A BEGINNER'S GUIDE TO SYSTEMS THINKING

Edited by Colleen Lannon

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SYSTEMS THINKING AS A LANGUAGE

BY MICHAEL R. 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.

• **Offers 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 means of communication because it distills the essence of a problem into a format that can be easily remembered, yet is rich in implications and insights.

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• **Adds precision.** The specific set of "syntactical" rules that govern systems diagrams greatly reduce the ambiguities and miscommunications that can occur when we tackle 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 clarify the problem."

• **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 col-laborate 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.

• **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 systems thinking courses at Innovation Associates, 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.

An inherent assumption of the systems thinking worldview is that problems are internally generated—we often create our own "worst nightmares."

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 the story fits one of the systems archetypes, or whether 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 using the language 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. ▪

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THE VOCABULARY OF SYSTEMS THINKING: A POCKET GUIDE

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) Diagram—One of the 10 tools of systems thinking. BOT diagrams 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 Diagram.**

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) diagram 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
- The American Heritage Dictionary *and* The Random House Dictionary.

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A PALETTE OF SYSTEMS THINKING TOOLS

There is a full array of systems thinking tools that you can think of in the same way as a painter views colors—many shades can be created out of three primary colors, but having a full range of ready-made colors makes painting much easier.

There are at least 10 distinct types of systems thinking tools (an abbreviated summary diagram appears on the facing page). They fall under four broad categories: brainstorming tools, dynamic thinking tools, structural thinking tools, and computer-based tools. Although each of the tools is designed to stand alone, they also build upon one another and can be used in combination to achieve deeper insights into dynamic behavior.

BRAINSTORMING TOOLS

The Double-Q (QQ) Diagram is based on what is commonly known as a fishbone or cause-and-effect diagram. The Qs stand for *qualitative* and *quantitative*, and the technique is designed to help participants begin to see the whole system. During a structured brainstorming session with the QQ diagram, both sides of an issue remain equally visible and properly balanced, avoiding a "top-heavy" perspective. The diagram also provides a visual map of the key factors involved. Once those factors are pinpointed, Behavior Over Time Diagrams and/or Causal Loop Diagrams can be used to explore how they interact.

A QQ diagram begins with a heavy horizontal arrow that points to the issue being addressed. Major "hard" (quantitative) factors branch off along the top and "soft" (qualitative) factors run along the bottom. Arrows leading off of the major factors represent sub-factors, which can in turn have *sub* sub-factors. Many layers of nesting, however, may be a sign that one of the sub-factors should be turned into a major factor.

DYNAMIC THINKING TOOLS

Behavior Over Time (BOT) Diagrams are more than simple line projections—they capture the dynamic relationships among variables. For example, say we were trying to project the relationship between sales, inventory, and production. If sales jump 20 percent, production cannot jump instantaneously to the new sales number. In addition, inventory must drop below its previous level while production catches up with sales. By sketching out the behavior of different variables on the same graph, we can gain a more explicit understanding of how these variables interrelate.

Causal Loop Diagrams (CLDs) provide a useful way to represent dynamic interrelationships. CLDs make explicit one's understanding of a system's structure, provide a visual representation to help communicate that understanding, and capture complex systems in a succinct form. CLDs can be combined with BOTs to form structure-behavior pairs, which provide a rich framework for describing complex dynamic phenomena. CLDs are the systems thinker's equivalent of the painter's primary colors.

Systems Archetypes is the name given to certain common dynamics that seem to recur in many different settings. These archetypes, consisting of various combinations of balancing and reinforcing loops, are the systems thinker's "paint-by-numbers" set—users can take real-world examples and fit them into the appropriate archetype. They serve as a starting point from which one can build a clearer articulation of a business story or issue. Specific archetypes include: "Drifting Goals," "Shifting the Burden," "Limits to Success," "Success to the Successful," "Fixes That Fail," "Tragedy of the Commons," "Growth and Underinvestment," and "Escalation" (see "Systems Archetypes at a Glance," p. 20).

STRUCTURAL THINKING TOOLS

Graphical Function Diagrams, Structure-Behavior Pairs, and *Policy Structure Diagrams* can be viewed as the building blocks for computer models. Graphical Functions are useful for clarifying nonlinear relationships between variables. They are particularly helpful for quantifying the effects of variables that are difficult to measure, such as morale or time pressure. Structure-Behavior Pairs link a specific structure with its corresponding behavior. Policy Structure Diagrams represent the processes that drive policies. In a sense, when we use these tools we are moving from painting on canvas to sculpting three-dimensional figures.

