

Compression

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1. *Compression* Defined

Five hundred years of global expansion are nearing an end. The physical resources to support it are limited, and we must closely heed the global environment that supports us. However, the financial and business systems developed during expansion goad us to continue physical expansion. These old legacies to which we are attached will not shut themselves off. We must do that. Questioning them is emotional, but we have to squelch our emotion to find a path to new systems of thought and work. This will not be easy.

The author did not reach this conclusion quickly. Expecting others to instantly concur is unreasonable. But we cannot afford to wait much longer to start on this new path.

Compression has many physical analogies: mechanical compression as with springs or air, or compressing information as in an e-mailed “zipped” attachment. Compression is Moore’s Law in computer processing, doing much more using less energy in smaller and smaller packages. It also implies psychological stress from changes occurring so quickly that we can’t absorb them, and respond in a daze, if at all

Compression implies that we must get out of this dazed state by learning how to learn faster. *The goal of Compression is to learn how to continue improving human quality of life while greatly reducing our consumption of energy and virgin raw material, and releasing no toxic chemicals into either air or water.* Compressing our physical economy while expanding our quality of life, having our cake and eating it too, is a supreme challenge to human intellect, technology, organization, and emotions. This implies a revolution in how we define and organize work – even how we think. Are we going to go for a higher state of civilization or relapse into a version of the dark ages?

Compression, the opposite of economic expansion, turns old economic and business assumptions upside down. Most business thinking; indeed most daily thinking, presumes an expanding economy. We expect money invested in a bank or corporate stock to grow. We expect companies and cities to grow. So we solve most problems by finding and using more resources – energy, materials, land. But in *Compression*, more is not better. Instead we must think “*quality over quantity, always.*” An arbitrary global objective is:

Globally create at least the same quality of life as in industrial societies today, while using less than half the energy and virgin raw materials as in the year 2000, while cutting known toxic releases to nearly zero.

Quantifying this challenge makes its enormity obvious. Only one of our mounting problems is fossil fuel CO₂ going into the atmosphere. If we have no concepts for actually doing it, proposals to reduce this by 80 percent within decades are terrifying. Such challenges can’t be met using the thinking of the past, and are unlikely to be met with technological magic alone. Our biggest challenge is changing us.

Quantifying these challenges, even if done arbitrarily, helps us simplify what we must do. For example, eliminating toxic releases is a large set of different problems, some very

complex. However, those problems and most others are easier to contain if we simply process and consume less physical “stuff.” That reduces the scale of all other problems. However, producing and consuming less runs against received economic wisdom.

Expansionary thinking is normal to humans when they can muster the resources to expand. All ancient empires were expansionary -- European, Asian, African or Native American. Agricultural civilizations built empires by opening virgin land for human use, or by capturing it from others. Since working the ground was labor intensive, somebody had to be coerced into doing it – de facto slavery in some form. Then they had to build and protect roads and waterways to bring produce to their centers of civilization – cities. When the amount of energy extracted from this system was no longer sufficient to keep it going, empires declined – if a stronger empire did not defeat them first.

Human habitation appears to have expanded slowly around the globe until European colonization began about 500 years ago. As this physical global expansion accelerated, the expansionary economic institutions that we know today grew with it. Many European colonies were business ventures chartered as limited-liability companies, the forerunners of today’s corporations. At least one, The Hudson Bay Company, is still going.

While colonizers had mixed motives, economically they developed the resources of the land. Those colonized usually viewed it as exploitation. Colonial capitalists staked claims and developed them more on sweat equity than capital, but by using a claim as collateral, they could borrow money to develop it. As the need for capital grew, the financial system expanded to supply it. Governments stabilized shaky private banks by regulating them, and by chartering them to draw reserve money for expansion; then supporting them if they ran short. (This became the Federal Reserve System in the United States). Stripping away the complications, capitalism essentially created money for physical expansion out of nothing by defining something measureable as an asset, then collateralizing it. Real estate development still works about the same way.

As long as the money thus generated is honored as markers of transactional value, it induces organization of work to “do something” with property and other resources. After appropriating resources that no one appeared to own, colonials began transforming them to increase their value as they saw it. With the industrial revolution, ingenuity devising fuel-powered equipment accelerated expansion. The need for capital with which to do it greatly increased. As this system matured into transactional market societies, it had to make credit routine, so it shed medieval customs like prohibiting charging of interest.

The system’s emphasis on return on money invested and returns to stockholders is a legacy from 19th century railroads. The United States and Britain were the only two economies whose private capital markets could finance railroads’ demand for capital that dwarfed all other demands for it at the time. Elsewhere governments had to finance railroads. But even more than today, early stock markets were volatile, speculative, fraud-ridden, and plagued by periodic boom-bust cycles all the way back to the 1630s Dutch Tulip bubble.

To defend rail operations from capital market predators, railroad boards organized to make “strategic finance” decisions, leaving operations to professional managers. They set up hierarchies easy for boards to understand, and pioneered many ideas we take for granted today. Centrally-coordinated national time zones are only one. Rail tycoons founded engineering colleges. Rail managers helped found professional societies. “Running like a railroad” came to describe a well-run business, and because of the huge capital investment, the chief criterion of railroad performance became return on investment with a system of control to assure it, so other industries copied that too.

In the 20th century the financial system became more-and-more global to support physical expansion on an ever-bigger scale. Over the century, world population expanded from 1.6 billion to 6 billion. The world population of registered vehicles expanded from nearly zero to about 750 million. Housing units in the United States expanded from 37 million in 1940 to 115 million in 2000. The size of housing units also increased. This is obvious without using statistics: just compare old photographs with new ones of built up areas with their traffic. Burgeoning physical expansion required more and more energy. To power this expansion in the United States alone between 1950 and 2000, energy production doubled from 35 billion quads to 71 billion quads.

To enable this consumption, the financial system ballooned credit capacity. From \$226 billion in 1970, American consumer credit zoomed to \$1.7 trillion in 2000 (real dollars, not constant). By 2006 it had lofted to \$2.4 trillion. Mortgage debt zipped from \$92 billion in 1952 to \$7.5 trillion by 2000; and on up to \$13.3 trillion by 2006.

Plenty of evidence suggests that the expansion party is coming to an end. Ultimately Malthus will be right, but nobody knows exactly when. He has been ridiculed for 200 years for pointing out that the human population can always expand faster than its food supply – but unfortunately, just before industrial expansion began to surge. The world has finite resources and a precarious environment, and while limits are uncertain, no financial models can change the laws of physics, and we can only push the balance of the ecosphere so far. We have to work with nature on its terms, not ours. The old economic order of the 20th century, based on expansion, cannot cope with Compression. A new, much more vigorous business and economic order has to take its place, and soon.

This new order can grow from sprouts shooting out of the rotting stump of the old. Our forefathers could scarcely dream of our technologies. Our best organizations engage people very deeply in their work, learning to reshape and refine it very quickly. We have lively, if discordant, “green movements.” We have major initiatives to improve “corporate social responsibility.” But experimenters’ attempts to graft new thinking onto our old legal and economic structures keep being rejected.

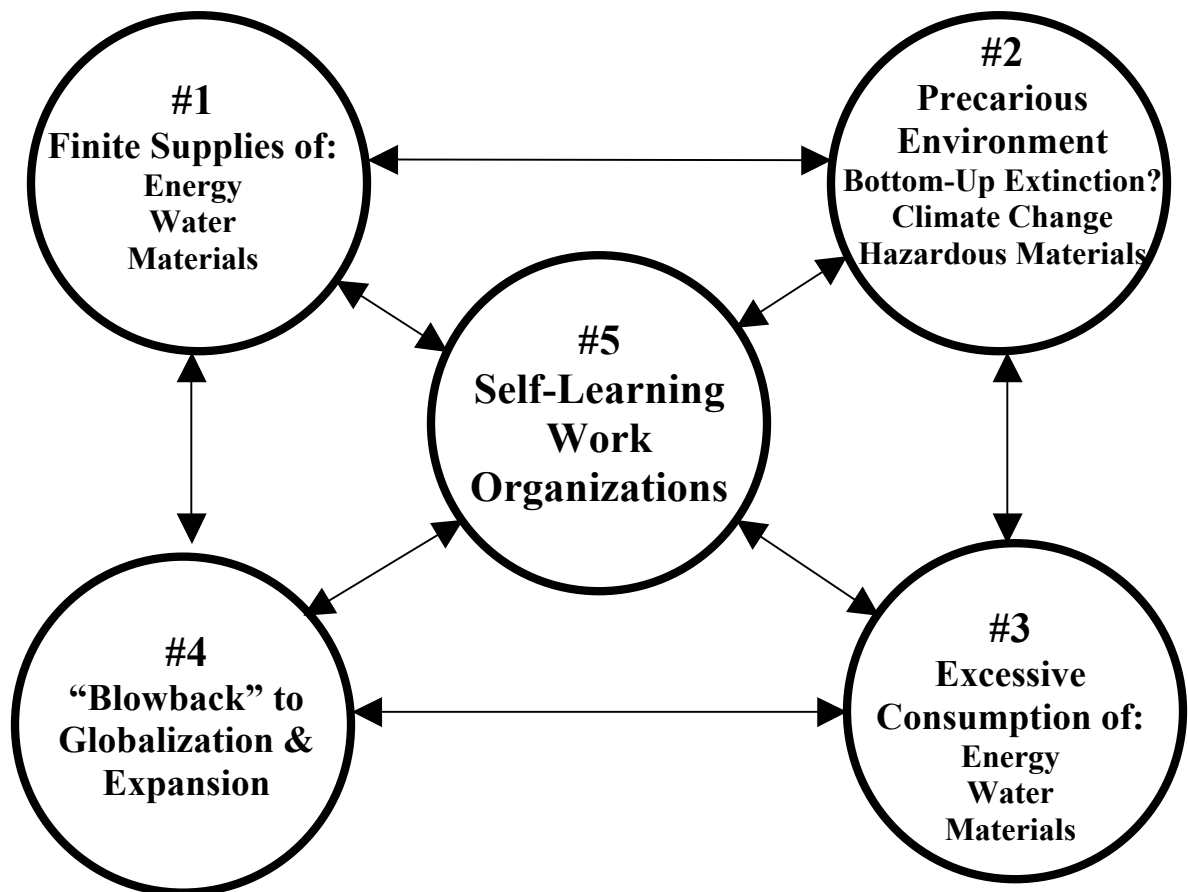
We have to change ourselves more deeply than trying experiments that the present system rejects as “fads,” and human change seems unlikely by a grand blueprint. We have to change how we think so that working organizations migrate into something fundamentally different, vigorous learning enterprises dedicated to broader missions than merely making money, with legal and economic structural changes to support them.

2. The Challenges of *Compression*

Our key challenge is in the center circle of Figure 1, vigorous self-learning work organizations able to deal with the challenges in the other four circles. Both the macro and micro nature of the other challenges force us to redefine work and how we organize it. No explanation of any of these circles can ever be complete, including self-learning work organizations (#5). These challenges are ever-changing. To understand them, one simply has to begin to think differently – as a life-long process-and-system learner.

The first challenge is to appreciate the scope and interrelated nature of these pervasive, ever-changing challenges. They are filled with endless unknowns; that’s why we need vigorous learning organizations. Readers may be provoked to personally investigate these challenges in depth, but one can investigate forever and never get around to actually dealing with them. Vigorous learning organizations have to learn while they are taking action in every area important to us. These challenges can no longer be “side issues.”

