FEATURE

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THE MOUSE AND THE EARTHQUAKE: AN INTRODUCTION TO SYSTEMS THEORY

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"Remember that you
are this universe
and this universe
is you."

—Joy Harjo

If you can study a part of a process, event, or thing . . .

- human behavior
- the mind
- ecology
- the birth of a baby
- social organization
- truth
- reality

by

- measuring it
- observing it
- testing it under different conditions
- making a mechanical or computer-assisted model of it
- making a mathematical model of it
- observing things around it
- seeing how it reacts to and acts upon its environment

. . . you can make some assumptions about the whole nature of it. Or can you?

Most fields of inquiry and research are based on this theory. It is so well understood to be true that we treat it as fact.

TEAM TIP

Read Margaret Wheatley's piece, "Relationships: The Basic Building Blocks of Life," as an excellent companion piece to this article (www.margaretwheatley.com/articles/relationships.html). Discuss how, with this knowledge of systems and interrelationships, your group might make better decisions.

For example, we know that people's thoughts are caused by the mechanics of brain function. We have performed tests directly stimulating the brain; we have studied the chemistry and biology of the brain; we have studied people with portions of their brain removed or damaged. We know how the brain works.

We can explain, predict, and fully describe things and processes by what we have observed about them. And if we study enough of the individual parts, we will understand how they all fit together as a whole entity or process.

Systems theory is an attempt to understand the previously indescribable and immeasurable.

It is generally understood that almost all events, things, and processes behave in a certain way. A causes B, which then results in C.

In the rare situation where that is not the case, we treat it as a random occurrence—unplanned and unconnected to anything else. It just happens.

But there are some in the fields of life sciences, ecology, social sciences, and other areas of study and theory who sense that things do not happen in linear or predictable ways. Perhaps our tangible, concrete ways of analyzing and building fact and theory are limited—and limit us from understanding the whole picture.

How do you explain intuition? Perception? How do we explain the "why" of things and processes—from molecules to social groups to the evolution of life forms—adjusting and adapting as they are affected by their environment, events, or occurrences?

Maybe it isn't "A causes B, which results in C" after all. Maybe it is more like "A and B change in relationship to one another, and when they change, something else changes, too—let's say Z." And maybe all the things and processes around this alphabet change in response to change. Maybe everything changes everything.

Maybe there are entirely new ways we can understand complexity, dynamics, and perhaps even our description of reality. Systems theory is an attempt to understand the previously indescribable and immeasurable.

A Definition of Systems Theory

Systems theory is a set of principles applying to complex, interacting wholes as a way to understand them. These principles are a tool to help us understand not just how things happen or are related in a linear way, but instead to conceptualize how processes, events, and things are *interrelated*, from cell to universe to time—to everything else. That is a difficult idea for our linear minds to grasp. Systems theory is an attempt to grasp the ungraspable—to understand reality in a larger way than just what we can see and measure.

Many of the world's religions honor the interrelatedness of everything to a greater whole and acknowledge that individual actions or events create change. For example, according to Buddhist scholar and systems theorist Joanna Macy, Buddha's writings teach that everything is connected, is part of a larger system, and that every

act results in a change to some part of the greater whole.

Cells, organs, organisms, communities, galaxies—all can be described as systems within systems within systems, all organized in some way and all interacting in some way and changing or being changed. If something happens in one part of the system, it causes change in other parts of the system. If something happens to one's body—such as a wound—not just the area of the arm or leg that was wounded but many other parts of the body change to accommodate and respond to that wound.

In the second World War, engineers studied, built, and refined a new kind of missile—one that could take in feedback about air patterns, temperature, the movement and path of an enemy plane, the missile's own path, and more. It could collect these bits of data throughout its whole flight, and with each new bit of data could adjust and adapt its own angle and path to accommodate for these changes and eventually hit the moving target. The self-guided missile was almost a participant with its target and everything that it passed through and was happening all around it. It was in a relationship to all of these things, and all of these things affected it. Both missile and target were interrelated—no longer two individual parts, but instead part of a greater whole, a greater system that is constantly changing and, in many cases, creating change.

