

4

THE LAWS OF THE FIFTH DISCIPLINE¹

1. *Today's problems come from yesterday's "solutions."*

Once there was a rug merchant who saw that his most beautiful carpet had a large bump in its center.² He stepped on the bump to flatten it out—and succeeded. But the bump reappeared in a new spot not far away. He jumped on the bump again, and it disappeared—for a moment, until it emerged once more in a new place. Again and again he jumped, scuffing and mangling the rug in his frustration; until finally he lifted one corner of the carpet and an angry snake slithered out.

Often we are puzzled by the causes of our problems; when we merely need to look at our own solutions to other problems in the past. A well-established firm may find that this quarter's sales are off sharply. Why? Because the highly successful rebate program last quarter led many customers to buy then rather than now. Or a new manager attacks chronically high inventory costs and "solves" the problem—except that the salesforce is now spending 20 percent more time responding to angry complaints from customers who are

still waiting for late shipments, and the rest of its time trying to convince prospective customers that they can have "any color they want so long as it's black."

Police enforcement officials will recognize their own version of this law: arresting narcotics dealers on Thirtieth Street, they find that they have simply transferred the crime center to Fortieth Street. Or, even more insidiously, they learn that a new citywide outbreak of drug-related crime is the result of federal officials intercepting a large shipment of narcotics—which reduced the drug supply, drove up the price, and caused more crime by addicts desperate to maintain their habit.

Solutions that merely shift problems from one part of a system to another often go undetected because, unlike the rug merchant, those who "solved" the first problem are different from those who inherit the new problem. *doesn't get to root of problem*

2. The harder you push, the harder the system pushes back.

In George Orwell's *Animal Farm*, the horse Boxer always had the same answer to any difficulty: "I will work harder," he said. At first, his well-intentioned diligence inspired everyone, but gradually, his hard work began to backfire in subtle ways. The harder he worked, the more work there was to do. What he didn't know was that the pigs who managed the farm were actually manipulating them all for their own profit. Boxer's diligence actually helped to keep the other animals from seeing what the pigs were doing.¹ Systems thinking has a name for this phenomenon: "Compensating feedback": when well-intentioned interventions call forth responses from the system that offset the benefits of the intervention. We all know what it feels like to be facing compensating feedback—the harder you push, the harder the system pushes back; the more effort you expend trying to improve matters, the more effort seems to be required.

Examples of compensating feedback are legion. Many of the best intentioned government interventions fall prey to compensating feedback. In the 1960s there were massive programs to build low-income housing and improve job skills in decrepit inner cities in the United States. Many of these cities were even worse off in the 1970s despite the largesse of government aid. Why? One reason was that low-income people migrated from other cities and from rural areas to those cities with the best aid programs. Eventually, the new housing units became overcrowded and the job training programs were

swamped with applicants. All the while, the city's tax base continued to erode, leaving more people trapped in economically depressed areas.

Similar compensating feedback processes have operated to thwart food and agricultural assistance to developing countries. More food available has been "compensated for" by reduced deaths due to malnutrition, higher net population growth, and eventually more malnutrition.

Similarly, efforts to correct the U.S. trade imbalance by letting the value of the dollar fall in the mid-1980s were compensated for by foreign competitors who let prices of their goods fall in parallel (for countries whose currency was "pegged to the dollar," their prices adjusted automatically). Efforts by foreign powers to suppress indigenous guerrilla fighters often lead to further legitimacy for the guerrillas' cause, thereby strengthening their resolve and support, and leading to still further resistance.

Many companies experience compensating feedback when one of their products suddenly starts to lose its attractiveness in the market. They push for more aggressive marketing; that's what always worked in the past, isn't it? They spend more on advertising, and drop the price; these methods may bring customers back temporarily, but they also draw money away from the company, so it cuts corners to compensate. The quality of its service (say, its delivery speed or care in inspection) starts to decline. In the long run, the more fervently the company markets, the more customers it loses.

Nor is compensating feedback limited to "large systems"—there are plenty of personal examples. Take the person who quits smoking only to find himself gaining weight and suffering such a loss in self-image that he takes up smoking again to relieve the stress. Or the protective mother who wants so much for her young son to get along with his schoolmates that she repeatedly steps in to resolve problems and ends up with a child who never learns to settle differences by himself. Or the enthusiastic newcomer so eager to be liked that she never responds to subtle criticisms of her work and ends up embittered and labeled "a difficult person to work with."

Pushing harder, whether through an increasingly aggressive intervention or through increasingly stressful withholding of natural instincts, is exhausting. Yet, as individuals and organizations, we not only get drawn into compensating feedback, we often glorify the suffering that ensues. When our initial efforts fail to produce lasting improvements, we "push harder"—faithful, as was Boxer, to the

Solutions may bring their own problems - look further ahead

creed that hard work will overcome all obstacles, all the while blinding ourselves to how we are contributing to the obstacles ourselves.

3. Behavior grows better before it grows worse. *

Low-leverage interventions would be much less alluring if it were not for the fact that many actually work, in the short term. New houses get built. The unemployed are trained. Starving children are spared. Lagging orders turn upward. We stop smoking, relieve our child's stress, and avoid a confrontation with a new coworker. Compensating feedback usually involves a "delay," a time lag between the short-term benefit and the long-term disbenefit. *The New Yorker* once published a cartoon in which a man sitting in an armchair pushes over a giant domino encroaching upon him from the left. "At last, I can relax," he's obviously telling himself in the cartoon. Of course, he doesn't see that the domino is toppling another domino, which in turn is about to topple another, and another, and that the chain of dominoes behind him will eventually circle around his chair and strike him from the right.

The better before worse response to many management interventions is what makes political decision making so counterproductive. By "political decision making," I mean situations where factors other than the intrinsic merits of alternative courses of action weigh in making decisions—factors such as building one's own power base, or "looking good," or "pleasing the boss." In complex human systems there are always many ways to make things look better in the short run. Only eventually does the compensating feedback come back to haunt you.

The key word is "eventually." The delay in, for example, the circle of dominoes, explains why systemic problems are so hard to recognize. A typical solution feels wonderful, when it first cures the symptoms. Now there's improvement; or maybe even the problem has gone away. It may be two, three, or four years before the problem returns, or some new, worse problem arrives. By that time, given how rapidly most people move from job to job, someone new is sitting in the chair.

4. The easy way out usually leads back in.

In a modern version of an ancient Sufi story, a passerby encounters a drunk on his hands and knees under a street lamp. He offers to help and finds out that the drunk is looking for his house keys. After

several minutes, he asks, "Where did you drop them?" The drunk replies that he dropped them outside his front door. "Then why look for them here?" asks the passerby. "Because," says the drunk, "there is no light by my doorway."

We all find comfort applying familiar solutions to problems, sticking to what we know best. Sometimes the keys are indeed under the street lamp; but very often they are off in the darkness. After all, if the solution were easy to see or obvious to everyone, it probably would already have been found. Pushing harder and harder on familiar solutions, while fundamental problems persist or worsen, is a reliable indicator of nonsystemic thinking—what we often call the "what we need here is a bigger hammer" syndrome.

*5. The cure can be worse than the disease.

Sometimes the easy or familiar solution is not only ineffective; sometimes it is addictive and dangerous. Alcoholism, for instance, may start as simple social drinking—a solution to the problem of low self-esteem or work-related stress. Gradually, the cure becomes worse than the disease; among its other problems it makes self-esteem and stress even worse than they were to begin with.

The long-term, most insidious consequence of applying nonsystemic solutions is increased need for more and more of the solution. This is why ill-conceived government interventions are not just ineffective, they are "addictive" in the sense of fostering increased dependency and lessened abilities of local people to solve their own problems. The phenomenon of short-term improvements leading to long-term dependency is so common it has its own name among systems thinkers—it's called "Shifting the Burden to the Intervenor." The intervenor may be federal assistance to cities, food relief agencies, or welfare programs. All "help" a host system, only to leave the system fundamentally weaker than before and more in need of further help.