COMPUTER-BASED TOOLS

This class of tools, including computer models, management flight simulators, and learning laboratories, demands the highest level of technical proficiency to create. On the other hand, very little advance training is required to use them once they are developed. ▪

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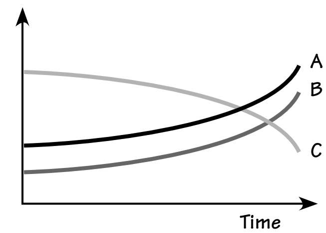
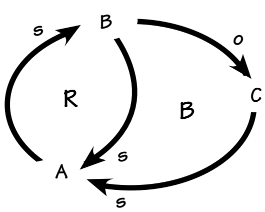
DYNAMIC THINKING TOOLS

Behavior Over Time Diagram



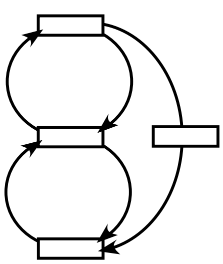
Can be used to graph the behavior of variables over time and gain insights into any interrelationships between them. (BOT diagrams are also known as reference mode diagrams.)

Causal Loop Diagram



Used in conjunction with behavior over time diagrams, can help you identify reinforcing (R) and balancing (B) processes.

Systems Archetype



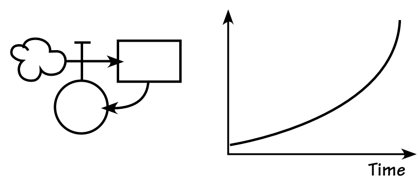
Helps you recognize common system behavior patterns such as "Drifting Goals," "Shifting the Burden," "Limits to Growth," "Fixes That Fail," and so on—all the compelling, recurring "stories" of organizational dynamics.

STRUCTURAL THINKING TOOLS

Graphical Function Diagram

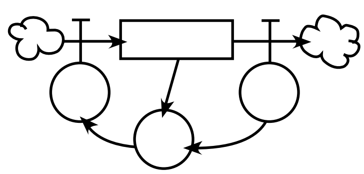
Captures the way in which one variable affects another, by plotting the relationship between the two over the full range of relevant values.

Structure-Behavior Pair



Consists of the basic dynamic structures that can serve as building blocks for developing computer models (for example, exponential growth, delays, smooths, S-shaped growth, oscillations, and so on).

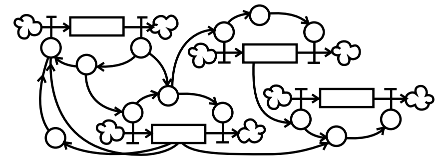
Policy Structure Diagram



A conceptual map of the decision-making process embedded in the organization. Focuses on the factors that are weighed for each decision, and can be used to build a library of generic structures.

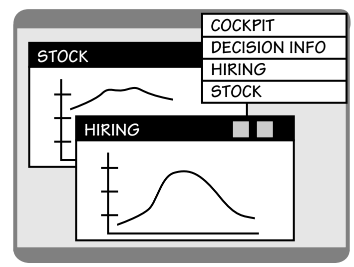
COMPUTER-BASED TOOLS

Computer Model



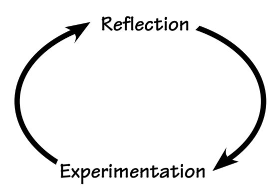
Lets you translate all relationships identified as relevant into mathematical equations. You can then run policy analyses through multiple simulations.

Management Flight Simulator



Provides "flight training" for managers through the use of interactive computer games based on a computer model. Users can recognize long-term consequences of decisions by formulating strategies and making decisions based on those strategies.

Learning Laboratory



A manager's practice field. Is equivalent to a sports team's experience, which blends active experimentation with reflection and discussion. Uses all the systems thinking tools, from behavior over time diagrams to MFSs.

TOOLBOX

GUIDELINES FOR DRAWING CAUSAL LOOP DIAGRAMS

The old adage "if the only tool you have is a hammer, everything 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 speedometer to see how fast you were going," says Bill Isaacs of *DIA*•logos.

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 that 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.