Figure 1: **21st Century Challenges of Compression**



1. Finite Supplies of Resources

Comprehending the systemic nature of shortages requires thinking through the interactions of physical systems on scales from global to micro. Cost models do not automatically suggest this. They often assume that if a change is made, everything else will stay the same or adjust favorably to it. In expansion we could ignore these mistakes, pay for them, and keep going. In *Compression*, we can't. We have to think differently and "get a lot smarter."

Three kinds of shortages will be discussed: energy, water, and food. They are interrelated. Some kinds of virgin material will be in short supply too, but fortunately few of them completely disappear once they have been extracted and refined, but re-using them depends on energy and a system to enable re-use. For example, re-melting aluminum takes about 5% of the energy required to mine and smelt bauxite.

Energy: Everything requires energy, even computers. We became so used to cheap energy that we regarded it as virtually free. It's not.

The deposits of fossil fuels first depleted were usually concentrated and easy to obtain. That is, they had a very high energy return from the energy expended to get them and use them. The original Texas oil gushers had a return of better than 100 to 1. No wonder they called it black gold.

Oil and gas became the preferred fossil fuels, clean burning, easy to handle, and with high heat content. Without them, mass-produced motor vehicles might never have been viable. All fossil fuels are finite in supply. Oil just happens to have attracted attention.

"Hubbert's Peak" is a term barely entering public awareness. It refers to the time at which an oil field, or a group of them, reaches maximum output and thereafter declines. Peak does not imply suddenly running out, but that ever-growing demand cannot be supplied. This limitation is serious because petroleum is not only burnt for energy, it is chemical feedstock for fertilizer, plastics, and other materials that we take for granted, and once extracted, nature cannot replace it quickly. Near the global "Hubbert's Peak" petroleum production will likely be fairly flat for several years before decline.

Neither higher market demand nor higher prices can put more fossil fuel in the ground. Data to predict the global "Hubbert's Peak" for petroleum are imprecise. Not only market demand, but the size of oil reserves and projected extraction rates are fuzzy. Ceasing price subsidies or adding taxes would obviously decrease the demand rate and stretch the supply. Satellite images of oil deposits are sufficiently advanced to make it unlikely that any land-based fields to be found are the size Saudi Arabia's Ghawar. Pessimists think peak oil is here; optimists put it at 2020 or beyond, but close enough for serious preparation. The most immanent threat is political disruption of existing supplies. Oil markets are mostly the noise from short-term supply-demand flaps.

No short-term source of alternative energy promises a high energy yield. Nuclear fusion is decades away. Biofuels depend on photosynthesis of plants covering large swaths of land – or intense water “aquaculture.” No matter what technology is used, the more dispersed a source of energy, including uranium ore, the more energy is required to collect it and concentrate it. Technology can improve energy yield by improving the efficiency of concentrating energy, but it can’t compensate for depletion of high-yield sources. Energy yield from Canadian tar sands, for instance, is no more than 3/1; probably closer to 2/1. To grasp how nature thus puts its own “high tax” on low-yield sources of energy, the public needs basic education in thermodynamics.

Water: We use water is for irrigation, sewage treatment, making paper, cooking, cooling, ad infinitum – and where it is plentiful we use it wastefully. About 70 percent of all fresh water is used for agricultural irrigation, including lawn grass. Humans regard fresh water as a basic “right,” but we have too much of it where we don’t need it, and often, none where we do. Only 3 percent of global water is fresh; 1 percent of it is underground; and only a puny 0.009 percent is surface water, the main human source. Some people spend hours carrying water daily, while many of us have water pumped to us, which consumes energy about 2-3 percent of all fuel energy, and roughly 20 percent of all generated electricity. Ninety percent of the lifetime cost of a pump is energy (at “cheap” prices). Water is a more critical shortage than fuel energy. Nothing lives without it.

Many important rivers are “tapped out:” the Colorado, Nile, Yellow, Yangtze, and a lengthy list of lesser known ones. We can gain more benefit from water by using it wisely, but doing so is no mere matter of bidding up the price. Wiser use implies more collaboration, better technology, and improved methods. Water is as big a factor as oil in human conflicts in Africa and the Middle East. That is not a new situation, just a direr one. Where water is scarce, humans have had customs for sharing it for centuries.

Industry plus population growth multiplied the toxins and microbes that can contaminate fresh water. Assuring water quality may take new technology, some investment, and social learning of public health and conservation. Privatization of water services isn’t magic; controversies depend on prior public experience and customs for sharing water. Water organizations must be more than technically competent to earn public confidence.

Food: Globally, serious hunger appears to be increasing. Global food supplies greatly expanded using industrial agriculture – machinery, hybrid seed, and water for irrigation. The “green revolution” depends on fuel energy. Most nitrogen fertilizers today come from natural gas. Excess nitrate run-off causes “dead zones” in waterways and river mouths. “Organic” alternatives better conserve the soil. Whether it can match the output of industrial agriculture is unknown, but agriculture has to decrease energy use and re-balance with the global ecology. One option is to eat less meat. Growing a chicken now takes about a third the grain as 75 years ago, but feeding animals still uses more grain than if humans ate it directly. Global food waste is “huge” but rarely estimated. A 1997 study estimated that 27 percent of all US edible foodstuffs entered a post-farm waste stream. Obviously, food shortages interrelate with all the other issues in Figure 1.

#2 Precarious Environment:

“Global warming,” better described as climate disruption, dominates media reports because drastically reducing CO₂ released to the atmosphere obviously changes industrial society. Denial is rampant, so global warming has been “politicized.” However, climate disruption is only one threat to a balanced ecosphere, so occasionally the media present snippets about other serious problems such as:

1. Honeybee “disappearing disease:” is it a specific chemical or general stress on their immune system from being industrially farmed and trucked about as a “resource?” In any case extinction of honeybees would extinguish a big segment of fruits and nuts in the human diet. Who knows what domino effect could endanger other species as a result?

2. Halocarbons and atmospheric balance: Remember Freon and the ozone hole? It’s still there, stable, but not shrinking. Even if no other catalyst appears to enlarge it, it will take decades to fade. If the ozone hole expanded to cover much of the earth, UV-B radiation would increase over the affected area. Its effects are not known in depth, but UV-B radiation adversely affects *all* life, with unknown consequences. Human skin cancer is a relatively minor one. From what is known, there is reason to fear a big ozone hole.

3. Almost all indicators of oceanic ecological health are deteriorating: acidification, trash floating in a Pacific gyre the size of Africa; coral reefs dying; over-fishing; dead zones from nutrient runoff. It’s a long list, not counting the dangers of UV-B radiation. One reason this is so vital is that the ocean is a big sink for CO₂ and its phytoplankton are the source of about 50 percent of all atmospheric oxygen, almost three times that which comes from tropical forests. A die-off of phytoplankton could trigger extinction of most life – period.

3. Biodiversity: Most species of life are microbial. Only a fraction of all species have been discovered and classified, so we do not know the roles of unknown species in maintaining a balanced ecosphere. We do know, for instance, that for centuries plant breeders treasured alternate species of crop plant seed as stock for hybridization to combat susceptibility to drought, new plant diseases, or attack by pests. Biodiversity is really genetic diversity, the “reserve pool” on which nature draws to adapt to changing conditions. Artificial genetic modification might fill this role for a few selected species, but there is reason to fear the unknown, because unseen “booby traps” can kill us. For example, much of the opposition to genetically modified seed is fear of unintended hybrids (“superweeds”) in the wild. In addition, having a food supply depend on seed that must be industrially formulated, not naturally bred, may not be a great idea either.

Most species go extinct because human expansion encroaches on their habitat or because human-released toxins poison them. The seriousness of over-stressing a complex system we cannot fully understand tends to stay in the shadows of popular campaigns to save endangered animals (biodiversity “marker” species) that attract public sympathy.

As complicated as this may seem, one point should be obvious. Pushing the ecosphere balance over a tipping point is less likely if we practice simple conservation – use less energy, extract fewer virgin materials, and avoid releasing hazardous chemicals. We cannot sustain quality of life indefinitely if we extract raw materials at rates faster than nature can replace, or discard them at rates faster than nature can absorb. We have to start helping nature fulfill these functions for us.

3. Excessive Consumption:

In 200 years, human life expectancy has nearly doubled, a big factor causing global population to grow at least six times. Without question, quality of life greatly improved, but at the expense of tapping more and more fuel energy and consuming many times more material. Per capita consumption of physical resources multiplied. Some of us consume much more than others and at a rate well above that necessary to sustain life – or even quality of life. The top seven industrial economies together, with a little more than ten percent of the world's population, account for over half of all world consumption based on monetary estimates. Consumption accelerated in the latter 20th century, and by any measure, the United States is its undisputed world champion. As suggested by just one physical indicator: between 1960 and 2005 American solid waste per capita rose from 2.7 to 4.4 pounds per day, and total American municipal solid waste ballooned from about 90 to 245 million tons. Around 2000, the per capita daily waste of Americans began to tail off, but total solid waste is still rising.

In the meantime, about a billion destitute people consume barely enough to live; some not even that. To stay alive, some strip the land bare. To reduce consumption, one must start where it is rampant, and to reduce ecosystem destruction, one must start where that is rampant.

Many countries want to emulate the American way of consumption, but the whole world can't live that way. If India and China had the same vehicle per capita ratio as the United States the world population of 850 million registered vehicles would nearly triple. The most optimistic of fuel forecasters cannot feature how they could be fueled. This is a problem that accumulated unseen because the system concentrates on markets, additions to the global vehicle population, not its cumulative effects. By 2010 or so, the global vehicle population will reach about a billion. Market myopia has to expand its vision to address these accumulations because they multiply subsequent consumption.

Vehicles take space – roads, driveways, parking lots, and garages. If parked in a Wal-Mart style lot, American cars (not including trucks) would cover Lake Ontario. Vehicles expand the space “needed” for buildings – another resource hog. During the 20th century, the number of annual additions to American housing units multiplied twenty-six times; and after World War II, the average new-house size expanded from about 1500 to 2320 square feet, plus at least a two-car garage attached. Suburban sprawl created automotive landscapes, making a vehicle necessary to do common errands. Interstate highway exits with a half-dozen or more motels are common; the stock of homes away from home expanded too. Those Americans that want to drive their house can get a motor home

with built-in garage for small vehicles. And now, 73 million workers commute from these housing units to about 64 billion square feet of commercial building space.

Championship consumption requires world class persuasion. By 2000, the United States' \$243 billion in annual ad spending exceeded the GNP of all but twenty other countries. About \$2.50 worth of ads is aimed at each American daily, more than the daily income of a quarter of the world's population, but dwarfed but still small compared with other selling costs. From Tupperware to software, high-mark up products burn half or more of their revenue in marketing. Decades of system refinement has saturated Americans with ploys to separate them from their money: infomercials, guerilla marketing, product placement, and on and on. It works. Americans guzzle an average of 50 gallons of cola per person per year (in total enough extra calories to feed Iraq for a year). At some point, if nothing else limits consumption, human body size does.

This rapid physical expansion has been sustained by mass credit, now condensed out of that mysterious ether, "the global financial markets." Early credit institutions were more rudimentary. Banks funded development of collateralized assets; to do it, many banks issued their own dubious currencies. By 1990, any future stream of income – home mortgages, credit card payments – could be "monetized:" bundled into payment streams in various risk categories and marketed as "derivative" packages. Although only a fraction was tied to consumer spending, in 2008 the froth of global derivative trading billowed up to \$465 trillion, about five times greater than global GNP. Is Adam Smith's invisible hand leading pigs to the trough? Is a money market trying to squeeze the last drop of physical expansion from a puckered resource lemon? Or are traders just skimming money by churning the trades?

