits mean that the market is not as attractive to companies as it was in the growth stage.

In the growth stage, even inefficient companies made money. However, only the best companies and their products survive in the maturity stage. Manufacturers begin to drop out as they see profits turn to losses. Though there is still competition in the computer industry, for example, companies such as Dell and Apple have emerged as the leaders in the market. During the later part of the maturity stage, even sales begin to dip, putting more pressure on the remaining manufacturers.

DECLINE. The number of companies abandoning the market continues and accelerates in the decline stage. Not only does the efficiency of the company play a factor in the decline, but also the product category itself now becomes a factor. By this time, the market may perceive the product as "old," and it may no longer be in demand. For example, the public replaced their preference for station wagons with their desire for minivans. Advancing technology may also bypass and replace a product, as when tapes and CDs replaced the vinyl record.

The product will continue to exist as long as a few manufacturers can maintain profitability. The laggards will resist switching to the alternative, and manufacturers who can profitably serve this niche will continue to do so. Eventually, even the laggards will switch, and the last companies producing the product will be forced to withdraw, thereby killing the product group.

PRODUCT STRATEGIES DURING THE PRODUCT LIFE CYCLE

Depending on the stage of the product life cycle, the marketing strategy should vary to meet the changing conditions. The marketing mix consists of the

product, promotion, price, and distribution. Each element must change with the product life cycle if the company expects to maximize sales and profits. It is important to note that as products move through each stage of the life cycle, they should be monitored and re-evaluated in terms of reducing both production costs and the time it takes to make a product or service profitable with its new position.

Strategic options for products during the product life cycle are examined below.

INTRODUCTION STAGE. In the introduction stage, the product's novelty and lack of competition dominate the marketing strategy. The public is not aware of the product and does not know what benefits it offers them.

Product strategy is focused on introducing one model. Since the public is unaware of the product, to offer more models could confuse them as they learn the purpose of the product. This model may offer various options, but there are usually no major variations on the basic idea of the product. The cost of development may also prohibit the company from developing more models for introduction. With no competition yet in the product category, one model is adequate for introduction.

Since the product is new, persuading the market to buy the product is of secondary importance to informing the public that the product exists. It is the innovators who will begin to buy the product, and they need to be informed. With only one company offering the product, those innovators that decide to purchase the product have only one company from which they can purchase the product. Consequently, the promotion efforts concentrate on informing the public of the product benefits and the company producing the product. Persuasion to buy a particular brand is not needed in the introduction stage.

The pricing policy offers the company an opportunity to regain some development costs. Since the company's product is not only new to the company, but also introduces a new product, the company can use a skimming pricing strategy; that is, a very high price for the new product. Though the high price of the new product may deter some potential customers, many innovators and early adopters will pay the high price to own the new product. The first electronic calculators, for example, were quite expensive. If the product is easily copied, however, the developer may want to use a low-price penetration policy to deter future competition.

Since there are few purchasers in the introduction stage, the distribution does not need to be widespread. The innovators are risk takers and desire to purchase something new. Consequently, they may seek out the distributors carrying the new product, and only a few distributors will suffice.

GROWTH STAGE. In the growth stage, the early adopters, followed by the early majority, begin to consume the product in growing numbers. The increasing sales result in the emergence of profits rather than losses.

During the early part of the growth stage, the company can continue its product policy of offering one basic model. However, if the new product group is successful, eventually competitors will offer their own products to compete in the new category. At that point, the original company will need to offer more models. The models should be differentiated from one another so that the company can continue to attract the new customers coming into the market.

Even with competition beginning to offer their products in the new category, the original company still dominates the market. However, as the market leader rather than a monopoly, the company will need to change its promotion policy of informing the public about their new product and new product category.

With an informing policy, the market leader would still receive the majority of new sales. Unfortunately for the original company, the competition will not be using an informative policy. They will be trying to persuade the public why their product is better than the market leader's product. Consequently, the market leader should switch to a persuasive promotion policy.

As the competition enters the market, they will probably be offering products at prices lower than the price of the original product. This is a penetration pricing policy designed to take sales away from the market leader. If the original company used a skimming pricing policy, its continued use would surely lead to rapid lost sales to the competition unless it is altered. Prices should be lowered so that sales can continue to grow, and the competition kept at bay.

In a growing market, the company's exclusive distribution policy would limit the potential growth for the firm, and sales would go to the competition. Consequently, the company must increase its product distribution to maintain its leadership in the market.

MATURITY STAGE. Many competitors characterize the maturity stage. With the large number of firms producing products, the competition for customers becomes quite intense, and profits decline. The strategy for firms during the maturity stage becomes one of survival, as many competitors will eventually withdraw from the market.

With many companies offering several models of the product, the number of products on the market becomes tremendous. The original company must continue differentiating their models so that the market is aware of the differences in the company's products and the competitors' products. The customers are going to ask why they should buy a particular company's product; just because the product was the first on the market is not going to persuade the customers to continue

buying the product. Quality, styling, and product features are a few of the means of differentiating the product from the competition.

During the maturity stage, the need to inform the public has long since passed. Now, the promotion strategy focus is on continuing the persuasion tactics started during the growth stage. The purpose of persuasion is to position the product to the market, which involves creating an image for a product. The image should not be an advertiser's creation, but based on the reality of the product.

The differentiation methods of quality, styling, and features are excellent means of positioning a product. For example, a Chevrolet Corvette and Porsche Boxster are both sports cars, but consumers see the different positions of the cars. The company differentiates its products and uses promotion to create the different position image. Each company hopes that its position is preferred by the consumers.

With the intense competition, management keeps the price of the product to its lowest possible level. For example, the competition for entry-level personal computers has now shifted to offering the lowest price. All of the companies in a mature market must now watch costs carefully.

Every aspect from development through production through marketing is designed to offer the lowest cost possible. A cost and a price advantage over competitors in this stage are significant competitive advantages. Consumers are aware of prices and will reward the company with the lower price, all else being equal. The firm that does not have a significant cost advantage risks losing customers and going out of business.

The absence of a company's product in a particular location may result in lost sales during the maturity period. Widespread distribution is essential. If the company's product is not in a particular location, one or more of the competitors' products are likely to be there. The firm cannot risk losing sales simply because their products were not available.

DECLINE STAGE. During the decline stage, sales and profits begin an even sharper drop, and the number of competitors is reduced even further. With public preference for this product waning, the decline stage continues until the last of the producers cannot make a profit, and the product category dies.

The product strategy now becomes one of reducing the number of models offered. With the public abandoning the product and competition declining, the need for many models is no longer there. The company now focuses its attention on the costs and profitability of the remaining models. Costs, such as research and development and production, are cut to the minimal amount necessary. After the cost cuts, management eliminates those products that are no longer profitable.

The promotion efforts also include an examination of costs. Only the minimal amount of promotion necessary to keep the product selling is done. The remaining people in the market want the product and do not need to be convinced that they should buy the product. They only need to know that the product is still available. Consequently, the promotion effort shifts to reminder promotion.

Products' prices are also kept as low as possible during the decline stage. Since the number of competitors has dropped, it may seem that a company could raise prices. If the remaining customers maintain strong brand loyalty, this policy might be possible. However, the product has fallen out of favor, and customers have other product alternatives. A price increase that could not be justified by cost increases runs the risk of alienating even the few customers left purchasing the product. Consequently, the strategy should be to keep the prices as low as possible.

Cost is also an overriding factor in the distribution of the product during the decline stage. The declining sales may not justify the widespread distribution reached during the maturity stage. Only those areas or markets that are still profitable should be covered, and the unprofitable distribution outlets eliminated. Hopefully for the last companies producing the product, the brand-loyal customers or laggards will seek out the limited locations of the products and continue purchasing it.

DECLINE STAGE TRAP. Just because a product's sales begin to decline does not mean that the product life cycle has reached the decline stage. However, if the company believes that the product is in a decline, the implementation of the decline stage strategies may lead to the death of the product long before its time.

Before the strategies for declining products are tried, the company should definitely establish that the product is in decline. The company should first follow strategies to boost sales and not resign themselves to the cost-cutting strategies of the decline stage. For example, Arm & Hammer could have easily decided that their baking soda was dying, and implemented decline stage strategies. However, they chose to fight for its life. They differentiated the product by finding new uses—such as a deodorizer and an ingredient in toothpaste. They so successfully repositioned the product that many people now think about baking soda as a deodorizer first and disregard its original use in baking.

Borrowed from biology, the life-cycle concept has been adapted and applied to products and industries. The product life cycle maintains that products and industries move through the stages of introduction, growth, maturity, and decline. By viewing a product from the perspective of its product-life-cycle position, management can use the product life cycle as a valuable decision-making tool. As the product moves through its

life cycle, the appropriate strategies for its future development vary greatly. Knowledge of the appropriate strategies can help guide management actions.

SEE ALSO: Product Design; Product-Process Matrix; Strategic Planning Tools; Strategy Formulation; Strategy Implementation

James Henley
Revised by Matthew Ross

FURTHER READING:

Hawkins, Del I., Roger J. Best, and Kenneth A. Coney. *Consumer Behavior: Building Marketing Strategy.* Boston, MA: McGraw-Hill, 1998.

Kotler, Philip, and Gary Armstrong. *Principles of Marketing.* Upper Saddle River, NJ: Prentice Hall, 2001.

Perreault, William D., Jr., and E. Jerome McCarthy. *Basic Marketing: A Global-Managerial Approach.* Boston, MA: Irwin McGraw-Hill, 1999.

Teresko, John. "Making a Pitch for PLM." *Industry Week* 253, no. 8 (August 2004): 57.

PRODUCTION PLANNING AND SCHEDULING

Production planning is the function of establishing an overall level of output, called the production plan. The process also includes any other activities needed to satisfy current planned levels of sales, while meeting the firm's general objectives regarding profit, productivity, lead times, and customer satisfaction, as expressed in the overall business plan. The managerial objective of production planning is to develop an integrated game plan where the operations portion is the production plan. This production plan, then, should link the firm's strategic goals to operations (the production function) as well as coordinating operations with sales objectives, resource availability, and financial budgets.

The production-planning process requires the comparison of sales requirements and production capabilities and the inclusion of budgets, pro forma financial statements, and supporting plans for materials and workforce requirements, as well as the production plan itself. A primary purpose of the production plan is to establish production rates that will achieve management's objective of satisfying customer demand. Demand satisfaction could be accomplished through the maintaining, raising, or lowering of inventories or backlogs, while keeping the workforce relatively stable. If the firm has implemented a just-in-time philosophy, the firm would utilize a chase strategy, which would mean satisfying customer demand while keeping inventories at a minimum level.

The term *production planning* is really too limiting since the intent is not to purely produce a plan for the operations function. Because the plan affects many firm functions, it is normally prepared with information from marketing and coordinated with the functions of manufacturing, engineering, finance, materials, and so on. Another term, *sales and operations planning,* has recently come into use, more accurately representing the concern with coordinating several critical activities within the firm.

Production planning establishes the basic objectives for work in each of the major functions. It should be based on the best tradeoffs for the firm as a whole, weighing sales and marketing objectives, manufacturing's cost, scheduling and inventory objectives, and the firm's financial objectives. All these must be integrated with the strategic view of where the company wants to go.

The production-planning process typically begins with an updated sales forecast covering the next 6 to 18 months. Any desired increase or decrease in inventory or backlog levels can be added or subtracted, resulting in the production plan. However, the production plan is not a forecast of demand. It is planned production, stated on an aggregate basis. An effective production-planning process will typically utilize explicit time fences for when the aggregate plan can be changed (increased or decreased). Also, there may be constraints on the degree of change (amount of increase or decrease).

The production plan also provides direct communication and consistent dialogue between the operations function and upper management, as well as between operations and the firm's other functions. As such, the production plan must necessarily be stated in terms that are meaningful to all within the firm, not just the operations executive. Some firms state the production plan as the dollar value of total input (monthly, quarterly, etc.). Other firms may break the total output down by individual factories or major product lines. Still other firms state the plan in terms of total units for each product line. The key here is that the plan be stated in some homogeneous unit, commonly understood by all, that is also consistent with that used in other plans.

PRODUCTION SCHEDULING

The production schedule is derived from the production plan; it is a plan that authorized the operations function to produce a certain quantity of an item within a specified time frame. In a large firm, the production schedule is drawn in the production planning department, whereas, within a small firm, a production schedule could originate with a lone production scheduler or even a line supervisor.

Production scheduling has three primary goals or objectives. The first involves due dates and avoiding late completion of jobs. The second goal involves throughput times; the firm wants to minimize the time

a job spends in the system, from the opening of a shop order until it is closed or completed. The third goal concerns the utilization of work centers. Firms usually want to fully utilize costly equipment and personnel.