So instead of a linear way of thinking that "this causes this," we have a nonlinear way of thinking not only that this causes this, but, for example, that both the nut and the squirrel eating it are affected and changed by the action of the squirrel munching on the nut. And both the nut and the squirrel—two systems—are part of the greater, more complex systems enclosing them. And each larger system is more complex than the one "below" it.

The nut is the simpler system in this short section of relationships—it is a small yet organized system full of cells and nutrients and time and structure, among other things. The squirrel is a more complex system—it is a system full of squirrel thoughts, the mechanics of mobility, and cells and nutrients and time and structure. The forest where the squirrel eats the nut is an even more complex system—it is a system consisting of many kinds of life, soil, air patterns, cells, nutrients, time, and structure. Don't forget: the forest changes because of the squirrel eating the nut, just as the squirrel and the nut are changed in their relationship. One can continue on with these images, noting that the forest is within the ecological system, which is within the earth system; the earth is within the planetary system; and so on up through greater levels of complexity, pattern, and order.

All of these systems change and are changed by the other systems within and encompassing them. All of them are interrelated and interdependent on one another.

The form and structure of the forest does not change, nor the squirrel's form and structure, nor the nut's. Each system, when affected by/effecting change, just self-organizes and adjusts itself to encompass the change. If the change has negative consequences for the squirrel—the nut makes the squirrel sick each time the squirrel eats a nut of that kind—it uses this data, or feedback, to reorganize, to evolve, and to change its codes into a slightly higher level of complexity so as to take this new information into account. The squirrel now avoids certain nuts and chooses others, and all runs smoothly again. The new feedback of all nuts now tasting great is data that reinforces the new pattern by which the squirrel can function.

And perhaps the squirrel's new pattern and new codes will change the forest, as now most of the bitter-tasting nuts will grow into trees previously rare in this particular forest. Maybe deer will love eating the bark of these trees and change their paths through the forest, and so on.

This humble example of squirrel, nut, and forest does not do justice to systems theory, as it is too linear a way to explain the interrelated systems of time, greater consciousness, evolution, and so many other wholes inside wholes inside wholes. Systems encompassing systems encompassing systems—all of them in a state of constant change and all of them continuously exchanging information.

Open Systems

Think again of the forest. It can be called an "open" system. An open system is constantly changing in relationship to its environment. It receives information from outside of itself and changes its behavior in relationship to that information. The human body, a community, a galaxy—all are open systems. And the principles demonstrated by or appearing in one system seem to apply to all different systems, from social systems to ecological systems to political systems to immune systems.

Change anywhere creates change elsewhere, as the systems within systems within systems (wholes the wholes are within) modify their codes and processes to adjust to new data. Each change affects the greater system it is part of as well as the simpler system it has changed. The squirrel is part of the more complex forest system, and the act of eating another kind of nut creates change in the nut system, as the nut system must adjust to new data and a new environment. The (forest/squirrel/nut) system reorganizes itself, adapting to information and changes in the surrounding environment according to its needs, changing and adjusting itself to create a new pattern of events or processes and thereby to maintain its stability.

The example of squirrel and nut illustrates changes in the ecological system. According to systems theory, every kind of system works in the same way. So let us now take as an

example the human mind. Our mind observes, notes, and sifts data and positive or negative feedback from the surrounding environment (both the body and the world outside the body). It often makes adaptations to this new information, for example, adjusting our decision-making or our perception of things, causing behavior change, and using knowledge.

Each change in our mind system gives it more flexibility and complexity, as it adds to its accumulation of data and its ability to respond. Each piece of irregular data is noted. If feedback of a certain sort keeps occurring—if something keeps happening in a different way than our usual understanding—the mind changes its codes and adjusts how it responds.