Finding examples of shifting the burden to the intervenor, as natural resource expert and writer Donella Meadows says, "is easy and fun and sometimes horrifying" and hardly limited to government intervenors. We shift the burden of doing simple math from our knowledge of arithmetic to a dependency on pocket calculators. We take away extended families, and shift the burden for care of the aged to nursing homes. In cities, we shift the burden from diverse local communities to housing projects. The Cold War shifted respon-

sibility for peace from negotiation to armaments, thereby strengthening the military and related industries. In business, we can shift the burden to consultants or other "helpers" who make the company dependent on them, instead of training the client managers to solve problems themselves. Over time, the intervenor's power grows—whether it be a drug's power over a person, or the military budget's hold over an economy, the size and scope of foreign assistance agencies, or the budget of organizational "relief agencies."

Shifting the Burden structures show that any long-term solution must, as Meadows says, "strengthen the ability of the system to shoulder its own burdens." Sometimes that is difficult; other times it is surprisingly easy. A manager who has shifted the burden of his personnel problems onto a Human Relations Specialist may find that the hard part is deciding to take the burden back; once that happens, learning how to handle people is mainly a matter of time and commitment.

6. *Faster is slower.*

This, too, is an old story: the tortoise may be slower, but he wins the race. For most American business people the best rate of growth is fast, faster, fastest. Yet, virtually all natural systems, from ecosystems to animals to organizations, have intrinsically optimal rates of growth. The optimal rate is far less than the fastest possible growth. When growth becomes excessive—as it does in cancer—the system itself will seek to compensate by slowing down; perhaps putting the organization's survival at risk in the process. In Chapter 8, the story of People Express airlines offers a good example of how faster can lead to slower—or even full stop—in the long run.

Observing these characteristics of complex systems, noted biologist and essayist Lewis Thomas has observed, "When you are dealing with a complex social system, such as an urban center or a hamster, with things about it that you are dissatisfied with and eager to fix, you cannot just step in and set about fixing with much hope of helping. This realization is one of the sore discouragements of our century."

When managers first start to appreciate how these systems principles have operated to thwart many of their own favorite interventions, they can be discouraged and disheartened. The systems principles can even become excuses for inaction—for doing nothing

rather than possibly taking actions that might backfire, or even make matters worse. This is a classic case of "a little knowledge being a dangerous thing." For the real implications of the systems perspective are not inaction but a new type of action rooted in a new way of thinking—systems thinking is both more challenging and more promising than our normal ways of dealing with problems.

7. *Cause and effect are not closely related in time and space.* *

Underlying all of the above problems is a fundamental characteristic of complex human systems: "cause" and "effect" are not close in time and space. By "effects," I mean the obvious symptoms that indicate that there are problems—drug abuse, unemployment, starving children, falling orders, and sagging profits. By "cause" I mean the interaction of the underlying system that is most responsible for generating the symptoms, and which, if recognized, could lead to changes producing lasting improvement. Why is this a problem? Because most of us assume they are—most of us assume most of the time, that cause and effect are close in time and space.

When we play as children, problems are never far away from their solutions—as long, at least, as we confine our play to one group of toys. Years later, as managers, we tend to believe that the world works the same way. If there is a problem on the manufacturing line, we look for a cause in manufacturing. If salespeople can't meet targets, we think we need new sales incentives or promotions. If there is inadequate housing, we build more houses. If there is inadequate food, the solution must be more food.

As the players in the beer game described in Chapter 3 eventually discover, the root of our difficulties is neither recalcitrant problems nor evil adversaries—but ourselves. There is a fundamental mismatch between the nature of reality in complex systems and our predominant ways of thinking about that reality. The first step in correcting that mismatch is to let go of the notion that cause and effect are close in time and space.

8. *Small changes can produce big results—but the areas of highest leverage are often the least obvious.*

Some have called systems thinking the "new dismal science" because it teaches that most obvious solutions don't work—at best, they improve matters in the short run, only to make things worse in the long run. But there is another side to the story. For systems

thinking also shows that small, well-focused actions can sometimes produce significant, enduring improvements, if they're in the right place. Systems thinkers refer to this principle as "leverage."

Tackling a difficult problem is often a matter of seeing where the high leverage lies, a change which—with a minimum of effort—would lead to lasting, significant improvement.

The only problem is that high-leverage changes are usually highly nonobvious to most participants in the system. They are not "close in time and space" to obvious problem symptoms. This is what makes life interesting.

Buckminster Fuller had a wonderful illustration of leverage that also served as his metaphor for the principle of leverage—the "trim tab." A trim tab is a small "rudder on the rudder" of a ship. It is only a fraction the size of the rudder. Its function is to make it easier to turn the rudder, which, then, makes it easier to turn the ship. The larger the ship, the more important is the trim tab because a large volume of water flowing around the rudder can make it difficult to turn.

But what makes the trim tab such a marvelous metaphor for leverage is not just its effectiveness, but its nonobviousness. If you knew absolutely nothing about hydrodynamics and you saw a large oil tanker plowing through the high seas, where would you push if you wanted the tanker to turn left? You would probably go to the bow and try to push it to the left. Do you have any idea how much force it requires to turn an oil tanker going fifteen knots by pushing on its bow? The leverage lies in going to the stern and pushing the tail end of the tanker to the right, in order to turn the front to the left. This, of course, is the job of the rudder. But in what direction does the rudder turn in order to get the ship's stern to turn to the right? Why to the left, of course.

You see, ships turn because their rear end is "sucked around." The rudder, by being turned into the oncoming water, compresses the water flow and creates a pressure differential. The pressure differential pulls the stern in the opposite direction as the rudder is turned. This is exactly the same way that an airplane flies: the airplane's wing creates a pressure differential and the airplane is "sucked" upward.

The trim tab—this very small device that has an enormous effect on the huge ship—does the same for the rudder. When it is turned to one side or the other, it compresses the water flowing around the rudder and creates a small pressure differential that "sucks the rudder

der" in the desired direction. But, if you want the rudder to turn to the left, what direction do you turn the trim tab?—to the right, naturally.

The entire system—the ship, the rudder, and the trim tab—is marvelously engineered through the principle of leverage. Yet, its functioning is totally nonobvious if you do not understand the force of hydrodynamics.

So, too, are the high-leverage changes in human systems nonobvious *until* we understand the forces at play in those systems.

There are no simple rules for finding high-leverage changes, but there are ways of thinking that make it more likely. Learning to see underlying "structures" rather than "events" is a starting point: each of the "systems archetypes" developed below suggests areas of high- and low-leverage change.

Thinking in terms of processes of change rather than "snapshots" is another.

9. *You can have your cake and eat it too—but not at once.*

Sometimes, the knottiest dilemmas, when seen from the systems point of view, aren't dilemmas at all. They are artifacts of "snapshot" rather than "process" thinking, and appear in a whole new light once you think consciously of change over time.

For years, for example, American manufacturers thought they had to choose between low cost and high quality. "Higher quality products cost more to manufacture," they thought. "They take longer to assemble, require more expensive materials and components, and entail more extensive quality controls." What they didn't consider was all the ways the increasing quality and lowering costs could go hand in hand, over time. What they didn't consider was how basic improvements in work processes could eliminate rework, eliminate quality inspectors, reduce customer complaints, lower warranty costs, increase customer loyalty, and reduce advertising and sales promotion costs. They didn't realize that they could have both goals, if they were willing to wait for one while they focused on the other. Investing time and money to develop new skills and methods of assembly, including new methods for involving everyone responsible for improving quality, is an up front "cost." Quality and costs may *both* go up in the ensuing months; although some cost savings (like reduced rework) may be achieved fairly quickly, the full range of cost savings may take several years to harvest.