Often, there is conflict among the three objectives. Excess capacity makes for better due-date performance and reduces throughput time but wreaks havoc on utilization. Releasing extra jobs to the shop can increase the utilization rate and perhaps improve due-date performance but tends to increase throughput time.

Quite a few sequencing rules (for determining the sequence in which production orders are to be run in the production schedule) have appeared in research and in practice. Some well-known ones adapted from Vollmann, Berry, Whybark and Jacobs (2005) are presented in Operations Scheduling.

THE PRODUCTION PLANNING AND PRODUCTION SCHEDULING INTERFACE

There are fundamental differences in production planning and production scheduling. Planning models often utilize aggregate data, cover multiple stages in a medium-range time frame, in an effort to minimize total costs. Scheduling models use detailed information, usually for a single stage or facility over a short term horizon, in an effort to complete jobs in a timely manner. Despite these differences, planning and scheduling often have to be incorporated into a single framework, share information, and interact extensively with one another. They also may interact with other models such as forecasting models or facility location models.

It should be noted that a major shift in direction has occurred in recent research on scheduling methods. Much of what was discussed was developed for job shops. As a result of innovations such as computer-integrated manufacturing (CIM) and just-in-time (JIT), new processes being established in today's firms are designed to capture the benefits of repetitive manufacturing and continuous flow manufacturing. Therefore, much of the new scheduling research concerns new concepts and techniques for repetitive manufacturing-type operations. In addition, many of today's firms cannot plan and schedule only within the walls of their own factory as most are an entity with an overall supply chain. Supply chain management requires the coordination and integration of operations in all stages of the chain. If successive stages in a supply belong to the same firm, then these successive stages can be incorporated into a single planning and scheduling model. If not, constant interaction and information sharing are required to optimize the overall supply chain.

SEE ALSO: Aggregate Planning; Operations Management; Operations Scheduling; Product-Process Matrix; Supply Chain Management

R. Anthony Inman

FURTHER READING:

Hurtubise, Stephanie, and Claude Olivier, and Ali Gharbi. "Planning Tools for Managing the Supply Chain." *Computers & Industrial Engineering* 46 (2004): 763–779.

Kreipl, Stephan, and Michael Pinedo. "Planning and Scheduling in Supply Chains: An Overview of Issues in Practice." *Production and Operations Management* 13, no. 1 (2004): 77–92.

Vollmann, Thomas E., William L. Berry, Clay D. Whybark, and F. Robert Jacobs. *Manufacturing Planning and Control for Supply Chain Management.* 5th ed. New York: Irwin McGraw-Hill, 2005.

PRODUCTIVITY CONCEPTS AND MEASURES

Productivity is an overall measure of the ability to produce a good or service. More specifically, productivity is the measure of how specified resources are managed to accomplish timely objectives as stated in terms of quantity and quality. Productivity may also be defined as an index that measures output (goods and services) relative to the input (labor, materials, energy, etc., used to produce the output). As such, it can be expressed as:

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

Hence, there are two major ways to increase productivity: increase the numerator (output) or decrease the denominator (input). Of course, a similar effect would be seen if both input and output increased, but output increased faster than input; or if input and output decreased, but input decreased faster than output.

Organizations have many options for use of this formula, labor productivity, machine productivity, capital productivity, energy productivity, and so on. A productivity ratio may be computed for a single operation, a department, a facility, an organization, or even an entire country.

Productivity is an objective concept. As an objective concept it can be measured, ideally against a universal standard. As such, organizations can monitor productivity for strategic reasons such as corporate planning, organization improvement, or comparison to competitors. It can also be used for tactical reasons such as project control or controlling performance to budget.

Productivity is also a scientific concept, and hence can be logically defined and empirically observed. It can also be measured in quantitative terms, which qualifies it as a variable. Therefore, it can be defined and measured in absolute or relative terms. However, an absolute definition of productivity is not very useful; it is much more useful as a concept dealing with relative productivity or as a productivity factor.

Productivity is useful as a relative measure of actual output of production compared to the actual input of resources, measured across time or against common entities. As output increases for a level of input, or as the amount of input decreases for a constant level of output, an increase in productivity occurs. Therefore, a "productivity measure" describes how well the resources of an organization are being used to produce input.

Productivity is often confused with efficiency. Efficiency is generally seen as the ratio of the time needed to perform a task to some predetermined standard time. However, doing unnecessary work efficiently is not exactly being productive. It would be more correct to interpret productivity as a measure of effectiveness (doing the right thing efficiently), which is outcome-oriented rather than output-oriented.

Productivity is usually expressed in one of three forms: partial factor productivity, multifactor productivity, and total productivity. Each one is now discussed.

PARTIAL-FACTOR PRODUCTIVITY

The standard definition of productivity is actually what is known as a partial factor measure of productivity, in the sense that it only considers a single input in the ratio. The formula then for partial-factor productivity would be the ratio of total output to a single input or:

$$\text{Productivity} = \frac{\text{Total output}}{\text{Single input}}$$

Managers generally utilize partial productivity measures because the data is readily available. Also, since the total of multifactor measures provides an aggregate perspective, partial factor productivity measures are easier to relate to specific processes. Labor-based hours (generally, readily available information) is a frequently used input variable in the equation. When this is the case, it would seem that productivity could be increased by substituting machinery for labor. However, that may not necessarily be a wise decision. Labor-based measures do not include mechanization and automation in the input; thus when automation replaces labor, misinterpretation may occur.

Other partial factor measure options could appear as output/labor, output/machine, output/capital, or output/energy. Terms applied to some other partial factor measures include capital productivity (using machine hours or dollars invested), energy productivity (using kilowatt hours), and materials productivity (using inventory dollars).

MULTIFACTOR PRODUCTIVITY

A multifactor productivity measure utilizes more than a single factor, for example, both labor and capital. Hence, multifactor productivity is the ratio of total output to a subset of inputs:

$$\text{Multifactor productivity} = \frac{\text{Total output}}{\text{Subset of inputs}}$$

A subset of inputs might consist of only labor and materials or it could include capital. Examples include:

$$\frac{\text{Output}}{\text{Labor + Machine}}$$

or

$$\frac{\text{Output}}{\text{Labor + Capital + Energy}}$$

or

$$\frac{\text{Quantity of production at standard price}}{\text{Labor cost + Materials cost + Overhead}}$$

Obviously, the different factors must be measured in the same units, for example dollars or standard hours.

TOTAL FACTOR PRODUCTIVITY

A broader gauge of productivity, total factor productivity is measured by combining the effects of all the resources used in the production of goods and services (labor, capital, raw material, energy, etc.) and dividing it into the output. As such the formula would appear as:

$$\text{Total productivity} = \frac{\text{Total output}}{\text{Total input}}$$

or

$$\text{Total productivity} = \frac{\text{Goods or services produced}}{\text{All inputs used to produce them}}$$

One example, is a ratio computed by adding standard hours of labor actually produced, plus the standard machine hours actually produced in a given time period divided by the actual hours available for both labor and machines in the time period.

Total output must be expressed in the same unit of measure and total input must be expressed in the same unit of measure. However, total output and total input need not be expressed in the same unit of measure. Resources are often converted to dollars or standard hours so that a single figure can be used as an aggregate measure of total input or output. For example, total output could be expressed as the number of units produced, and total input could be expressed in dollars, such as tons of steel produced per dollar input. Other varieties of the measure may appear as dollar value of good or service produced per dollar of input, or standard hours of output per actual hours of input.

Total productivity ratios reflect simultaneous changes in outputs and inputs. As such, total productivity

ratios provide the most inclusive type of index for measuring productivity and may be preferred in making comparisons of productivity. However, they do not show the interaction between each input and output separately and are thus too broad to be used as a tool for improving specific areas.

Total Factor Productivity is a measure favored by the Japanese, whereas labor productivity is the measure favored by the United States. As such, the individual "productivity" of the American employee tends to be the best in the world, in that an American employee can purchase more eggs per one hour of work than anyone else in the world. But as a measure of national productivity, the Japanese have, in the past, tended to be better performers.

PRODUCTIVITY MEASURES

It has been said that the challenge of productivity has become a challenge of measurement. Productivity is difficult to measure and can only be measured indirectly, that is, by measuring other variables and then calculating productivity from them. This difficulty in measurement stems from the fact that inputs and outputs are not only difficult to define but are also difficult to quantify.

Any productivity measurement system should produce some sort of overall index of productivity. A smart measurement program combines productivity measurements into an overall rating of performance. This type of system should be flexible in order to accommodate changes in goals and policies over time. It should also have the ability to aggregate the measurement systems of different units into a single system and be able to compare productivity across different units.

The ways in which input and output are measured can provide different productivity measures. Disadvantages of productivity measures have been the distortion of the measure by fixed expenses and also the inability of productivity measures to consider quality changes (e.g., output per hour might increase, but it may cause the defect rate to skyrocket). It is easier to conceive of outputs as tangible units such as number of items produced, but other factors such as quality should be considered.

Experts have cited a need for a measurement program that gives an equal weight to quality as well as productivity. If quality is included in the ratio, output may have to be defined as something like the number of defect-free units of production or the number of units which meet customer expectations or requirements.

The determination of when productivity measures are appropriate performance measures depends on two criteria. The first is the independence of the transformation process from other processes within the organization. Second is the correspondence between the inputs and outputs in the productivity measurement process.

USE OF PRODUCTIVITY MEASURES

Productivity is a required tool in evaluating and monitoring the performance of an organization, especially a business organization. When directed at specific issues and problems, productivity measures can be very powerful. In essence, productivity measures are the yardsticks of effective resource use.

Managers are concerned with productivity as it relates to making improvements in their firm. Proper use of productivity measures can give the manager an indication of how to improve productivity: either increase the numerator of the measure, decrease the denominator, or both.

Managers are also concerned with how productivity measures relate to competitiveness. If two firms have the same level of output, but one requires less input thanks to a higher level of productivity, that firm will be able to charge a lower price and increase its market share or charge the same price as the competitor and enjoy a larger profit margin.

Within a time period, productivity measures can be used to compare the firm's performance against industry-wide data, compare its performance with similar firms and competitors, compare performance among different departments within the firm, or compare the performance of the firm or individual departments within the firm with the measures obtained at an earlier time (i.e., is performance improving or decreasing over time?).

Productivity measures can also be used to evaluate the performance of an entire industry or the productivity of a country as a whole. These are aggregate measures determined by combining productivity measures of various companies, industries, or segments of the economy.

PRODUCTIVITY INDEX

Since productivity is a relative measure, for it to be meaningful or useful it must be compared to something. For example, businesses can compare their productivity values to that of similar firms, other departments within the same firm, or against past productivity data for the same firm or department (or even one machine). This allows firms to measure productivity improvement over time, or measure the impact of certain decisions such as the introduction on new processes, equipment, and worker motivation techniques.

In order to have a value for comparison purposes, organizations compute their productivity index. A productivity index is the ratio of productivity measured in

some time period to the productivity measured in a base period. For example, if the base period's productivity is calculated to be 1.75 and the following period's productivity is calculated to 1.93, the resulting productivity index would be 1.93/1.75 = 1.10. This would indicate that the firm's productivity had increased 10 percent. If the following period's productivity measurement fell to 1.66 the productivity index of 1.66/1.75 = 0.95 it would indicate that the organization's productivity has fallen to 95 percent of the productivity of the base period. By tracking productivity indexes over time, managers can evaluate the success, or lack thereof, of projects and decisions.

FACTORS AFFECTING PRODUCTIVITY

There is quite a variety of factors which can affect productivity, both positively and negatively. These include:

1. capital investments in production
2. capital investments in technology
3. capital investments in equipment
4. capital investments in facilities
5. economies of scale
6. workforce knowledge and skill resulting from training and experience
7. technological changes
8. work methods
9. procedures
10. systems
11. quality of products
12. quality of processes
13. quality of management
14. legislative and regulatory environment
15. general levels of education
16. social environment
17. geographic factors

The first 12 factors are highly controllable at the company or project level. Numbers 13 and 14 are marginally controllable, at best. Numbers 15 and 16 are controllable only at the national level, and 17 is uncontrollable.

IMPROVING PRODUCTIVITY

Productivity improvement can be achieved in a number of ways. If the level of output is increased faster than that of input, productivity will increase. Conversely, productivity will be increased if the level of input is decreased faster than that of output. Also, an organization may realize a productivity increase from producing more output with the same level of input. Finally, producing more output with a reduced level of input will result in increased productivity.