Following 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 changing from a technology-driven to a marketing-oriented strategy," for example, 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 computer chips, $/MIPS (million instructions per second) decreased in a straight line in the 1990s. It would be incorrect, however, to draw a causal connection between time and $/MIPS. Instead, increasing investments and learning curve effects were 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 our growth, 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, 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, the level 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. ◘

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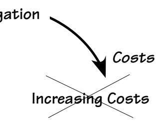
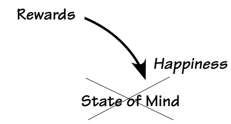
	GUIDELINE	EXAMPLE

SELECTING VARIABLE NAMES

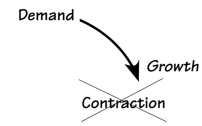
1 Use nouns when choosing a variable name. Avoid verbs and action phrases, because the action is conveyed in the loop's arrows. For example, "Costs" is better than "Increasing Costs," because a decrease in Increasing Costs is confusing. The sign of the arrow ("s" for same or "o" for opposite) indicates whether Costs increase or decrease relative to the other variable.



2 Use variables that represent quantities that can vary over time. It does not make sense to say that "State of Mind" increases or decreases. A term like "Happiness," on the other hand, can vary.

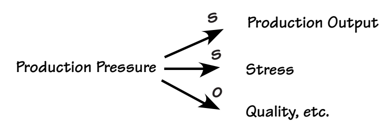


3 Whenever possible, choose the more "positive" sense of a variable name. For example, the concept of "Growth" increasing or decreasing is clearer than an increase or decrease in "Contraction."

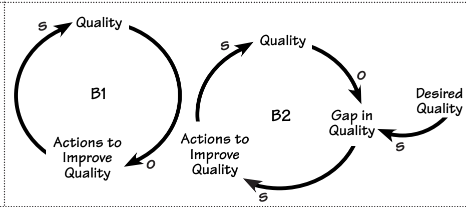


LOOP CONSTRUCTION

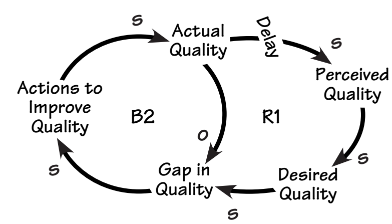
4 Think of the possible unintended consequences as well as the expected outcomes for every course of action included in the diagram. For example, an increase in "Production Pressure" may increase "Production Output," but it may also increase "Stress" and decrease "Quality."



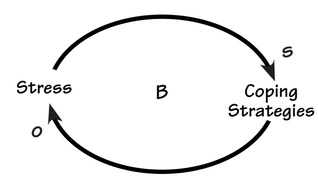
5 All balancing loops are goal-seeking processes. Try to make explicit the goals driving the loop. For example, Loop B1 may raise questions as to why increasing "Quality" would lead to a decrease in "Actions to Improve Quality." By explicitly identifying "Desired Quality" as the goal in Loop B2, we see that the "Gap in Quality" is really driving improvement actions.



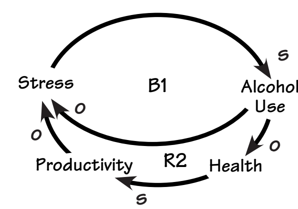
6 Distinguishing between perceived and actual states, such as "Perceived Quality" versus "Actual Quality," is important. Perceptions often change slower than reality does, and mistaking the perceived status for current reality can be misleading and create undesirable results.



7 If a variable has multiple consequences, start by lumping them into one term while completing the rest of the loop. For example, "Coping Strategies" can represent many different ways we respond to stress (exercise, meditation, alcohol use, etc.).

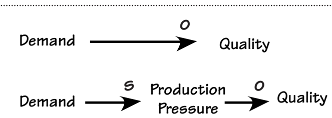


8 Actions almost always have different long-term and short-term consequences. Draw larger loops as they progress from short- to long-term processes. Loop B1 shows the short-term behavior of using alcohol to combat stress. Loop R2, however, draws out the long-term consequences of this behavior, showing that it actually *increases* stress.



GENERAL TIPS

9 If a link between two terms requires a lot of explanation to be clear, redefine the variables or insert an intermediate term. Thus, the relationship between "Demand" and "Quality" may be more obvious when "Production Pressure" is inserted between them.



10 A shortcut to determining whether a loop is balancing or reinforcing is to count the number of "o's" in the loop. An odd number of "o's" indicates a balancing loop (i.e., an odd number of U-turns keeps you headed in the opposite direction); an even number or no "o's" means it is a reinforcing loop. CAUTION: After labeling the loop, you should always read through it to make sure the story agrees with your R or B label.