Many apparent dilemmas, such as central versus local control, and happy committed employees versus competitive labor costs, and rewarding individual achievement versus having everyone feel valued are by-products of static thinking. They only appear as rigid "either-or" choices, because we think of what is possible at a fixed point in time. Next month, it may be true that we must choose one or the other, but the real leverage lies in seeing how both can improve over time.⁶

10. *Dividing an elephant in half does not produce two small elephants.*

Living systems have integrity. Their character depends on the whole. The same is true for organizations; to understand the most challenging managerial issues requires seeing the whole system that generates the issues.

Another Sufi tale illustrates the point of this law. As three blind men encountered an elephant, each exclaimed aloud. "It is a large rough thing, wide and broad, like a rug," said the first, grasping an ear. The second, holding the trunk, said, "I have the real facts. It is a straight and hollow pipe." And the third, holding a front leg, said, "It is mighty and firm, like a pillar." Are the three blind men any different from the heads of manufacturing, marketing, and research in many companies? Each sees the firm's problems clearly, but none see how the policies of their department interact with the others. Interestingly, the Sufi story concludes by observing that "Given these men's way of knowing, they will never know an elephant."

Seeing "whole elephants" does not mean that every organizational issue can be understood only by looking at the entire organization. Some issues can be understood only by looking at how major functions, such as manufacturing, marketing, and research interact; but there are other issues where critical systemic forces arise within a given functional area; and others where the dynamics of an entire industry must be considered. The key principle, called the "principle of the system boundary," is that the interactions that must be examined are those most important to the issue at hand, *regardless of* parochial organizational boundaries.

What makes this principle difficult to practice is the way organizations are designed to keep people from seeing important interactions. One obvious way is by enforcing rigid internal divisions that inhibit inquiry across divisional boundaries, such as those that grow up between marketing, manufacturing, and research. Another is by

"leaving" problems behind us, for someone else to clean up. Many European cities have avoided the problems of crime, entrenched poverty, and helplessness that afflict so many American inner cities because they have forced themselves to face the balances that a healthy urban area must maintain. One way they have done this is by maintaining large "green belts" around the city that discourage the growth of suburbs and commuters who work in the city but live outside it. By contrast, many American cities have encouraged steady expansion of surrounding suburbs, continually enabling wealthier residents to move further from the city center and its problems. (Impoverished areas today, such as Harlem in New York and Roxbury in Boston were originally upper-class suburbs.) Corporations do the same thing by continually acquiring new businesses and "harvesting" what they choose to regard as "mature" businesses rather than reinvesting in them.

Incidentally, sometimes people go ahead and divide an elephant in half anyway. You don't have two small elephants then; you have a mess. By a mess, I mean a complicated problem where there is no leverage to be found because the leverage lies in interactions that cannot be seen from looking only at the piece you are holding.

11. *There is no blame.*

We tend to blame outside circumstances for our problems. "Someone else"—the competitors, the press, the changing mood of the marketplace, the government—did it to us. Systems thinking shows us that there is no outside; that you and the cause of your problems are part of a single system. The cure lies in your relationship with your "enemy."

been applied to understand a wide range of corporate, urban, regional, economic, political, ecological, and even physiological systems.¹ And systems thinking is a sensibility—for the subtle interconnectedness that gives living systems their unique character.

Today, systems thinking is needed more than ever because we are becoming overwhelmed by complexity. Perhaps for the first time in history, humankind has the capacity to create far more information than anyone can absorb, to foster far greater interdependency than anyone can manage, and to accelerate change far faster than anyone's ability to keep pace. Certainly the scale of complexity is without precedent. All around us are examples of "systemic breakdowns"—problems such as global warming, ozone depletion, the international drug trade, and the U.S. trade and budget deficits—problems that have no simple local cause. Similarly, organizations break down, despite individual brilliance and innovative products, because they are unable to pull their diverse functions and talents into a productive whole.

Complexity can easily undermine confidence and responsibility—as in the frequent refrain, "It's all too complex for me," or "There's nothing I can do. It's the system." Systems thinking is the antidote to this sense of helplessness that many feel as we enter the "age of interdependence." Systems thinking is a discipline for seeing the "structures" that underlie complex situations, and for discerning high from low leverage change. That is, by seeing wholes we learn how to foster health. To do so, systems thinking offers a language that begins by restructuring how we think.

I call systems thinking the fifth discipline, because it is the conceptual cornerstone that underlies all of the five learning disciplines of this book. All are concerned with a shift of mind from seeing parts to seeing wholes, from seeing people as helpless reactors to seeing them as active participants in shaping their reality, from reacting to the present to creating the future. Without systems thinking, there is neither the incentive nor the means to integrate the learning disciplines once they have come into practice. As the fifth discipline, systems thinking is the cornerstone of how learning organizations think about their world.

There is no more poignant example of the need for systems thinking than the U.S.-U.S.S.R. arms race. While the world has stood and watched for the past forty years, the two mightiest political powers have engaged in a race to see who could get fastest to where no one wanted to go. I have not yet met a person who is in favor of

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A SHIFT OF MIND

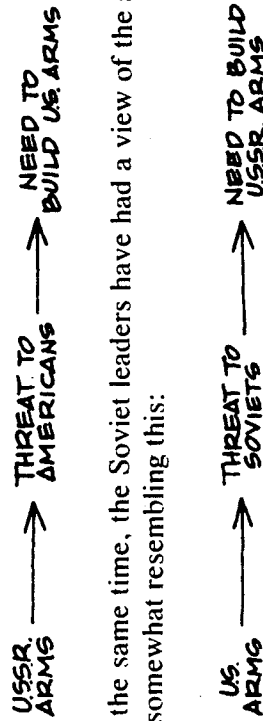
SEEING THE WORLD A NEW

There is something in all of us that loves to put together a puzzle, that loves to see the image of the whole emerge. The beauty of a person, or a flower, or a poem lies in seeing all of it. It is interesting that the words "whole" and "health" come from the same root (the Old English *hal*, as in "hale and hearty"). So it should come as no surprise that the unhealthiness of our world today is in direct proportion to our inability to see it as a whole.

Systems thinking is a discipline for seeing wholes. It is a framework for seeing interrelationships rather than things, for seeing patterns of change rather than static "snapshots." It is a set of general principles—distilled over the course of the twentieth century, spanning fields as diverse as the physical and social sciences, engineering, and management. It is also a set of specific tools and techniques, originating in two threads: in "feedback" concepts of cybernetics and in "servo-mechanism" engineering theory dating back to the

the arms race. Even those who regard it as absolutely necessary, or who profit from it, will, in their quieter moments, confess that they wish it were not necessary. It has drained the U.S. economy and devastated the Soviet economy. It has ensnared successive administrations of political leaders, and terrified two generations of the world's citizens.

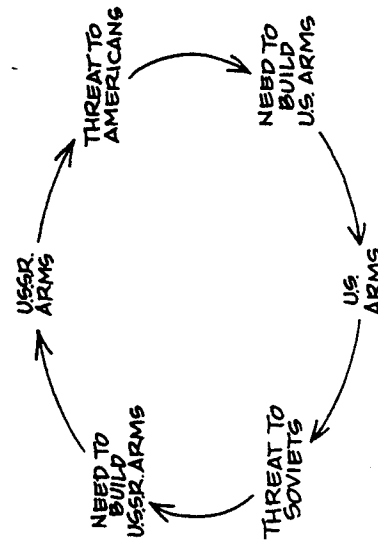
The roots of the arms race lie not in rival political ideologies, nor in nuclear arms, but in a way of thinking both sides have shared. The United States establishment, for example, has had a viewpoint of the arms race that essentially resembled the following:



At the same time, the Soviet leaders have had a view of the arms race somewhat resembling this:

From the American viewpoint, the Soviets have been the aggressor, and U.S. expansion of nuclear arms has been a defensive response to the threats posed by the Soviets. From the Soviet viewpoint, the United States has been the aggressor, and Soviet expansion of nuclear arms has been a defensive response to the threat posed by the Americans.