Any of these scenarios may be realized through improved methods, investment in machinery and technology, improved quality, and improvement techniques and philosophies such as just-in-time, total quality management, lean production, supply chain management principles, and theory of constraints.

A firm or department may undertake a number of key steps toward improving productivity. William J. Stevenson (1999) lists these steps to productivity improvement:

- Develop productivity measures for all operations; measurement is the first step in managing and controlling an organization.
- Look at the system as a whole in deciding which operations are most critical, it is overall productivity that is important.
- Develop methods for achieving productivity improvement, such as soliciting ideas from workers (perhaps organizing teams of workers, engineers, and managers), studying how other firms have increased productivity, and reexamining the way work is done.
- Establish reasonable goals for improvement.
- Make it clear that management supports and encourages productivity improvement. Consider incentives to reward workers for contributions.
- Measure improvements and publicize them.
- Don't confuse productivity with efficiency. Efficiency is a narrower concept that pertains to getting the most out of a given set of resources; productivity is a broader concept that pertains to use of overall resources. For example, an efficiency perspective on mowing the lawn given a hand mower would focus on the best way to use the hand mower; a productivity perspective would include the possibility of using a power mower.

As a cautionary word, organizations must be careful not to focus solely on productivity as the driver for the organization. Organizations must consider overall competitive ability. Firm success is categorized by quality, cycle time, reasonable lead time, innovation, and a host of other factors directed at improving customer service and satisfaction.

PRODUCTIVITY AT THE NATIONAL LEVEL

Since productivity is one of the basic variables governing economic production activity some mention of national productivity concerns would be appropriate.

As a matter of fact, productivity may be the most important variable governing economic production activity. It is the fundamental controllable factor in wealth production. Since other economic variables depend on it, increasing productivity tends to have a beneficial multiplying effect on other economic variables. This is generally true at every level of economic aggregation.

Productivity growth in the United States lagged that of other leading industrial countries in the 1970s and 1980s. This caused some concern among American government officials and business leaders. Although, the United States' productivity was still among the world's highest, it was losing ground to other nations, most notably Japan, Korea, the United Kingdom, and West Germany.

Concern was especially great in the area of manufacturing; a significant portion of American productivity could be attributed to high agricultural productivity, whereas manufacturing tended to be lower. Productivity in services lagged that of both agriculture and manufacturing. However, the picture may be changing. While the United States' productivity growth slowed during the late twentieth century, it has since increased. With the aspect of automation within service industries, service sector productivity is continually on the increase.

Improving productivity is of national importance because, for a society to increase its standard of living, it must first increase productivity. Overall productivity for individual countries is calculated by dividing output, as measured by GDP or GNP, by the country's total population. Thus, productivity is measured as the dollar value per capita outputs. An increase in this measure of productivity means that each person in the country, on average, produced more goods and services. Also if productivity increases, then profits increase. The resulting profits can then be used to pay for wage increases (inherent in inflation) without having to raise prices. In this way, productivity gains actually help curb inflation.

It has been estimated that technology was responsible for at least half of the growth in productivity in the United States between 1948 and 1966. It would appear, then, that if the United States wants to continue to increase productivity, technology may be the key. Extensive press attention has focused on the factory of the future, where factory workers are being replaced in order to improve flexibility and productivity. Apparently, the role and importance of productivity will not diminish any time soon.

SEE ALSO: Economies of Scale and Economies of Scope; Effectiveness and Efficiency; Experience and Learning Curves; Financial Issues for Managers; Financial Ratios

R. Anthony Inman
Revised by Gerhard Plenert

FURTHER READING:

Plenert, Gerhard. *The eManager: Value Chain Management in an eCommerce World.* Dublin, Ireland: Blackhall Publishing, 2001.

———. *International Operations Management.*Copenhagen, Denmark: Copenhagen Business School Press, 2002.

Stevenson, William J. *Production and Operations Management.* Boston, MA: Irwin McGraw-Hill, 1999.

Vora, Jay A. "Productivity and Performance Measures: Who Uses Them." *Production and Inventory Management Journal* 33, no. 1 (1992): 46-49.

PROFESSIONAL READINGS FOR MANAGERS

"Information was once a sought-after and treasured commodity like a fine wine. Now, it's regarded more like crabgrass, something to be kept at bay," observes Richard Saul Wurman in his book *Information Anxiety2.* Professional reading, like every other aspect of a manager's professional activities, must be well thought out. Today's manager is surrounded, even bombarded, by information, but the shape, scope and delivery method of this professional literature changes daily. To keep up with general trends or focus in-depth on one industry, it is not sufficient to read traditional print titles. Information savvy managers monitor a variety of information streams. The Internet, e-mail, cell phones, seminars, webinars, blogs, television, radio, industry DVDs, popular business magazines, newsletters, e-zines, scholarly journals, newspapers, books, and technical reports compete continuously for the busy manager's time and attention.

THE INTERNET

By its nature, the Internet is too much for one manager to take on. Guides are needed to make the most of the incredible wealth of information available online. The Business Reference and Services Section (BRASS) of the American Library Association's (ALA) Best of the Best Business Web Sites product (http://www.ala.org/ala/rusa/rusa.htm) is an excellent guide. This free service identifies and categorizes significant Web sites within broad business categories such as "general management," "human resource management and labor relations," and "MIS and knowledge management." Each category then contains lists of topic-based, content-rich Web sites. For example under "human resource management" one might find a link to the Society for Human Resource Management (http://www.shrm.org/) or Workindex.com (www.workindex.com), a site sponsored by and prepared as a joint venture between Cornell University and *Human*

Resource Executive Magazine. Other sites that have been listed include hrvillage (www.hrvillage.com) and Workplace via WorkNet@ILR (www.ilr.cornell.edu/workplace.html).

Like BRASS, About.com (www.about.com) has a central philosophy that "people are the best guides to the Internet." Therefore, the site recruits enthusiastic experts in nearly 500 fields of endeavor who create online informational guides that are well organized, focused, and practical. About.com's management section (www.management.about.com) allows one to choose from basic information, links to other articles, what links are most popular on the site, as well as a section of links on hot topics.

Bpubs (www.bpubs.com) speaks to the busy manager with the tagline "No homepages. No indexes. No surfing. . . just content. Because your time is worth something." This free site allows the busy professional to read articles online at no cost. There is a search engine to provide access by specific subject, or the site can be searched by navigating through established categories such as "management science" and "human resources." Under "management science" one can focus further on such issues as "total quality management" or "change management," among others.

The Institute of Management and Administration (IOMA) Web site (www.ioma.com) is an example of a site that charges a fee for access to certain resources, but allows free searching along with some free, full-text information.

BLOGS

As the Internet grows and matures, new types of communication are being introduced. With these new avenues of expression comes another choice in the panoply of choices for the information-seeking manager to consider. In 2001 the term "blog" was barely a blip on the screen of the general reader, but by 2005 blogs had become an important and sometimes powerful method of discovering and disseminating information. Blogging is on the rise and corporate blogging adds another publishing platform for businesses to get their message out to internal and external customers. Corporate executives at Boeing, Sun Microsystems, General Motors, and others are publishing these online journals, discussing issues, trends, products, and business philosophies.

MAGAZINES AND NEWSPAPERS

Traditional trade magazines and newspapers still play an important role in keeping managers informed of current issues in the business world. Familiar titles such as *Forbes* (www.forbes.com), *Fortune* (www.fortune.com), *Business Week* (www.businessweek.com), and *Inc.* (www.inc.com), as well as newer entries into this field such as *Fast Company* (www.fastcompany.com), all have Web sites that serve as companions to their print publications. Major newspapers, such as *The New York Times* (www.nytimes.com), *The Wall Street Journal* (www.wsj.com), and *The Washington Post* (www.washingtonpost.com), are all accessible via the Internet. Each of these Web sites offers at least a selection of articles at no cost. Some require paid subscriptions for access to "premium content" and some offer pay-per-view services that allow access to single articles for a one-time fee. All include features that are not available in the print versions, and some include features in print that are not available online. Some newspapers require readers to register—for free—before gaining access to the site.

Workforce Management is the latest incarnation of a venerable title in the area of human resource management. Formerly titled *Workforce, Personnel Journal*, and *Journal of Personnel Research,* this publication continues to include articles on practical topics facing managers, including compensation and benefits, employee training, supervision, communications, and other relevant subjects. Like any serious business publication, *Workforce Management* has a Web version (www.workforce.com). Like other resources the Web site contains access to free content, as well as articles and services that are restricted to paid subscribers.

PROFESSIONAL ASSOCIATIONS

Professional associations are one of the richest veins of business information, offering a variety of resources. The three associations outlined below represent the tip of the iceberg in the large sea of management associations. However, they are time-honored, all-encompassing organizations that have served managers of every stripe for a long time.

The American Management Association (www.amanet.org) provides individual and corporate members with "access to the latest and the best management thinking and practice." Members receive association publications including *AMA Management Update,* a monthly electronic newsletter that emphasizes current topics, strategies, and trends; *Executive Matters,* a print newsletter focusing on management issues; and *MWorld: The American Management Association Journal,* a quarterly print journal with articles written by executives and educators that focuses on inventive solutions to management problems, as well as best practices and emerging trends.

The Academy of Management (www.aomonline.org) is a leading professional association that focuses on disseminating knowledge about management and organizations. The academy publishes four, well-established scholarly journals dedicated to the theory, research, education, and practice of management.

These journals, *The Academy of Management Review* (AMR), *Academy of Management Journal* (AMJ), *Academy of Management Learning and Education* (AMLE), and *Academy of Management Executive* (AME) are included in the organization's membership cost. Academic journals like these generally include articles that are longer than professional magazine literature. The articles are documented with notes, tables, charts, or graphs. As a general rule, authors are college or university professors. Article content usually provides extensive analysis of a topic or issue.

The Society for Human Resource Management's (SHRM) (www.shrm.org) mission is "to serve the needs of HR Professionals by providing the most essential and comprehensive resources available." This mission is accomplished in part through a variety of publications, most notably *HR Magazine*—formerly *Personnel Administrator* and *Journal for Personnel Administration.* This well-established monthly magazine covers a wide variety of articles on topics related to human resources management, including global issues, training and development, outsourcing, and technology trends.

SUBSCRIPTION DATABASES

While online business databases come in a variety of formats, they all consist of a data collection that is organized around a subject or group of subjects and made electronically available and searchable through an interface provided by the database developer. Online databases can be the product of one company or the aggregation of information collected from a variety of content providers. Access to electronic databases is almost always through subscription, and the cost is generally significant. However, libraries of all kinds—college and university, public, and corporate—subscribe to the databases that are most appropriate for their patrons. Many states also have launched statewide library projects that provide citizens with electronic access to business/management databases through libraries. Although the look and feel of each database is different, searching can be done by author, title, keyword, publication title, words in an abstract, product names, and a variety of other key data points.

ABI/INFORM, a product of ProQuest Information and Learning, is advertised as "one of the world's first electronic databases" and has been a leading source of business information for more than thirty years. ABI/INFORM indexes more than one thousand journals covering articles on business conditions, trends, management techniques, and corporate strategies. Approximately 50 percent of titles covered in the database are presented in full-text on a user's desktop. Thomson Gale, a business of The Thomson Corp., offers a variety of business-related databases including Business and Company Profile ASAP and Business & Management Practices. Business and Company Profile ASAP gives searchers a broad, deep collection from which to choose, including journals, newspapers, a company directory, hard to find private company data, and newswire releases. Business & Management Practices is a more highly focused product, containing information on management, planning, production, finance, information technology, and human resources. Both Thomson Gale products offer substantial full-text coverage of articles.

Factiva, a joint venture between Dow Jones and Company and Reuters Group, includes coverage of Dow Jones and Reuters newswires and *The Wall Street Journal,* plus more than 7,000 other sources from around the world. In addition to current news, Factiva offers access to historical articles going back 30 years. Many articles are available in languages other than English.

LexisNexis Academic is an interdisciplinary, full-text database providing searchable access to more than 5,600 sources including national and regional newspapers, non-English language sources, journals, wire services, newsletters, company reports, SEC filings, U.S federal and state case law, codes, regulations, legal news, law reviews, international legal information, transcripts of broadcasts, and selected reference works.

Emerald is a leading publisher of journals in the management arena. Emerald currently publishes more than 150 titles including *Management Decision, TQM Magazine, Journal of Documentation,* and *Journal of Consumer Marketing.* Emerald also offers a variety of products aimed at making journal content easily accessible. Emerald Fulltext provides the ability to search more than 40,000 articles from more than 100 Emerald journals. Emerald Management Reviews (formerly Anbar) gives subscribers access to article reviews from "the world's leading 400 journals and periodicals as determined by an independent Accreditation Panel." Key titles reviewed include the *Harvard Business Review, Journal of Marketing, Sloan Management Review,* and *The Economist.* Emerald also offers a "support resource" called Management First, which is aimed at the "working manager." This product includes articles, interviews, case studies, discussion forums, and an electronic newsletter.

