Introduction to Systems Thinking

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System. We hear and use the word all the time. "There's no sense in trying to buck the system," we might say. Or, "Mary, she's a systems analyst." Or, "This job's getting out of control; I've got to establish a system." Whether you are aware of it or not, you are a member of many systems—a family, a community, a church, a company. You yourself are a complex biological system comprising many smaller systems. And every day, you probably interact with dozens of systems, such as automobiles, ATM machines, retail stores, the organization you work for, etc. But what exactly is a system? How would we know one if we saw one, and why is it important to understand systems? Most important, how can we manage our organizations more effectively by understanding systems?

This volume explores these questions and introduces the principles and practice of a quietly growing field: systems thinking. With roots in disciplines as varied as biology, cybernetics, and ecology, systems thinking provides a way of looking at how the world works that differs markedly from the traditional reductionistic, analytic view. But this is not an either-or distinction we are making here. Because some problems are best solved through analytic thinking and others through a systemic perspective, we need both to better understand and manage the world around us.

Why is a systemic perspective an important complement to analytic thinking? One reason is that understanding how systems work—and how we play a role in them—lets us function more effectively and proactively within them. The more we understand systemic behavior, the more we can anticipate that behavior and work with systems (rather than being controlled by them) to shape the quality of our lives.

It's been said that systems thinking is one of the key management competencies for the 21st century. As our world becomes ever more tightly interwoven globally and as the pace of change continues to increase, we will all need to become increasingly "system-wise." This volume gives you the language and tools you need to start applying systems thinking principles and practices in your own organization.

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Contents

What Is Systems Thinking?

What exactly is systems thinking? In simplest terms, systems thinking is a way of seeing and talking about reality that helps us better understand and work with systems to influence the quality of our lives. In this sense, systems thinking can be seen as a perspective. It also involves a unique vocabulary for describing systemic behavior, and so can be thought of as a language as well. And, because it offers a range of techniques and devices for visually capturing and communicating about systems, it is a set of tools.

For anyone who is new to systems thinking, the best way to "get your feet wet" is to first learn about the defining characteristics of systems; in short, what is a system? But to be a true systems thinker, you also need to know how systems fit into the larger context of day-to-day life, how they *behave*, and how to manage them. The final three sections of this volume tackle those issues.

What Is a System?

In the most basic sense, a system is any group of interacting, interrelated, or interdependent parts that form a complex and unified whole that has a specific purpose. The key thing to remember is that all the parts are interrelated and interdependent in some way. Without such interdependencies, we have just a collection of parts, not a system.

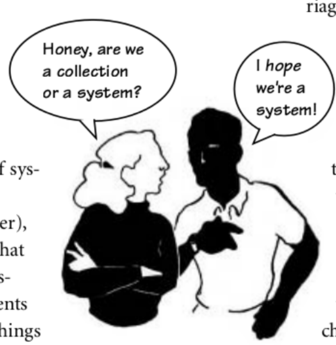
Collections Versus Systems

Let's illustrate this point with the following exercise. Take a look at the list of items below and determine for yourself which ones are systems and which ones are just collections of parts. Ready, set, go!

- Bowl of fruit
- Football team
- Toaster
- Kitchen
- Database of customer names
- Tools in a toolbox
- A marriage

So, which ones are systems and which are merely collections? This question isn't as easy to answer as it might seem at first. Your responses depend on what assumptions you are making about the item in question. Let's walk through each example (starting with the simpler ones first) and make our assumptions as explicit as we can.

Kitchen, database of customer names, and ***tools in a toolbox.*** These are all collections, because none of them meets our original criteria of interrelatedness and interdependence. Even though the kitchen itself is full of systems (refrigerator, microwave, dishwasher), it is still just a place that has a collection of systems and other elements in it. None of those things interrelate or interact in an interdependent way. (Note, though, that once humans enter a kitchen, they, together with the other elements, form a system. It's a curious fact, but *whenever you add people to a collection, you almost always transform a collection into a system!*)



Football team and ***toaster.*** Both are systems. Notice that in addition to our criteria of interrelatedness and interdependence, a team and a toaster are each put together for a specific purpose. Indeed, purpose acts as the predominant organizing force in any system. If you want to understand why a system is organized in a particular way, find out the system's purpose.