We trip on a rock in our path and scrape our knee. As all systems change in order to stabilize and continue, our mind develops a new pattern of organization to encompass this experience and information. It makes changes, which in turn effect changes in behavior and other systems in our body. We are now changed on the outside, as well, and wear sturdier shoes and long pants on future hikes.

Our sensory system, balance system, neurological system—all of these interrelated systems work in the same way, mapping out a new way of responding to changing data as information is exchanged among them all. Feedback from the next similar situation reinforces the way that each system has evolved. We do not trip on rocks as often now.

Feedback Informs Change

Nature evolves, planets evolve, and social structures evolve, organize, and complexify. All are systems that are constantly in a state of change as they adjust according to feedback from both the whole they are encompassed by and the wholes embedded within them. Desert, galaxy, and school system give and receive feedback to and from temperature, solar system, and parent-teacher group.

Using the definitions created by systems theory, the term "feedback" is divided into negative and positive feedback. In systems theory, the words "negative" and "positive" are used a little differently than we might otherwise use them.

Feedback that reinforces the system's codes and patterns of organization—the school system deals with similar issues each year—is negative feedback. *Negative* feedback means no change is needed—it tells the system to keep functioning in the same direction as it has previously. The parent-teacher group gathers and discusses issues each year. The people may change, but the issues and meeting process generally stay the same.

As wholes are interrelated, change in one system creates change in another system (or several, or many).

Positive feedback is that which leads the system to adapt and change as it works its way back toward stabilization and continuance. Yes, change is needed. The school system experiences a serious financial crisis. This does not match how the parent-teacher system has organized its patterns of response. So the parent-teacher system adapts and reorganizes—perhaps it develops task forces or calls in consultants—as each system seeks stability.

Negative feedback equals "continue in the same direction—all is stable," and the system stays the same. Positive feedback equals "change direction—adapt and change to return to stability," and the system evolves.

This Affects That (and That, and That, and That . . .)

"Everything flows." —Heraclites

Think of a person's new understanding of the world in which she lives. This change in thought doesn't just stay in the body; the body and the mind interweave with other systems—the environment, society, nature, the world, the universe. Each is a complete whole, yet all are part of a greater whole encompassing it. As wholes are interrelated, change in one system creates change in another system (or several, or many), which causes change in other systems, and so on and so on, as each system exchanges information with every other system. A person's action, a society evolving, a life form becoming extinct, even a change in a person's perception of the world—each of these reorganizing systems affects the larger whole and affects how other things happen.

Science fiction author Ray Bradbury writes about this interrelatedness in a short story entitled, "A Sound of Thunder" (from *The Stories of Ray Bradbury*, originally published by Alfred A. Knopf, 1943). In this tale, a man travels back in time to shoot a Tyrannosaurus Rex. Travis, the time safari leader, tells him that no matter what happens, he must not step off the elevated path on which they are walking.

> *"Say we accidentally kill one mouse here. That means all the future families of this one particular mouse are destroyed, right? . . . And all the families of the families of the families of that one mouse! With a stamp of your foot, you annihilate first one, then a dozen, than a thousand, a million, a billion possible mice!"*
>
> *"So they're dead," said Eckels, "So what?"*
>
> *"So what?" Travis snorted quietly.*
>
> *"Well, what about the foxes that'll need those mice to survive? For want of ten mice, a fox dies. For want of ten foxes, a lion starves. For want of a lion, all manner of insects, vultures, infinite billions of life forms are thrown into chaos and destruction. Eventually it all boils down to this: Fifty-nine million years later, a cave man, one of a dozen on the entire world, goes hunting wild boar or saber-tooth tiger for food. But you, friend, have stepped on all the tigers in that region. By stepping on one single mouse. So the cave man starves. And the cave man, please note, is not just any expendable man, no! He is an entire future nation. From his loins would have sprung ten sons. From*

