

## 1. What is a system? What is a process? How are they alike or different?

In general, a *system* is a related set of elements that can function, or be operated as, a whole. The functioning or operating of a system is termed a *process*. A process operates through *time*, and represents changes in the state of the system over time. In this sense, a system *is*; a process *does*. In a given system, the elements represent *resources* such as tools, furniture, information, or people. These resources have certain *attributes*, such as shape, size, strength, knowledge, or skill.

When we look at a specific system of interest, and focus on it, we refer to that system as the *focal* system, to distinguish it from others. In human-made systems there is usually some intended purpose of the system. An organization is a goal achieving entity, and every organization is a system.

We call the interaction of one system (or subsystem) with another a *process*. Looking outward from the focal system, a process is the interaction through time of that system with other systems; looking inward, a process is the interaction of system elements (subsystems) over time.

Systems and processes are hierarchical. The system “elements” are actually subsystems, containing subprocesses. The relations among the elements define the *structure* of the system, and the interaction among them is a *process*. It is important to realize that the range of possible processes is determined by the structure of the system. A change to one part of a system often causes other parts to react.

Interaction occurs in three primary ways with respect to a given focal system:

- \* input processes to the system, e.g., bringing in material or human resources
- \* transformation processes within the system, e.g., technological or managerial operations
- \* output processes from the system, e.g., products or services

Because no system can not exist in isolation, an organization is an *open* system, and as such, interacts with its environment. The *environment* is all the other systems outside the boundary of our focal system. *Feedback* is a special set of input, output, and transformation processes by which the focal system obtains information from the environment about stability, direction, and goal achievement.

It has become commonplace to view the linkages within and among organizations as chains. We speak of a *value chain* (Porter, *Competitive Advantage*, 1995), a *service profit chain* (Heskett et al, *The Service Profit Chain*, 1997), and generically, a *supply chain* (or demand chain.) Goldratt also used this analogy, referring to an organization as being made up of chains with potential interdependencies among the links (p. 332 *The Goal*).

Viewing organizations in this way enables one to more easily recognize the fact that performance of one part is strongly dependent on the performance of other parts, and that synchronized efforts among the parts is a necessity if the organization is to achieve its goal. This recognition unavoidably demands that we treat organizations as systems, and engage in what is called *systems thinking*.

Systems thinking requires that we understand the concept of feedback, both positive (reinforcing or amplifying) and negative (counteracting or stabilizing). Systems thinking includes consideration of both the *structure* of systems and on how systems *function*, i.e., the processes through which they control their actions and communicate with other systems or with their own components. Systems thinking recognizes that the structure and function of a system cannot be understood in separation.

## 2. What is management and why is it important?

Management is the systematic, ongoing exercise of four activities or functions in the attempt to achieve personal and/or organizational goals. The four functions are planning, organizing, leading, and control. These four functions focus on the input, transformation, output, and feedback processes of an organization. By experience and logical thought we believe that such management activities will increase the likelihood of goal achievement. We say that management is *effective* to the extent that goals are achieved as a result of management actions.

Management is important because without it we are more likely to fail. With no management or poor management we are unlikely to accomplish our goals. Ostensibly, all organizational processes are focused on the goal or goals of the organization. However we do well to remember that many people spend their lives in organizations without caring much for the system or its goals (Katz and Kahn, *The Social Psychology of Organizations*, 1978, p. 331). Individuals care first for their own goals. An important part of a manager's job is to cause people to care, or at least be responsive to, the organization and its goals.

## 3. In the context of Operations Management, comment on your interpretation of the phrase, "Variability is the enemy."

Management is in large part about producing intended outcomes. This is why we plan, organize, lead, and control. Variability can and often does thwart our efforts. *Variability* is random statistical fluctuation. It is the enemy because it can not be predicted and can not be easily controlled. Variability manifests itself in many ways from many sources. Examples of sources outside the organization that contain variability are interest rates, consumer activity, competitor moves, technological innovations, and regulatory changes, raw material prices, labor availability, product demand, and inventory availability. Inside the organization, we contend with variability in our processes.

Each operation of a process, especially if it involves human action, will exhibit variability, i.e., statistical fluctuation about some average over time. One of the more troublesome forms of variability is in activity times for the steps in a process or the activities in a project. The effects of variability are often propagated through these sequential process steps, and those effects may be magnified by the *dependent event* chains within processes or projects. The combination of dependent events and statistical fluctuations (variation) means the variation will accumulate non-uniformly. The variation will tend to be an accumulation of delay because dependency limits opportunities for regaining time lost at an earlier activity.

To deal effectively with this enemy variability, we must better understand it and how it is manifested in dependent event process chains. In doing so we learn to avoid the fruitless search for the perfectly balanced plant, where the capacity of each and every resource is balanced exactly with market demand. By understanding the enemy variability, we realize that such a plant is not only unachievable but undesirable. It is unachievable because market conditions are always changing and because our process steps exhibit random variation. It is undesirable because it makes for a fragile system, i.e., one in which there is no protective capacity to compensate for interruptions at the system constraint. It is also undesirable because the next product change will require that we revise our "perfect" process. By better understanding variability we can make use of protective capacity and strategically placed buffers to protect system throughput.

**4. What is the so called “iron triangle” of project management? (This is also called the “golden triangle” by some.) How does the iron triangle exhibit some of the characteristics of a system?**

You all pretty much nailed this one.

**5. In a “balanced” ten station serial flow line with no buffers the processing time of each station is normally distributed with a mean of 60 minutes and a standard deviation of 12 minutes. If there were no variation the theoretical system capacity (output) would be one unit per hour. About how much is the system capacity (output) with variation?**

Random statistical fluctuations of process time at each unbuffered station, combined with the linear dependence of the sequential stations, results in a degradation of system capacity. The longer the line, for a given level of variation, the greater the capacity loss. The larger the variation (fluctuation) in process times for a given line length, the greater the capacity loss.

In this ten station unbuffered serial line the average capacity is reduced from 1.00 units per hour (at zero variation) to about 0.77 units per hour for the stated level of variation (standard deviation of 12 minutes).

This result can be readily obtained through static simulation of a ten station model using Excel.