

SUSTAINABILITY AND

This article discusses two steps—both drawn from the author's study of the Toyota Production System, the inspiration for the concept of "lean operations"—that businesses might take to create a truly sustainable economy someday.

"LEAN OPERATIONS" ©

H. THOMAS JOHNSON, PH.D.

The Toyota Production System, often referred to as "lean operations," focuses on removing all forms of waste from business operations. Indeed, the Toyota Motor Corporation has removed waste from its operations so rigorously for the past 40 years that it now is the undisputed leader in its industry for worker safety, customer quality, lead times, cost, and profitability. It should seem surprising, therefore, that authorities in the field of sustainable business practice seldom, if ever, mention Toyota. Surprising, because business sustainability is so often associated with achieving "eco-efficiency" by minimizing and eliminating wasteful consumption of resources, a goal presumably no different than Toyota's.

Those who study business sustainability miss a unique opportunity by ignoring Toyota, not because Toyota is a paragon of sustainability but because key features of its current operating system will likely be emulated by any companies that might become truly sustainable in the future. However, virtually no company today, certainly no large publicly traded company, conducts operations that Earth's biosystem can sustain in the long run. By pursuing growth without limit, companies inevitably conduct operations that are unsustainable. Businesses differ in their degree of unsus-

tainability—some are less unsustainable than others—but none operates in a way that is truly sustainable, not even Toyota.¹ This situation will persist as long as companies design operations primarily to achieve imperatives of financial markets, such as growth and market value, not imperatives demanded by Earth's biosystem, the system that sustains all human social and economic activity.²

What is sustainability?

The most popular definition of sustainability in business literature is the definition of "sustainable development" first enunciated by Lester Brown around 1980 and then enshrined by the United Nations in the Brundtland Report of 1987: "Sustainable development . . . meets the needs of the present without compromising the ability of future generations to meet their own needs."³ This definition places primary emphasis on the term development. Sustainable is simply an adjective that modifies the noun development, the main subject of the definition. In the context of the Brundtland Report, the term development means *economic* development. This definition does not mention the word "life," nor does it mention the needs of non-human species. It focuses attention only on the needs of the human economic system.

Development—the primary need to be met by the economy in this definition—usually means growth of economic output sufficient to insure a rising standard of living for each and every generation. In other words, development presupposes sustained growth of human production and con-

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sumption, subject only to the condition that meeting the needs of the present generation must not compromise the ability of future generations to meet their needs. Presumably this condition requires Earth's biosystem to somehow absorb the demands placed on it by human economic development. In fact, the architects of this concept of "sustainability" did acknowledge that economic development could not occur without paying some attention to Earth's requirements. The issue that gave rise to the Brundtland Report was, of course, increasing awareness that human economic growth was coming at a higher and higher cost each decade in terms of air, water, and soil pollution, social disruptions, and countless other "externalities." But sustainable development meant that a way would be found to resolve those externalities without giving up economic growth. The answer, of course, was to use the supposedly endless power of human technology and creative innovation to find ways to accommodate Earth's biosystem to man's economic system.⁴

In the aftermath of the Brundtland Report it became common to refer to Earth's biosystem as the "environment" and to describe

it as co-equal with the human economic and social systems. This idea is implicit in the "triple bottom line," an account-

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ing tool that appeared in the late 1980s to measure the contributions of each of those three systems to human welfare. The triple bottom line encourages the belief that Earth's life-sustaining biosystem (the "environment") functions co-equally with and mutually subject to the needs of the human economic and social systems. This belief supports the idea that "environmental problems" emanating from human activity can always be remedied by interventions from human technology. Proponents of this idea, often following the lead of economist Julian Simon, view such environmental problems as a matter that technology and the assumed infinite substitutability of Earth's resources can always solve. In other words, if some resource is made scarce by human activity, say depletion of topsoil needed to grow

crops, then technology can provide answers such as chemicals that restore lost nutrients or hydroponic systems that grow plants without soil.