Many of these traded instruments are several stages of abstraction from any physical asset whose value they purport to represent. For example, those derived from credit card debt only represent the promise of someone, somewhere, to pay a future stream of income sometime. This market for them rests on interlocking promises of "parties and counterparties" to pay each other "if," like a form of insurance. But if defaults cascade outside the risk levels modeled in the trading logic, it begins to fall apart. Financial confidence may be restored and prop up the fall out from the 2007 sub-prime mortgage debacle for several more years, but the big "if" is how long the physical expansion which the system promotes can continue. The Japanese bubble popping in 1989 and the global one in 2008 may show the financial effects of limitations on global expansion – a system trying to prime a well with a dropping water level. Whatever happens, the global financial system will have to be "reconstituted" for Compression because its basic premises are expansionary.

At the firm level, seldom-questioned decision criteria also presume expansion. The expectation of asset value growth is built into compound interest, the present value of future returns, and maximum return on investment. When organizations focus on winning markets, they maximize output (and resource consumption), giving other considerations second priority. From a societal and environmental view this growth may or may not be good, but from the same view, overgrown companies should be able to

shrink operations more gracefully than a growth-oriented system allows. Many fall into “commodity traps,” doing more and more for less and less, unable to revise “doing what they always did” very quickly. Well-known examples are airlines, steel, paper, fast food, and automotive. If cash strapped, they may trot out new products and services still half-baked, defer basic maintenance, and otherwise emphasize quantity over quality.

Retrenchment usually displaces people. With few exceptions, slash-and-burn to save a company for ownership neglects people – customers, suppliers, and employees. An overly-specialized system to maximize output from assets lacks the flexibility to shift what it does. Many companies have survived a brush with financial death by migrating into something different – Xerox and IBM are examples. Others like Chrysler in the 1980s survived for a time because lots of people did not want them to fail. In a time of turbulent change, thinking has to switch from growth to adaptation and fast learning.

A system that rewards success primarily as physical growth accumulates trouble for itself. A system in *Compression* has to emphasize *quality over quantity, always*.

#4. Have-Not’s Blowback to Globalization:

Global have-nots are restless. Remembering the colonial mind set that accompanied expansion, few have illusions about the “system.” And now they number in the billions.

To business minds, globalization means expansion of “free markets,” financial systems, and corporate management throughout the world. Executives who think this gives them a “win” generally favor it. Defunct business owners and displaced workers everywhere, not just in North America, fume that globalization is crapping on them. Social critics protest social inequality, global corporate dictatorship, and environmental degradation – an extension of fairness arguments since capitalism began. Protesters are united only in detesting a system symbolized by the World Bank and International Monetary Fund. Using phrases like “blood diamonds,” harsh critics allege that privateers abuse workers extracting resources “from their own ground,” inflame tribal feuding, and destroy local economies. An American version of this is the anti-Wal-Mart movement decrying destruction of neighborly local economies. Pro-globalization pundits counter that the rising tide of economic growth – expansion – will eventually lift everyone’s boat.

In global corporate dominance critics see the same benevolent arrogance that often turned colonialism – by anyone – cruel in practice by population displacements that we now call ethnic cleansing, and by conscripted labor in various guises, including slavery or forced pauperization. Global corporate “hegemony” is seen as one-sided trade disguised as democracy – de facto colonialism – only with transnational corporations as conquistadors looting riches for their investors. In industrial society an anti-global argument might be that a “corporate-controlled press” muffles dissent. In the developing world, many folk who don’t “get it” voice complaints more like; “We’ve lost the freedom to drink water from the village well” (forced to pay a water company for that which was free).

Displaced people, their culture ripped asunder, are at sea adapting to a new world. If they see only negative benefit from it, they resist doing so. Old issues with Native Americans exemplify new ones world-wide. The corporate world, oblivious to this, has largely ignored human pushback for decades – or centuries. It can't much longer. One factor is lower concentration of ores and energy to extract; the more dispersed and the higher the necessary extraction rate, the more real estate that must be torn up to get it. Protests by people directly affected (and their sympathizers) become louder and louder.

Hernando de Soto, a Peruvian globalization advocate, ominously captures this danger, "The hour of capitalism's greatest triumph is its hour of crisis." Resentment easily leads to violence. While terrorism has religious and ethnic motives, it boils out of groups that believe that they are ignored, disrespected, and oppressed. Most anti-globalists were appalled by the 9/11 attacks. Few were surprised by the targets. Wall Street and the Pentagon symbolize global corporate oppression to far more people than Al Quida.

Will greater global communication bandwidth improve human understanding around the world? Don't bet on it. People living next to each other for centuries still feud. Modern technology gives them more lethal arms to feud with.

Much of the world still lacks the social and legal infrastructure of capitalism. Most occupied land does not certifiably belong to anyone. Property surveys or land titles, if they exist, are imprecise, so courts frequently invalidate "squatter claims" of ownership. Without proof of ownership, the poor cannot collateralize any existing assets to generate liquid capital for a business. They lose out to the financially adept (and politically connected). Unrest and rioting from this happening on a large scale in China recently pushed the government to enact laws defining the rights and rules of private property.

Inability to comprehend industrial operating requirements is also a problem. For example, Guatemalan small-holders could not understand the schedules or quality standards demanded by supermarket buyers. When unable to make it on the land, they migrate to cities, living however they can. Nearly ten percent of the Guatemalan population has emigrated, many to Mexico. There, aided by "coyote" expeditors, they join Mexicans headed for a city or to the United States. The immigration "problem" in the United States is part of this global rural-to-urban migration. Over half of the world's population now lives in a city. About a billion of them live in a slum, defined by the United Nations as: poor weather protection, unsafe water, more than three people per room, no sanitary toilet, and insecurity of tenure, which means that *anyone* else coveting the space may seize it at any time. Globally, most population growth is urban. By 2020, global urban population is projected to grow about 60 percent to 5 billion.

Mumbai, with a population of 20 million or so, is typical. Its population density is eight times that of New York City. About 5 million residents live in slums. Given earth's resource constraints, remediation will take out-of-the-box thinking. Any long-term solution has to enable slum dwellers to develop a reasonable quality of life themselves.

From Bolivia to China, have-not push back is significant. China has displaced millions of people; uprooted socialized medical care; and addressed environmental messes slowly, caught between building an industrial society quality of life for many millions of people and the physical toll this extracts. In India, one reason the BJP party lost the 2005 election was that the poor felt abused by displacement for growth. Even Nelson Mandela's African National Congress is accused of exacerbating income inequality.

Expansionist solutions for this are to soak up the dislocated in low-skill, but high-pay employment like manufacturing. In the early mass production phase of industrialization, this worked, but now companies chasing cheap labor in a finite world, leaving upheaval in their wake. Industrial societies prefer to believe that growth will eventually trickle down and cure social imbalance automatically. This has not been happening.

For example, oil wealth from Nigeria's two million barrels of oil pumped a day has never done much for its people by any mechanism – capitalist or socialist – and the country has many other problems besides. Between 1970 and 2005, Nigerian income to the bottom half of the population dropped. Now persistent attacks on Nigerian oil installations keep 20 percent or so of oil production knocked out, and some of the oil is siphoned off and sold on black/grey markets. Letting local strong men keep a lid on this is a less and less viable corporate strategy; the down-and-out have lost confidence in “the system” to improve their quality of life. At present, dealing with this situation is outside the purview of for-profit work organizations, while non-government organizations (NGOs) are swamped. Coping with human fallout has to be part of the mission of new 21st century work organizations. It's not a relic of bygone centuries.

American “liberals” are not the only people opposed to expansion of drilling and mining. Unless well compensated for it, most “conservatives” also oppose being personally displaced for this purpose. Nearly all of us would like the benefits of abundant resource use if somebody else contends with messes and pays the penalties. Almost everywhere, locals don't need a technical grasp of issues to object to their backyard and way of life being torn up. It's not hard to imagine the levels of corruption from “hitting a strike” degenerating to having literally to extract resources at gunpoint. .

5 Self-Learning Work Organizations:

Our first human challenge is to grasp the combined scope of the first four challenges. One can research the issues daily and never grasp a complete picture. If blinded by the myths of the “system” and never taking time to reflect, trouble signs are apt to be faint.

Many of the myths and mores that inspired expansion are becoming obsolete in an age of complexity and interdependence of human systems, not just environmental ones. One for example, is that everyone can and should be independent and self-reliant. Presumption that everyone is or should be a knowledgeable buyer underpins faith in arms-length market exchange. Reality is that to solve our problems, most of us have to rely on the people from whom we buy and their work systems. Only by detailed search can even vehicle designers learn the source of every material and component that goes in a vehicle,

and exactly how they work. Consequently, human work organizations have to assume a heavy responsibility for the integrity of human systems on which our lives depend, and for the environment that supports us. That is, they have to concentrate on quality over quantity, and learn how to work more collectively. If they do, the rest of us have to help them recognize errors and correct them faster, rather than indulge in excessive litigation.

We need differently motivated work organizations dedicated to making the most of what is available to us in a finite world. They must become more innovative, fast-learning, and highly adaptable while avoiding big, catastrophic mistakes. That's a tall order.

Although a name with more pizzazz may be desirable, let's call them "vigorous learning organizations." Such an organization consists of people, just as a military unit or a health clinic primarily consists of people. Physical resources, both man-made and natural, are what they work with. The value of such an organization is more in what its people can collectively do than in any "assets" it may claim. The implications of this are huge. It changes both how working organizations function, and how the overall system works. We can no longer afford divisions based on who "owns" a work organization or who controls it, or who "runs" some little part of it. If it makes you feel better, think of it as work organizations stepping up from "free enterprise" to "decentralized collective responsibility."

Fortunately, work organizations that have actually been moving in this direction for some time give us a few precedents to go by, but the best we have today still is not good enough. This is a bottom-up revolution. Determine at the working levels what we must really do and devise the financial and legal system changes necessary to support them.

If we can do this, we have a chance of dealing with our other challenges. Otherwise, cues from "the system" tell us to fragment into little warring units competing with each other for survival. It is not a beautiful scenario.

3. Our Legacy Systems

Colonial expansion and the industrial revolution greatly advanced quality of life in all industrialized societies. No wonder most other regions wanted its benefits – without its problems and without changing their old ways. But now, recognizing the limits of our resources, advancing quality of life for billions more people will take a new mind set, free of old expansionist legacies and their supporting myths. Three big myths are: 1) Individual achievement will conquer all. 2) We can do anything we please with *our* property. 3) Someone will invent technology to magically solve all our woes with no need to change our systems or behavior.

These legacy beliefs, having become nearly instinctive, will be tough to shake, for old industrial societies are gripped by resistance to change similar to pre-industrial societies being overrun by industrial expansion. The “fairness” of the system can be improved, but no system will be seen as perfectly fair. The old system has to change, not because it is unfair, but for a more serious reason. It is incompatible with creating vigorous learning enterprises; therefore incompetent coping with 21st century challenges.

Some of these legacy beliefs never completely escaped pre-industrial history. Some, for example, descend from slavery. The industrial revolution ended legalized slavery, but the behavior associated with it lingered on. All old agricultural societies – including all democracies – depended on involuntary servitude, feudal arrangements in some form. Somebody had to do hard, dirty physical labor. “Somebody” stigmatized by race, social class, or debt bondage was forced to do it. Masters blamed slaves for their plight (“only inferior, dependent people could be in that fix”). All major religions waffled on the ethics of slavery.

