This is the sixth of a series of 12 articles on systems thinking, a way of understanding complex organizations and society offering significant promise for improving the leadership and management of commercial companies, not-for-profit organizations, and government agencies.

Part 6

Systems and Constraints: The Concept of Leverage

By H. William Dettmer

Give me a lever long enough and a place to stand, and I can move the world.
—Archimedes, 287-212 BC

If he didn't actually discover it, Archimedes certainly popularized the concept of leverage. In the third century BC, he designed war machines exploiting the lever for the armies of Greece in their pursuit of empire in the Mediterranean. As the quotation above implies, an understanding of leverage can enable one to apply force to something far out of proportion to one's individual strength.

The concept of leverage applies to systems, too—particularly to organizational systems. But before we see how, let's revisit the concept of a system.

Deming characterized a system as a network of interdependent components that work together to accomplish the aim of the system. **[1:50]** As soon as we acknowledge the idea that a system is composed of multiple component parts, a question immediately arises: Are all the components equally important, or are some more instrumental than others in striving for the goal of the system? In most organizations, people act as if all components are equivalent. For example, everybody is considered an "equal member of the team." But is this really the case? Does every component contribute equally to the system's success? As George Orwell observed in his classic allegorical novel, *Animal Farm*, "all animals are equal—but some are more equal than others." **[5:Ch.10]**

The Pareto Principle

In 1906, Vilifredo Pareto, an Italian economist, observed that 80 percent of Italy's wealth was owned by 20 percent of its population. **[6]** In the 1930s, Joseph Juran observed a similar relationship—what he referred to as "the vital few versus the trivial many." Though he didn't cite Pareto in particular, his observation of the "80/20 rule"—meaning 20 percent of a system is responsible for 80 percent of its results—became known as Pareto's Principle. Howard Gardner uses the Pareto Principle as a teaching example, and in the process, he points out that "it is important to be judicious about where one places one's efforts..." **[2:9]**

The wisdom of the Pareto Rule is generally accepted. What is less commonly understood is the key underlying assumption behind it, which Gardner hinted at and Orwell said somewhat more explicitly: not all of the system's components are equally important in achieving its goal.

The Concept of a System Constraint

All systems, whether open or closed, are limited (or constrained) in some way. Organizational systems are no exception. What, exactly, *is* a system constraint? It's some factor that limits what the system can achieve. Were it not for *this* limiting factor, the rest of the system might be able to achieve much more in realizing its goal. The limiting factor may be internal or external to the system. It may be a physical component, a condition, or an imposed policy of some kind. Whatever it is, however, it does frustrate efforts from within the system to achieve better performance.

Goldratt has characterized constrained systems as chains, and a system's constraint as the “weakest link” in that chain. **[3:53]** Conceptually, this is an adequate analogy, but it does tend to imply a linear nature of processes that might oversimplify some systems. The important point of the analogy, however, is that some identifiable factor or component restricts the system's ability to perform.

The System Constraint: An "Archimedes Point"

Let's synthesize a few concepts. The first is the idea of a system constraint, or limiting factor. The second is the Pareto Principle—20 percent of the system is responsible for 80 percent of its results. And the third is the mental model of a system as a chain with one weakest link. (By definition, there is only one in a chain, or we'd have to call it only *a* weak link, not *the weakest* link.)

The hybrid result might be something like this. Since systems are composed of many interdependent parts, all working toward a common goal, and since the 80/20 rule generally applies to most systems, it follows that not all system components are equally capable—or equally crucial to the success of the system. And since the least capable part of the system—the "weakest link"—determines the maximum performance of the whole chain, it follows that this weakest link (the system constraint) should represent an "Archimedes Point"—a leverage point that if force is properly applied, offers the greatest potential for system performance improvement.

The Myth of Efficiency

According to the Pareto Principle, 80 percent of a system's performance results from only 20 percent of the system. But E.M. Goldratt, widely credited with conceiving constraint theory, suggests that the ratio might be more like 99-to-one. **[3:53]** In the early 1980s, when he was focusing almost exclusively on the application of constraint theory to manufacturing, Goldratt articulated nine principles for optimizing production technology (OPT). **[4]** While they refer to bottlenecks rather than constraints, three of these principles have significant implications for systems thinking:

1. The level of utilization of a non-bottleneck is not determined by its own potential but by some constraint in the system.
2. An hour lost at the bottleneck is an hour lost for the total system.
3. An hour saved at a non-bottleneck is a mirage.

If we substitute the word *constraint* for *bottleneck*, these three principles make a powerful statement about efficiency in systems. Recalling that the system's constraint—the "Archimedes point"—represents Pareto's critical 20 percent (or, as Goldratt maintains, the critical one percent), the implication of the first principle, above, is that *efficiency really doesn't matter much in 80 percent (or 99 percent) of the system!* The third principle, concerning the insignificance of saving time at a non-constraint, reinforces this point. The second principle, concerning the criticality of efficiency at the system constraint, is the converse of the first and third—it emphasizes the importance of *ensuring* efficiency at the system constraint.

The conclusion we can draw from this discussion of the Pareto Principle, leverage points, and non-constraints is crucial in simplifying management's primary job: ensuring overall system success. It's that *we must worry about efficiency really at only one point in the system: the constraint or leverage point*. The efficiency at non-constraints—almost all of the rest of the system—matters only when a non-constraint's inefficiency puts it in danger of *becoming* the system constraint.