The idea of limitless substitutability creates one of the weakest links in all the work on sustainable development that has emerged in the last two decades. The flaw isn't to believe that individual resources can substitute for each other. They surely can, as when energy from solar panels substitutes for electricity generated by shrinking reserves of fossil fuel or when desalinization technology can permit relatively limitless stores of ocean water to substitute for fresh potable water from a depleted aquifer. The creative genius of human technology insures almost endless ability to come up with such examples of resource substitutions. But human technology cannot create a substitute for one resource that is truly limited and truly indispensable to sustaining life on Earth—the capacity of Earth's biosystem to regenerate the degradation of order, or "waste," caused by the process of life itself. The capacity of Earth's regenerative systems was always adequate to sustain the needs of all life forms until the human species arrived. Then the emergence of technology enabled humans to consume more order from the biosystem than the biosystem's regenerative capacity can restore without impairing the needs of other species.

The Earth's capacity to regenerate order exists in myriad forms. In one very basic form it is seen in the "food chain" by which every living thing acquires the energy to live by consuming food created by other life forms. In another form the Earth's capacity for renewal is seen in the continual process of speciation—the biosystem's endless generation of newness. Without the constant regenerative dance of death and newness the Earth's biosystem would long ago have perished in an entropic march toward homogeneity. Before the human arrived on the scene, one species' demand for resources had never impaired the biosystem's capacity to generate renewal, nor had it threatened the survival of other species. To the extent that the human economic system's excessive demands on Earth's biosystem impair that capacity, thereby nurturing homogeneity and entropy, the human species is not sustainable.

Concepts such as sustainable development and the triple bottom line often seem to cause their advocates to forget how it is that the human economic and social systems depend on the biosystem. Earth's biosystem, especially its capacity to reverse entropy and create newness, is the primary life system. It is not co-equal with the human systems. It does not answer to the human systems' demand for economic development. It is the system that sustains all life, and it does so on its own terms. True sustainability, which MIT industrial ecologist John Ehrenfeld defines as the possibility that human and all other life forms on Earth will flourish forever—is not the same thing as sustainable development. Sustainable development simply invites people to ask how they might use technology to offset the degradation of Earth's system caused by ever-growing human consumption. True sustainability invites one to ask, instead, how humans should conduct economic activity so that it does not damage the ability of Earth's system to sustain all life, including human. An advocate of true sustainability asks how humans might conduct economic activity so that the human species and all other species can flourish indefinitely.

Achieving true sustainability will require a radical change in thinking. To better understand this change in thinking, consider two steps businesses might take that offer promise for creating a genuinely sustainable human economy. The first step is for businesses to design their operations according to the principles that guide all living systems. The second step is for businesses to capitalize on the ability of such redesigned operations to make them competitive at smaller and smaller scales and at the local (not global) level. Both of these steps to true sustainability draw importantly on knowledge gleaned from the Toyota Production System.

The first step: a new mode of operations

If businesses are to become sustainable they must first learn how to conduct operations in alignment with the patterns observed in the only truly sustainable system we know, the system of all living systems on Earth. To conduct operations

according to rules contrary to those that guide Earth's biosystem and all its living parts is to court self-extinction. Modern scientists, building on the new cosmology emerging from relativity and quantum theories in the past century, have reached two conclusions especially pertinent to understanding the principles that have guided the evolution and operation of living systems since Earth emerged some 4.5 billion years ago. The first conclusion is that all life systems (like all natural systems in the entire universe) operate according to three broad principles:

- Everything that exists is related, ultimately, to everything else that exists
- Everything that exists is self-organizing
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The second conclusion scientists have reached about the operation of natural living systems is that the *system* of interactions defined by these three principles is primary. The results produced by that system—that is, the outcomes that emerge from the process—are subordinate. The results, in other words, are an emergent feature of the system's operation, and cannot be predicted or foreordained.