Fuel-powered machinery undercut the wobbly ethics of slavery. From 1750-1900 industrial societies disgorged legalized slavery. Only remnants of it still exist in cultures not yet into industrial norms. Illegal versions of it infest a few pits of industrial societies, but a slave-master mentality continues in attitudes toward hordes of people globally displaced into a socially marginal underclass.

In the early 20th century “master-slave” attitudes were very evident. For example, Henry Ford I ran Ford Motor Company as a personal fiefdom. His well-documented patriarchal blunders and spying on employees tend to be forgiven because he was also an inventor and had an altruistic streak – and because we assume that he could run *his* company into the ground if he wanted to. “The market” would pass the only judgment needed. Henry Ford’s attitudes nearly brought the company down in his own time, and they are utterly dysfunctional coping with Compression.

Unfortunately, parent-child relationships and “tribal divisions” still pervade 21st century industrial society work organizations. These legacies remain associated with assuming a managerial role. They retard creation of much more effective work organizations, but like slaves of old and the hidden poor now, they seem instinctive, embedded in work cultures

and unseen by those for whom running any work organization as if it were an old plantation seems the natural order of things.

Fortunately, industrial expansion also fostered different legacies, like an expectation of universal literacy, and a stream of scientific and technical discoveries. These “new” legacies promise more benefit than return on physical assets, but to realize this promise, we have to break another legacy, valuing knowledge by the cash flow expected from it (e.g. valuing a diploma by its added lifetime earnings). Learning to learn fast and quickly is a living capability that individuals and organizations develop. It’s not an inert asset.

Another serious flaw from our business legacy is using money as our dominant measure of performance. Driving performance to achieve financial goals has been called management by results or management by the numbers. Since accounting and finance quantify business values, measuring personal performance by money, and rewarding it with money seems natural. Quantification makes any cost model seem more objective than it really is, but like any other quantitative model, it is an abstract representation of reality. Analysts lacking perception of how things work by non-monetary models are not positioned to question its assumptions, and thus easily deceive themselves.

Management by the numbers became celebrated in the mid-20th century. Robert McNamara (Ford and the Department of Defense), personified the 1950s “Whiz Kid” era, which made quantitative models popular. With computers and internet, these grew into prolific modeling, computer simulation, and – sometimes – fascination with software just because is “cool” or can be sold. But if remote from reality, analysts limit their ability to question assumptions, or ask whether software helps do something that is really needed, or is just another complex exercise that only creates more waste.

Quantification eventually made global financial transaction models very complex. It also gave false confidence to traders. By 1998, exuberance pushing risks beyond the limits of these models led to Long-Term Capital unraveling in the Russian and Asian monetary melt-downs. Complex finance pumping artificial growth abetted the dot.com bust; the telecom bust; Enron, and other murk-filled disasters. By 2008, “correction” of the sub-prime housing self-delusion appeared capable of crashing the global financial system. Self-deception is built into the system when growth is the primary assumption underlying all models. Reinforce that with the delusion that millions of entities promising to pay each other constitute wealth, and one can believe that the great market in the sky will rain money. Believing this is easier if this system is visualized as only a money-in-money-out mechanism.

But the mismatch between expansionist systems and our needs in Compression extend to the basic concepts of compound interest and the present value of money, which presume growth. In a dim, bygone past the Catholic Church as well as Islam regarded almost any interest charge as usury because without hope of “growth” to pay off accumulated interest it symbolized binding a person of one’s own tribe into involuntary servitude. As it became evident that trading and credit could not become pervasive without interest, the

church relented, but in Compression even such fundamentals need rethinking. Old habits from expansion may render us incapable of abrupt change.

At the same time, increasing complexity of modern products and processes mandates quality in all kinds of work – a low tolerance for sloppiness, errors, and slow learning. For example, a computer-laden vehicle or even a washing machine, designed and built to the standards of thirty years ago, would accumulate so many flaws that most work would consist of correcting defects and mistakes – if they could be found. (In addition one couldn't cram all that “stuff” in the allowable space.)

In a simpler era, a Ford or Whirlpool could integrate most operations within the same company, if not under the same roof. Outsourcing became popular for three reasons. One, it appears to reduce costs, which may be illusive if one is chasing the mirage of lower local costs in rapidly evolving locations. Two, one lone operating organization can't keep up with the complexity of a great many rapidly changing fields. Three, outsourcing promises to simplify operational complexity (which may also be illusory).

Human system complexity adds to the problems of material shortages, energy shortages, and preserving a global ecosphere. Many work organizations must collectively develop a level of working competence that they can imagine only with great difficulty. This objective is to maximize practical, operational learning speed working with what we have, *not* to accumulate as much as possible, the opposite of a get-rich-quick mentality.

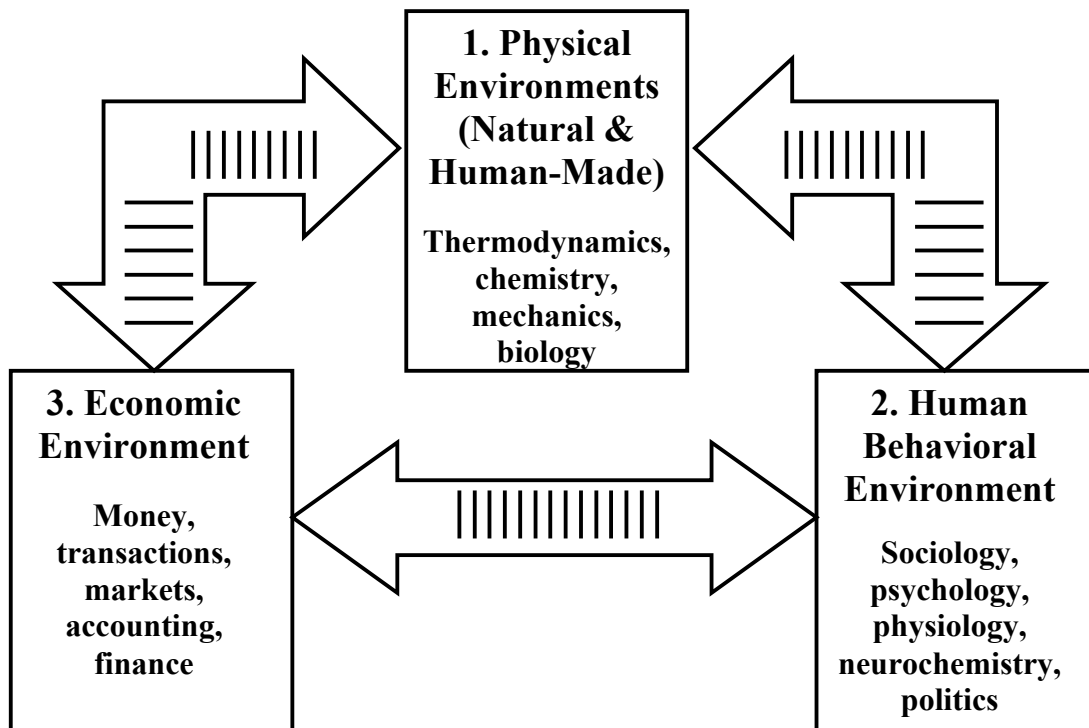
Expansionary legal legacies inhibit us too. In a for-profit company, the role of the manager derives from fiduciary duty to ownership and agency theory. Professional managers are hired and aligned with ownership interests to maximize profits for owners. (Historically the rationale for this was that people of means are more apt to have both the education and the initiative to make economic decisions significant for us all.) This simplifies decision making, but arouses fairness disputes when managers abuse other stakeholders. However, fairness not this system's fatal weakness, but its incompetence creating work organizations capable of coping with Compression.

Keen observers have seen this struggling to form for decades. During the 20th century, many initiatives to develop employees to be fully responsible for their work, including its improvement, faded because managers felt compelled to regard themselves as “parents” of not-fully-responsible “children” employees. Work Simplification, Training Within Industries (World War II), and Quality Circles are three examples. In this culture, taking initiative means becoming an entrepreneur starting a business or at least managing a business. Owners and managers “born” into this culture are often oblivious to how it truncates development of a full range of work performance.

The foregoing sets up three different models of how we see the world working, as in Figure 2 (replicated in some form by many authors). While everyone sees all three mental maps to some extent, the business-oriented tend to be dominated by #3, the Economic Environment. But to fully participate in organizations coping with *Compression*, we need to see and integrate all three in our daily work.

Physical environments (#1) consist of two parts; human made or human controlled processes, and the unaided processes of nature. For human self-preservation, we have to give the natural environment top priority. Second in priority is the human behavioral environment (#2) because without a cadre of professional citizens, each physically and mentally capable, and superbly organized, we cannot cope with *Compression*. That leaves in third priority the economic environment (#3), the world of transactions, marketing, and financial success; to be third in priority. These environments interact. Money obviously motivates humans to develop physical processes, which perturbs the natural environment, which in turn limits human physical processes; and on around the circle.

Figure 2. **Three Different “Model Maps” of How the World Works**



The author has been amazed by the gulfs of misunderstanding that separate very intelligent people between these three environments (or “domains”). Some are utterly incapable of comprehending issues in another model domain, or even accepting that they might exist. Although there are many exceptions, a significant gap exists for people trapped in finance-and-accounting think, and adamant if their rewards come from it. They may be remote from the human dynamic within their own organizations, ignorant of how its physical operations work, and oblivious to environmental issues. The most extreme seem to think that enough money can change the laws of physics. On the other hand, social critics of a business may harp on its unfairness with little understanding of financial resource limits, its customers’ needs, its physical processes, or any environmental issues created. Environmental zealots may imagine restoring a pristine biosphere without affecting quality of life if executives merely “curbed their greed.” Crossing these divides takes more than conceptual learning. Debate from hardened positions, rather than genuine dialog, only widens them. To start closing these gaps, perhaps acquaintance with biology and thermodynamics should begin in

the second grade. People cannot serve society with a professional attitude alone, but a system of development from which to make reasoned judgment about the right things to do on everyone's behalf.

Thinking that either environmental issues or improving quality of life can wait until the financial system tells us we can afford it is an illusion no longer affordable. This illusion is dispelled when it becomes obvious that physical human activity is a subset of the ecosphere; therefore environmental sustainability is not a nice-to-do adjunct of financial success. But to deal with that, work organizations must consist of people dedicated to superior performance on behalf of everyone. Financial health is necessary, but secondary. People then are not a business' "most important asset;" they *are* the business. All must become professional in two senses: 1) dedication to serve society and 2) in learning capability; both in depth and in breadth. Appraisable assets – the "things" in the denominator of return on investment ratios – are merely what professionals work with. Developing ourselves and our work organizations is our key to both survival and to improving our quality of life – having our cake and eating it too, if we can. So demanding is this challenge that it is a new step refining human civilization.

This challenge turns many of the legacy assumptions from an expansionary world upside down and inside out. It changes concepts of what work consists of and how people organize to do it. We even need different theories of value other than the market theory and labor theory that underpin expansionary economic thought. What we don't need is another "ism" that is a solution in search of the problem. This revolution has to come from the bottom up, from people who actually take first line responsibility figuring out what we need to do and how to do it. Institutions to support them can be built on that.

If it is more palatable, call this the birth of "entrepreneurial networks," or even a second American Revolution of Responsibility. But a big, dramatic change has to begin soon.