BOOKS

Bookstores, newsstands, the Internet, and libraries—whether they are public, academic, or corporate—all offer a wealth of information, inspiration, and guidance for today's manager. Investing time and energy into professional reading should be a personal commitment for every manager and a corporate-level commitment for any company interested in successfully

riding the wave of information that threatens to drown the unprepared.

SEE ALSO: Domestic Management Societies and Associations; International Management Societies and Associations; Popular Press Management Books

Sheila Delacroix

FURTHER READING:

Moss, Rita W. *Strauss's Handbook of Business Information: A Guide for Librarians, Students, and Researchers.* 2nd ed. Westport, CT: Libraries Unlimited, 2004.

White, Gary W. *The Core Business Web: A Guide to Key Information Resources.* New York: The Haworth Information Press, 2003.

Wurman, Richard Saul. *Information Anxiety 2.* Indianapolis, IN: Que, 2001.

PROFIT SHARING

Profit sharing is an organizational incentive plan whereby companies distribute a portion of their profits to their employees in addition to prevailing wages. Profit sharing can generate benefits to the company by fostering greater employee cooperation, reducing labor turnover, raising productivity, cutting costs, and providing retirement security. Profit sharing gives employees a direct stake in the profitability of a company, creating an atmosphere in which employees want the business to succeed as much as management does. The annual U.S. Chamber of Commerce *Employee Benefits Survey* shows that approximately 19 to 23 percent of U.S. companies have offered some form of profit sharing since 1963. According to the Profit Sharing/401(k) Council of America, 700,000 American businesses offered defined contribution plans (including profit sharing and 401(k) plans) to their employees in 2003. These plans covered 62.5 million American workers and contained $2.4 trillion in assets.

HISTORY

Profit sharing was quite common in primitive fishing and farming economies; in fact, it still persists among fisherman in many parts of the world. Albert Gallatin, Secretary of the Treasury under Presidents Jefferson and Madison, introduced profit sharing into his New Geneva, Pennsylvania, glassworks in the 1790s. Profit-sharing plans as we know them today were developed in the 19th century, when companies such as General Foods and Pillsbury distributed a percentage of their profits to their employees as a bonus. The first deferred profit-sharing plan was developed in 1916 by Harris Trust and Savings Bank of Chicago. Profit sharing was also instrumental during World War II, enabling wartime employers to provide additional compensation to their employees without actually raising their wages.

FORMS OF PROFIT SHARING

There are three basic types of profit-sharing plans:

1. Cash plans distribute cash or stock to employees at the end of the year. The main drawback of this plan is that employee profit-sharing bonuses are taxed as ordinary income. Even if the distribution takes the form of stock or some other payment, it becomes taxable as soon as the employee receives it.
2. Deferred plans direct profit shares into a trust fund on behalf of individual employees and distribute them at a later date, often at retirement. The Internal Revenue Service allows immediate taxation to be avoided in this plan. The deferred profit-sharing plan is a type of defined-contribution plan. A separate account is established for every employee. The accounts increase as contributions are made to them, earning interest or capital gains. Qualified deferred profit-sharing plans give employees a variety of investment choices for their accounts; these choices are common when outside firms manage the accounts.
3. Combination plans pay part of the profit share out directly in cash and defer the remainder into a trust fund.

VESTING REQUIREMENTS

It is becoming less common for companies to manage their own accounts, due to the fiduciary responsibilities and liabilities involved with them. Instead, companies typically contract the responsibility to financial management firms. The amount of future benefits depends on the performance of the account. The balance of the account will include the employer's contributions from profits, any interest earned, any capital gains or losses, and possibly any forfeiture from other plan participants, which may occur when participants leave the company before they are vested (that is, eligible to receive the funds in their accounts); the funds in their accounts are then distributed to the other employees' accounts.

The time required to become fully vested varies from company to company. Immediate vesting means employees are entitled to the funds in their accounts as soon as their employer makes the contribution.

Some companies utilize partially vested schedules, entitling employees to, say, 20 percent of the account before gradually becoming fully vested over a period of time. Establishing a vesting schedule is one way to limit access to the account. Another way is to create strict rules as to when payments can be made from employees' accounts, such as at retirement, death, disability, or termination of employment.

CONTRIBUTION LIMITS

The IRS also limits the amount that employers may contribute to their profit-sharing plans. Tax laws allow employers to contribute a maximum of 15 percent of an employee's salary to his or her account. If a company contributes less than 15 percent to an account in a particular year, they can make up the difference in a following year, up to a maximum of 25 percent of an employee's salary.

Individual companies may determine the amount of their contributions in one of two ways. One is a set formula written into the plan document. Formulas are commonly based on the company's pre-tax net profits, earnings growth, or another measure of profitability. Some companies determine a certain amount to contribute each year, settled on by the board of directors.

Many companies incorporate profit-sharing plans when economic times are hard and they are unable to provide guaranteed wage increases. Chrysler Corporation, for example, developed a profit-sharing plan for its union and non-union employees in the economic recession of 1988. The plan was incorporated into the union contract in exchange for wage concessions made by its workers. Although harsh economic times made contributions small, by 1994 (when the economy had recovered) Chrysler was paying an average bonus of $4,300 per person to 81,000 employees, for a total of about $348 million.

Many companies are also encouraged to develop profit-sharing programs because they provide significant tax advantages, which can benefit higher-paid as well as lower-paid employees. IRS regulations allow the deductibility of the employer's profit-sharing contributions as a business expense and also allow the deferral of this money into a trust without any tax liabilities until the money is received (usually at retirement, disability, death, severance of employment, or under withdrawal provisions), at which point the employee is usually in a lower tax bracket.

The Employee Retirement Income Security Act (ERISA), which was passed on September 2, 1974, is the primary legislation regulating the standards for pension plans and other employee-benefit plans. The intent of the ERISA was to protect employee rights under plans such as corporate pensions, deferred profit sharing, stock-bonus plans, and welfare. ERISA does not mandate companies to establish a profit-sharing plan, nor does it require any minimum benefit levels. ERISA did, however, establish guidelines for participation, vesting, funding, fiduciary standards, reporting/disclosing, and plan-termination insurance.

ADVANTAGES AND DISADVANTAGES

Profit sharing has become one of a new breed of incentives called *total system incentives.* These incentives link all of the employees of a company to the pursuit of organizational goals. A common misconception of profit sharing is that it is more suited for smaller companies where employees can more easily see the connection between their efficiency and company contributions. In actuality, profit sharing is being successfully utilized in large and small companies, labor-intensive and capital-intensive industries, mass production and job-shop situations, and industries with volatile profits as well as those with stable profits. Profit sharing can reward employee performance, seniority, and thrift, depending on the design of the plan.

Although the concept has experienced a tremendous growth rate, profit-sharing plans do not always work. Roughly 2 percent of deferred plans are terminated annually—some as a result of mergers, others because companies are liquidated or sold. The majority of terminations tend to occur after consecutive years of losses, when investment performance is poor, or when ineffective communication has resulted in lack of employee understanding, appreciation, or interest. Profit sharing may also entail some disadvantages for a company. Such plans may limit the company's ability to reward the performance of individual employees, for example, since the pay for all employees moves up or down according to a formula. At smaller companies, tying employee compensation to often-uncertain profits may result in drastic income swings from one year to the next. Finally, some critics claim that profit sharing may encourage employees to focus only on increasing profitability, perhaps at the expense of quality or other goals.

Kevin Nelson
Revised by Laurie Collier Hillstrom

FURTHER READING:

Girard, Bryan. "Is There an ESOP in Your Company's Future? An Employee Stock Ownership Plan Could Enhance Your Company's Bottom Line." *Strategic Finance* May 2002.

HR Guide to the Internet. "Profit Sharing." 1999. Available from <http://www.hr-guide.com/data/G444.htm>.

Metzger, Bert L. *How to Motivate with Profit Sharing.* Evanston, IL: Profit Sharing Research Foundation, 1978.

Profit Sharing/401(k) Council of America. "45th Annual Survey of Profit Sharing and 401(k) Plans." *Pension Benefits* (December 2002).

PROGRAM EVALUATION AND REVIEW TECHNIQUE AND CRITICAL PATH METHOD

Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM) are tools widely used in project scheduling. Both are based on network diagrams applicable for both the planning and control aspects of production. Visual display of the network enhances the communication and highlights the interdependency of the various activities required for project completion. Perhaps the greatest contribution of these tools is the identification of sequentially time-critical activities that require the closest monitoring.

BACKGROUND

In the early 1900s the Gantt chart was widely hailed as the reason that ships were built in record time. Developed by an engineer named Henry Gantt, this horizontal bar chart shows the scheduled times for individual jobs to be accomplished by specific resources. However, this tool is static in nature, and requires frequent manual updating, especially when activities are sequentially dependent.

In Figure 1, the Gantt chart shows the prospective times for five activities in a project, but does not show an underlying dependency of Activity D on the completion of Activity B.

In the 1950s, two groups independently developed what has become known as the PERT/CPM method of project scheduling. Each of these techniques improved on the Gantt chart by building into the tool the explicit sequencing of activities.

PERT was developed by the U.S. Navy, the Lockheed Corporation, and the consulting firm of Booz, Allen and Hamilton to facilitate the Polaris missile project. As time was a primary issue, this technique used statistical techniques to assess the probability of finishing the project within a given period of time.

By contrast, CPM was created in the environment of industrial projects, where costs were a major factor. In addition to the identification of the time-critical path of activities, representatives from the Du Pont Company and Sperry-Rand Corporation also developed a time-cost tradeoff analysis mechanism called crashing.

These two tools differ in the network diagram display. PERT historically uses the activity-on-arrow (AOA) convention, while CPM uses activity-on-node (AON). For most purposes, these two conventions are interchangeable; however some propriety software requires the logic of a specific convention. Both forms of network diagrams use arrows (lines implying direction) and nodes (circles or rectangles) to define the set of project activities or tasks. The flow of logic is from left to right. To simplify the diagram, letters are frequently used to represent individual activities. Figures 2 and 3 illustrate the differences for the same simple project.

Figure 2 illustrates the AOA convention, in which arrows depict activity requiring time and resources. The node represents an event, which requires neither time nor resources; this event is actually recognition that prior tasks are completed and the following tasks can begin. While the length of the arrow is not necessarily related to the duration of the task, there may be a tendency on the part of the analyst to sketch longer arrows for longer activities. To maintain the integrity of the network, there may be need for a dummy activity, as it is not acceptable to have two tasks that share the same beginning and ending nodes.

In Figure 3, the AON uses nodes to represent activities. The arrows have no implication of time, used only to indicate sequential flow. Since the AOA

Figure 1

Gantt Chart

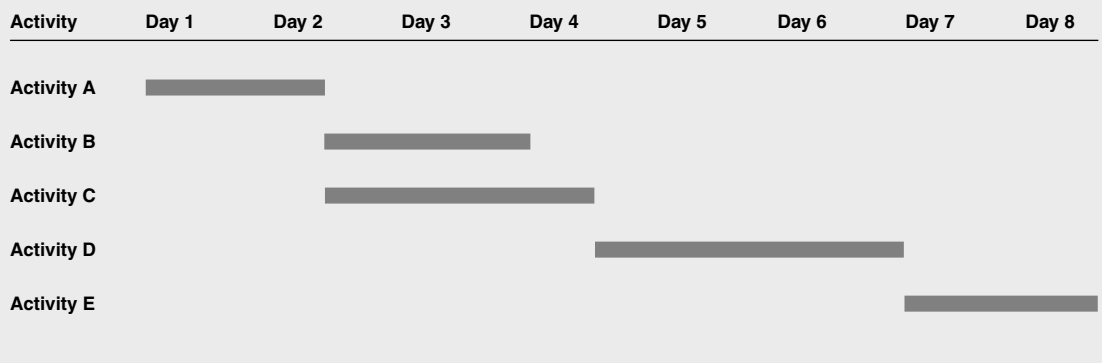
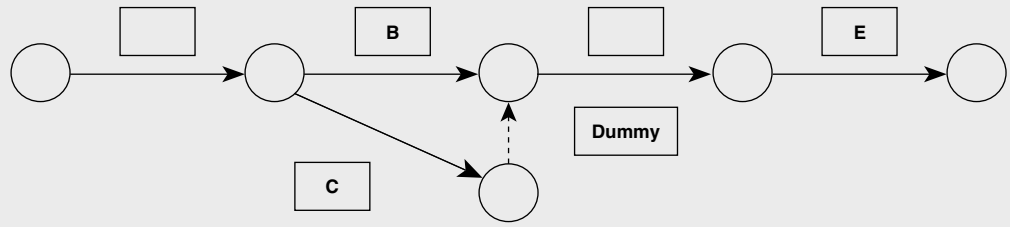
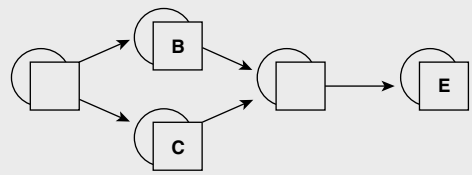


Figure 2
Network Diagram, Activity on Arrow



convention requires the use of dummy activities, the simpler AON convention will be used here to illustrate an example.

