WHAT IS SYSTEMS THINKING?

Systems thinking offers us a powerful new perspective, a specialized language, and a set of tools that one can use to address the most stubborn problems in his everyday life and work. A system thinking is a way of understanding reality that emphasizes the relationships among a system’s parts, rather than the parts themselves. Based on a field of study known as system dynamics, systems thinking have a practical value that rests on a solid theoretical foundation.

Why Is Systems Thinking Important?

Why is a system thinking valuable? Because it can help us design smart, enduring solutions to problems. In its simplest sense, system thinking gives you a more accurate picture of reality, so that you can work with a system's natural forces in order to achieve the results you desire. It also encourages you to think about problems and solutions with an eye toward the long view—for example, how might a particular solution you're considering play out over the long run? And what unintended consequences might it have? Finally, systems thinking is founded on some basic, universal principles that you will begin to detect in all arenas of life once you learn to recognize them.

What Are Systems?

What exactly is a system? A system is a group of interacting, interrelated, and interdependent components that form a complex and unified whole. Systems are everywhere—for example, the R&D department in your organization, the circulatory system in your body, the predator/prey relationships in nature, the ignition system in your car, and so on. Ecological systems and human social systems are living systems; human-made systems such as cars and washing machines are nonliving systems. Most systems thinkers focus their attention on living systems, especially human social systems. However, many systems thinkers are also interested in how human social systems affect the larger ecological systems in our planet.

Systems have several defining characteristics:

• Every system has a purpose within a larger system. Example: The purpose of the R&D department in your organization is to generate new product ideas and features for the organization.

• All of a system’s parts must be present for the system to carry out its purpose optimally. Example: The R&D system in your organization consists of people, equipment, and processes. If you removed any one of these components, this system could no longer function.

• A system’s parts must be arranged in a specific way for the system to carry out its purpose. Example: If you rearranged the reporting relationships in your R&D department so that the head of new-product development reported to the entry-level lab technician, the department would likely have trouble carrying out its purpose.

• Systems change in response to feedback. The word feedback plays a central role in systems thinking. Feedback is information that returns to its original transmitter such that it influences that transmitter’s subsequent actions. Example: Suppose you turn too sharply while driving your car around a curve. Visual cues (you see a mailbox rushing toward you) would tell you that you were turning too sharply. These cues constitute feedback that prompts you to change what you're doing (jerk the steering wheel in the other direction somewhat) so you can put your car back on course.

• Systems maintain their stability by making adjustments based on feedback. Example: Your body
temperature generally hovers around 98.6 degrees Fahrenheit. If you get too hot, your body produces sweat, which cools you back down.

**Systems Thinking as a Perspective: Events, Patterns, or System?**

Systems thinking is a perspective because it helps us see the events and patterns in our lives in a new light—and respond to them in higher leverage ways. For example, suppose a fire breaks out in your town. This is an event. If you respond to it simply by putting the fire out, you're reacting. (That is, you have done nothing to prevent new fires.) If you respond by putting out the fire and studying where fires tend to break out in your town, you'd be paying attention to patterns. For example, you might notice that certain neighborhoods seem to suffer more fires than others. If you locate more fire stations in those areas, you're adapting. (You still haven't done anything to prevent new fires.) Now suppose you look for the systems—such as smoke-detector distribution and building materials used—that influence the patterns of neighborhood-fire outbreaks. If you build new fire-alarm systems and establish fire and safety codes, you're creating change. Finally, you're doing something to prevent new fires!

This is why looking at the world through a systems thinking "lens" is so powerful: It lets you actually make the world a better place.

**Topics in Systems Thinking**

- **Behavior over Time Graphs:** How to Detect Patterns of a System at Work
- **Causal Loop Diagrams:** How to Depict Your Understanding of a System
- **The Language of Links and Loops:** A concise explanation of the symbols
- **Organizational Learning:** Creating the Future You Envision
- **Reinforcing and Balancing Processes:** The "Building Blocks" of Every System
- **Simulation Modeling:** How to "Test-Flight" Your Business-Without Crashing It!
- **Stocks and Flows:** Or How Fast Is the Bathtub Draining?
- **System Dynamics:** The Foundation of Systems Thinking
- **Systems Archetypes:** Or "Why Do We Keep Having the Same Problems?!"

**Glossary of terms**

**Systems Thinking as a Special Language**

As a language, systems thinking has unique qualities that help you communicate with others about the many systems around and within us:

- It emphasizes wholes rather than parts, and stresses the role of interconnections—including the role we each play in the systems at work in our lives.
It emphasizes circular feedback (for example, A leads to B, which leads to C, which leads back to A) rather than linear cause and effect (A leads to B, which leads to C, which leads to D, . . . and so on).