But the two straight lines form a circle. The two nations' individual, "linear," or nonsystemic viewpoints interact to create a "system," a set of variables that influence one another:



The systems view of the arms race shows a perpetual cycle of aggression. The United States responds to a perceived Threat to Americans by increasing U.S. arms, which increases the Threat to the Soviets, which leads to more Soviet arms, which increases the Threat to the United States, which leads to more U.S. arms, which increases the Threat to the Soviets, which . . . and so on, and so on. From their individual viewpoints, each side achieves its short-term goal. Both sides respond to a perceived threat. But their actions end up creating the opposite outcome, increased threat, in the long run. Here, as in many systems, *doing the obvious thing does not produce the obvious, desired outcome*. The long-term result of each side's efforts to be more secure is heightened insecurity for all, with a combined nuclear stockpile of ten thousand times the total firepower of world War II.

Interestingly, both sides failed for years to adopt a true systems view, despite an abundance of "systems analysts," sophisticated analyses of each others' nuclear arsenals, and complex computer simulations of attack and counterattack war scenarios.² Why then have these supposed tools for dealing with complexity not empowered us to escape the illogic of the arms race?

The answer lies in the same reason that sophisticated tools of forecasting and business analysis, as well as elegant strategic plans, usually fail to produce dramatic breakthroughs in managing a business. They are all designed to handle the sort of complexity in which there are many variables: *detail complexity*. But there are two types of complexity. The second type is *dynamic complexity*, situations where cause and effect are subtle, and where the effects over time of interventions are not obvious. Conventional forecasting, planning, and analysis methods are not equipped to deal with dynamic complexity. Mixing many ingredients in a stew involves detail complexity, as does following a complex set of instructions to assemble a machine, or taking inventory in a discount retail store. But none of these situations is especially complex dynamically.

When the same action has dramatically different effects in the short run and the long, there is dynamic complexity. When an action has one set of consequences locally and a very different set of consequences in another part of the system, there is dynamic complexity. When obvious interventions produce nonobvious consequences, there is dynamic complexity. A gyroscope is a dynamically complex machine: If you push downward on one edge, it moves to the left; if you push another edge to the left, it moves upward. Yet, how trivi-

ally simple is a gyroscope when compared with the complex dynamics of an enterprise, where it takes days to produce something, weeks to develop a new marketing promotion, months to hire and train new people, and years to develop new products, nurture management talent, and build a reputation for quality—and all of these processes interact continually.

The real leverage in most management situations lies in understanding dynamic complexity, not detail complexity. Balancing market growth and capacity expansion is a dynamic problem. Developing a profitable mix of price, product (or service) quality, design, and availability that make a strong market position is a dynamic problem. Improving quality, lowering total costs, and satisfying customers in a sustainable manner is a dynamic problem.

Unfortunately, most "systems analyses" focus on detail complexity not dynamic complexity. Simulations with thousands of variables and complex arrays of details can actually distract us from seeing patterns and major interrelationships. In fact, sadly, for most people, "systems thinking" means "fighting complexity with complexity," devising increasingly "complex" (we should really say "detailed") solutions to increasingly "complex" problems. In fact, this is the antithesis of real systems thinking.

The arms race is, most fundamentally, a problem of dynamic complexity. Insight into the causes and possible cures requires seeing the interrelationships, such as between our actions to become more secure and the threats they create for the Soviets. It requires seeing the delays between action and consequence, such as the delay between a U.S. decision to build up arms and a consequent Soviet counter-buildup. And it requires seeing patterns of change, not just snapshots, such as continuing escalation.

Seeing the major interrelationships underlying a problem leads to new insight into what might be done. In the case of the arms race, as in any escalation dynamic, the obvious question is, "Can the vicious cycle be run in reverse?" "Can the arms race be run backward?"

This may be just what is happening today. Soviet General Secretary Mikhail Gorbachev's initiatives in arms reduction have started a new "peace race" with both sides eager to keep pace with the other's reductions in nuclear arsenals. It is too early to tell whether the shifts in policy initiated by the Soviets in 1988 and 1989 will initiate a sustained unwinding of the U.S.-U.S.S.R. arms race. There

are many other factors in the global geopolitical system beyond the pure U.S.-U.S.S.R. interaction. But we appear to be witnessing the first glimmer of a genuinely systemic approach.

The essence of the discipline of systems thinking lies in a shift of mind:

- seeing interrelationships rather than linear cause-effect chains, and
- seeing processes of change rather than snapshots

The practice of systems thinking starts with understanding a simple concept called "feedback" that shows how actions can reinforce or counteract (balance) each other. *It builds to learning to recognize types of "structures" that recur again and again: the arms race is a generic or archetypal pattern of escalation, at its heart no different from turf warfare between two street gangs, the demise of a marriage, or the advertising battles of two consumer goods companies fighting for market share. Eventually, systems thinking forms a rich language for describing a vast array of interrelationships and patterns of change. Ultimately, it simplifies life by helping us see the deeper patterns lying behind the events and the details.*

Learning any new language is difficult at first. But as you start to master the basics, it gets easier. Research with young children has shown that many learn systems thinking remarkably quickly. *It appears that we have latent skills as systems thinkers that are undeveloped, even repressed by formal education in linear thinking. Hopefully, what follows will help rediscover some of those latent skills and bring to the surface the systems thinker that is within each of us.*

SEEING CIRCLES OF CAUSALITY

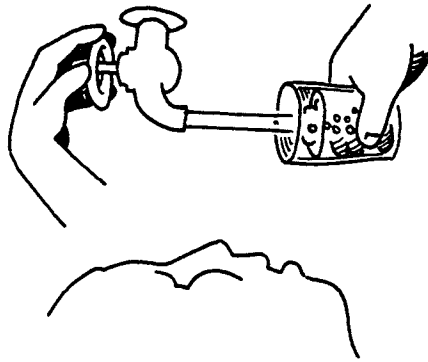
Reality is made up of circles but we see straight lines. Herein lie the beginnings of our limitation as systems thinkers.

One of the reasons for this fragmentation in our thinking stems

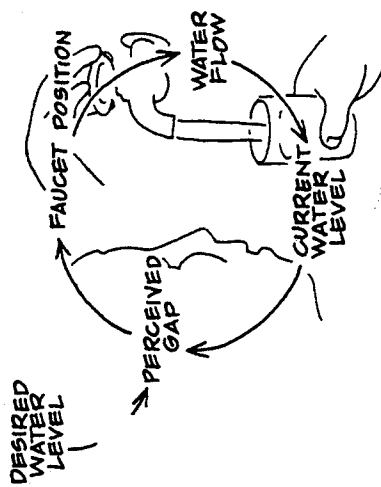
from our language. Language shapes perception. What we *see* depends on what we are prepared to *see*. Western languages, with their subject-verb-object structure, are biased toward a linear view.⁶ If we want to see systemwide interrelationships, we need a language of interrelationships, a language made up of circles. Without such a language, our habitual ways of seeing the world produce fragmented views and counterproductive actions—as it has done for decision makers in the arms race. Such a language is important in facing dynamically complex issues and strategic choices, especially when individuals, teams, and organizations need to see beyond events and into the forces that shape change.

To illustrate the rudiments of the new language, consider a very simple system—filling a glass of water. You might think, “That’s not a system—it’s too simple.” But think again.

From the linear viewpoint, we say, “I am filling a glass of water.” What most of us have in mind looks pretty much like the following picture:



But, in fact, as we fill the glass, we are watching the water level rise. We monitor the “gap” between the level and our goal, the “desired water level.” As the water approaches the desired level, we adjust the faucet position to slow the flow of water, until it is turned off when the glass is full. In fact, when we fill a glass of water we operate in a “water-regulation” system involving five variables: our desired water level, the glass’s current water level, the gap between the two, the faucet position, and the water flow. These variables are organized in a circle or loop of cause-effect relationships which is called a “feedback process.” The process operates continually to bring the water level to its desired level.