their loins one hundred sons, and thus onward to a civilization. Destroy this one man, and you destroy a race, a people, an entire history of life. It is comparable to slaying some of Adam's grandchildren. The stamp of your foot, on one mouse, could start an earthquake, the effects of which could shake our Earth and destinies down through Time, to their very foundations. With the death of that one cave man, a billion others yet unborn are throttled in the womb. Perhaps Rome never rises on its seven hills. Perhaps Europe is forever a dark forest, and only Asia waxes healthy and teeming. Step on a mouse and you crush the Pyramids. Step on a mouse and you leave your print, like a Grand Canyon, across Eternity. Queen Elizabeth might never be born, Washington might not cross the Delaware, there might never be a United States at all. So be careful. Stay on the Path. Never step off! . . . Crushing certain plants could add up infinitesimally. A little error here would multiply in sixty million years, all out of proportion. Of course maybe our theory is wrong. Maybe Time can't be changed by us. Or maybe it can be changed only in little subtle ways. A dead mouse here makes an insect imbalance there, a population disproportion later, a bad harvest further on, a depression, mass starvation, and, finally, a change in social temperament in far-flung countries."

Change Is Essential if the System Is to Continue

If there were never change, a system might not survive. If people's tastes changed because of a trend toward restaurants serving fancy kinds of lettuce, then the number of iceberg lettuce growers might decrease. The iceberg lettuce system would destabilize, and without change, it would not survive.

A bit of chaos in the system can be a good thing, however, as in order to return to stability, a system has to develop a new order and pattern of how to organize itself. With a choice of either surviving (evolving to a new order, reorganizing the patterns) or not surviving (maintaining the same order and same organization of pattern, and the system doesn't thrive any more because other things have changed), often unique and creative results can occur.

The grower has the choice of either closing his lettuce business (system not surviving) or reorganizing how he operates within the existing greater system (system surviving). He decides to form an alliance with another grower to pool their resources. In other words, they both reorganize their patterns and codes—

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they exchange information, evolve, and become more complex and more expansive in their abilities. Together they now provide a fuller range of lettuces to the restaurant market. Together they form a new system and a new response to the system they operate within. In the future, they will be able to be a little more flexible toward changes in consumer taste trends.

Perception

Taste, touch, perception of a situation—all of these inform the human system. According to systems theory, perception includes both that which is perceived and that which is perceiving. A person's perception of a rock requires both the person (her previous experience with similar items, her senses, her mind, and her sense of touch for comparing this object with previously gathered data) and the rock (its weight, its form, its appearance, its similarity or dissimilarity with other rocks—the information it presents to the human). In this way, each system—both rock system and human system—exchange information. Systems theorist Macy says, "We do not see objects so much as our ideas of them" (in *Mutual Causality in Buddhism and General Systems Theory*, State University of New York Press, 1991).

We extract information with our senses, refer it to our current understanding of "rock" (which has been developed through past experience with similar items), and notice whether it fits or does not fit with our understanding (our codes, our patterns) of "rock." If the information our senses give us matches our "rock" codes, then we keep the same codes. If it does not match, we cast off our old codes and now have a new and expanded code. Some rocks have sharp edges, and some rocks are round.

We each have our own filters—our own filtration system—that sees things in our own unique way. Our way of seeing things is built by our senses and our own individual experience. Other people—with other understandings and experiences—may have a different way of seeing the same thing—a different pattern of codes.

The Notion of Self

"Our own pulse beats in every stranger's throat." —Barbara Deming

Systems theory offers a new look at what is the self versus what is the world within which the self operates. It is traditionally assumed that the self is separate from its environment—a person is separate from the world through which he walks. What a person sees and touches and walks on exists as a separate entity from the person.

Using systems theory, it is impossible to separate one system from the interrelated and interdependent systems within which it exists—and it is impossible to separate the systems that it encompasses. The physical form of the body is interconnected both with its environment and with its own processing and response systems. One system does not control the other; rather all work together to exchange information to form a pattern of health or understanding.