At the beginning of the 21st century, the signs of this change are all around. Many little movements are going in a similar direction; appreciative inquiry, learning organizations, Six-Sigma quality, lean operations, servant leadership, green business alliances, corporate social responsibility.... When they coagulate, the old order will fall of its own weight.

4. Lessons from “Toyota”

As here defined, Toyota is not a vigorous learning organization, but it is further toward it than most. Other companies like Honda are much like Toyota, but because of its consistent commercial success becoming “Bank Toyota” producing quality vehicles, it is probably the world’s most benchmarked company. Many managers like to benchmark their performance with others so they can try to replicate or match the best practices observed, because they are actually done by real people; not ethereal dreams. Financially betting a company on the completely unknown is so risky that few leaders try it. That’s reason enough to take hints from Toyota to help prepare for Compression.

However, many benchmarks are fragmented observations, not seen within the full context in which the practices take place. That’s certainly true of Toyota. Legions of industrial tourists have snooped through its installations looking for “secrets.” Toyota hides most of them in plain sight, but many observers leave with a warped view because Toyota’s philosophy and culture differ sharply from their own.

Most companies develop assets. Toyota develops people – all people, not just a few fast track stars. Every employee is expected to become a professional. Collectively, they should see and solve problems using Toyota’s learning systems. Toyota is far from perfect, but its consistency of performance allows it to do many things very well while shunning gimmicks. But learning to do this is like learning golf by watching a skilled pro. You can see the moves, but can’t sense how to execute them yourself.

Most manufacturing executives know of the Toyota Production System (TPS) as some “industrial engineering” techniques to eliminate waste and smooth the flow of operations. Techniques they can easily see. Far fewer see that the purpose of the system is to develop everyone in Toyota to readily see process problems and counter them. Toyota now refers to TPS as their Thinking Production System.

All automotive executives also know that Toyota develops new vehicles quickly, with very few design flaws. The most different aspect of Toyota’s New Product Development system (TNPD) is that it first develops and codifies technology packages for use. Oversimplifying, design of a vehicle then becomes the integration of tested “knowledge packages” into a reliable system. This methodology for organizational learning is so well done that many research organizations could take pointers from it.

The bedrock for this is a few principles called The Toyota Way, frugally encoded on one printed page that the company will not officially release. Toyota prefers that people absorb the principles thoughtfully and carefully, by being mentored in them and learning to live them. If posted for reading, The Toyota Way would become eyewash. *Learning to live* The Toyota Way until it becomes habitual in daily thought is an unwritten tacit principle of The Toyota Way. However, two of its publicly proclaimed pillars are: 1) respect for people (individually and collectively) and 2) continuous improvement. Respect for people is about attitude and behavior. Continuous improvement is about doing and learning to do better. One is incomplete without the other.

The Toyota Way applies to all activity in the company. No words can fully encompass it. Despite this caveat, a tentative Western description might have five major elements:

1. Respect other people; share your knowledge with them; build trust.
2. Stimulate professional development of yourself and others; share opportunities; maximize others' performance before your own.
3. Create "organizational learning" using facts and evidence; whenever possible go see the facts of a situation first hand at the scene yourself.
4. Continuously improve all processes through innovation as well as evolution.
5. Dare to pursue perfection, from all details to long-term visions.

Both pillars of The Toyota Way support each of these five elements. Note that they point toward what we must *do*, not what we will get. Nothing suggests growth, winning, or being the best, a living philosophy so deep that it cannot be fully appreciated in a lifetime. A financially driven, results-oriented observer is apt to miss the obvious.

The continuous improvement pillar concentrates on eliminating waste, where waste is defined as anything that customers would not pay for if they knew of it. So Toyota employees assiduously try to identify anything that really does not need to be done and eliminate it. For example, one of seven classic wastes to eliminate is defects and errors, either in design or execution. Do it right the first time, so you don't have to do it over. But the catalyst for many of the other wastes is the one called "overproduction," doing things that the customer does not need done at the time. Stopping that leads to low inventories, short lead times, and the just-in-time deliveries for which Toyota is famous.

A key point: Process improvement by eliminating waste is not a trade-off. Classic micro-economics emphasizes trade-offs, and nature often requires us to make them. However, eliminating that which never needed to be done requires no trade off. It improves every factor of productivity at once. Furthermore by definition, a process improvement boosts at least one factor of performance while not deteriorating any of the others.

The logic of all Toyota learning systems is similar to that of TPS. Concentrate thought and energy on work processes, not blame games. Simplify work processes. Design them with built-in visibility to make problems obvious, not hidden. Never pass on a problem; stop to resolve it, contrary to the human instinct to look better than we actually are.

But the core of TPS and all Toyota learning systems is the problem solving discipline called the Deming Circle: Plan-Do-Check-Act. PDCA adapts the scientific method to pragmatic problem solving for anything from devising strategy to finding the root cause of a paint blemish. This formal pattern of thinking is inculcated in everyone, although its full rigor is not always required. For many problems asking why repeatedly will suffice to root out the root cause. In addition, once a problem is fixed, a single-page "A3 Paper" documents the logic by which it was identified and counteracted. Distilling this episode onto a page creates clarity of thought helpful both for problem solving and for problem communication. Within Toyota this standard problem-solving format communicates

across native language differences. Also important: Documenting what didn't work as well as what did, so we do not have to learn the same lessons over and over.

Figure 3 briefly explains how this “peopleware” system uses “professional workers” in Toyota repetitive work areas. The “takt” time refers to the planned time between unit completions. Work at all linked stations can be designed to that time. Workers re-design their own work, incorporating all new ideas for eliminating waste. The ability to do this lets Toyota adjust the production rate of an assembly line up and down within a range as vehicle demand changes, and do it quickly. Very few auto factories can do that. Instead they attempt to optimize a much more restrictive process, but that doesn't stop the waste backing up into almost all other operations, all the way to their dealer's order lead times.

If this is hard to understand, try thinking “process and system interactions,” not “cost models.” Doing so also helps reveal the hidden financial value of creating process flexibility, which can eliminate the waste of a lot of capital spending.

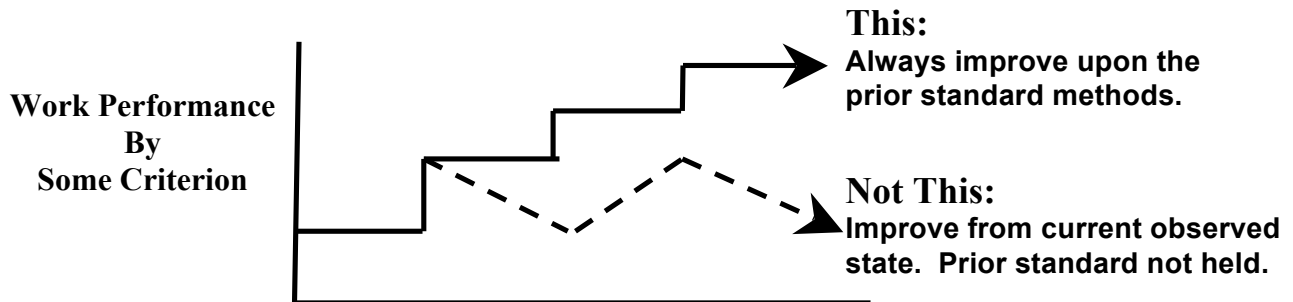
Decades ago, Toyota extended their learning systems into relationships with their key suppliers. Uncomprehending Westerners copied it as “supply chain management.”

Figure 3. Overview of Toyota Standardized Work

Quick Definition: Routine process improvement by all workers who actually do the work. All help develop new methods; so that all understand them, are able to do them and, as a team, integrate the flow of work.

Criteria for Designing Work: Greatest overall efficiency (not local optimizations) evaluating, in priority order: safety, quality, waste (cost), quantity, flexibility, and visibility.

Objective: Once an existing method is documented as standard, develop new methods to improve upon it. Each new standard method should clearly be “better” than the prior one.



How To:

1. Observe the current state (method) carefully; document it as the base standard. *Hold* this standard method until a better one is established.
2. Gather ideas for improvement; ask 5 whys, do PDCA, etc.
3. Design a proposed method. Check it by doing. Document it as operator instructions useful for learning and holding the new standard. Train others how to do it.

When: Whenever takt time changes (schedule), or when production volumes, mixes, or engineering design change the work. Or any time ideas for improvement present a significant opportunity.

Toyota thinking is so counterintuitive that investors have never understood it, and a Western consultant can make a living on just a few of the differences (see Figure 4). One of the most vital ones is resisting the egotistic complacency that usually ensues from making a lot of money; it distorts objectivity, weakens respect for people, and relaxes alertness. Nonetheless, like all organizations, Toyota has problems. It expanded faster than the mentoring system sustaining the Toyota Way could keep up. De facto, Toyota slipped into favoring quantity growth over preservation of quality processes, a victim of its own success and huge cash hoard.

And although it pioneered hybrid vehicles, Toyota is still motivated to achieve success in the expansionist economy. It has barely begun to address the challenges of Compression. Vigorous learning enterprises can learn a lot from Toyota, but it is not enough.

Figure 4. **Counterintuitive Concepts from the Toyota Way**

Financially-Driven Business	The Toyota Way
Profit and growth are the primary goals.	Survival is primary; profits let you survive.
A company is primarily a financial entity.	A company is primarily people.
Develop a few people as leaders. Train non-management workers.	Regard <i>all</i> employees as professional. Develop all of them to their maximum capability.
Leaders design and direct work processes.	Leaders primarily develop people.
Managerial status depends on results.	Managerial status depends on developing people.
Quality is a trade off.	Quality always comes first (after safety).
Success is monetary. Enjoy success; milk a cash cow.	Never become complacent, accepting the status quo. Always strive for perfection.
Make money from assets: business models, brand images, patents, software, etc.	For "capital avoidance," develop people to "do-it-yourself." Ingenuity before investment.
Top down communication dominates. Most action is directed; supervisors or managers deliver many action messages.	Much horizontal communication expected. Many action messages from the process itself. Routine operations "run themselves."
Motivate people with financial goals and performance measures.	Develop people to improve processes. Lead their development by mentoring.
Assume employee turnover. Hire talent as needed. If profitability is threatened, all employees are vulnerable to dismissal.	Assumption of low turnover employees. Try to keep margins high to preclude dismissals in downturns.
All process changes should be cost-justified by an accounting model.	Make physical processes broadly visible. Improve physical performance.
Limit access to data without a need to know.	Most company data is open.
Guide improvement by financial thinking.	Guide improvement by scientific thinking applied to real processes (like PDCA).
Improve my personal work or improve my department's work. (Limited process view)	Improve the work as everyone sees it. (Broad process view.)
Improvement is primarily by technology.	Simplify processes first; then use technology wherever and however it is helpful.
Maximize revenue; minimize expense.	Minimize process waste.
Maximize return on capital or RONA.	Minimize the need for capital with flexibility.
Capture economies of scale.	Capture economies of time and energy.
We do most things right.	Respond to negative feedback immediately.
React to problems when necessary.	Anticipate problems whenever possible.
Managers and staff plan; workers execute it.	Everyone participates in work planning.
Do the work to the best of your ability, but keep going.	Always think about correction or improvement. When something is wrong, stop work to think.

5. Learning to Learn

People and companies that just want to do what they do, hoping to hang on to what they've got, can't cope with Compression. That's why individuals and organizations learning to learn more quickly is the most significant issue of our time.