Figure 3
Network Diagram, Activity on Node



USING CPM TO SCHEDULE AND CONTROL A PROJECT

Scheduling is an important part of the planning of any project. However, it is first necessary to develop a list of all the activities required, as listed in the work breakdown structure. Activities require both time and the use of resources. Typically, the list of activities is compiled with duration estimates and immediate predecessors.

To illustrate the use of CPM, we can imagine a simple cookie-baking project: the recipe provides the complete statement of work, from which the work breakdown structure can be developed. The resources available for this project are two cooks and one oven with limited capacity; the raw materials are the ingredients to be used in preparing the cookie dough. As listed in Table 1, the activities take a total of 80 minutes of resource time. Because some activities can run parallel, the cooks should complete the project in less than 80 minutes.

Table 1 displays some of the planning that will save time in the project. For example, once the oven is turned on, it heats itself, freeing the cooks to perform other activities. After the dough is mixed, both batches of cookies can be shaped; the shaping of the second batch does not have to wait until the first batch is complete. If both cooks are available, they can divide the dough in half and each cook can shape one batch in the same four-minute period. However, if the second cook is not available at this time, the project is not delayed because shaping of the second batch need not be completed until the first batch exits the oven.

Table 1
List of Project Activities (CPM)

Description of Activity	Duration (minutes)	Immediate Predecessor(s)
A. Preheat oven	15 minutes	—
B. Assemble, measure ingredients	8 minutes	—
C. Mix dough	2 minutes	B
D. Shape first batch	4 minutes	C
E. Bake first batch	12 minutes	A, D
F. Cool first batch	10 minutes	E
G. Shape second batch	4 minutes	C
H. Bake second batch	12 minutes	E, G
I. Cool second batch	10 minutes	H
J. Store cookies	3 minutes	F, I
Total time	80 minutes	

Some expertise is required in the planning stage, as inexperienced cooks may not recognize the independence of the oven in heating or the divisibility of the dough for shaping. The concept of concurrent engineering makes the planning stage even more important, as enhanced expertise is needed to address which stages of the project can overlap, and how far this overlap can extend.

After beginning the project at 8:00 A.M., the first batch of dough is ready to go into the oven at 8:14, but the project cannot proceed until the oven is fully heated—at 8:15. The cooks actually have a one-minute cushion, called slack time. If measuring, mixing, or shaping actually take one additional minute, this will not delay the completion time of the overall project.

Figure 4
Network Diagram of the Cookie Baking Project (AON)

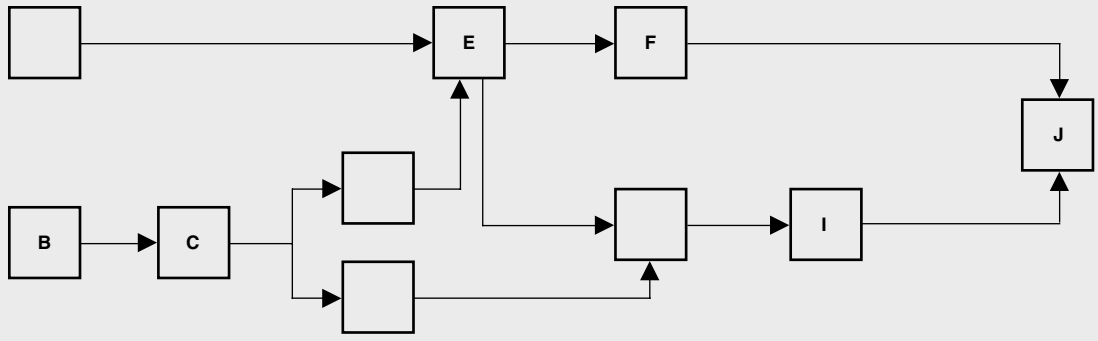


Figure 4 illustrates the network diagram associated with the cookie-baking project. The set of paths through the system traces every possible route from each beginning activity to each ending activity. In this simple project, one can explicitly define all the paths through the system in minutes as follows:

A-E-F-J = 15 + 12 + 10 + 3 = 40
A-E-H-I-J = 15 + 12 + 12 + 10 + 3 = 52
B-C-D-E-F-J = 8 + 2 + 4 + 12 + 10 + 3 = 39
B-C-D-E-H-I-J = 8 + 2 + 4 + 12 + 12 + 10 + 3 = 51
B-C-G-H-I-J = 8 + 2 + 4 + 12 + 10 + 3 = 39

The critical path is the longest path through the system, defining the minimum completion time for the overall project. The critical path in this project is A-E-H-I-J, determining that the project can be completed in 52 minutes (less than the 80-minute total of resource-usage time). These five activities must be done in sequence, and there is apparently no way to shorten these times. Note that this critical path is not dependent on the number of activities, but is rather dependent on the total time for a specific sequence of activities.

The managerial importance of this critical path is that any delay to the activities on this path will delay the project completion time, currently anticipated as 8:52 A.M. It is important to monitor this critical set of activities to prevent the missed due-date of the project. If the oven takes 16 minutes to heat (instead of the predicted 15 minutes), the project manager needs to anticipate how to get the project back on schedule. One suggestion is to bring in a fan (another resource) to speed the cooling process of the second batch of cookies; another is to split the storage process into first- and second-batch components.

Other paths tend to require less monitoring, as these sets of activities have slack, or a cushion, in which activities may be accelerated or delayed without penalty. Total slack for a given path is defined as the difference in the critical path time and the time for the given path. For example, the total slack for B-C-G-H-I-J is 13 minutes (52–39 minutes). And the slack for B-C-D-E-H-I-J is only one minute (52–51), making this path near critical. Since these paths share some of the critical path activities, it is obvious that the manager should look at the slack available to individual activities.

Table 2 illustrates the calculation of slack for individual activities. For projects more complex than the simplistic cookie project, this is the method used to identify the critical path, as those activities with zero slack time are critical path activities. The determination of early-start and early-finish times use a forward pass through the system to investigate how early in the project each activity could start and end, given the dependency on other activities.

Table 2
Calculation of Slack Time

Activity	Early Start	Early Finish	Late Start	Late Finish	Slack
A	8:00	8:15	8:00	8:15	0
B	8:00	8:08	8:01	8:09	1
C	8:08	8:10	8:09	8:11	1
D	8:10	8:14	8:11	8:15	1
E	8:15	8:27	8:15	8:27	0
F	8:27	8:37	8:39	8:49	12
G	8:10	8:14	8:23	8:27	13
H	8:27	8:39	8:27	8:39	0
I	8:39	8:49	8:39	8:49	0
J	8:49	8:52	8:49	8:52	0

The late-time calculations use the finish time from the forward pass (8:52 A.M.) and employ a backward pass to determine at what time each activity must start to provide each subsequent activity with sufficient time to stay on track.

Slack for the individual activities is calculated by taking the difference between the late-start and early-start times (or, alternatively, between the late-finish and early-finish times) for each activity. If the difference is zero, then there is no slack; the activity is totally defined as to its time-position in the project and must

therefore be a critical path activity. For other activities, the slack defines the flexibility in start times, but only assuming that no other activity on the path is delayed.

CPM was designed to address time-cost tradeoffs, such as the use of the fan to speed the cooling process. Such crashing of a project requires that the project manager perform contingency planning early in the project to identify potential problems and solutions and the costs associated with employing extra resources. Cost-benefit analysis should be used to compare the missed due-date penalty, the availability and cost of the fan, and the effect of the fan on the required quality of the cookies.

This project ends with the successful delivery of the cookies to storage, which brings two questions to mind: First, should the oven be turned off? The answer to this depends on the scheduling of the oven resource at the end of this project. It might be impractical to cool the oven at this point if a following project is depending on the heating process to have been maintained. Second, who cleans up the kitchen? Project due dates are often frustrated by failure to take the closeout stages into account.

USING PERT TO SCHEDULE AND CONTROL A PROJECT

In repetitive projects, or in projects employing well-known processes, the duration of a given activity may be estimated with relative confidence. In less familiar territory, however, it may be more appropriate to forecast a range of possible times for activity duration. Using the same cookie-baking project example, Figure 4 still accurately represents the sequencing of activities.

Table 3 illustrates the project with three time estimates for each activity. While *m* represents the most likely time for the activity, *a* suggests the optimistic estimate and *b* is the pessimistic estimate. The estimated time and or standard deviation for each activity (*E*) are calculated from the formula for the flexible beta distribution. With a reasonably large number of activities, summing the means tends to approximate a normal distribution, and statistical estimates of probability can be applied.

The mean is calculated as $[(a + 4m + b) \div 6]$, an average heavily weighted toward the most likely time, *m.* The standard deviation for an activity is $[(b - a) \div 6]$, or one-sixth of the range. Managers with a basic understanding of statistics may relate this to the concept of the standard deviation in the normal distribution. Since ±3 standard deviations comprise almost the entire area under the normal curve, then there is an intuitive comparison between a beta standard deviation and the normal standard deviation.

Using these new estimates for activity duration, the activity paths through the system have not changed, but the estimates of total time (*T*) are as follows:

A-E-F-J = 40.66 minutes
A-E-H-I-J = 53 minutes
B-C-D-E-F-J = 40.66 minutes
B-C-D-E-H-I-J = 53 minutes
B-C-G-H-I-J = 40.66 minutes

There are two factors that should be considered coincidental to the comparison of PERT and CPM in the example. First, there are two critical paths of T = 53 minutes each in the PERT analysis. Second, all the other paths have the same duration of T = 40.66 minutes. These concepts are neither more nor less likely to happen under PERT as opposed to CPM; they are strictly a function of the numbers in the estimates. However, the serendipity of two critical paths allows us to address the issue of which would be considered the more important of the two.

In Table 4, each of the critical paths is considered. Relevant to this analysis is the sum of the variances on the critical path; note that summing variances

Table 3
List of Project Activities (PERT)

Description of Activity	Duration (minutes) a	m	b	E_t	V_t	S_t
A. Preheat oven	12	15	18	15.00	1	1
B. Assemble, measure ingredients	6	8	12	8.33	1	1
C. Mix dough	2	2	2	2.00	0	0
D. Shape first batch	3	4	9	4.67	1	1
E. Bake first batch	10	12	16	12.33	1	1
F. Cool first batch	5	10	11	9.33	1	1
G. Shape second batch	3	4	9	4.67	1	1
H. Bake second batch	10	12	16	12.33	1	1
I. Cool second batch	5	10	11	9.33	1	1
J. Store cookies	2	3	10	4.00	1.78	1.33
Total times	58	90	114			

Table 4
Variability of Project Activities (PERT)

Path = A–E–H–I–J Description of Activity	Duration (minutes) a	m	b	E_t	V_t	S_t
A. Preheat oven	12	15	18	15.00	1	1
E. Bake first batch	10	12	16	12.33	1	1
H. Bake second batch	10	12	16	12.33	1	1
I. Cool second batch	5	10	11	9.33	1	1
J. Store cookies	2	3	10	4.00	1.78	1.33
Total variance					5.78	
Standard deviation					2.40	

Path = B–C–D–E–H–I–J Description of Activity	Duration (minutes) a	m	b	E_t	V_t	S_t
B. Assemble, measure ingredients	6	8	12	8.33	1	1
C. Mix dough	2	2	2	2.00	0	0
D Shape first batch	3	4	9	4.67	1	1
E. Bake first batch	10	12	16	12.33	1	1
H. Bake second batch	10	12	16	12.33	1	1
I. Cool second batch	5	10	11	9.33	1	1
J. Store cookies	2	3	10	4.00	1.78	1.33
Total variance					6.78	
Standard deviation					2.60	

is mathematically valid, while summing standard deviations is not. Path A-E-H-I-J has a total variance of 5.78 minutes, while path B-C-D-E-H-I-J has a variance of 6.78. Thus, path B-C-D-E-H-I-J, with the larger variance, is considered the riskier of the two paths and should be the primary concern of the project manager. We assign the entire project a variance of 6.78 minutes, and the standard deviation (the square root of the project variance) is 2.60 minutes.