It contains special terminology that describes system behavior, such as reinforcing process (a feedback flow that generates exponential growth or collapse) and balancing process (a feedback flow that controls change and helps a system maintain stability).

**Systems Thinking as a Set of Tools**

The field of systems thinking has generated a broad array of tools that let you (1) graphically depict your understanding of a particular system's structure and behavior, (2) communicate with others about your understandings, and (3) design high-leverage interventions for problematic system behavior.

These tools include causal loops, behavior over time graphs, stock and flow diagrams, and systems archetypes—all of which let you depict your understanding of a system—to computer simulation models and management "flight simulators," which help you to test the potential impact of your interventions.

Whether you consider systems thinking mostly a new perspective, a special language, or a set of tools, it has a power and a potential that, once you've been introduced, are hard to resist. The more you learn about this intriguing field, the more you'll want to know!

**Systems Thinking as a Language**

*by Michael Goodman*

*Language has a subtle, yet powerful effect on the way we view the world. English, like most other Western languages, is linear—its basic sentence construction, noun-verb-noun, translates into a worldview of "x causes y." This linearity predisposes us to focus on one-way relationships rather than circular or mutually causative ones, where x influences y, and y in turn influences x. Unfortunately, many of the most vexing problems confronting managers and corporations today are caused by a web of tightly interconnected circular relationships. To enhance our understanding and communication of such problems, we need a language more naturally suited to the task.*

**Elements of the Language**

Systems thinking can be thought of as a language for communicating about complexities and interdependencies. In particular, the following qualities make systems thinking a useful framework for discussing and analyzing complex issues:

- **Focuses on "closed interdependencies."** The language of systems thinking is circular rather than linear. It focuses on closed interdependencies, where x influences y, y influences z, and z influences x.

- **A "visual" language.** Many of the systems thinking tools—causal loop diagrams, behavior-over-time diagrams, systems archetypes, and structural diagrams—have a strong visual component. They help clarify complex issues by summing up, concisely and clearly, the key elements involved.
Diagrams also facilitate learning. Studies have shown that many people learn best through representational images, such as pictures or stories. A systems diagram is a powerful communication tool because it distills the essence of a problem into a format that can be easily remembered, yet is rich in implications and insights.

- **Adds precision.** The specific set of "syntactical" rules that govern systems diagrams greatly reduces the ambiguities and miscommunications that can occur when tackling complex issues.

  *Example:* In drawing out the relationships between key aspects of a problem, causal links are not only indicated by arrows, but are labeled "s" (same) or "o" (opposite) to specify how one variable affects another. Such labeling makes the nature of the relationship more precise, ensuring only one possible interpretation.

- **Forces an "explicitness" of mental models.** The systems thinking language translates "war stories" and individual perceptions of a problem into black-and-white pictures that can reveal subtle differences in viewpoint.

  *Example:* In one systems thinking course, a team of managers was working on an issue they had been wrestling with for months. One manager was explaining his position, tracing through the loops he had drawn, when a team member stopped him. "Does that model represent your thinking about this problem?" he asked.

  The presenter hesitated a bit, reviewed his diagram, and finally answered, "Yes."

  The first man, evidently relieved, responded, "After all of these months, I finally really understand your thoughts on this issue. I disagree with it, but at least now that we are clear on our different viewpoints, we can work together to find a solution."

- **Allows examination and inquiry.** Systems diagrams can be powerful means for fostering a collective understanding of a problem. Once individuals have stated their understanding of the problem, they can collaborate on addressing the challenges it poses. And by focusing the discussion on the diagrams, systems thinking defuses much of the defensiveness that can arise in a high-level debate.

  *Example:* When carrying on a systems discussion, differing opinions are no longer viewed as "human resources' view of our productivity problem" or "marketing's description of decreasing customer satisfaction," but simply different structural representations of the system. This shifts the focus of the discussion from whether human resources or marketing is right, to constructing a diagram that best captures the behavior of the system.

- **It embodies a worldview** that looks at wholes, rather than parts, and that recognizes the importance of understanding how the different segments of a system are interconnected. An inherent assumption of the systems thinking worldview is that problems are internally generated—that we often create our own "worst nightmares."

  *Example:* At some systems thinking courses, participants play a board game known as the "Beer Game," where they assume the position of retailer, wholesaler, distributor, or producer. Each player tries to achieve a careful balance between carrying too much inventory or being backlogged. When things go wrong, many people blame their supplier ("I kept ordering more, but he didn't respond") or the buyers ("fickle consumers—one day they're buying it by the truckload, the next day they won't even touch the stuff"). In reality, neither the buyers nor the suppliers are responsible for the wide fluctuations in inventory—they are a natural consequence of the structure of the system in which the players are functioning.