Bowl of fruit. Most people would classify this as an obvious collection, because the pieces of fruit are not interrelated in any way and do not interact with each other. In truth, however, they *are* interacting—at a microscopic level. For instance, if you put certain fruits together, they are apt to decay faster because they interact at a molecular level. Someone for whom these interactions are important (a fruitologist?) might even consider this bowl of fruit to be a very interesting system—one whose purpose is to maximize the biodegrading process.

Marriage. For any of you who saw this one as a collection, please seek marriage counseling immediately! All kidding aside, the question of whether one has a healthy marriage has a lot to do with whether the relationship more resembles a collection or a system. Marriage is essentially a voluntarily chosen state of interdependence with another person (not codependence, which is something altogether different). This state actually characterizes any long-term relationship, including friendships. Is there anybody among us who has not been reminded by someone that our actions have an impact on him or her? Sometimes, that is how we first encounter systems, and how we learn (often painfully) that we are part of a larger system than we may have realized.

Well, that was quite an excursion. I hope this tour has revealed that systems are indeed all around us and that they take many different forms. In spite of these differences, though, all systems share several defining characteristics. It may be helpful at this point to summarize those characteristics.

Defining Characteristics of Systems

Systems have purpose. As we saw in the examples above, every system has some purpose that defines it as a discrete entity and that provides a kind of integrity that holds it together. The purpose, however, is a property of the system as a whole and not of any of the parts. For example, the purpose of an automobile is to provide a means to take people and things from one place to another. This purpose is a property of the automobile as a whole and cannot be detected in just the wheels, the engine, or any other part.

All parts must be present for a system to carry out its purpose optimally. If you can take pieces away from something without affecting its functioning, then you have a collection of parts, not a system. In the toolbox example, if you remove a wrench, you have fewer tools, but you have not changed the *nature* of what is in the box. Likewise, if you can add pieces to a collection without affecting its functioning, it's still just a collection.

The order in which the parts are arranged affects the performance of a system. If the components of a collection can be combined in any random order, then they do not make up a system. In our toolbox, it doesn't matter whether the screwdrivers are piled on top or buried at the bottom of the box (unless, of course, you really need a screwdriver now!). In a system, however, the arrangement of all the parts matters a great deal. (Imagine trying to randomly rearrange the parts in your automobile!)

Systems attempt to maintain stability through feedback. In simplest terms, feedback is the transmission and return of information. The most important feature of feedback is that it provides information to the system that lets it know how it is doing relative to some desired state. For example, the normal human body temperature is 98.6 degrees Fahrenheit. If you go for a run, the exertion warms your body beyond that desired temperature. This change activates your sweat glands until the cooling effect of the perspiration readjusts your temperature back to the norm. Or, in our car example, imagine that you are steering your car into a curve. If you turn too sharply, you receive feedback in the form of visual cues and internal sensations that you are turning too much for the speed at which you're traveling. You then make adjustments to correct the degree of your turn or alter your speed, or some combination of both. If you are a passenger in a car driven by someone who is not paying attention to such feedback, you might be better off getting a ride with someone else!

The Importance of Purpose

We talked about systemic purpose a bit, but let's take a closer look at it. A key to understanding any system is knowing its purpose, either as a separate entity or in relation to a larger system of which it is a part. In human-made (or mechanical) systems, the *intended* purpose is usually explicit and reasonably clear, at least at the outset. The purpose of a washing machine, for example, is to wash clothes. The washing system is designed so that all the components work together to accomplish that purpose as effectively as possible.[1] In mechanical systems, the purpose is usually "hard-wired" into the design and therefore does not evolve over time. Your car, for example, was designed to take you places and will continue to operate with that purpose (provided you do your part in taking regular care of it). You'll never encounter a situation where you wake up one morning and your car has changed its purpose to be a lawnmower (though it may turn into a big, heavy, unmoving paperweight!).

Living (or natural) systems, on the other hand, are continually evolving and have the capacity to change their purpose, temporarily or permanently. For example, one of the most basic assumptions people make about animals is that they are driven only by survival instincts and the need to pass on their genes. As we deepen our understanding of nature, however, scientists are discovering that many animals seem to have much more complex set of purposes—some of them quite social—that govern their behavior. (Of course, we humans take it for granted that we have higher purposes beyond survival.)