Armed with this project standard deviation, the next step is to estimate the probability of finishing the project within a defined period. Applying the critical path time of 53 minutes to the normal distribution, the probability of finishing in exactly $T = 53$ minutes is 50/50. The relevant formula for calculating the number of standard normal distributions is as follows:

$$Z = (C - T) \div S \text{ where}$$

T = total time of the critical path ($T = 53$)
S = standard deviation of the project ($S = 2.60$)
C = arbitrary time for end of project

If C = 9:00 a.m., then $Z = [(9{:}00 - 8{:}53) \div 2.60] = 7 \div 2.60 = 2.69$ standard normal deviations. Referring to a cumulative standard normal table, we find that $Z =$ 0.99632, or a 99.632 percent chance of finishing by 9:00 A.M.

If C = 8:50 A.M., then $Z = [(8{:}50 - 8{:}53) \div 2.60] = -3 \div 2.60 = -1.15$. In this case, we use (1 − table value) for the probability = 1 − 0.87493 = 0.1251, or a 12.51 percent chance of finishing 3 minutes earlier than predicted.

From a managerial viewpoint, it should be reiterated that there is only a 50/50 chance of completing the project within the sum of the activity-time estimates on the critical path (T). This perspective is not emphasized in the CPM analysis, but is likely relevant in that context also. Adding a buffer to the promised due date (where $C > T$) enhances the probability that the project will be completed as promised.

There may be competitive advantages to bidding a project on the basis of a nearer-term completion date (where $C < T$), but managers can assess the risks involved using PERT analysis. In the cookie example, there may be a promised delivery time riding on this project estimate, or the resources (cooks and oven) may be promised to other projects. By using PERT, managers can allocate the resources on a more informed basis.

Both PERT and CPM rely heavily on time estimates, as derived from local experts, to determine the overall project time. While the estimating process may intimidate local managers, this may suffice to produce an estimate that becomes a *fait accompli,* as managers strive to meet the goal rather than explain why they failed to do so.

These two project management tools, frequently used together, can assist the project manager in establishing contract dates for project completion, in estimating the risks and costs of contingencies, and in

monitoring project progress. Many commercial software packages exist to support the project manager in tracking both costs and time incurred to date throughout the project duration.

SEE ALSO: Operations Scheduling; Project Management

Karen L. Brown
Revised by Badie N. Farah

FURTHER READING:

Mantel, Samuel J., Jr., Jack R. Meredith, Scott M. Shafer, and Margaret M. Sutton. *Core Concepts: Project Management in Practice.* New York, NY: John Wiley & Sons, Inc., July 2004.

Meredith, Jack R., and Samuel J. Mantel, Jr. *Project Management: A Managerial Approach.* New York, NY: John Wiley & Sons, Inc., 2002.

Ragsdale, Cliff T. *Spreadsheet Modeling and Decision Analysis.* Cincinnati, OH: Thomson/South-Western College Publishing, 2004.

Stevenson, William J. *Operations Management.* Boston, MA: McGraw-Hill, 2005.

Taylor, Bernard W., III. *Introduction to Management Science.* Englewood Cliffs, NJ: Prentice-Hall, 2004.

PROJECT MANAGEMENT

Project management is the application of relevant logic and tools to planning, directing, and controlling a temporary endeavor. While some organizations specialize in projects, others may require project management skills only occasionally to effect a change, either physical or sociological in nature, from the norm.

BACKGROUND

The origin of project management is in the construction industry, going back as far as the construction of the pyramids. A pharaoh "contracted" for the construction of his personal resting place, assigned to a project manager. This manager was responsible for the logical development of the physical structure, including quarrying and transport of stone, marshalling of labor, and construction of the pyramid as envisioned by the monarch.

Today, directives come from corporations and municipal agencies, from prospective home-owners and nonprofit organizations. Modern construction firms employ an updated model of project management, using visual tools and software to help manage the sequencing of materials delivery, equipment usage, and labor specialization. Frequently, a single firm will have multiple projects under way at a given time, complicating the need for precise timing of resource availability to complete each task effectively and efficiently.

Some professionals have recognized a similarity to construction firms in operational style. For example, legal and public accounting firms, while not requiring steel beams or earth-moving equipment, have multiple legal cases or professional audits in progress simultaneously. For these firms, it is necessary to allocate the availability of professional specialists.

Almost all companies encounter the need for project management at some point. The need may arise for a new physical plant, an expansion, or a move to a new location. Reengineering may suggest a change in processes, with an accompanying equipment rearrangement and retraining to ensure the effectiveness of the change. The speed at which technology changes, forces companies to adopt new hardware and software to stay current. Softer issues, such as the implementation of quality programs, also are within the project management purview.

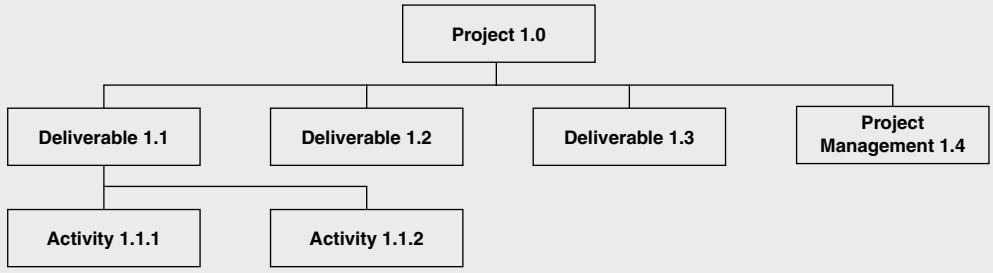
NATURE OF A PROJECT

A project is typically defined as a set of interrelated activities having a specific beginning and ending, and leading to a specific objective. Probably the most important concept in this definition is that a project is intended as a temporary endeavor, unlike ongoing, steady state operations. Secondary is the uniqueness of the output.

To ensure that a project is temporary, it is necessary to define the ending explicitly. The outputs of the project, or deliverables, may be tangible (a new heating system) or intangible (a retrained workgroup), but in either case should be defined in measurable terms (completed installation or documented level of expertise). While the reason for undertaking the project may have been to reduce utility costs by 10 percent or to increase productivity by 20 percent, achieving such goals may be outside the scope of the project.

Each project requires specific definition of its goals. In a training project example, the project manager may be given responsibility for identifying and implementing a training system that will enhance productivity by 15 percent; in this case, the project is not complete until the 15 percent goal is reached. If the initial training program enhances productivity by only 12 percent, the project manager is obligated to provide additional training, or the project may be terminated as a failure. Note that a 12 percent increase in productivity was something to celebrate, but did not meet the

Figure 1
Work Breakdown Structure



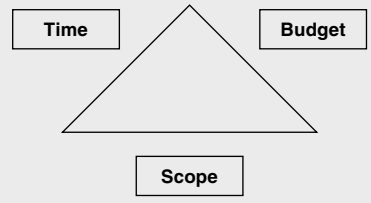
hurdle rate of acceptability. If instead the project is to implement a previously identified training program, known to achieve excellent results, then the project is finished when the trainees achieve the test scores known to correlate with a specified level of improvement in productivity. At this point, the project manager has achieved the deliverable, as measured in specific terms; the project is a success. Whether or not the desired improvement in productivity follows is outside the scope of the project.

Obviously, it behooves the project manager to have a well-defined scope for the project. The more nebulous the assignment, the more the project is subject to "scope-creep," or the tendency for the project to acquire additional duties. A "statement of work" document or charter, outlining the relevant specifications of deliverables, helps to keep a project clearly defined. Once the work is completely specified, the requisite activities can be identified and assigned.

The work breakdown structure (WBS) is one of the tools used by project managers to ensure that all activities have been included in planning. By numbering the project "1.0." the implication is that this is the first project for the company; subsequent projects would be numbered sequentially. In the illustrated example, the deliverables are specified on the second layer of the WBS, along with an overhead allocation for the project management team. Under each deliverable is an increasingly specified description of the activities involved in achieving the deliverable. Alternatively, the second line may be functional headings (finance, marketing, operations) or time periods (January, February, March). The objective of the WBS is to clarify that all activities have been addressed and assigned.

While the definition of a project also tends to include the word *unique,* this may be true only in a narrowly defined sense. A company that builds a new branch location (first project) has a template for the construction of a second branch location (second project). In the marketing field, subsequent product rollouts can learn from the initial product introduction. To the extent that the project is repetitive, the planning process, WBS, and cost estimates can provide a valuable template for future projects.

Figure 2
Project Performance Measures

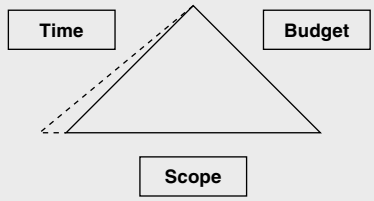


PROJECT PERFORMANCE MEASURES

The traditional measures for judging project success are: the fulfillment of scope, time and within budget. This is frequently depicted as a triangle.

Increasing any of the triangle's sides inherently changes at least one of the other sides. Thus, increasing the scope of the project will necessarily increase either the time required to complete the project or the budget allocated to the project. Unfortunately, the expanded scope can cause both time and budget to escalate simultaneously, as constrained resources come into conflict. Some project contracts have penalty clauses that elicit hefty payments if the project completion is past the contract date. Similarly, when the scope is decreased, the requisite time and budget may be reduced; resources may be assigned elsewhere.

Figure 3
Performance Measures When Scope is Increased (A)



The triangle analogy breaks down when the time factor is reduced, i.e., the project completion date is moved up. An unexpected deadline change may necessitate the use of overtime resources. Overtime hours strain the budget, and may still be insufficient to complete the project within the specified time. Managers attempting to respond to deadline changes should note the relative costs of time-intensive expenses (such as weekly rental of equipment) and of resource-intensive expenses (wages).

The schedule and budget are developed subsequent to the work breakdown structure, so that all activities and resources are identified. Scheduling requires that the project manager recognize two primary aspects of project activities. First, some activities must be done in sequence, while others may be done at the same time. Second, activities that could be run in parallel with multiple resources must be performed sequentially if the same limited resources are required for both activities. Gantt charts provide time-line displays, while network diagrams, such as Program Evaluation and Review Technique (PERT) or CPM diagrams, illustrate the sequentially dependency of activities. A baseline overview of the project is developed at this point for later comparison to actual progress.

From the beginning to the ending of the project, there is a critical path, or longest time-line path through the sequenced activities. This critical path determines the minimum time required for the project, and is the focus of the project manager's attention. If any of these activities are delayed, the on-time delivery of the project is at risk. To track this risk, milestones are established; the project review process addresses the actual progress as compared to the scheduled progress.

The budget is typically developed by estimating expenses at the bottom layer of the WBS, then rolling up the expenses to a project total. The numbering system in the WBS can be tailored to form a chart of accounts for tracking expenses associated with each activity. The project management heading is appropriate under any of these alternatives to ensure that staff salaries/wages are suitably allocated to the project. Earned value analysis incorporates both on-time and within-budget concepts of tracking the costs incurred to date on a project.

While customer satisfaction is sometimes added as a fourth factor in the list of project performance measures, this complicates the evaluation. If the project manager brings in the project according to scope specifications, on time, within budget, then customer dissatisfaction may be due to the customer's inability to define the scope in terms that would achieve the objective. Customer service in the project management context should include adequate discussion of alternative outcomes at the scope development stage.

ROLES IN THE PROJECT MANAGEMENT ENVIRONMENT

Who is the customer of a project? Generically, the customer is the entity to which the deliverables are actually delivered. In an externally contracted project, the customer is easily identified. In an in-house project, the customer is the executive authorizing both the initiation of the project and the money allocated to it. In either case, the customer is the one with the right to complain when the performance measures of scope, time, and budget are not met.

Ideally, a project will have a sponsor, an intermediary between the customer and the project manager. This individual can help to define the scope for optimal delivery of results, to allocate appropriate funding, to resolve conflicts during the execution of the project.

The project champion is the source of the idea for the project. While the champion is frequently an individual, the idea may originate with the board of directors or the safety committee in a company. The project champion, however, may not be the ideal choice for project manager.