  The systems thinking worldview dispels the "us versus them" mentality by expanding the
boundary of our thinking. Within the framework of systems thinking, "us" and "them" are part of the same system, and thus responsible for both the problems and their solutions.

Learning the Language

Learning systems thinking can be likened to mastering a foreign language. In school, we studied a foreign language by first memorizing the essential vocabulary words and verb conjugations. Then we began putting together the pieces into simple sentences. In the language of systems thinking, systems diagrams such as causal loops can be thought of as sentences constructed by linking together key variables and indicating the causal relationships between them. By stringing together several loops, we can create a "paragraph" that tells a coherent story about a particular problem under study.

If there were a Berlitz guide to systems thinking, archetypes such as "Fixes that Fail" or "Shifting the Burden" would be listed as "commonly-used phrases." They provide a ready-made library of common structures and behaviors that can apply to many situations. Memorizing them can help you recognize a business situation or problem that is exhibiting common symptoms of a systemic breakdown.

Of course, the key to becoming more proficient in any language is to practice—and practice often. When reading a newspaper article, for example, try to "translate" it into a systems perspective:

• take events reported in the newspaper and try to trace out an underlying pattern that is at work
• check whether it fits one of the systems archetypes, or if it is perhaps a combination of several archetypes
• try to sketch out a causal loop or two that captures the structure producing that pattern.

Don't expect to be fluent in systems thinking right away. Remember, after your first few Latin classes, you still couldn't read The Odyssey. For that matter, you probably knew only a few key phrases and vocabulary words, but you improved your skills by practicing as often as possible. The same holds true for systems thinking.

When sitting in a meeting, see if you can inform your understanding of a problem by applying a systems perspective. Look for key words that suggest linear thinking is occurring—statements such as "we need more of the same" or "that solution worked for us the last time this happened, why not use it again?" You can also create low-key practice sessions by working with a small team of colleagues to diagram a particular problem or issue.

Becoming Fluent

We say someone is fluent when they begin to think in a particular language and no longer have to translate. But fluency means more than just an ability to communicate in a language; it means understanding the surrounding culture of the language—the worldview. As with any foreign language, mastering systems thinking will allow us to fully engage in and absorb the worldview that pervades it. By learning the language of systems thinking, we will hopefully change not only the way we discuss complex issues, but the way we think about them as well.

BEHAVIOR OVER TIME GRAPHS

Behavior over time (BOT) graphs are a kind of systems thinking tool. Like other basic graphs, they have horizontal and vertical axes, with a line showing how something is changing over time. You draw a BOT graph in order to depict patterns of behavior that you want to explore from a systems thinking perspective. For example, you might want to show changes in your company's
sales over the past, say, five years—as well as future sales patterns that you'd like or expect to see happen.

BOT graphs often reveal "signature" patterns of behavior that indicate that a particular systemic process is at work. For instance, suppose your company makes a cell phone with snazzy new features on it. If your graph of the sales history of this product shows sales increasing dramatically and then leveling off, then perhaps your product is experiencing market saturation—e.g., everyone who wants one of these phones has bought one. This is a common eventual constraint on the sales growth of a hot new product.

You can also graph more than one thing on a BOT graph, which helps you see how the two things might be related. To illustrate, suppose you graphed your cell-phone sales history and the number of dollars spent on marketing for that product. You might come up with a graph that looks like this:

This graph vividly shows how a rise in investment in marketing a product might be contributing to a jump in sales of that product.

BOT graphs also encourage you to think about what time frame to use in your analysis. For example, if it typically takes several years to develop a new product, you wouldn't want to graph "number of new products developed" over the course of just a few quarters—you'd want to extend that horizontal axis of your graph to include plenty of product-development cycles, perhaps six or 10 years' worth to start seeing patterns.

Though they might seem simple at first, BOT graphs let you form some theories about why things might be happening as they are in your organization. And once you form some theories, you have a much better chance of testing them—and possibly turning around some of the more troubling patterns!

CAUSAL LOOP DIAGRAMS

Causal loop diagrams (CLDs) are a kind of systems thinking tool. These diagrams consist of arrows connecting variables (things that change over time) in a way that shows how one variable
affects another. Here are some examples:

Each arrow in a causal loop diagram is labeled with an "s" or an "o." "S" means that when the first variable changes, the second one changes in the same direction (for example, as your anxiety at work goes up, the number of mistakes you make goes up, too). "O" means that the first variables causes a change in the opposite direction in the second variable (for example, the more relaxation exercises you do, the less stressed you feel).