Natural and social systems can be far more difficult to understand than nonliving systems, because we can never know for sure what their purpose

1 Beware: Customers who buy these systems may use them for other purposes that fit their own needs. In such situations, where a system is used for a purpose different from the one for which it was originally designed, the system is likely to degrade or fail. An unexpected use of washing machines actually occurred in Japan, where farmers employed the machines to wash their potatoes—and then complained to the manufacturer about the frequent breakdowns! The company had the option of trying to redesign the machine to accomplish both purposes effectively or to persuade the farmers not to wash their potatoes in them. In this case, the company chose to change the design and tout the machine's ruggedness as an extra feature.

or design is. As a result of this inability to truly know their purpose and design, we tend to take actions in these systems without really understanding the impact of our actions on the system. Whenever we do this, we risk causing a breakdown of the system. For example, people smoked tobacco for years before it was discovered that one of smoking's long-term consequences is lung cancer. Even though we had a fairly good understanding of the purpose of our lungs, we did not have a sufficient understanding of how the lungs worked and what impact smoking would have on them—and us—over a long period of time. Since we aren't the designers of the human body, we have to learn about how it works as a system largely by trial and error. Similarly, farmers have had to learn about ecological systems in much the same way, and managers struggle with organizational behavior for the same reasons. Like the human body, nature and human social systems don't come with an owner's manual.

Despite our ignorance about natural and social systems, we still can't seem to resist attributing some purpose to them. We even tend to impose a purpose on natural systems and then behave toward them in a way that is consistent with that purpose. For example, in some countries, people view dogs as pets for families to enjoy. In such regions, people might treat dogs almost as members of the family. In other parts of the world, dogs are seen as a source of food, and people treat them accordingly. In both situations, the practices toward dogs are consistent with each different, perceived purpose. Neither viewpoint is intrinsically right or wrong, although each may seem wrong when viewed through the "lens" of the other.

Clearly, there are lots of systems to choose from if you want to study systemic behavior. But as we will see, social systems make up the most complex class of systems—which you probably already know from direct experience in trying to manage some of them!

Putting Systems in Context: "The Iceberg"

Before we dive more deeply into the world of systems, it's helpful to see how systems fit into a broader context. We can actually view reality from the following multiple levels of perspective: *events, patterns,* and *systemic structures* (see "The Iceberg"). As we'll see below, systems occupy a key position in this framework. But what do these levels mean? Some basic definitions and a few examples might help:

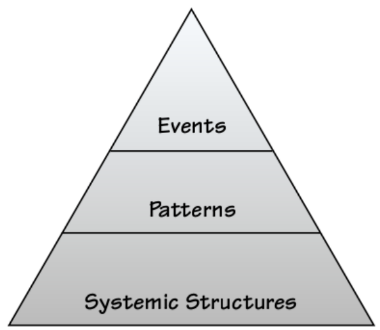
Events are the occurrences we encounter on a day-to-day basis. For example, we catch a cold, a fire breaks out, or a defective product comes off the assembly line at our company.

Patterns are the accumulated "memories" of events. When strung together as a series over time, they can reveal recurring trends. For example, we catch colds more often when we're tired, fires break out more frequently in certain neighborhoods, or we notice a higher number of product defects during shift changes.

Systemic structures are the ways in which the parts of a system are organized. These structures actually generate the patterns and events we observe. In the example above about defective products, perhaps shifts are scheduled such that there is no overlap between the outgoing and incoming work crews—hence, there's a greater likelihood of defects during these times. Note that systemic structures can be physical (such as the way a workspace is organized, or the way a machine is built) as well as intangible (such as ways employees are rewarded, or the way shift changes are timed).

A key thing to notice about the three different levels of perspective is that we live in an event-oriented world, and our language is rooted at the level of events. Indeed, we usually notice events much more easily than we notice patterns and systemic structures even though it is systems that are actually

THE ICEBERG



Because systemic structures generate patterns and events—but are very difficult to see—we can imagine these three levels as a kind of iceberg, of which events are only the tip. Because we only see the tip of the iceberg, the events, we often let those drive our decision-making. In reality, however, the events are the results of deeper patterns and systemic structures.
Source: Innovation Associates