To understand how these principles of living systems could guide sustainable business operations, compare the principles that seem to guide Toyota's operations with the mechanistic rules that guide most business operations today. Most businesses today, seeing reality through the lens

of 18th-century science, view operations as a collection of independent parts. Moreover, each part is identified by an absolute external measure of its contribution to the business—cost, revenue, and so forth—and all parts are held together by external connections defined in a plan or a financial model, often articulated in a spreadsheet. Overall results, the whole,

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are seen as an arithmetic sum of all the parts. To change the overall results by some desired amount, simply move parts with financial values that add up to that amount, say by outsourcing, laying people off, driving suppliers to accept lower prices, merging or divesting operating units, and so forth.

Toyota, apparently seeing the world through the lens of modern science, views operations as a community of relationships, not a collection of parts. No part has an absolute value apart from the context of interrelationships that connects it to all other parts. Results emerge from the relationships people create between parts, not from adding up the parts themselves. The passage that follows captures much of the difference that this worldview brings to Toyota's operations:

Relationships are the reality that makes the difference in Toyota. Financial results and quantitative outcomes matter to them, of course, but Toyota people seem to understand that how relationships are orchestrated between people—particularly between shop floor workers—determines how good those results will be. Basically, a Toyota plant has the same materials and parts, the same machine technologies, the same workforce, and the same types of customers as one would see in any of its competitors' plants. What is different in the Toyota plant is how work is organized. Material always flows in direct, simple pathways, and workers always are linked through unambiguous "supplier-customer" connections. Every production worker is guided by one aim: to meet the needs of his or her direct customer—the person to whom the work flows next. That relationship permits one to know at any moment if something is abnormal and, if it is, to stop, correct the problem and act to prevent it happening again. As a result of these carefully orchestrated relationships, everyone's work at any moment is focused on only one order at a time, with features in place to insure, as much as possible, that no more resources are consumed than necessary to complete that one order.

The relationships created by the way the work is organized virtually guarantee that every step in the process is performed at the highest quality and at the lowest cost, including time. Moreover, the design of the work also insures maximum flexibility to vary types and volume of product made in the plant. And every step in the work, every moment, embodies hypotheses to be continually tested, leading to continual awareness of opportunities for change and improvement. If one observes the overall scene in a Toyota plant long enough and carefully enough, one begins to see a pattern that resembles the working of a self-organizing [living] system.⁵

Indeed, operations in a Toyota plant resemble the operations one observes in a tree:

A tree's quality of life and its survival reside . . . in each and every cell. The metabolic process flows through every cell in the entire system at a common rate—a common "beat" that resembles the takt time of workstations on a perfectly balanced production line. Abnormalities are detected and corrected by immunological processes at the cell level. No central control system passes instructions down and receives performance reports from below. Information concerning operations exists in each and every cell in the DNA that standardizes the content, timing, sequence, and outcomes of chemical processes necessary for the tree's ongoing existence.⁶

This, then, is the first step—to operate according to principles like those observed in Earth's system of living systems, the only sustainable system we know. Although it is beyond the scope of this article to describe specific operating practices observed in Toyota's plants, readers can turn for those details to a vast literature that has been written about those practices. However, very little has been written about the principles underlying those practices, and even less about the topic under discussion here—how those principles square with the principles that guide the operation of natural living systems.⁷ But patterning business operations according to the principles that guide living systems is a necessary step to insure sustainability. By itself, it is not sufficient, especially if a company feels compelled to pursue endless growth. That brings us, then, to step two on the pathway to true sustainability.