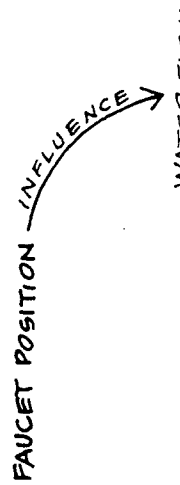


People get confused about “feedback” because we often use the word in a somewhat different way—to gather opinions about an act we have undertaken. “Give me some feedback on the brewery decision,” you might say. “What did you think of the way I handled it?” In that context, “positive feedback” means encouraging remarks and “negative feedback” means bad news. But in systems thinking, feedback is a broader concept. It means any reciprocal flow of influence. In systems thinking it is an axiom that every influence is both *cause* and *effect*. Nothing is ever influenced in just one direction.

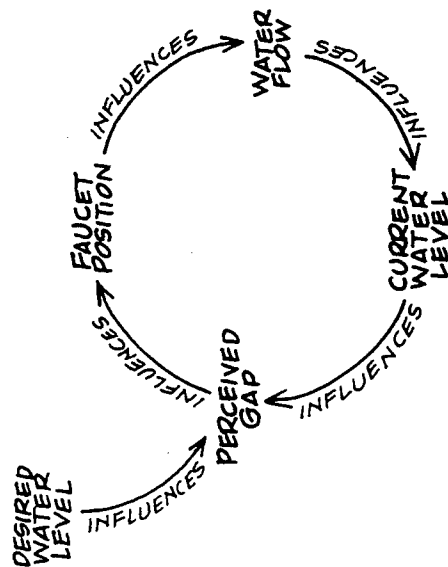
HOW TO READ A SYSTEMS DIAGRAM

The key to seeing reality systemically is seeing circles of influence rather than straight lines. This is the first step to breaking out of the reactive mindset that comes inevitably from “linear” thinking. Every circle tells a story. By tracing the flows of influence, you can see patterns that repeat themselves, time after time, making situations better or worse.

From any element in a situation, you can trace arrows that represent influence on another element:



Above, the faucet position arrow points to water flow. Any change made to the faucet position will alter the flow of water. But arrows never exist in isolation:



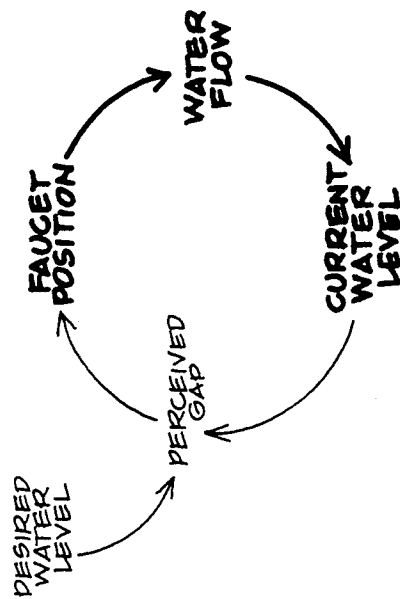
To follow the story, start at any element and watch the action ensue, circling as the train in a toy railroad does through its recurring journey. A good place to start is with the action being taken by the decision maker:

I set the faucet position, which adjusts the water flow, which changes the water level. As the water level changes, the perceived gap (between the current and desired water levels) changes. As the gap changes, my hand's position on the faucet changes again. And so on . . .

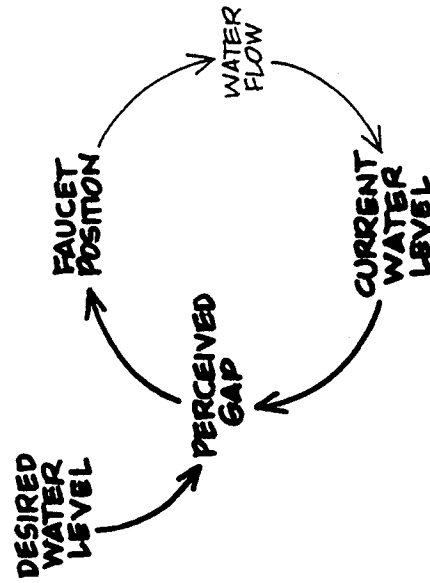
When reading a feedback circle diagram, the main skill is to see the "story" that the diagram tells: how the structure creates a particular pattern of behavior (or, in a complex structure, several patterns of behavior) and how that pattern might be influenced. Here the story is filling the water glass and gradually closing down the faucet as the glass fills.

Though simple in concept, the feedback loop overturns deeply ingrained ideas—such as causality. In everyday English we say, "I am filling the glass of water" without thinking very deeply about the meaning of the statement. It implies a one-way causality—"I

am causing the water level to rise." More precisely, "My hand on the faucet is controlling the rate of flow of water into the glass." Clearly, this statement describes only half of the feedback process: the linkages from "faucet position" to "flow of water" to "water level."



But it would be just as true to describe only the other "half" of the process: "The level of water in the glass is controlling my hand."



Both statements are equally incomplete. The more complete statement of causality is that my intent to fill a glass of water creates a system that causes water to flow in when the level is low, then shuts the flow off when the glass is full. In other words, the structure causes the behavior. This distinction is important because seeing only individual actions and missing the structure underlying the actions, as we saw in the beer game in Chapter 3, lies at the root of our powerlessness in complex situations.

In fact, all causal attributions made in everyday English are highly suspect! Most are embedded in linear ways of seeing. They are at best partially accurate, inherently biased toward describing portions of reciprocal processes, not the entire processes.

Another idea overturned by the feedback perspective is anthropocentrism—or seeing ourselves as the center of activities. The simple description, “I am filling the glass of water,” suggests a world of human actors standing at the center of activity, operating on an inanimate reality. *From the systems perspective, the human actor is part of the feedback process, not standing apart from it. This represents a profound shift in awareness. It allows us to see how we are continually both influenced by and influencing our reality. It is the shift in awareness so ardently advocated by ecologists in their cries that we see ourselves as part of nature, not separate from nature. It is the shift in awareness recognized by many (but not all) of the world’s great philosophical systems—for example, the Bhagavad Gita’s chastisement:*

“All actions are wrought by the qualities of nature only. The self, deluded by egoism, thinketh: ‘I am the doer.’”

In addition, the feedback concept complicates the ethical issue of responsibility. In the arms race, who is responsible? From each side’s linear view, responsibility clearly lies with the other side: “It is their aggressive actions, and their nationalistic intent, that are causing us to respond by building our arms.” A linear view always suggests a simple locus of responsibility. When things go wrong, this is seen as blame—“he, she, it did it”—or guilt—“I did it.” At a deep level, there is no difference between blame and guilt, for both spring from linear perceptions. From the linear view, we are always looking for someone or something that must be responsible—they can even be directed toward hidden agents within ourselves. When my son was four years old, he used to say, “My stomach won’t let me eat it,” when turning down his vegetables. We may chuckle, but it is his assignment of responsibility really different from the adult who says, “My neuroses keep me from trusting people.”

In mastering systems thinking, we give up the assumption that there must be an individual, or individual agent, responsible. The feedback perspective suggests that *everyone shares responsibility for problems generated by a system*. That doesn’t necessarily imply that everyone involved can exert equal leverage in changing the system.

But it does imply that the search for scapegoats—a particularly alluring pastime in individualistic cultures such as ours in the United States—is a blind alley.