Consider how important this could be for overstressed managers. It's not necessary to watch everything in the system with equal attention or intensity. In other words, when the system constraint is known, only a very few key metrics must be closely monitored to ensure system success. And by extension, only a few key nodes of the system—in most cases just one—require rapid response to deviations or variances. By focusing on the critical few at the expense of the trivial many, the quality of management improves and the probability of system success increases.

Breaking Constraints: How Much Improvement?

What is required to actually *increase* the performance of a system? Clearly, based on what we've seen so far, efforts to do this should be aimed at the "Archimedes point"—at least in the short term, or it's likely they'll be wasted. But how much system improvement can we expect?

Say, for example, we know that our system constraint is the capability of the sales department. If we double the size of the sales force, can we expect to see overall system performance double? Possibly in some circumstances, but only up to the level of the next constraining factor. If the production process had been only 80 percent utilized before the sales force was doubled in size, the increase in system performance could be no more than 20 percent, at most. The production process capacity would constrain system performance before all of the added sales capability could be effectively used.

So there's another lesson here: when a system constraint is broken, the system's performance improves, but only up to the level of the next most restrictive factor. That factor becomes the new system constraint, which brings up still another lesson: it's not possible to completely eliminate all constraints, so the system's leverage point moves every time a constraint is broken. Consequently, it's crucial for system leaders to know *where* the system's leverage point lies, where it will move *to* when the system's constraint is broken, and what the *best choices* of action are for maximizing the leverage at that new point.

Five Focusing Steps: A Prescription for Maximizing System Performance

E.M. Goldratt created a five-step process for managing system constraints: **[3:58-63]**

1. Identify the system constraint. Determine the factor that most limits the system's ability to perform. This factor could be internal (a resource, knowledge or competence, financial condition, or policy). Or it could be external (market demand, competitive environment issues, materials and suppliers, or government regulations and laws).

2. Decide how to exploit the current constraint. What action is required to wring the most efficiency and effectiveness from the current leverage point? This action will differ depending on what that limiting factor is. Sales constraints require different actions to break than production or supply constraints.

3. Subordinate all other parts of the system to the exploitation of the current constraint. This is a short- or medium-term tactic. The objective is to maximize system performance while working on a longer term strategy to break or eliminate the constraint from its current location. It requires all non-constraints—all elements of the system other than the leverage point—to subordinate (or sacrifice) their own efficiencies in the interest of maximizing the efficiency of the leverage point. In other words, this is the tacit recognition that the Pareto Principle applies to all systems. It's pertinent to mention that exploitation and subordination normally don't require the expenditure of more money—usually the only thing required is to *change* the way current assets or resources are used.

4. Elevate the constraint. "Elevation" in this case means to increase capacity. Whether that means purchasing more equipment, hiring more people, or expanding facilities, elevating the capability of the leverage point requires spending more money. But notice that this does not happen until after maximum system performance has been realized through exploitation and subordination. This is where many (most?) organizations make a serious mistake of omission: they ignore the opportunities to wring the maximum performance out of their existing leverage point before they run out and spend more money (sometimes a lot of money!) on more physical capacity.

5. Go back to the first step. It's possible that the exploit and subordinate steps may change the leverage point. But if they don't, the elevate step certainly will. Thus, leaders must be constantly on watch for a shift in the leverage point from one point in the system to another. Knowing that in different locations, the leverage point requires different tactics for exploitation and subordination, it's absolutely critical for

leadership to actively search for a shift in leverage point location and change their system improvement tactics accordingly.

Cycling through these five Focusing Steps should be a continuous process for all systems—a never-ending *systemic* continuous improvement process. This is the only way to ensure that a system is performing to its highest potential levels.

Summary and Conclusion

All systems—whether commercial, government agency, not-for-profit, or social—are constrained in some way. That constraint represents a leverage point in each system, a point at which a measured amount of effort will produce a disproportionate benefit to the system. But a system constraint exists with non-constraints in a Pareto Principle-type relationship: there are far fewer leverage points (probably only one) than non-constraints. Capitalizing on this knowledge requires the application of a structured, repetitive continuous improvement process—the Five Focusing Steps.

In our next installment, we'll begin a systematic approach to system management by exploring a logical way to analyze complex systems.

> The only things that evolve by themselves in an organization are disorder, friction, and malperformance.
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> —Peter Drucker

Endnotes

1. Deming, W. Edwards. *The New Economics for Industry, Government, Education.* Cambridge, MA: MIT Center for Advanced Engineering Study, 1993.
2. Gardner, Howard. *Changing Minds: The Art and Science of Changing Our Own and Other People's Minds.* Boston: Harvard Business School Press, 2004.
3. Goldratt, E.M. *The Haystack Syndrome: Sifting Information Out of the Data Ocean.* Great Barrington, MA: The North River Press, 1990.
4. Robert Lundrigan, "What is this thing called OPT?", Production and Inventory Management, Second Quarter 1986.
5. Orwell, George. *Animal Farm.* (http://www.online-literature.com/orwell/animalfarm/)
6. http://management.about.com/cs/generalmanagement/a/Pareto081202.htm