In CLDs, the arrows come together to form loops, and each loop is labeled with an "R" or a "B." "R" means reinforcing; i.e., the causal relationships within the loop create exponential growth or collapse. (For instance, the more anxious you are at work, the more mistakes you make, and as you make more mistakes, you get even more anxious, and so on, in a vicious, upward spiral). "B" means balancing; i.e., the causal influences in the loop keep things in equilibrium. (For example, if you feel more stressed, you do more relaxation exercises, which brings your stress level down.)

CLDs can contain many different "R" and "B" loops, all connected together with arrows. By drawing these diagrams with your work team or other colleagues, you can get a rich array of perspectives on what's happening in your organization. You can then look for ways to make changes so as to improve things. For example, by understanding the connection between anxiety and mistakes, you could look for ways to reduce anxiety in your organization.
THE LANGUAGE OF LINKS AND LOOPS

WHAT IS ORGANIZATIONAL LEARNING?

The world seems to be changing faster and faster—from the technologies available to us, to the increasingly global scope of our interactions. Moreover, the problems facing us as a global community seem to be growing ever more complex and serious. How do we navigate such change and address these problems—not only in our work lives but also in our families, communities, and schools?
We believe that organizations—groups of people who come together to accomplish a purpose—hold an important key to these questions. The field of organizational learning explores ways to design organizations so that they fulfill their function effectively, encourage people to reach their full potential, and, at the same time, help the world to be a better place.

This field is rooted in a set of powerful principles, values, and disciplines. As Peter Senge wrote in his seminal book *The Fifth Discipline: The Art & Practice of the Learning Organization*, an organization is learning when it can bring about the future it most desires. In the business community, learning is much more than just a way to create the future you want; in today's fast-paced, highly competitive work world, it may actually give your organization the edge it needs to survive—and thereby keep fulfilling its purpose.

Organizational learning focused originally on the practice of five core disciplines, or capacities, of which systems thinking forms the cornerstone:

- systems thinking
- team learning
- shared vision
- mental models
- personal mastery

Let's take a closer look at these disciplines:

**Systems thinking** is the art of seeing the world in terms of wholes, and the practice of focusing on the relationships among the parts of a system. By looking at reality through a systems thinking "lens," you can work with a system—rather than against it—to create enduring solutions to stubborn problems in every arena of your life. Practicing this discipline involves learning to recognize "signature" systemic behaviors all around you, and familiarizing yourself with some special terminology and some powerful tools unique to this field.

**Team learning** is what happens when a group of people working on something together experiences that rare feeling of synergy and productiveness that happens when you're "in the groove." When a team is truly learning, the group as a whole becomes much more than just the sum of its parts. Practicing this discipline involves startlingly different kinds of conversations and a remarkable degree of honesty and mutual respect—all of which you can learn to do through familiarizing yourself with specific tools from this field.

**Shared vision** emerges when everyone in an organization understands what the organization is trying to do, is genuinely committed to achieving that vision, and clearly grasps how his or her role in the organization can contribute to making the vision real. Practicing this discipline involves knowing how all the parts of the organization work together and being clear about how your own personal goals align with those of your organization.

**Mental models** are the deep beliefs and assumptions we hold about how the world works. These models shape the decisions we make in life, the actions we take in response to events, and the ways in which we interpret others' behavior. Practicing this discipline involves surfacing and testing your deepest assumptions and beliefs, and helping others do the same. Again, there are specific tools available from this field that can help you with this practice.

**Personal mastery** is the art of identifying what mark you want to leave on the world during your lifetime. That is, what's your unique purpose in life, and how do you want to go about fulfilling that purpose? Practicing this discipline involves some honest exploration of your own life experiences and desires and a willingness to take some risks.

These five disciplines were originally outlined in 1990 in *The Fifth Discipline* and are core to
many organizational learning efforts. We also believe there are many other disciplines that support and expand on the above five, including:

**Corporate culture** is that intangible "something" that influences the environments in which we work every day. Technically, culture is an anthropological concept. But in the field of organizational learning, it refers to the policies, beliefs, activities, and rituals that determine an organization's "personality." A company's culture can support or hinder learning, encourage or stifle creativity, and so on. Fortunately, we can shape our organizations' culture through careful attention to how we do things and treat one another in the workplace.

**Corporate social responsibility** addresses the question of how the business community fits into the larger social picture. Specifically, what responsibility do organizations have beyond just their own industries and arenas of competition? How do the actions of a particular organization or industry affect neighborhoods, the public sector, educational institutions, and families? It's tempting to compartmentalize these dimensions of human life, but of course they all influence each other. The discipline of corporate social responsibility focuses specifically on these interconnections and ways in which businesses can make the larger social world a better place for everyone.

**Dialogue** focuses on new communication forms that strengthen a group's collective intelligence. This discipline offers several intriguing tools and techniques that may seem strange to you at first but that, with practice, will transform the way you talk with others, stimulating questions and insights that we often miss through traditional forms of conversation.