Finally, the feedback concept illuminates the limitations of our language. When we try to describe in words even a very simple system, such as filling the water glass, it gets very awkward: “When I fill a glass of water, there is a feedback process that causes me to adjust the faucet position, which adjusts the water flow and feeds back to alter the water position. The goal of the process is to make the water level rise to my desired level.” This is precisely why a new language for describing systems is needed. If it is this awkward to describe a system as simple as filling a water glass, *imagine our difficulties using everyday English to describe the multiple feedback processes in an organization.*

All this takes some getting used to. We are steeped in a linear language for describing our experience. We find simple statements about causality and responsibility familiar and comfortable. It is not that they must be given up, anymore than you give up English to learn French. There are many situations where simple linear descriptions suffice and looking for feedback processes would be a waste of time. But not when dealing with problems of dynamic complexity.

REINFORCING AND BALANCING FEEDBACK AND DELAYS: THE BUILDING BLOCKS OF SYSTEMS THINKING

There are two distinct types of feedback processes: reinforcing and balancing. *Reinforcing (or amplifying) feedback processes are the engines of growth.* Whenever you are in a situation where things are growing, you can be sure that reinforcing feedback is at work. Reinforcing feedback can also generate accelerating decline—a pattern of decline where small drops amplify themselves into larger and larger drops, such as the decline in bank assets when there is a financial panic.

Balancing (or stabilizing) feedback operates whenever there is a goal-oriented behavior. If the goal is to be not moving, then balancing feedback will act the way the brakes in a car do. If the goal is to be moving at sixty miles per hour, then balancing feedback will cause you to accelerate to sixty but no faster. The “goal” can be an explicit target, as when a firm seeks a desired market share, or it can be

implicit, such as a bad habit, which despite disavowing, we stick to nevertheless.

In addition, many feedback processes contain "delays," interruptions in the flow of influence which make the consequences of actions occur gradually.

All ideas in the language of systems thinking are built up from these elements, just as English sentences are built up from nouns and verbs. Once we have learned the building blocks, we can begin constructing stories: the systems archetypes of the next chapter.

REINFORCING FEEDBACK:

DISCOVERING HOW SMALL CHANGES CAN GROW

If you are in a reinforcing feedback system, you may be blind to how small actions can grow into large consequences—for better or for worse. Seeing the system often allows you to influence how it works.

For example, managers frequently fail to appreciate the extent to which their own expectations influence subordinates' performance. If I see a person as having high potential, I give him special attention to develop that potential. When he flowers, I feel that my original assessment was correct and I help him still further. Conversely, those I regard as having lower potential languish in disregard and inattention, perform in a disinterested manner, and further justify, in my mind, the lack of attention I give them.

Psychologist Robert Merton first identified this phenomenon as the "self-fulfilling prophecy."⁸ It is also known as the "Pygmalion effect," after the famous George Bernard Shaw play (later to become *My Fair Lady*). Shaw in turn had taken his title from Pygmalion, a character in Greek and Roman mythology, who believed so strongly in the beauty of the statue he had carved that it came to life.

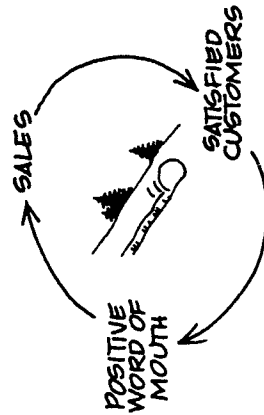
Pygmalion effects have been shown to operate in countless situations.⁹ An example occurs in schools, where a teacher's opinion of a student influences the behavior of that student. Jane is shy and does particularly poorly in her first semester at a new school (because her parents were fighting constantly). This leads her teacher to form an opinion that she is unmotivated. Next semester, the teacher pays less attention to Jane and she does poorly again, withdrawing further. Over time, Jane gets caught in an ever-worsening spiral of withdrawal, poor performance, "labeling" by her teachers, inattention, and further withdrawing. Thus, students are unintentionally

"tracked" into a high self-image of their abilities, where they get personal attention, or a low self-image, where their poor class work is reinforced in an ever-worsening spiral.

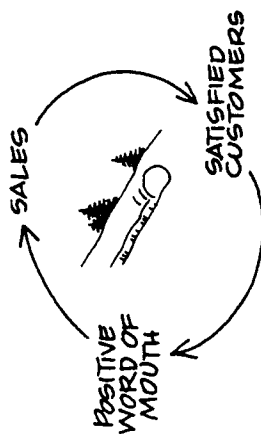
In reinforcing processes such as the Pygmalion effect, a small change builds on itself. Whatever movement occurs is amplified, producing more movement in the same direction. A small action snowballs, with more and more and still more of the same, resembling compounding interest. Some reinforcing (amplifying) processes are "vicious cycles," in which things start off badly and grow worse. The "gas crisis" was a classic example. Word that gasoline was becoming scarce set off a spate of trips to the local service station, to fill up. Once people started seeing lines of cars, they were convinced that the crisis was here. Panic and hoarding then set in. Before long, everyone was "topping off" their tanks when they were only one-quarter empty, lest they be caught when the pumps went dry. A run on a bank is another example, as are escalation structures such as the arms race or price wars.

But there's nothing inherently bad about reinforcing loops. There are also "virtuous cycles"—processes that reinforce in desired directions. For instance, physical exercise can lead to a reinforcing spiral; you feel better, thus you exercise more, thus you're rewarded by feeling better and exercise still more. The arms race run in reverse, if it can be sustained, makes another virtuous circle. The growth of any new product involves reinforcing spirals. For example, many products grow from "word of mouth." Word of mouth about a product can reinforce a snowballing sense of good feeling (as occurred with the Volkswagen Beetle and more recent Japanese imports) as satisfied customers tell others who then become satisfied customers, who tell still others.

Here is how you might diagram such a process:



HOW TO READ A REINFORCING CIRCLE DIAGRAM

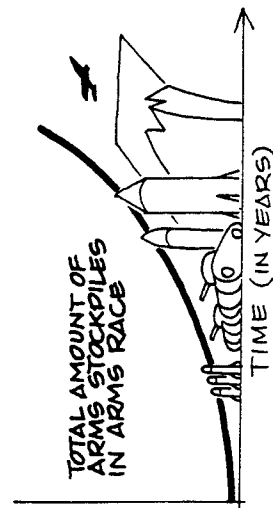


Reinforcing Sales Process Caused by Customers Talking to Each Other About Your Product

This diagram shows a reinforcing feedback process wherein actions *snow-ball*. Again, you can follow the process by walking yourself around the circle:

If the product is a good product, more sales means more satisfied customers, which means more positive word of mouth. That will lead to still more sales, which means even more widespread word of mouth . . . and so on. On the other hand, if the product is defective, the virtuous cycle becomes a vicious cycle: sales lead to less satisfied customers, less positive word of mouth, and less sales; which leads to still less positive word of mouth and less sales.

* The behavior that results from a reinforcing loop is either accelerating growth or accelerating decline. For example, the arms race produces an accelerating growth of arms stockpiles:



Positive word of mouth produced rapidly rising sales of Volkswagens during the 1950s, and videocassette recorders during the 1980s. A bank run produces an accelerating decline in a bank's deposits.

Folk wisdom speaks of reinforcing loops in terms such as "snow-ball effect," "bandwagon effect," or "vicious circle," and in phrases describing particular systems: "the rich get richer and the poor get poorer." In business, we know that "momentum is everything," in building confidence in a new product or within a fledgling organization. We also know about reinforcing spirals running the wrong way. "The rats are jumping ship" suggests a situation where, as soon as a few people lose confidence, their defection will cause others to defect in a vicious spiral of eroding confidence. Word of mouth can easily work in reverse, and (as occurred with contaminated over-the-counter drugs) produce marketplace disaster.

Both good news and bad news reinforcing loops accelerate so quickly that they often take people by surprise. A French schoolchildren's jingle illustrates the process. First there is just one lily pad in a corner of a pond. But every day the number of lily pads doubles. It takes thirty days to fill the pond, but for the first twenty-eight days, no one even notices. Suddenly, on the twenty-ninth day, the pond is half full of lily pads and the villagers become concerned. But by this time there is little that can be done. The next day their worst fears come true. That's why environmental dangers are so worrisome, especially those that follow reinforcing patterns (as many environmentalists fear occurs with such pollutants as CFCs). By the time the problem is noticed, it may be too late. Extinctions of species often follow patterns of slow, gradually accelerating decline over long time periods, then rapid demise. So do extinctions of corporations.