As individuals we learn in many different ways. We usually think of learning in a classroom; mostly linguistic and logical-mathematical skills, but learning has other dimensions too, like musical, hand-eye, spatial, athletic, and emotional. And learning to see ourselves somewhat as others see us is critical to functioning as an adult respecting others in collective learning situations. Although tough to measure, "political" gaming and clashing motives have to be among the biggest wastes hindering performance in every human organization from kindergarten to senior citizen centers. To create vigorous learning organizations – to do it all – we have to learn on every dimension.

Start with what humans are that they might learn anything. We're bipeds with hands that can manipulate things that most animals can't, but the human body is also physically less robust than other mammals the same size because it has to support an oversized brain. This unique apparatus is the center of our individual learning. Neural pathways connect it to our sensory organs, which are nothing special compared with many animals.

Brains learn by comparing new sensory experiences with a stored history of similar experiences in neural patterns sometimes called engrams. New experiences are examined to see if they fit the established pattern; if not, brains decide whether to adjust the pattern to help predict something deemed important. Adult learning consists of modifying old engrams to greater or lesser degrees. Psychologically, most of the time we expect our ability to predict to always get better. Accepting that one was "totally wrong" devastates one's ego; it's humiliating. Consequently, adults slowly shift engrams to learn something totally different. This has been described in four tongue-in-cheek stages:

1. This is worthless nonsense!
2. This is an interesting, but perverse point of view.
3. This is true, but quite unimportant.
4. I always said so!

This neural learning mechanism lets us imagine activity that fits the pattern. Engrams fill in something is missing from an observed pattern. Or it lets us mix and modify patterns to imagine something different, and plan how to make something innovative happen. But the same mechanism can deceive us into thinking that something has happened that did not, and vice versa, like magicians' tricks. And it can deceive us into thinking that events *must* unfold according to our stored engrams, thus "addicting" us to an ideology.

Our powers of observation are limited. Our eyes detect only four percent of the total electromagnetic spectrum, from a limited field of vision. The brain has to tell the eyes what to focus on. It is easily distracted. TV commercials as well as magicians take advantage of that.

The human brain and its learning mechanisms evolved for our survival in a world full of enemies. Some were natural; others were humans from other tribes. Learning to take a much bigger, more observant, and more rational view to cope with Compression is not a challenge to be underestimated. Fossilized engrams encase us in our past.

In addition, much of our sensory perception and learning in the industrial world is “hyper rational.” That is, it is sensed indirectly by instruments and converted to something we can perceive. It’s not sensed directly, like a swift kick to our personal butt. Examples are almost all observations on genetics or astronomy – and company financial statements and the symbols on the computer screens of financial traders.

To retain quality of life while coping with Compression, we would like people in working organizations to “see” an integrated world from at least the three different model maps in Figure 2. Given the engram learning mechanism we work with, this is tough to master. It helps to have a humble attitude, to *want* to learn.

Rationality and Its Limits

Everything we know is a mental map of prior experience. One body of thought holds that this means that there is no such thing as a fact; it’s just how another human’s engram happens to encode something. Therefore no such thing as science based on fact really exists; one person’s observations and opinions are as good as another’s. Unfortunately that leaves us no way to learn anything that everyone can agree on. Fortunately, in practice most of us recognize that physical reality does exist outside human perception of it. The consequences of stepping in front of a speeding beer truck are highly predictable.

The opposite of this is thinking that how the world works is immutable, so engrams, once fixed, never have to change. The classic example of this was the medieval inquisition that condemned any learning deemed contrary to ancient wisdom. A less cruel version of it is rational determinism, holding that knowledge can stack up like a brick wall, so once science proves the existence of a brick, plunk it on the knowledge wall, keep stacking and we can know everything. That concept of science inspired Sir Frances Bacon, best known for making the scientific method popular among the literate folk of his day, only Bacon stacked axioms, not bricks.

In the scientific community, hope that rational determinism would prove valid persisted into the 20th century. Mathematicians labored to create a “theory of everything” based on mathematical axioms, an interlocking logical construct explaining everything, much like Isaac Newton’s earlier compilation of a “principia” of Newtonian mechanics. In 1931, Kurt Gödel deflated the rationalists’ ambition using their own logic by proving that:

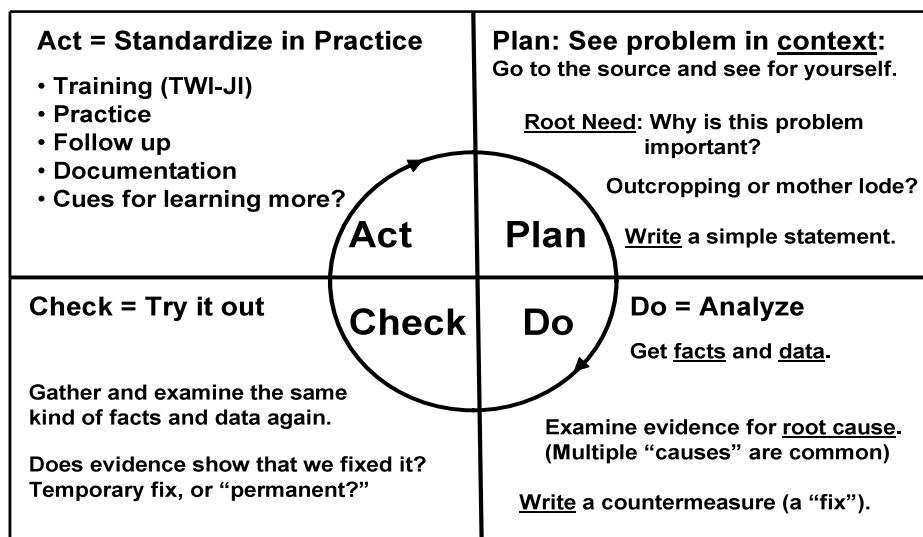
“To any system of formal arithmetic a proposition can be put that cannot be formally proved or disproved within the system.” Why? Because any system, or model, is either internally inconsistent or it is incomplete. The proof covered all systems and all models.

Gödel’s party-pooper is unknown to most 21st century knowledge workers, but it is significant to their work. From engineering to e-commerce, much human activity uses models. A company’s statement of accounts is a model. All cost systems are models. Most products are designed using computer models. Cars, airplanes, heating systems – anything with digital logic in it – runs on a model. When we see a video, we see not the real thing, but a representation of it, and digital images are now so easy to “photoshop” that seeing is no longer believing. Even the images stored in our own neural engrams are models, not real. In a world in which learning depends on hyper rational models, we can add their limitations to a lengthy list of other human limitations.

So how can we ever agree on anything? We can’t if we can never agree on the facts of a matter. The scientific method is a way to agree on facts and on interpretations of them. Science is a predictive discipline based on empirically falsifiable facts. No finding is absolute and final. The same facts and data may have contending explanations. Later evidence may prove that earlier observations were incorrect or incomplete, or that a better explanation (model) for the facts is possible. Extraordinary claims (needing a big engram shift) require extraordinary proof. Agreement on a model as explaining the same facts is scientific concurrence. Without this, models remain only theories no matter how quantitatively impressive. And with no supporting evidence they are only conjectures.

This is far from easy for those skilled in the method and really trying. Partly because of our engram learning, few of us understand the rules for learning this way. If we are motivated by monetary reward and money is at stake, scientific impartiality is easily bent. If a discovery favors a vested interest it is a “new marvel;” if not, it’s “junk science.”

Figure 5. **Brief, But Rigorous Version of Deming Circle Problem Solving**



The first time around the circle, start with the upper right quadrant, PLAN, and work your way around. Once an accepted countermeasure is standardized in practice with ACT, start again with PLAN. This format is enigmatic at first, but that has a benefit: anyone seriously using it to guide thought has to think it through. It’s not a cookie-cutter formula. It’s a guide for learning how to approach any problem scientifically, and learning how to do that is done only by practice, like learning to do anything else.

A number of problem-solving templates based on the scientific method have appeared in the last few years. Work organizations use them to solve operational problems from strategic planning to location of pallets. Probably the oldest of these is the Deming Circle shown in Figure 5. It's one of the least self-explanatory, but all such templates are self-similar because all are based on scientific reasoning. Learn one, and it's easy to switch to another. However, all personnel in a specific organization should hang their problem-solving logic on the same scaffold; makes communication easier.

None of these structural guides work magic. Like all learning guides, they're only good if used. And when actually applying PDCA in an organization, one also has to learn the behavior to solve problems collectively. That's done practicing the skills necessary to show respect for people, that pillar of the Toyota Way. One must also learn to patiently dig through a problem to root cause; then document and standardize. In addition to system structure, this human development is necessary to create fast, routine learning that is just part of everyone's work, not a sporadic process exercised by only a few people. *And this is largely what distinguishes Toyota from most of its imitators.*

Process Learning

“Process” means about the same thing as “system.” It's a combination of small steps and feedback loops by which anything is done. Bill paying is a wholly-human process. Beer making is a natural process that humans control. Photosynthesis is a wholly natural process that usually happens without any human intervention.

A process is as big or small as you define it. Flow diagrams and other hyper rational aids help humans conceptualize processes that they can't sense directly, or grasp all at once.

So what is process learning? It takes place in several senses:

1. Improving human understanding of how any process works.
2. Making an existing process more effective for human purposes.
3. Creating new processes to benefit humans.
4. Improving human intervention to shape natural processes more favorably to humans.

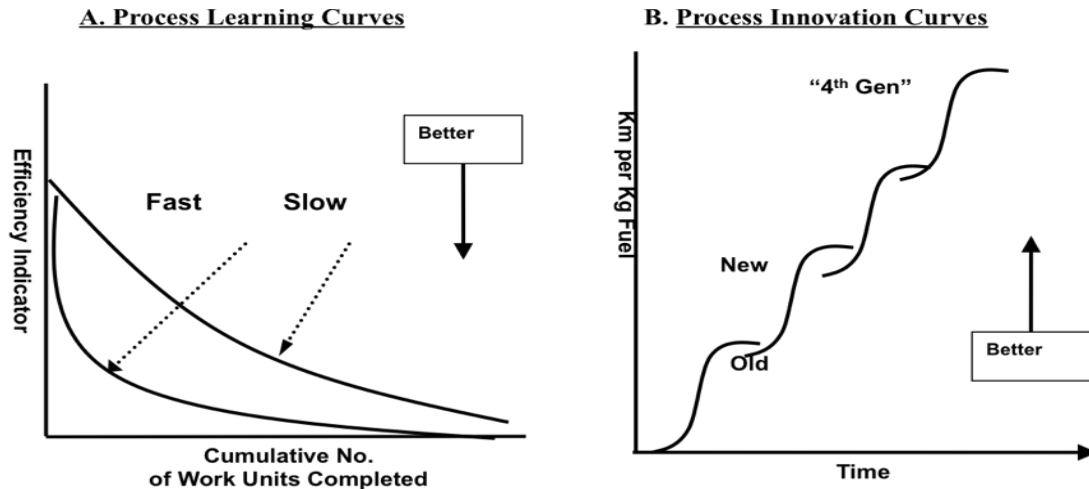
Almost any action to understand or improve a process can be thought of as a set of problems to solve. Thus process learning is intertwined with problem solving.

There's a lot to learn about even prosaic, everyday phenomena. An example is the unusual chemical and physical properties of water. We may yet discover that it has uses so far untapped. And almost all biology is water-based chemistry in which the roles of water as a medium are still mysterious.