**Leadership** in the field of organizational learning takes on a particular focus. Specifically, the discipline of leadership explores how managers—and leaders at every level in an organization—can unleash the full potential of each and every employee in the organization. Often this involves moving away from more traditional command-and-control management structures and toward more fluid, self-organizing leadership. This discipline is truly redefining the role of management for businesspeople everywhere.

**Sustainability**, as a discipline, entails being thoughtful stewards of the natural resources on which our organizations depend. After all, if we use those resources without regard to their limits, we may deplete them permanently—and our organizations can't survive that. Sustainable management practices help us design organizations that respect and balance human needs with the natural cycles and limitations of our planet.

**Work/life balance** is another area receiving increasing attention in the organizational learning field. More and more, people are seeking to design their work so that they have room for the other important dimensions of their lives—family, community, self-development, and so on. At the same time, the boundaries between work and home life have blurred in recent decades. The discipline of work/life balance seeks to explore the ramifications of these changes and address the question of how to set priorities and find meaning in both our work and non-work lives.

Because everything really is structurally connected (systems thinking again!), an organization committed to true learning practices all of the above disciplines in some form, rather than tackling them in isolation. After all, they each reinforce one another, and when they come into alignment, the organization truly soars! And as we move into the 21st century, we'll no doubt see new disciplines emerge in this dynamic field.

**REINFORCING AND BALANCING PROCESSES**

Human social systems—like organizations—can seem pretty complicated. However, they're really made up of just two kinds of building blocks. We call these building blocks reinforcing and balancing processes. Reinforcing processes create exponential growth and collapse; for example, the world population explosion or the U.S. stock market crash of the 1930s. Balancing
processes keep a situation at equilibrium. You can sense this balancing taking place in organizations where it's hard to make a change, or when a company's sudden growth seems to hit a plateau.

It's the number and particular combinations of reinforcing and balancing processes within a system that cause that system's complex—and sometimes baffling—behavior. Systems thinking can help you understand how those two kinds of processes are interacting to produce troublesome behavior, and how you might better manage those processes.

SIMULATION MODELING

Have you ever wished that you could try out a new idea in your organization—without risking the entire business? Simulation modeling, a powerful systems thinking tool, lets you do just that. To build a model, you can use one of the several software packages developed by companies like High Performance Systems, Ventana Systems, or Powersim, or you can work with a consultant who is well versed in these tools.

When you work with software or a consultant to build a model, you define the variables (things that change over time) that are important in the problem you're trying to address. You then clarify your assumptions about how those variables affect one another, and assign mathematical equations to reflect those relationships (for example, "Let's assume that every dollar invested in marketing will generate two dollars worth of sales"). Once you've assigned these equations, you can plug in various changes, run the simulation, and see what outcome your changes might generate!

Even if you don't actually get to the point of building and using a simulation model, the mere process of defining variables, clarifying assumptions about their interrelationships, and expressing those relationships in mathematical equations is valuable. Why? Because it forces you and your team to think carefully about the problem at hand. And by working through your problem with that kind of discipline, you'll be much more likely to arrive at an effective, enduring solution.

STOCKS AND FLOWS

Stock and flow diagrams contain specific symbols and components representing the structure of a system. Stocks are things that can accumulate—such as employee head count or inventory. (Think of a stock as a bathtub.) Flows represent rates of change—such as annual employee turnover or quarterly reductions in inventory through sales. (Think of a flow as a bathtub faucet, which adds to the stock, or a bathtub drain, which reduces the stock.) These diagrams also contain "clouds," which represent the boundaries of the problem or system in question. Here's a simple example:
Stock and flow diagrams provide a bridge to simulation modeling, because they help you assign equations to the relationships between variables. Creating a stock and flow diagram together with your team is valuable because it generates as full a picture as possible of how everyone views the system in question. Remember the parable about the blind men feeling the elephant (the man feeling the trunk thinks of elephants as long and skinny; the one feeling the ear thinks of the animals as flat and floppy)? As this parable suggests, you can design effective solutions to problems only after you have as complete a picture as possible of what systemic structures are causing your problem.

WHAT IS SYSTEM DYNAMICS?

System dynamics is a field of study that Jay Forrester founded at the Massachusetts Institute of Technology (MIT) in the 1950s. The field has a long history, and has drawn from other fields as diverse as mechanical engineering, biology, and the social sciences.

In its simplest sense, system dynamics focuses on the flow of feedback (information that is transmitted and returned) that occurs throughout the parts of a system—and the system behaviors that result from those flows. For example, system dynamicists study reinforcing processes—feedback flows that generate exponential growth or collapse—and balancing processes—feedback flows that help a system maintain stability.