But pure accelerating growth or decline rarely continues unchecked in nature, because reinforcing processes rarely occur in isolation. Eventually, limits are encountered—which can slow growth, stop it, divert it, or even reverse it. Even the lily pads stop growing when the limit of the pond's perimeter is encountered. These limits are one form of *balancing feedback*, which, after reinforcing processes, is the second basic element of systems thinking.

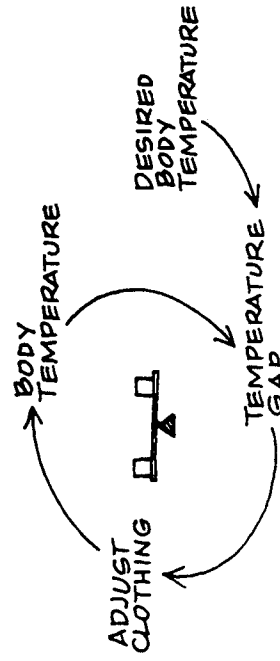
BALANCING PROCESSES: *Self-regulation* DISCOVERING THE SOURCES OF STABILITY AND RESISTANCE

If you are in a balancing system, you are in a system that is seeking stability. If the system's goal is one you like, you will be happy. If it is not, you will find all your efforts to change matters frustrated—until you can either change the goal or weaken its influence.

Nature loves a balance—but many times, human decision makers act contrary to these balances, and pay the price. For example, managers under budget pressure often cut back staff to lower costs, but eventually discover that their remaining staff is now overworked, and their costs have not gone down at all—because the remaining work has been farmed out to consultants, or because overtime has made up the difference. The reason that costs don't stay down is that *the system has its own agenda*. There is an implicit goal, unspoken but very real—the amount of work that is expected to get done.

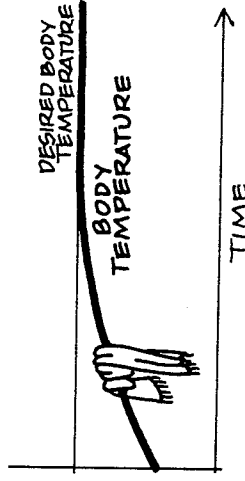
In a balancing (stabilizing) system, there is a self-correction that attempts to maintain some goal or target. Filling the glass of water is a balancing process with the goal of a full glass. Hiring new employees is a balancing process with the goal of having a target work force size or rate of growth. Steering a car and staying upright on a bicycle are also examples of balancing processes, where the goal is heading in a desired direction.

Balancing feedback processes are everywhere. They underlie all goal-oriented behavior. Complex organisms such as the human body contain thousands of balancing feedback processes that maintain temperature and balance, heal our wounds, adjust our eyesight to the amount of light, and alert us to threat. A biologist would say that all of these processes are the mechanisms by which our body achieves *homeostasis*—its ability to maintain conditions for survival

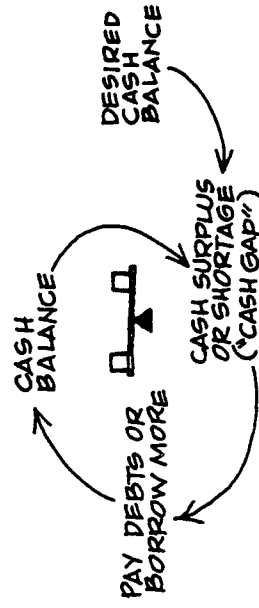


in a changing environment. Balancing feedback prompts us to eat when we need food, and to sleep when we need rest, or—as shown in the diagram above—to put on a sweater when we are cold.

As in all balancing processes, the crucial element—our body temperature—gradually adjusts itself toward its desired level:



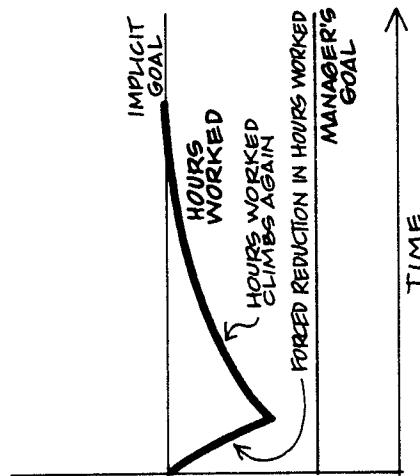
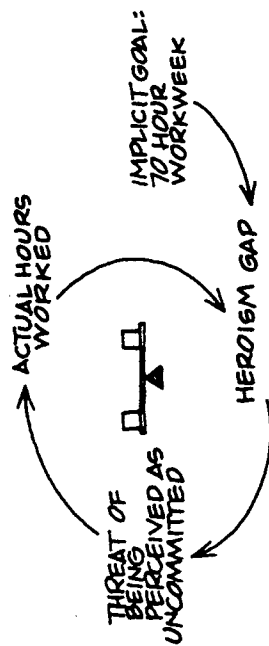
Organizations and societies resemble complex organisms because they too have myriad balancing feedback processes. In corporations, the production and materials ordering process is constantly adjusting in response to changes in incoming orders; short-term (discounts) and long-term (list) prices adjust in response to changes in demand or competitors' prices; and borrowing adjusts with changes in cash balances or financing needs.



Planning creates longer-term balancing processes. A human resource plan might establish long-term growth targets in head count and in skill profile of the work force to match anticipated needs. Market research and R&D plans shape new product development and investments in people, technologies, and capital plant to build competitive advantage.

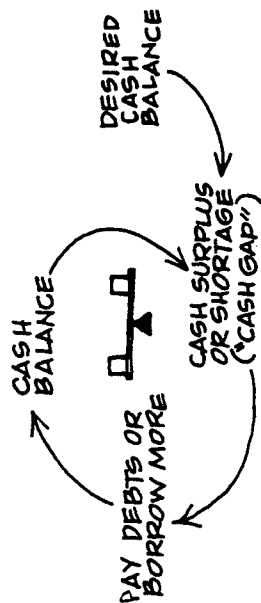
* What makes balancing processes so difficult in management is that the goals are often implicit, and no one recognizes that the balancing process exists at all. I recall a good friend who tried, fruitlessly, to reduce burnout among professionals in his rapidly growing training business. He wrote memos, shortened working hours, even closed

and locked offices earlier—all attempts to get people to stop overworking. But all these actions were offset—people ignored the memos, disobeyed the shortened hours, and took their work home with them when the offices were locked. Why? Because an unwritten norm in the organization stated that the *real* heroes, the people who really cared and who got ahead in the organization, worked seventy hours a week—a norm that my friend had established himself by his own prodigious energy and long hours.



To understand how an organism works we must understand its balancing processes—those that are explicit and implicit. We could master long lists of body parts, organs, bones, veins, and blood vessels and yet we would not understand how the body functions—until we understand how the neuromuscular system maintains balance, or how the cardiovascular system maintains blood pressure and oxygen levels. This is why many attempts to redesign social systems fail. The state-controlled economy fails because it severs the multiple self-correcting processes that operate in a free market system.¹⁰ This is why corporate mergers often fail. When two hospitals in Boston, both with outstanding traditions of patient care, were

HOW TO READ A BALANCING CIRCLE DIAGRAM



Balancing Process for Adjusting Cash Balance to Cash Surplus or Shortage

This diagram shows a balancing feedback process.

To walk yourself through the process, it's generally easiest to start at the gap—the discrepancy between what is desired and what exists:

Here, there is a shortfall in cash on hand for our cash flow needs. (In other words, there's a gap between our desired and actual cash balances.)

Then look at the actions being taken to correct the gap:

We borrow money, which makes our cash balance larger, and the gap decreases.