The *results* of process improvement are graphically depicted in Figure 6-A, the classic log-log graph of a learning curve. It was devised for aircraft engine production prior to World War II. However, speakers often use the phrase “learning curve” loosely without

knowing this curve. Some improvement takes place just by skill improvement and reduction of rework. It goes faster if a company structures a process improvement program, but most programs foster irregular, episodic improvements anyway. Few build process learning into regular work routines like Toyota.

Figure 6. **Graphic Models of Process Improvement**



(A) Process Learning Curves follow a power function to graph process improvement by some criterion, often work-time per unit or cost per unit. The horizontal axis is not time, but the cumulative number of work units completed. Improvement decreases by a constant percentage each time the cumulative number of completions doubles., so unit-to-unit improvement is much greater at the start than later and the curve gradually flattens out.

(B) Process Innovation Curves are “Gompertz Curves” depicting innovative changes – resetting processes from a different. In this case the Y axis is labeled with a design criterion for the product being developed, for example fuel economy, as for an engine or a total vehicle package.

Learning curves show only one criterion of performance, but process improvement should be multi-factor, not a trade-off. Using cost as a criterion does not assure this. Non-cost factors such as quality, lead time, or delivery may deteriorate. The two curves in Figure 6A illustrate the difference between aggressive, structured improvement and piecemeal efforts. These curves only summarize improvements; they don't suggest *how* to improve anything. However, learning curves follow a power function. Those also characterize many other phenomena, like language, that we associate with “intelligence.”

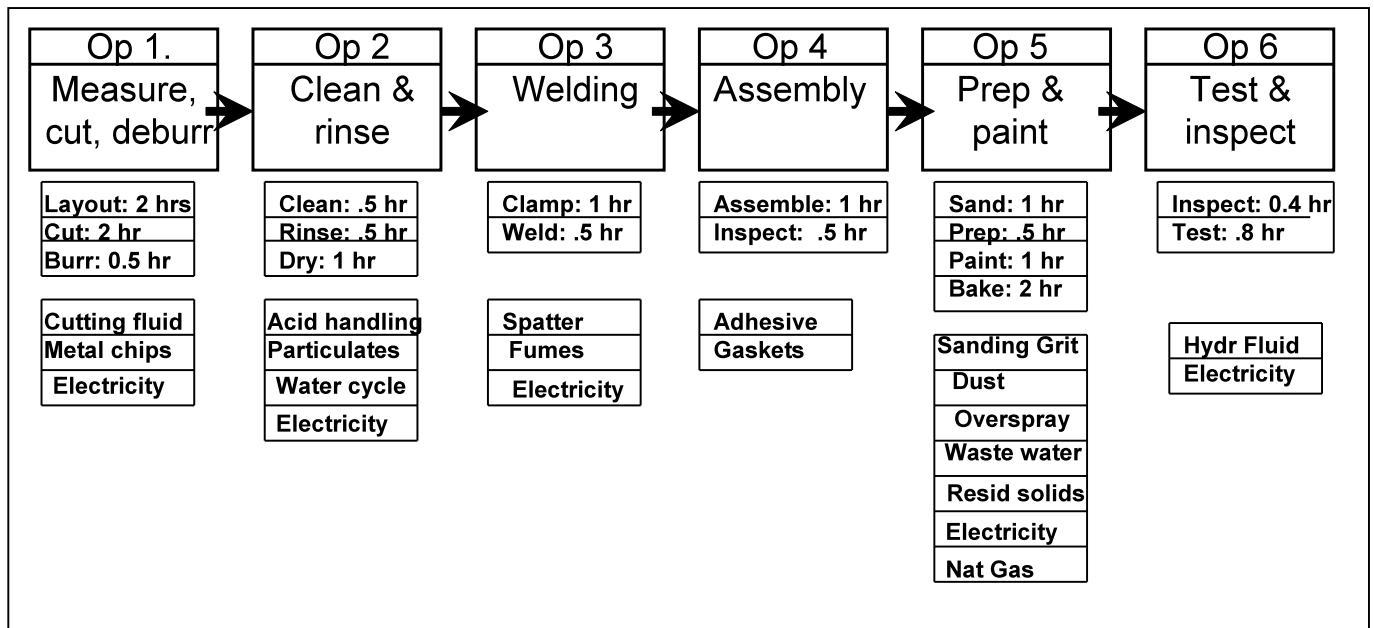
Existing processes approach limits of improvement. Little improvements continue; offsetting slippage, but dramatic improvement tails off. To do better we need innovative thinking to create work processes using different basic product designs, process principles, and technology. That may not be enough. We need different “business models,” for example, one in which a manufacturer’s products are returned for refurbishment, re-manufacturing, or recycling. Indeed, one may question whether the entire outcome of work processes is actually a waste of resources, and if they do serve important social needs, perhaps they can be met by less wasteful means.

The how-to dealing with *Compression* is detailed, wide in scope, and radically different, which is why decentralized work organizations need to deal with it. However, even when highly motivated, real people can't quickly master a very different concept of work with everyone assuming more responsibility for better outcomes with no waste.

So where to start? Create self-coaching methods in a system of learning embedded in the work itself, not something separate. Four-step Job Instruction (from TWI) is a perfect example, and so is Toyota's TPS if it is deployed for that purpose. Behavior doesn't change by preaching about it in a work environment in which the same old things are done the same old way. Alter behavioral engrams by learning different work regimens that encourage behaving differently. Engrams revise themselves through repetition.

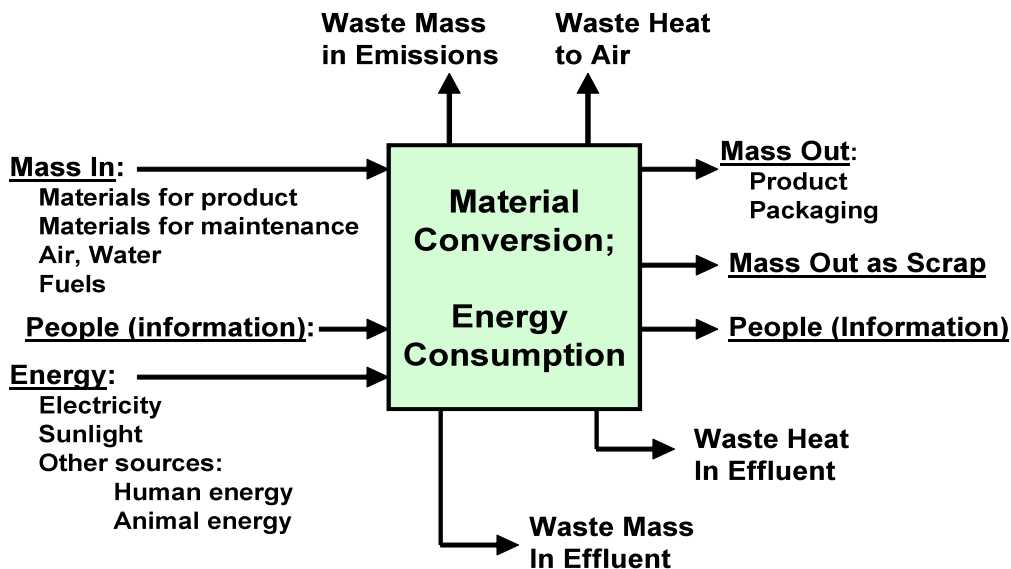
To begin creating a vigorous learning organization that can deal with *Compression*, it's easier to start from what people already know. Many of us know how to diagram an overall process with a flow chart, or Value Stream Map, or we can learn how quickly. With minimal learning about resource waste and environmental problems, we can note obvious opportunities on the chart, as in Figure 7. Actually doing something about them is a different matter. Some are easy fixes; others are not.

Figure 7. Simplified Value Stream Map with Environmental Issues Added



This simplified Value Stream Map (VSM) doesn't even show inventories, but it illustrates going beyond the classic seven wastes by adding notes on environmental wastes and hazards that can be addressed. It shows metal working, not carpet manufacture. The notes on the VSM may prompt some obvious remedial actions, but to really dig in, one needs to create a block flow diagram for each operation and do a quantitative mass-energy balance. Of course, one can do a block diagram and mass-energy balance for all six operations together, or for a bigger system than this, or for some sub-part of any of the six operations.

Figure 8. **Diagram of a Mass-Energy Balance**



An input-output diagram like the one above requires defining the boundary of a system; then measuring everything going in or out of that boundary. Outputs must equal inputs. The boundaries do not have to be walls. Mass-energy balances have been done for ecological areas not bounded by a fence, and this works as long as one can estimate the flows across those boundaries. The diagram above presumes a factory converting material into any kind of product, but physical input-output analysis can be applied to any area around which a boundary can be defined: sales offices, call centers, IT centers, clinics, police stations, airports – even human bodies when studying dietary and medicinal effects. And a mass-energy balance can be applied to processes over a long period of time, as with life-cycle analysis.

Except in chemical plants, few commercial systems now do this. If chemical changes and material phase changes alter the properties of material coming out and going in, analysis may “get technical.” However, most work organizations need to undertake a simple form of this analysis to clearly understand what we take from nature and what we discharge to it. (Adapted from diagrams by Dave Gustashaw, Interface Inc.)

Running water needlessly or pouring toxic chemicals down a sewer can be corrected with little analysis, but a much broader view takes a thermodynamic analysis of processes as shown in Figure 8. Few of us are familiar with thermodynamics, but in Compression, many more of us should learn a few basics about it.

The two main difficulties actually applying a mass-energy balance is first is drawing a boundary around a system; and second, gathering data. To learn how to do this, start with a modest system where data seem available, drawing a boundary around a small factory, warehouse, or office. Then measure everything coming in and going out using physical measures. This will be frustrating enough the first time.

Using cost is tempting. Economically we measure “everything” that way. An estimate of electrical energy may come from a bill, but use kilowatt hours, not dollars; measure fuel use in BTU or joules, mass in pounds or kilograms, etc., like an engineer. For practical use, these measures are constant world-wide. Costs vary place to place and over time.

Look at all mass and energy in and out; all water used, for instance, whether metered for cost or not. If possible, measure these, but rough estimates are sometimes all one can do: better to measure everything approximately than only a few things precisely.

After learning how to do a mass-energy balance of one operating site, including how to get data, one can try one for a collection of sites – a company. Doing so uses physical measurements across the same boundaries as the financial statements. Measurements from separate sites can be consolidated into one for a “company” by allowing for outputs from one being inputs to others. Then try drawing a bigger system boundary covering the entire life cycle of a product or service, in space and in time. That takes in a complete supply chain or network, inbound, outbound, and round-and-round. At present this usually bogs down in data deficiencies. We know too little of the processes outside a company. We have difficulty even knowing the thermodynamic history of a plastic carton, or the chemical releases that may be associated with its production.

We must analyze qualitatively as well as quantitatively. What chemicals or other agents were formulated and possibly released to the environment in a particular product or service’s “thermodynamic history.” For example, does the process require hexavalent chromium (a carcinogen) or a halocarbon that is far more potent greenhouse gas than CO₂? What wastes and hazards are entailed in the use, maintenance, and end-of-life disposal (or refurbishment) of the product?

Gathering this data requires more process disclosure than many private companies (suppliers) are now willing to divulge. They fear revealing competitive secrets; maybe lawsuits too; or being open to public defamation. On the other hand disclosure may prompt some to take action because they never before paid attention.) One solution is to create open access data banks where such data is gathered and kept anonymous by trusted third parties. An example is a project being headed by Dr. Manish Mehta of the National Center for the Manufacturing Sciences that will enable product designers to develop rough “baseline” estimates, but substantive progress coping with Compression depends on learning much more to actually design very differently.