These reinforcing and balancing processes really aren't mysterious—they're all around us and within us. The world population explosion, the U.S. stock market crash of the 1930s, and the sudden onset of disease when foreign microbes proliferate in our bodies are all examples of reinforcing cycles. Our bodies' ability to maintain a basic temperature of 98.6 degrees Fahrenheit, the stability that occurs in predator/prey systems, and the difficulty we often face when we try to change the way our organization does things are all examples of balancing cycles.

In addition, system dynamicists study the impact of delay on systemic behavior. Specifically, what are the implications when a cause takes a long time to exert its effect, and when cause and effect are physically far apart? For example, if your organization raises prices on its products beyond the comfort level of your customers, it may take a while for customers to get fed up and stop buying. If it takes a really long time for you to notice this feedback, you may not realize that customer buying habits are connected to the price hike you instituted "way back when." (In fact, you might even panic about declining revenues and hike prices up even higher to try to save the business!)

Perhaps the most exciting thing about system dynamics is that it focuses on computer simulation modeling—using special software programs to figure out how a system's behavior might play out over time if you implement certain changes. Simulation models are often embedded in what are known as "management flight simulators" or "microworlds," computer programs with accessible user interfaces that let you "test flight" your ideas—without crashing your business!

The field of system dynamics gave rise to and serves as the bedrock for the field of systems thinking. What's the difference between the two? With its emphasis on simulation modeling, system dynamics is generally seen as the more rigorous, academic field—though many management consultants use computer models in their work with clients.
Systems thinking takes the principles of systemic behavior that system dynamics discovered—and applies them in practical ways to common problems in organizational life. In fact, simulation modeling, management flight simulators, and microworlds are merely some of the tools used by systems thinkers to understand the world around them and address problems.

Together, these two fields can become a potent ally as you navigate your way through the sometimes rocky terrain of organizational life!

**SYSTEMS ARCHETYPES**

Do you keep grappling with the same stubborn problems in your organization? If so, perhaps there’s a systems archetype lurking in the background. Systems archetypes are a class of systems thinking tools that capture common challenges that occur in all kinds of industries and organizations.

The archetypes themselves consist of causal loop diagrams depicting typical and problematic systemic structures. From “Fixes That Fail” (in which your “solutions” seem to backfire) to “Tragedy of the Commons” (in which people “overgraze” a limited resource, such as admin support), the archetypes give you an inside look at these structures and reveal high-leverage actions you can take to manage them.


**Guidelines for Drawing Causal Loop Diagrams**

The old adage "if the only tool you have is a hammer, every-thing begins to look like a nail" can also apply to language. If our language is linear and static, we will tend to view and interact with our world as if it were linear and static. Taking a complex, dynamic, and circular world and linearizing it into a set of snapshots may make things seem simpler, but we may totally misread the very reality we were seeking to understand. Making such inappropriate simplifications "is like putting on your brakes and then looking at your speed-ometer to see how fast you were going," says Bill Isaacs of the MIT Center for Organizational Learning.

**Articulating Reality**

Causal loop diagrams provide a language for articulating our understanding of the dynamic, interconnected nature of our world. We can think of them as sentences which are constructed by linking together key variables and indicating the causal relationships between them. By stringing together several loops, we can create a coherent story about a particular problem or issue.

The next page includes some suggestions on the mechanics of creating causal loop diagrams. Below are some more general guidelines that should help lead you through the process:

- **Theme Selection.** Creating causal loop diagrams is not an end unto itself, but part of a process of articulating and communicating deeper insights about complex issues. It is pointless to begin creating a causal loop diagram without having selected a theme or issue that you wish to understand better. "To understand the implications of chang-ing from a technology-driven to a marketing-oriented strategy," for ex-ample, is a better theme than "to better understand our strategic planning process."

- **Time Horizon.** It is also helpful to determine an appropriate time horizon for the issue—one long enough to see the dynamics play out. For a change in corporate strategy, the time horizon may span several years, while a change in advertising campaigns may be on the order of months.
Time itself should not be included as a causal agent, however. After a heavy rainfall a river level steadily rises over time, but we would not attribute it to the passage of time. You need to identify what is actually driving the change. In manufacturing, for example, costs of a new product often decline over time. It would be incorrect, however, to draw a causal connection between time and unit costs. Instead, process improvements and learning curve effects are likely causal forces.

• **Behavior Over Time Charts.** Identifying and drawing out the behavior over time of key variables is an important first step toward articulating the current understanding of the system. Drawing out future behavior means taking a risk—the risk of being wrong. The fact is, any projection of the future will be wrong, but by making it explicit, we can test our assumptions and uncover inconsistencies that may otherwise never get surfaced. For example, drawing projections of steady productivity growth while training dollars are shrinking raises the question “If training is not driving productivity, what will?” The behavior over time diagram also points out key variables that should be included in the diagram, such as training budget and productivity. Your diagram should try to capture the structure that will produce the projected behavior.