The second step: a new sense of scale and place

A fundamental pattern one observes in nature, both on Earth and in the universe as a whole, is that no part of the system ever grows without limit. With the possible exception of the universe itself that has expanded for some 13 to 14 billion years and is likely to continue expanding for billions of years to come, nothing in the universe ever grows beyond some limit. Galaxies, perhaps the largest forms in the universe, don't grow endlessly. The hundreds of billions of galaxies astronomers now see are distributed across the mantle of the universe like grains of sand on an ocean beach. The same is true of stars and planets and all living things on Earth. Elephants grow to the size of elephants and



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ants to the size of ants. Likewise, no single species of life on Earth grows in numbers without limit, although the human species in recent times seems bent on defying that pattern.

Toyota does pursue growth, an imperative imposed by financial markets on all large publicly traded firms today. Moreover, it is widely assumed in the business world that to achieve competitive costs a firm must grow to the largest scale possible, to achieve so-called "economies of scale." But Toyota's unique operating strategy seems to offer a way out of the imperative to grow endlessly in order to achieve competitive costs. Indeed, evidence that Toyota can achieve competitive costs without having to grow to large scale is found in a comparison of its plant that makes Camry and Avalon models in Georgetown, Kentucky with the plant that makes the same models in Melbourne, Australia. Each plant contains facilities to build engines and axles, to stamp and weld body parts, to produce plastic trim and bumpers, to build seats, and to carry out final assembly. According to the company these two vertically integrated plants are equally effective and efficient, even though the Melbourne plant currently produces about 90,000 units per year for Australia's market and the Georgetown plant produces about 500,000 units per year for the American market. What is to be said about scale economies when a fivefold difference in scale yields no unit-cost differences? This example suggests that a wide range of manufacturers that adopt Toyota's practices might support high-variety and low-cost operations serving bioregional economies of 10 to 30 million people (roughly the size of Australia, Canada, or California).

Having an operating system that achieves competitive costs at almost any scale is not only one of the most important strategic advantages a firm can possess; it also eliminates one of the chief barriers to creating a truly sustainable human economy on Earth—the financial imperative to grow endlessly. If no firm had a financial incentive to grow beyond the limits of its bioregion, then any firm could focus its activities on a specific place where it knows its customers, employees, and suppliers face to face and it draws on sources of energy and

materials found literally in its own backyard. By drawing the decisions of customers and owners of capital closer to the consequences for workers and their communities, those conditions would increase the visibility of, and increase pressure to eliminate, the externalities that plague today's widely-dispersed, global economy. A company that inhabits the region where it operates is more likely than one of today's global giants to see externalities (what Toyota might call an abnormality) when and where they occur, and have an incentive to mitigate the consequences as quickly as possible.

Having more companies operate at smaller scale and in local regions has other beneficial consequences for achieving true sustainability in the human economy. One likely consequence of greater localization of economic activity is diminished inequality in the distribution of rewards and externalities. Extreme inequality of wealth and income such as the American economy has experienced in recent decades gives those individuals at the top of the heap increased power to act in ways that are contrary to the interest of sustainability for all. Another likely consequence of increased localization and smaller scale operations is less need for large amounts, or any amounts, of funds raised by sale of equities as opposed to funds generated internally from current earnings. With less emphasis on equity capital there presumably would be less interest in financial markets and stock trading. It is not impossible to imagine a locally oriented economic system where no publicly traded corporations exist to flaunt the cause of sustainability in the interest of maximizing shareholder wealth and top executive compensation packages.

Finally, with closer proximity of actions and consequences in a locally oriented economy there would hopefully be less need for accounting data to define and assess results and responsibilities. Just as the presence of those conditions in Toyota's operations virtually eliminated the use of production and financial controls to direct and assess operations, so might the business community and the larger public recognize the waste of complex and extensive accounting controls in a locally-oriented, "small is beautiful" economy. Increased proximity



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of actions and consequences might even reduce the need for taxes, subsidies, and regulations enforced from afar to encourage sustainable behavior. Results would now be visible real time in the local arena as part of local processes. As in Toyota, all the information needed would be contained in the work and the work would be the primary source of information about results and consequences. ■

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