The chart shows that a balancing process is always operating to reduce a gap between what is desired and what exists. Moreover, such goals as desired cash balances change over time with growth or decline in the business. Regardless, the balancing process will continue to work to adjust actual cash balances to what is needed, even if the target is moving.

merged several years ago, the new larger hospital had state-of-the-art facilities but lost the spirit of personal care and employee loyalty that had characterized the original institutions. In the merged hospital, subtle balancing processes in the older hospitals that monitored quality, paid attention to employee needs, and maintained friendly relationships with patients were disrupted by new administrative structures and procedures.

Though simple in concept, balancing processes can generate surprising and problematic behavior if they go undetected.

In general, balancing loops are more difficult to see than reinforcing loops because if often looks like nothing is happening. There's no dramatic growth of sales and marketing expenditures, or nuclear arms, or lily pads. Instead, the balancing process maintains the status quo, even when all participants want change. The feeling, as Lewis Carroll's Queen of Hearts put it, of needing "all the running you can do to keep in the same place," is a clue that a balancing loop may exist nearby.

Leaders who attempt organizational change often find themselves unwittingly caught in balancing processes. To the leaders, it looks as though their efforts are clashing with sudden resistance that seems to come from nowhere. In fact, as my friend found when he tried to reduce burnout, the resistance is a response by the system trying to maintain an implicit system goal. Until this goal is recognized, the change effort is doomed to failure. So long as the leader continues to be the "model," his work habits will set the norm. Either he must change his habits, or establish new and different models.

Whenever there is "resistance to change," you can count on there being one or more "hidden" balancing processes. Resistance to change is neither capricious nor mysterious. It almost always arises from threats to traditional norms and ways of doing things. Often these norms are woven into the fabric of established power relationships. The norm is entrenched because the distribution of authority and control is entrenched. Rather than pushing harder to overcome resistance to change, artful leaders discern the source of the resistance. They focus directly on the implicit norms and power relationships within which the norms are embedded.

DELAYS: WHEN THINGS HAPPEN . . . EVENTUALLY

As we've seen, systems seem to have minds of their own. Nowhere is this more evident than in delays—interruptions between your actions and their consequences. Delays can make you badly overshoot your mark, or they can have a positive effect if you recognize them and work with them.

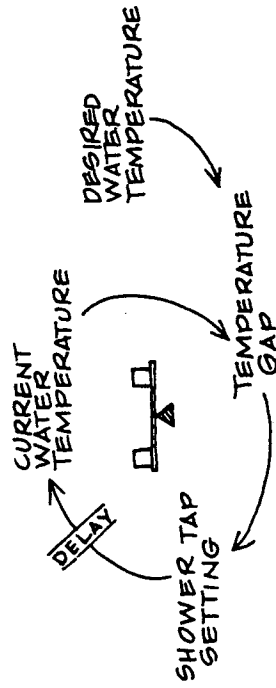
"One of the highest leverage points for improving system performance," says Ray Stata, CEO of Analog Devices, "is the minimization of system delays." Stata is referring to an increasing awareness on the part of American manufacturers that while they have worked traditionally to control tightly the amount of inventory in warehouses, their Japanese counterparts have concentrated on reducing delays—a much more successful effort. "The way leading companies manage time," says George Stalk, vice president of the Boston Consulting Group, "—in production, in new product development, in sales and distribution—represents the most powerful new source of competitive disadvantage."

Delays between actions and consequences are everywhere in human systems. We invest now to reap a benefit in the distant future; we hire a person today but it may be months before he or she is fully productive; we commit resources to a new project knowing that it will be years before it will pay off. But delays are often unappreciated and lead to instability. For example, the decision makers in the beer game consistently misjudged the delays that kept them from getting orders filled when they thought they would.

Delays, when the effect of one variable on another takes time, constitute the third basic building block for a systems language. Virtually all feedback processes have some form of delay. But often the delays are either unrecognized or not well understood. This can result in "overshoot," going further than needed to achieve a desired result. The delay between eating and feeling full has been the nemesis of many a happy diner; we don't yet feel full when we should stop eating, so we keep going until we are overstuffed. The delay between starting a new construction project and its completion results in overbuilding real estate markets and an eventual shakeout. In the beer game, the delay between placing and receiving orders for beer regularly results in overordering.

Unrecognized delays can also lead to instability and breakdown, especially when they are long. Adjusting the shower temperature.

HOW TO READ A DELAY



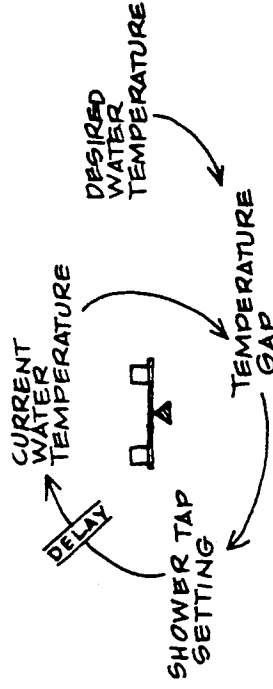
Balancing Process with a Delay: A Sluggish Shower

Here's our earlier "water faucet" feedback diagram again—but this time, with antiquated plumbing. Now there's a significant delay between the time you turn the faucet, and the time you see change in the water flow. Those two cross-hatch lines represent the delay.

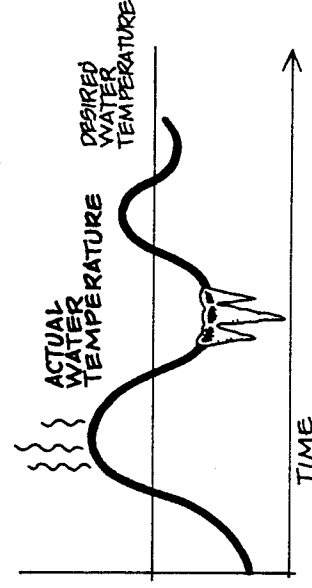
Arrows with cross-hatch lines don't tell you how many seconds (or years) the delay will last. You only know it's long enough to make a difference.

When you follow an arrow with a delay, add the word "eventually" to the story you tell in your mind. "I moved the faucet handle, which eventually changed the water flow." Or, "I began a new construction project and, eventually, the houses were ready." You may even want to skip a beat—"one, two"—as you talk through the process.

for instance, is far more difficult when there is a ten-second delay before the water temperature adjusts, then when the delay takes only a second or two.



During that ten seconds after you turn up the heat, the water remains cold. You receive no response to your action; so you *perceive* that your act has had no effect. You respond by continuing to turn up the heat. When the hot water finally arrives, a 190-degree water gusher erupts from the faucet. You jump out and turn it back; and, after another delay, it's frigid again. On and on you go, through the balancing loop process. Each cycle of adjustments compensates somewhat for the cycle before. A diagram would look like this:



The more aggressive you are in your behavior—the more drastically you turn the knobs—the longer it will take to reach the right temperature. That's one of the lessons of balancing loops with delays: that aggressive action often produces exactly the opposite of what is intended. It produces instability and oscillation, instead of moving you more quickly toward your goal.

Delays are no less problematic in reinforcing loops. In the arms race example, each side perceives itself as gaining advantage from

expanding its arsenal because of the delay in the other side's response. This delay can be as long as five years because of the time required to gather intelligence on the other side's weaponry, and to design and deploy new weapons. It is this temporary perceived advantage that keeps the escalation process going. If each side were able to respond instantly to buildups of its adversary, incentives to keep building would be nil.

The systems viewpoint is generally oriented toward the long-term view. That's why delays and feedback loops are so important. In the short term, you can often ignore them; they're inconsequential. They only come back to haunt you in the long term.

Reinforcing feedback, balancing feedback, and delays are all fairly simple. They come into their own as building blocks for the "systems archetypes"—more elaborate structures that recur in our personal and work lives again and again.