• **Boundary Issue.** How do you know when to stop adding to your diagram? If you don't stay focused on the issue, you may quickly find yourself overwhelmed by the number of connections possible. Remember, you are not trying to draw out the whole system—only what is critical to the theme being addressed. When in doubt about including something, ask, "If I were to double or halve this variable, would it have a significant effect on the issue I am mapping?" If not, it probably can be omitted.

• **Level of Aggregation.** How detailed should the diagram be? Again, this should be determined by the issue itself. The time horizon also can help determine how detailed the variables need to be. If the time horizon is on the order of weeks (fluctuations on the production line), variables that change slowly over a period of many years may be assumed to be constant (such as building new factories). As a rule of thumb, the variables should not describe specific events (a broken pump); they should represent patterns of behavior (pump breakdowns throughout the plant).

• **Significant Delays.** Make sure to identify which (if any) links have significant delays relative to the rest of the diagram. Delays are important because they are often the source of imbalances that accumulate in the system. It may help to visualize pressures building up in the system by viewing the delay connection as a relief valve that either opens slowly as pressure builds or opens abruptly when the pressure hits a critical value. An example of this might be a delay between long work hours and burnout: after sustained periods of working 60+ hours per week, a sudden collapse might occur in the form of burnout.

**GLOSSARY OF TERMS**

Systems thinking can serve as a language for communicating about complexity and interdependencies. To be fully conversant in any language, you must gain some mastery of the vocabulary, especially the phrases and idioms unique to that language. This glossary lists many terms that may come in handy when you're faced with a systems problem.

**Accumulator**
Anything that builds up or dwindles; for example, water in a bathtub, savings in a bank account, inventory in a warehouse. In modeling software, a stock is often used as a generic symbol for accumulators. Also known as Stock or Level.

**Balancing Process/Loop**
Combined with reinforcing loops, balancing processes form the building blocks of dynamic systems. Balancing processes seek equilibrium: They try to bring things to a desired state and keep them there. They also limit and constrain change generated by reinforcing processes. A balancing loop in a causal loop diagram depicts a balancing process.
Balancing Process with Delay
A commonly occurring structure. When a balancing process has a long delay, the usual response is to overcorrect. Overcorrection leads to wild swings in behavior. Example: real estate cycles.

Behavior Over Time (BOT) Graph
One of the 10 tools of systems thinking. BOT graphs capture the history or trend of one or more variables over time. By sketching several variables on one graph, you can gain an explicit understanding of how they interact over time. Also called Reference Mode.

Causal Loop Diagram (CLD)
One of the 10 tools of systems thinking. Causal loop diagrams capture how variables in a system are interrelated. A CLD takes the form of a closed loop that depicts cause-and-effect linkages.

Drifting Goals
A systems archetype. In a "Drifting Goals" scenario, a gradual downward slide in performance goals goes unnoticed, threatening the long-term future of the system or organization. Example: lengthening delivery delays.

Escalation
A systems archetype. In the "Escalation" archetype, two parties compete for superiority in an arena. As one party's actions put it ahead, the other party "retaliates" by increasing its actions. The result is a continual ratcheting up of activity on both sides. Examples: price battles, the Cold War.

Feedback
The return of information about the status of a process. Example: annual performance reviews return information to an employee about the quality of his or her work.

Fixes That Fail
A systems archetype. In a "Fixes That Fail" situation, a fix is applied to a problem and has immediate positive results. However, the fix also has unforeseen long-term consequences that eventually worsen the problem. Also known as "Fixes That Backfire."

Flow
The amount of change something undergoes during a particular unit of time. Example: the amount of water that flows out of a bathtub each minute, or the amount of interest earned in a savings account each month. Also called a Rate.

Generic Structures
Structures that can be generalized across many different settings because the underlying relationships are fundamentally the same. Systems archetypes are a class of generic structures.

Graphical Function Diagram (GFD)
One of the 10 tools of systems thinking. GFDs show how one variable, such as delivery delays, interacts with another, such as sales, by plotting the relationship between the two over the entire range of relevant values. The resulting diagram is a concise hypothesis of how the two variables interrelate. Also called Table Function.

Growth and Underinvestment
A systems archetype. In this situation, resource investments in a growing area are not made, owing to short-term pressures. As growth begins to stall because of lack of resources, there is less incentive for adding capacity, and growth slows even further.

Learning Laboratory
One of the 10 tools of systems thinking. A learning laboratory embeds a management flight
simulator in a learning environment. Groups of managers use a combination of systems thinking tools to explore the dynamics of a particular system and inquire into their own understanding of that system. Learning labs serve as a manager's practice field.