The project manager is in charge of the work to be accomplished. This is not to say that the manager actually does the work, but rather that he/she is the coordinator of all relevant activities through delegation. In many cases, this manager may not possess expertise in the field, but rather possesses the skills to oversee a large number of diverse tasks and to identify the best-qualified employees to carry out the tasks. The manager should exercise judgment in assigning tasks; seasoned professionals will expect to accomplish the tasks according to their knowledge and experience, while others may require much definition and direction. In some cases, the project manager's ability to accomplish the job depends on negotiating and persuasive skills.

The authority of the project manager depends heavily on the organizational structure. In the "projectized" organization, resources are assigned exclusively to the project, then returned to a pool and assigned to a new project. The manager has near absolute authority and responsibility. In the functional organization (finance, marketing, operations, etc.), the project manager must negotiate with the functional manager for resources obtained from the department. Individuals tend to feel a greater responsibility to the functional manager. In this organization, the project manager has responsibility for the project, but relatively little authority without interference by the sponsor. The matrix organization is a managerial attempt to compromise these extremes by transferring some extent of authority from the functional manager to the project manager; thus, there are both strong-form and weak-form matrix organizations.

The project manager should be a master of many skills. Organization, negotiation, and teambuilding are desirable, while technical expertise may be less important. An expert whose intense focus on technical detail excludes the broader aspects of the project can undermine projects. Communication skills are of prime importance, as written and oral reports are mandatory. In addition, clarity of the initial assignment can reduce the amount of conflict management required in later stages of the project.

Surrounding the project manager is a team with the goal of supporting the planning, directing, and controlling functions. Typically, a full-time (or nearly full-time) team member is assigned responsibility for traditional office functions, such as communication coordination. This member may also be in charge of fielding reports and recording the responses for comparison to the baseline schedule. Other members exercise delegated authority in project oversight, up to and including direct responsibility for sub-projects within the larger project context.

PROJECT MANAGEMENT INSTITUTE

The primary professional organization in this field is the Project Management Institute (PMI). Founded in 1969, PMI has more than 40,000 worldwide members including representatives of government, industry, and academia. This body publishes standards for the profession of project management and awards certification as a Project Management Professional (PMP) on the basis of examination; continuing certification is dependent on continuing education and service to the field of project management.

The Standards Committee of PMI has continually updated versions of the generically worded Guide to the Project Management Body of Knowledge (PMBOK). As project management is widely applicable, the membership is diverse, with a large number of specific interest groups, and the standards are of necessity generically stated. However, the Standards Committee has agreed in the focus on nine primary areas of requisite knowledge for project managers.

These knowledge areas cover the obvious concerns of scope, time, cost, and quality, conforming to

Figure 4

Performance Measures When Scope is Increased (B)

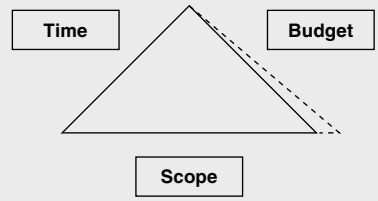


Table 1

PMI Specific Interest Groups (SIGS)

Aerospace & Defense
Automation Systems
Automotive
Configuration Management
Consulting
Design-Procurement-Construction
Diversity
eBusiness
Education & Training
Financial Services
Government
Healthcare Project Management
Human Resources
Information Systems
Information Technology & Telecommunications
International Development
Manufacturing
Marketing & Sales
Metrics
New Product Development
Oil, Gas & Petrochemical
Pharmaceutical
Program Management Office
Quality in Project Management
Retail
Risk Management
Service & Outsourcing
Students of PM
Troubled Projects
Utility
Women in Project Management

Table 2

Project Management Knowledge Areas (PMBOK)

Integration Management
Scope Management
Time Management
Cost Management
Quality Management
Human Resource Management
Communication Management
Risk Management
Procurement Management

the performance measures applied to projects. In addition, the softer issues of communication and human resource management are addressed; procurement management is included, as this concept is of major importance to many of the industries involved. Of particular note, however, are the areas of project integration and risk management.

PROJECT INTEGRATION MANAGEMENT

Management of project integration includes the process of synthesis and response to change. The overall project employs five basic processes: *initiating, planning, executing, controlling, and closing.*

The initiating process incorporates development of the idea for the project and justification based on a feasibility study. It is at this stage that the boundaries of the project should be defined. To return to the earlier training example, the responsibility for identifying a specific training program should be determined.

Project planning addresses the specific timeframe and budget for the project. Activities are identified and assigned. Planning is considered a most important process because without excellent planning the ensuing activities are unlikely to succeed. Executing involves carrying out the assigned activities, while controlling monitors the activity for scope, time, and budget concerns.

Perhaps the most ignored process of projects in general is the closing process. Toward the end of a project, enthusiasm can wane, and it is the responsibility of the project manager to maintain active collaboration until the end of the project. Phased-out employees should be evaluated and returned to the pool/function from which they were recruited. A series of meetings should be held to review the degree to which the performance measures were met, from both the defined scope and the satisfaction of the customer. If these are not in agreement, then the reasons should be documented. Areas of success and failure are both important to note, as these can be the basis for company-wide learning. Even dissimilar projects can provide some learning opportunities, as the company understands, for instance, its tendency to underestimate costs or scheduling requirements.

While these processes, initiating through closing, appear to be linear in nature, they instead define a feedback system. The specifics of the Planning process may indicate that the initiating idea was flawed. Execution may encounter problems with planning. controlling may indicate a return to planning, or even to the earlier initiating idea process. And closing may determine that the entire project was doomed from the outset. Failure to recognize the iterative nature of these processes can be costly, as a project may be adjusted or abandoned at early stages to prevent loss.

Within the company, the project life-cycle stages of the project should be identified. Generically, these may be identified as definition, design, test, implementation, and retirement stages, or some variation on this theme. Interestingly, each of these stages employs each of the processes described above. For example, in the definition life-cycle stage, there is an initiation process, progressing to a feasibility study. As the definition stage reaches its conclusion, it "delivers" the project to the design stage, but only if the mini-project of definition has been successful. Many projects have lingered when a rational analysis would suggest that revision or abandonment would be less costly. The iterative nature of project management logic suggests a stringent review at frequent stages to ensure that both the project itself and the environment to which the project was to respond are in agreement. Management of the integration of project stages is especially important in a rapidly changing environment.

PROJECT RISK MANAGEMENT

Among the project management knowledge areas, risk management is likely the activity that best defines project management. This umbrella concept addresses the risks in all aspects of managing a project.

First are the traditional performance measures. Was the scope well defined? If the customer assumed that a specific aspect was included, then the contracting firm's reputation may be damaged when the aspect was not specified in the charter. Were the costs estimated correctly? Underestimating can undermine profits, while overestimating can lose an opportunity for business or in-house improvement. Were the time estimates reasonable? Past-due penalties can be significant.

Other risks can include the insolvency of the customer and/or a subcontractor, or the lack of in-house expertise to accomplish the tasks involved in the project. Weather, economic changes, and governmental

regulations can change the feasibility of any project. Above all is the risk that the project is not sufficient to respond to changes in the environmental circumstances that triggered the project's initiation, especially in a project of long duration.

Project management is a structured approach to solving a problem with a temporary, unique solution. Project planning is a most important stage, setting the stage on which the rest of the project must play out. The project manager should be heavily involved in this planning process to ensure his/her understanding of scope, time, and cost, the primary performance measures by which project success is measured. Monitoring of the activities enhances the probability that the project will stay on track for all of these measures. Each stage and process of project management should address the minimization of risk to the firm, in terms of both money and reputation.

SEE ALSO: Product-Process Matrix; Program Evaluation and Review Technique and Critical Path Method; Program Evaluation and Review Technique and Critical Path Method

Karen L. Brown
Revised by Wendy H. Mason

FURTHER READING:

Gido, Jack, and James P. Clements. *Successful Project Management.* Cincinnati: South-Western College Publishing, 1999.

Kerzner, Harold. *Project Management: A Systems Approach to Planning, Scheduling, and Controlling.* 8th ed. Hoboken, NJ: John Wiley & Sons, Inc., 2003.

Martin, Paula. *The Project Management Memory Jogger: A Pocket Guide for Project Teams (Growth Opportunity Alliance of Lawrence).* Salem, NH: GOAL/QPC, 1997.

Meredith, Jack R., and Samuel J. Mantel, Jr. *Project Management: A Managerial Approach.* 5th ed. New York: John Wiley & Sons, Inc., 2002.

PMI Standards Committee. *A Guide to the Project Management Body of Knowledge (PMBOK Guide).* 2000 ed. Upper Darby, PA: Project Management Institute, 2000.

PURCHASING AND PROCUREMENT

Purchasing and procurement is used to denote the function of and the responsibility for procuring materials, supplies, and services. Recently, the term "supply management" has increasingly come to describe this process as it pertains to a professional capacity. Employees who serve in this function are known as buyers, purchasing agents, or supply managers. Depending on the size of the organization, buyers may further be ranked as senior buyers or junior buyers.

HISTORY

Prior to 1900, there were few separate and distinct purchasing departments in U.S. business. Most pre-twentieth-century purchasing departments existed in the railroad industry. The first book specifically addressing institutionalized purchasing within this industry was *The Handling of Railway Supplies—Their Purchase and Disposition,* written by Marshall M. Kirkman in 1887.

Early in the twentieth century, several books on purchasing were published, while discussion of purchasing practices and concerns were tailored to specific industries in technical trade publications. The year 1915 saw the founding of The National Association of Purchasing Agents. This organization eventually became known as the National Association of Purchasing Management (NAPM) and is still active today under the name The Institute for Supply Management (ISM).

Harvard University offered a course in purchasing as early as 1917. Purchasing as an academic discipline was furthered with the printing of the first college textbook on the subject, authored by Howard T. Lewis of Harvard, in 1933.

Early buyers were responsible for ensuring a reasonable purchase price and maintaining operations (avoiding shutdowns due to stockouts). Both World Wars brought more attention to the profession due to the shortage of materials and the alterations in the market. Still, up until the 1960s, purchasing agents were basically order-placing clerical personnel serving in a staff-support position.

In the late 1960s and early 1970s, purchasing personnel became more integrated with a materials system. As materials became a part of strategic planning, the importance of the purchasing department increased.

In the 1970s the oil embargo and the shortage of almost all basic raw materials brought much of business world's focus to the purchasing arena. The advent of just-in-time purchasing techniques in the 1980s, with its emphasis on inventory control and supplier quality, quantity, timing, and dependability, made purchasing a cornerstone of competitive strategy.

By the 1990s the term "supply chain management" had replaced the terms "purchasing," "transportation," and "operations," and purchasing had assumed a position in organizational development and management. In other words, purchasing had become responsible for acquiring the right materials, services, and technology from the right source, at the right time, in the right quantity.

Only in small firms is purchasing still viewed as a clerical position. When one notes that, on average, purchasing accounts for over half of most organizations' total monetary expenditures, it is no wonder that purchasing is marked as an increasingly pivotal position.

FACTORS FOR PURCHASING

The importance of purchasing in any firm is largely determined the four factors: availability of materials, absolute dollar volume of purchases, percent of product cost represented by materials, and the types of materials purchased. Purchasing must concern itself with whether or not the materials used by the firm are readily available in a competitive market or whether some are bought in volatile markets that are subject to shortages and price instability. If the latter condition prevails, creative analysis by top-level purchasing professionals is required.

If a firm spends a large percentage of its available capital on materials, the sheer magnitude of expense means that efficient purchasing can produce a significant savings. Even small unit savings add up quickly when purchased in large volumes. When a firm's materials costs are 40 percent or more of its product cost (or its total operating budget), small reductions in material costs can increase profit margins significantly. In this situation, efficient purchasing and purchasing management again can make or break a business.

Perhaps the most important of the four factors is the amount of control purchasing and supply personnel actually have over materials availability, quality, costs, and services. Large companies tend to use a wide range of materials, yielding a greater chance that price and service arrangements can be influenced significantly by creative purchasing performance. Some firms, on the other hand, use a fairly small number of standard production and supply materials, from which even the most seasoned purchasing personnel produce little profit, despite creative management, pricing, and supplier selection activities.

THE ROLE OF PURCHASING

There are two basic types of purchasing: purchasing for resale and purchasing for consumption or transformation. The former is generally associated with retailers and wholesalers. The latter is defined as industrial purchasing.

Purchasing can also be seen as either strategic or transactional. Also, the words "direct" and "indirect" have been used to distinguish the two types. Strategic (direct) buying involves the establishment of mutually beneficial long-term relationship relationships between buyers and suppliers. Usually strategic buying involves purchase of materials that are crucial to the support of the firm's distinctive competence. This could include raw material and components normally used in the production process. Transactional (indirect) buying involves repetitive purchases, from the same vendor, probably through a blanket purchase order. These orders could include products and services not listed on the bill of materials, such as MRO goods, but are used indirectly in producing the item.