Self as a whole is not a separate "me" but rather is a part of all

related systems. Systems theory explains that we are connected with everything else because we draw from and exchange information with everything else. For example, we receive information through our senses and our collection of past experiences that a rock is an inanimate object, separate from us. We are not the rock.

However, if we are interrelated with our environment (through our existing pattern of interpretation), if we are exchanging touch sensation or sight sensation in our perception of that rock, are we not exchanging data with that rock? Is not perception a constant, ever-changing information flow? Are we not a system interacting with our environment in a constant state of information exchange, feedback, and change? Where are the boundaries of our self? At the skin? At the edge of our understanding? There really are no boundaries, no distinctions between us and what we perceive of as outside of us.

Can the "self," whatever that might mean (identity, consciousness, thought, perception, physical entity), ever be separate from anything else? The self as a system is always interacting with, changed by, affecting, within, and encompassing other systems. It is a whole that is part of interconnected wholes. All are related, all are in relationship to one another, all are affected and changed by one another, all evolve due to changes within the others. We humans are all connected to one another as well.

We are unique and yet inseparable from each other, the ecology, time, society, past and present history, even the rock that we hold in our hand.

Humans Create Change

"Whatever befalls the earth
befalls the sons and daughters of the earth.
We did not weave the web of life;
We are merely a strand in it.
Whatever we do to the web,
we do to ourselves."

—Chief Seattle

Whether we are a sculpture of blood, bone, organ, and muscle, or whether we are a process or a series of events or a small piece of a greater whole, through systems theory, we see that everything happens in relationship to everything else, and everything is interrelated with everything else.

We cannot choose to participate or not participate—the nature of systems is to exchange with, change, and be changed by other systems.

Everything we do affects everybody else and everything else. We cannot choose to participate or not participate—the nature of systems is to exchange with, change, and be changed by other systems. And as systems, we are participating all the time.

But one element specific to humans and other animals is that they can decide to create change. They can consciously alter their patterns, their way of interacting, and their actions and their responses.

Consider if more of us changed our comprehension of the world in which we live. If more of us had the awareness that we are connected to every event, everything, and everyone, we could perceive wholeness and therefore know that our own actions (or lack of action) affect the greater whole of which we are a part. With this greater awareness, we could move through the world more consciously, creating little concentric explosions of change in our world, our environment, our ecosystem, our social, our political or economic system, and so on. The possibilities are virtually endless. ◘

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For Further Reading

Deming B. and Meyerding J., *We Are All Part of One Another* (New Society Publishers, 1984)

Morin, Edgar, "A New Way of Thinking," *UNESCO Courier*, 1996

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http://pespmc1.vub.ac.be/NUTSHELL.html

NEXT STEPS

- What does it mean, on a practical level, for your organization to be a system within a larger system, part of an interconnected and interdependent network of relationships? As a group, consider how an action you have taken has had ripple effects in the greater systems you are part of as well as in the simpler systems you have changed. For example, what is the impact of changing, say, a marketing strategy. Instead of sending out monthly fliers by mail, you decide to rely solely on email promotions. Going from largest system (the earth) to smallest (the individual customer), what are the effects of this change? Which ones did you anticipate in advance of the change? Which were unexpected? How did these responses, in turn, change your group or the way in which it operates?
- What are some examples in your organization of *negative* feedback? List some instances in which change initiatives never seemed to take hold and, after a temporary shift, things returned to the status quo. What systems forces were keeping the existing system in place?
- What are some examples in your organization of *positive* feedback? List some examples of times in which rapid change occurred, either for the better or for the worse. What caused this momentum to take hold? Did the process eventually hit a limit that slowed further change or growth?
- What would it look like to purposely instigate chaos in your system to prompt creativity and innovation?

—JM