**Level**
See Accumulator.

**Leverage Point**
An area where small change can yield large improvements in a system.

**Limits to Success**
A systems archetype. In a "Limits to Success" scenario, a company or product line grows rapidly at first, but eventually begins to slow or even decline. The reason is that the system has hit some limit—capacity constraints, resource limits, market saturation, etc.—that is inhibiting further growth. Also called "Limits to Growth."

**Management Flight Simulator (MFS)**
One of the 10 tools of systems thinking. Similar to a pilot's flight simulator, an MFS allows managers to test the outcome of different policies and decisions without "crashing and burning" real companies. An MFS is based on a system dynamics computer model that has been changed into an interactive decision-making simulator through the use of a user interface.

**Policy Structure Diagram**
One of the 10 tools of systems thinking. Policy structure diagrams are used to create a conceptual "map" of the decision-making process that is embedded in an organization. It highlights the factors that are weighed at each decision point.

**Rate**
See Flow.

**Reference Mode**
See Behavior Over Time Graph.

**Reinforcing Process/Loop**
Along with balancing loops, reinforcing loops form the building blocks of dynamic systems. Reinforcing processes compound change in one direction with even more change in that same direction. As such, they generate both growth and collapse. A reinforcing loop in a causal loop diagram depicts a reinforcing process. Also known as vicious cycles or virtuous cycles.

**Shifting the Burden**
A systems archetype. In a “Shifting the Burden” situation, a short-term solution is tried that successfully solves an ongoing problem. As the solution is used over and over again, it takes attention away from more fundamental, enduring solutions. Over time, the ability to apply a fundamental solution may decrease, resulting in more and more reliance on the symptomatic solution. Examples: drug and alcohol dependency.

**Shifting the Burden to the Intervener**
A special case of the "Shifting the Burden" systems archetype that occurs when an intervener is brought in to help solve an ongoing problem. Over time, as the intervener successfully handles the problem, the people within the system become less capable of solving the problem themselves. They become even more dependent on the intervener. Example: ongoing use of outside consultants.

**Simulation Model**
One of the 10 tools of systems thinking. A computer model that lets you map the relationships that are important to a problem or an issue and then simulate the interaction of those variables
over time.

**Stock**  
See Accumulator.

**Structural Diagram**  
Draws out the accumulators and flows in a system, giving an overview of the major structural elements that produce the system's behavior. Also called flow diagram or accumulator/flow diagram.

**Structure-Behavior Pair**  
One of the 10 tools of systems thinking. A structure-behavior pair consists of a structural representation of a business issue, using accumulators and flows, and the corresponding behavior over time (BOT) graph for the issue being studied.

**Structure**  
The manner in which a system's elements are organized or interrelated. The structure of an organization, for example, could include not only the organizational chart but also incentive systems, information flows, and interpersonal interactions.

**Success to the Successful**  
A systems archetype. In a "Success to the Successful" situation, two activities compete for a common but limited resource. The activity that is initially more successful is consistently given more resources, allowing it to succeed even more. At the same time, the activity that is initially less successful becomes starved for resources and eventually dies out. Example: the QWERTY layout of typewriter keyboards.

**System Dynamics**  
A field of study that includes a methodology for constructing computer simulation models to achieve better understanding of social and corporate systems. It draws on organizational studies, behavioral decision theory, and engineering to provide a theoretical and empirical base for structuring the relationships in complex systems.

**System**  
A group of interacting, interrelated, or interdependent elements forming a complex whole. Almost always defined with respect to a specific purpose within a larger system. Example: An R&D department is a system that has a purpose in the context of the larger organization.

**Systems Archetypes**  
One of the 10 tools of systems thinking. Systems archetypes are the "classic stories" in systems thinking—common patterns and structures that occur repeatedly in different settings.

**Systems Thinking**  
A school of thought that focuses on recognizing the interconnections between the parts of a system and synthesizing them into a unified view of the whole.

**Table Function**  
See Graphical Function Diagram.

**Template**  
A tool used to identify systems archetypes. To use a template, you fill in the blank variables in causal loop diagrams.

**Tragedy of the Commons**  
A systems archetype. In a "Tragedy of the Commons" scenario, a shared resource becomes
overburdened as each person in the system uses more and more of the resource for individual gain. Eventually, the resource dwindles or is wiped out, resulting in lower gains for everyone involved. Example: the Greenhouse Effect.

The above glossary is a compilation of definitions from many sources, including:
• Innovation Associates' and GKA's Introduction to Systems Thinking coursebooks
• The Fifth Discipline: The Art and Practice of the Learning Organization, by Peter Senge
• High Performance Systems' Academic User's Guide to STELLA