Some experts relate that the purchasing function is responsible for determining the organization's requirements, selecting an optimal source of supply, ensuring a fair and reasonable price (for both the purchasing organization and the supplier), and establishing and maintaining mutually beneficial relationships with the most desirable suppliers. In other words, purchasing departments determine what to buy, where to buy it, how much to pay, and ensure its availability by managing the contract and maintaining strong relationships with suppliers.

In more specific terms, today's purchasing departments are responsible for:

- coordinating purchase needs with user departments
- identifying potential suppliers
- conducting market studies for material purchases
- proposal analysis
- supplier selection
- issuing purchase orders
- meeting with sales representatives
- negotiating
- contract administration
- resolving purchasing-related problems
- maintenance of purchasing records

These functions obviously entail no insignificant amount of responsibility.

As the role of purchasing grows in importance, purchasing departments are being charged with even more responsibilities. Newer responsibilities for purchasing personnel, in addition to all purchasing functions, include participation in the development of material and service requirements and related specifications, conducting material and value-analysis studies, inbound transportation, and even management of recovery activities such as surplus and scrap salvage, as well as its implications for environmental management.

In the 1970s and 1980s purchasing fell under the rubric of "materials management." Many corporations and individual facilities employed executives who held the title "materials manager," responsible for purchasing and supply management, inventory management,

receiving, stores, warehousing, materials handling, production planning, scheduling and control, and traffic/transportation. Today, the term materials management has expanded to include all activities from raw material procurement to final delivery to the customer, to management of returns; hence, the newer title supply chain management.

As purchasing personnel became even more central to the firm's operations they became known as "supply managers." As supply managers, they are active in the strategic-planning process, including such activities as securing partnering arrangements and strategic alliances with suppliers; identification of threats and opportunities in the supply environment; strategic, long-term acquisition plans; and monitoring continuous improvement in the supply chain.

A study by found that strategic purchasing enables firms to foster close working relationships with a limited number of suppliers, promotes open communication among supply chain partners, and develops a long-term strategic relationship orientation for achievement of mutual goals. This implies that strategic purchasing plays a synergistic role in fostering value-enhancing relationships and knowledge exchange between the firm and its suppliers, thereby creating value. In addition, supply managers are heavily involved in cross-functional teams charged with determining supplier qualification and selection, as well ensuring early supplier involvement in product design and specification development.

A comprehensive list of objectives for purchasing and supply management personnel would include:

- to support the firm's operations with an uninterrupted flow of materials and services:
- to buy competitively and wisely (achieve the best combination of price, quality and service);
- to minimize inventory investment and loss;
- to develop reliable and effective supply sources;
- to develop and maintain healthy relations with active suppliers and the supplier community;
- to achieve maximum integration with other departments, while achieving and maintaining effective working relationships with them;
- to take advantage of standardization and simplification;
- to keep up with market trends;
- to train, develop and motivate professionally competent personnel;
- to avoid duplication, waste, and obsolescence;
- to analyze and report on long-range availability and costs of major purchased items;
- to continually search for new and alternative ideas, products, and materials to improve efficiency and profitability; and
- to administer the purchasing and supply management function proactively, ethically, and efficiently.

DETERMINING REQUIREMENTS

In progressive firms, purchasing has a hand in new product development. As a part of a product development team, purchasing representatives have the opportunity to help determine the optimal materials to be used in a new product, propose alternative or substitute materials, and assist in making the final decision based on cost and material availability. Purchasing representatives may also participate in a make-or-buy analysis at this point. The design stage is the point at which the vast majority of the cost of making an item can be reduced or controlled.

Whether or not purchasing had an impact on a product's design, the purchasing agent's input may certainly be needed when defining the materials-purchase specifications. Specifications are detailed explanations of what the firm intends to buy in order to get its product to market.

Generally specified is the product itself, the material from which it is to be made, the process for making it, minimum levels of quality, tolerances (a range in which a specified characteristic is acceptable, e.g., an outer diameter must be a certain size, ±25 millimeters), inspection and test standards, and a specific function the product must perform.

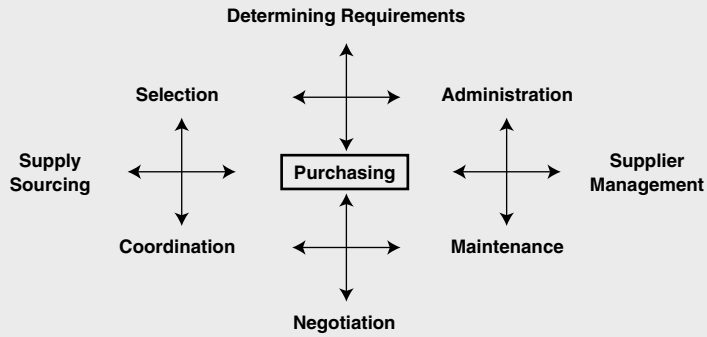
If the product requires a standardized component, the specifications are easily communicated by specifying a trade or brand name. However, a custom part can complicate the situation considerably; if incorrectly manufactured, such a product can severely damage a relationship, resulting in unnecessary costs and possible legal action. It is the buyer's responsibility to adequately communicate the specifications to the supplier so that there is no misunderstanding.

SUPPLY SOURCING

Part of the sourcing decision involves determining whether to purchase a part from an outside supplier or produce the part internally. This is typically known as a make-or-buy decision. If the buyer chooses to purchase the part externally, then he must find qualified suppliers who are willing to make and sell the product to his or her firm under the specified conditions.

Buyers have a number of places to go to locate sources of supply, some obvious and some indirect. The most obvious sources would include the Yellow

Figure 1
Determining Requirements



Pages, other purchasing departments, and direct marketing. Purchasing departments typically have a number of trade publications to which they subscribe, such as *Purchasing, Iron Age,* and *Purchasing World,* which are filled with advertisements for a multitude of suppliers. Also, being a subscriber usually puts the buyer's name on a mailing list so that flyers, postcards, and other varieties of direct marketing find their way into the purchasing department's hands.

Other sources of supply include manufacturer directories and trade registers. The best known of these is *Thomas' Register of American Manufacturers,* frequently referred to simply as the *Thomas Register.* With 125,000 trade and brand names, 151,000 U.S. and Canadian company listings, and 6,000 catalogs, it is a valuable tool for buyers. Practically every purchasing department has access to this source, either through the 34-volume book series or CD-ROMs.

Suppliers also may be found at trade exhibits, in supplier catalogs, or via recommendations from other knowledgeable sources, such as salesmen and engineers. Probably the most important and frequently used source will soon be the World Wide Web; countless firms maintain Web pages and are listed in online catalogs and directories.

Many firms find themselves in a situation where a suitable supplier cannot be found. In this situation, the firm is forced to develop a supplier. Supplier development is sometimes referred to as "reverse marketing," which entails finding the supplier with the most potential for success and providing the resources necessary for the supplier to manufacture the needed product. This could include training in production processes, quality, and management assistance, as well as providing temporary personnel, tooling, and even financing.

When the product being purchased is fairly standard and readily available, most firms choose to utilize the competitive bidding process of supplier selection. This involves little or no negotiation. A request for bids is sent to a limited number of qualified suppliers asking for a price quote for the product, given the terms and conditions of the contract. The contract generally goes to the lowest bidder. For government bid requests, the contract legally must go to the lowest bidder qualified to fulfill the contract.

NEGOTIATION

When competitive bidding is not the appropriate mechanism for reaching the purchasing department's objectives, the buyer turns to the process of negotiation. This does not indicate a second-choice alternative, since the negotiation process is more likely to lead to a complete understanding of all issues involved between the supplier and the purchasing firm. This improved understanding can greatly reduce the number and impact of unseen problems that may arise later.

A number of circumstances dictate the use of negotiation. When a thorough analysis is required to solve a difficult make-or-buy decision, or when the risks and costs involved cannot be accurately predetermined, negotiation should be used. Also, when a buyer is contracting for a portion of the seller's production capacity rather than a product, negotiation is typically appropriate.

Other circumstances where negotiation is favored include: when early supplier involvement is employed, when tooling and setup costs represent a large percentage of the supplier's costs, when production is interrupted frequently for change orders, or when a long time is required to produce the purchased products.

If successful negotiation is to occur, the buyer must have a reasonable knowledge of what is being purchased, the process involved, and any factors that may affect cost, quality, delivery, and service. A thorough cost and/or price analysis is essential. The negotiating buyer must also know the strengths and weaknesses of the negotiating supplier, as well as his own. Also, in light of today's global marketplace, strong cultural awareness is a must. Through proper preparation and

some negotiating skill, the purchasing agent should be able to secure a contract that fulfills his/her company's needs and is adequately beneficial to the supplier as well.

SUPPLIER MANAGEMENT

After locating proper suppliers and securing contracts, it then falls to the purchasing function to monitor and control the suppliers' performance until the contracts are fulfilled—and beyond, if further business is to be conducted. All purchasing organizations need some vehicle for assessing supplier performance. Many firms have formal supplier-evaluation programs that effectively monitor supplier performance in a number of areas, including quality, quantity delivery, on-time delivery, early delivery (just-in-time users do not like early deliveries), cost, and intangibles.

For some firms, consistent supplier performance results in certification. Supplier certification generally implies (or in some cases formally asserts) that the supplier has been a part of a formal education program, has demonstrated commitment to quality and delivery, and has proven consistency in his processes. Frequently, organizations are able to take delivery from certified suppliers and completely bypass the receiving inspection process.

The buyer is also responsible for maintaining a congenial relationship with the firm's suppliers. If the buyer is an unreasonable negotiator, and does not allow the supplier to make an adequate profit, future dealings may be endangered. The supplier may refuse to deal with the buyer in the future, or the supplier may greatly increase the price of a product the buyer could not obtain elsewhere. Also, relations can become strained when the buyer consistently asks for favored treatment such as expediting or constantly changing a particular order's delivery schedule.

E-PURCHASING AND E-PROCUREMENT

The Internet and e-commerce is drastically changing the way purchasing is done. Internet use in buying has led to the terms "e-purchasing" or "e-procurement." Certainly, communication needed in competitive bidding, purchase order placement, order tracking, and follow-up are enhanced by the speed and ease afforded by establishing online systems. In addition, negotiation may be enhanced and reverse auctions facilitated. Reverse auctions allow buying firms to specify a requirement and receive bids from suppliers, with the lowest bid winning.

E-procurement is considered one of the characteristics of a world-class purchasing organization. The use of e-procurement technologies in some firms has resulted in reduced prices for goods and services, shortened order-processing and fulfillment cycles, reduced administrative burdens and costs, improved control over off-contract spending, and better inventory control. It allows firms to expand into trading networks and virtual corporations.

Criteria for e-purchasing include:

- Supporting complete requirements of production (direct) and non-production (indirect) purchasing through a single, internet-based, self-service system.
- Delivering a flexible catalog strategy.
- Providing tools for extensive reporting and analysis.
- Supporting strategic sourcing.
- Enhancing supply-chain collaboration and coordination with partners.

SEE ALSO: Distribution and Distribution Requirements Planning; Quality and Total Quality Management; Supply Chain Management

R. Anthony Inman

FURTHER READING:

Burt, David N., Donald W. Dobler, and Stephen L. Starling. *World Class Supply Management: The Key to Supply Chain Management.* Boston, MA: McGraw-Hill Irwin, 2003.

Caridi, Maria, Sergio Cavalieri, Giorgio Diazzi, and Cristina Pirovano. "Assessing the Impact of e-Procurement Strategies Through the Use of Business Process Modelling and Simulation Techniques." *Production Planning and Control* 15, no. 7 (2004): 647–661.

Chang, Yoon, Harris Markatsoris, and Howard Richards. "Design and Implementation of an e-Procurement System." *Production Planning & Control* 15, no. 7 (2004): 634–646.

Chen, Injazz J., Antony Paulraj, and Augustine A. Lado. "Strategic Purchasing, Supply Management, and Firm Performance." *Journal of Operations Management* 22 (2004): 505–523.

Inside Supply Management: Resources to Create Your Future. Tempe, AZ: Institute for Supply Management.

Mehra, Satish, and R. Anthony Inman. "Purchasing Management and Business Competitiveness in the Coming Decade." *Production Planning and Control* 15, no. 7 (2004): 710–718.

"Procurement Head Reveals Keys to Achieve World-Class Status." *Supplier Selection & Management Report* 5, no. 2 (2005): 1–4.