Both the “lean” view of waste and the thermodynamic view of efficiency greatly differ from a view based on cost. It’s easy to believe that if a company is making money it must be efficient. Making money in financial competition is not easy, but doing so is no indicator that an operation is thermodynamically efficient if customers pay for the waste. For example, a recreational drug dealer need not be efficient to make a pile of money.

On the other hand, efficiency of a physical process can be measured using only its physical attributes: mass, space, time, energy, and material conversion. To advance our quality of life in Compression, physical efficiency and toxic fallout from human-made

systems is what counts, not money. Thermodynamic efficiency of a process is usable output compared with all its inputs, whether paid for like electricity, or not paid for, like air. This is so different from currency-based economics that it deserves a different “process theory of value.” Financial systems or rewards only motivate human activity.

Organizational Learning

In Compression, the primary purpose of all work organizations essential for human welfare has to shift from “making money” to a social mission serving society. The goal has to be excellent performance of that mission while minimizing the use of resources to do it (socially subsidized if necessary, like with fire departments, in return for excellent performance). In order to meet the challenges of Compression, they have to transform into learning organizations much faster than human organizations ordinarily transform themselves. Some key points:

- Establish a social mission for the organization, including some shorter-term goals for better performing it. As leaders, involve people in developing mission and goals so that they also think through the “why;” they don’t just blindly comply.
- Start with an internal learning system, building rigorous learning structures and practices into the work itself, starting from whatever exists. Introduce a scientific framework of thought like PDCA, if it’s not already in place. If one is, stimulate everyone to use it rigorously, practicing problem solving regularly – by a schedule – and documenting solutions in a standard format until it becomes a “language” at work. Identify common “tools” that everyone uses. For broader, mushier issues, extend this framework so that people reach logical conclusions. (Something like a forward-looking After Action Review can do this.)
- Develop the behavioral side of this new working environment – rules of behavior for dialog that suppress “politics” and concentrate everyone’s energy on needs to be served and processes for serving them. Regard learning processes like any other work processes; strive to improve them, including the behavioral rules, so that people are conscious of this aspect of work. Lead by asking questions. Expect everyone to think and to become professional, both in attitude and in skill.
- Develop the visibility of work and work processes everywhere (including “knowledge work”) to prompt attention to problems. Coach people and teams to manage themselves. Open up systems, so that no secrets are kept from the core workforce, including financial information.
- Extend the learning system externally to customers, suppliers, available databases, etc. Expand the context for learning with environmental and thermodynamic education and information so that people have a basis for making decisions.
- Coach people in efficient communication, in meetings, by e-mail, and by using other media. Coach them in listening – in real dialog examining facts and testing logic -- not in contending for a “win.” Regard this as an initiative to civilize normal, tribal human behavior. Accomplishing this is obviously no small feat.

6. Out of Our Incompetence

Our economic systems based on expansion can't deal with Compression. Only a few of many reasons for this in Figure 9. The contrast between these assumptions and what we must begin doing very quickly is sharp. To avoid decades of thrashing, we need a firm idea of what we need to change, and how.

Figure 9. Assumptions Hidden in Expansionary Business Thinking

Assumption	Brief Description
Unlimited Growth	Long-term physical growth is impossible, but linear monetary models presume no limit to growth except market acceptance.
Economy of Scale	Organizations and processes that outgrow the size at which they are effective start to become dysfunctional. Bigger is not always better.
Short-Term Bias	By financial logic, money sooner is worth more than money later. For anything that won't materialize for 50 years, payoff is so near zero, why worry about consequences, environmental or otherwise?
Self-Deceptive Results Bias	Concentrate on outcomes that can be sold; they are the source of wealth. Be no more concerned than necessary about how these results come about, or any consequences they create.
Inflexibility	Inflexibility is rigid specialization, able to "do only one trick." If conditions change, you're sunk. For flexibility, an operation should have short lead times, fast feedback, versatility in both people and equipment – and fast learning capability.
Fragmentation -- Tribalism	Fragmented work organizations divided into parts are unable to communicate closely for complex, integrative work. These fragments may be independent companies or agencies, or they may be departments under one organizational name. If separate fragments "tribalize," they form greater affinity for their fragment than with a total enterprise and its larger mission.
Unable to Deal with Complexity	Unable to break organizational and systemic molds to form teams able to deal with complex issues or designs quickly.
Complacency and Panic	The feeling that if profits are high, everything must be going well; relax; enjoy it; brag. But if losing money, panic. This contrasts with meticulous attention to a mission at all times.
Self-Destructiveness	In business this is the commodity trap, competing on low margin with a high breakeven. When growth reverses, companies race into mediocrity, poorly serving all stakeholders while shrinking.
Market rationality	Assuming that "fragments" profitably meeting a market test is proof of effectiveness, when buy-sell decisions are obviously influenced by emotion. In addition, when supply can't increase at any price, as with peak oil, a conventional market no longer exists.
Hyper Rational Models and Reality	Temptation to depend on hyper rational models without learning how to validate how well they describe reality.
Ownership dominance	Assuming that the main purpose of a work organization is to make a return on capital invested by the owner. Therefore owners should have ultimate control, with manager agents controlling operations primarily in ownership's interest; it's their fiduciary duty.
Lack of a Common "Problem Language"	Without a system to quickly resolve differences based on facts, human energy is wasted on emotion instead of learning.

Any system resembling an industrial economy can't work without markets and transactions. However, many decisions are too important to be trapped in competitive business thought; hence regulations. Thoughtful business leaders know that basing decisions only on financial calculus is inadequate, and perhaps destructive, but obeisance to financial rituals often truncates broader vision. Immediate financial peril is more urgent than long-term physical peril. "Lean" companies struggle to demonstrate that process improvement has more benefit than cost slashing. "Green" companies struggle to factor external costs into their financial frameworks to assure themselves that becoming environmentally sustainable will not bankrupt them. Budgetary and financial reporting boundaries help fragment people into competing groups when they need to closely collaborate integrate complex product designs. Leaders sense that better is needed, but pervasive "money-think" infects thinking in ways unseen. Just becoming aware of a few of these assumptions starts moving our engrams out of this box.

Unlimited Growth: Shrinkage using natural resources is almost impossible to represent in financial statements or reconcile with market logic. Most business leaders' objective of the business is apt to be to "grow the business." Exactly what they mean by that is not always easy to discern – literal growth use of resources, dynamic innovation, fast response to change? Revenue growth with a fat margin is always a "happier problem."

This applies to both commodity and capital markets – indeed to entire economies. But when higher prices cannot produce a bigger supply, the basic assumption of a simple market is undercut. Those that have money can buy it all, and those without money can't buy any. That's a zero-sum world, a different game from expansion.

Economy of Scale: Linear projections with simple business models suggest that processes scale-up in nearly the same proportion until one reaches capacity. This begs the question, "What is capacity, the limit?" No tree grows to the moon because water can carry nutrient no higher than about 400 feet in a tree, the limit for even a Giant Redwood.

If business strategists regard a company as only a financial machine, it scales financially. If they regard it as organized human capability, size depends on human networks for communication and learning – and scaling of physical processes. Payback from the time invested in learning is difficult to project financially. The effects of quality, flexibility, innovation, and tight integration are only "assumed into" financial frameworks.

Economy of scale becomes more obvious in shrinkage than in growth. If shrinking companies follow financial logic, they "slash and burn." Costs regarded as fixed suddenly become variable. A high breakeven point makes profit vulnerable to small sales dips. When financial survival always has immediate, top priority, consideration of consequences to process integrity or stakeholder welfare takes a back seat. This instability masks the key question in Compression: For quality performance, what should be the size of a human learning organization addressing a key social need? As in microcircuits, smaller and faster and generating less waste heat is superior. Growth companies are really projects; many die stillborn while others last for centuries, but all eventually die or merge into something else.

During expansion, one theory was that money invested in longer-term development had interest rates closer to 2-3%, while 6-10% compounded became the long-term investment in stocks, a rapid growth assumption. Playing the system, borrowing money at 6% and investing it in stock at an 8-10% average return, generates money wealth through financial leverage, and plenty of people have astutely made money by this leveraging. This works only as long as investments hold their value – by the physical economy expanding to collateralize this financial swirl.

Short-Term Bias: Most executives bemoan quarterly earnings advisories pressuring them for short-term monetary results. They debate whether this is a disincentive to fund longer-term objectives. Wall Street values companies as “things” for trade; the value depends on the cash earnings from each of these “machines.” Reporting consistent earnings gains sustains investor confidence, so desire for consistent growth leads to accounting games to smooth earnings or defer losses – by shifting the timing of cost and income recognition. And that leads to spats over the financial accounting rules for the game.

But the roots of short-term bias run deeper than stock market expectations. Setting short-term budget goals are another version of it – and not just in for-profit business organizations. Did missing a budget projection (or expectation) show poor performance or an unrealistic plan? A financial projection is no better than the assumptions in its forecasts, and most budget systems are filled with opportunities to shift cost and blame. Despite all this, leaders do rise above the game playing to develop people, and to invest in programs that won't pay off for decades. However, preparing for big future challenges is inhibited if leaders must fixate on showing a payoff doing what they do now.

Self-Deception of Models: Much of our work now depends on hyper rational models. The flaws in many are not hard to spot if we are dispassionate about them. Accounting systems are also models, and when our rewards systems are based on them, it may be more difficult to recognize how they distort perception. Since anything not transacted is not in an accounting model, it doesn't capture use of “free” natural resources. In addition, accrual accounting distorts the financial effects of process changes. For instance, if cutting output to shrink inventories does not absorb planned overhead, the variance may actually show a loss even though the cash position improves. Such distortions have provoked a “lean accounting” movement.

Transactional thinking multiplies everything by a cost or price value, painting everything with the same currency brush. This mentally converts them all into objects for trading, which has advantages, but with the hazard of obscuring the interrelations and feedbacks in operating processes or in human relations; out of the model; out-of-mind. To be considered, they must be separately analyzed and factored back into a financial model.

Demanding results according to accounting and financial models compounds the distortion. In the complex world of Compression, such narrowly focused systems are dysfunctional – perhaps even incompetent, like a two-year old child squalling for a whim, oblivious to the processes needed to fulfill them, or of undesirable consequences.

Market Rationality: In Compression, supplies of petroleum, water, fish, and other commodities may be impossible to expand just because prices go higher. In some cases, substitutes may be found; in others an allocation system other than a market will be necessary – rationing either by a marketing mechanism (like cap and trade) or by social custom, like the ancient doctrine of allocating water by customary need and usage in areas where water is short.

Another shaky premise of market rationality is that buyers and sellers have equal information, or at least the opportunity to obtain equal information. Economic researchers know this does not hold, and it is obvious to everyone purchasing complex goods or services. One can't anticipate how every provision of an insurance contract, or maintenance agreement, or software package will work in practice. As with medical diagnosis and treatment, we are buying professional care and competence to serve our welfare better than we can serve it ourselves. Likewise with many other purchases, we are really buying the competence and integrity of a total supplying work enterprise.

Market rationality completely breaks down when buying or selling complex products and services between work organizations, as for example designing software, computer circuits, or vehicles. Getting three bids and taking the lowest doesn't work. Much more information than that has to be exchanged, and furthermore, the real work is solving problems. If it makes it easier, think of this as a competence market with dense exchange of information because confidence in the technical competence and performance integrity of other work groups is not established by a price bidding process.

Ownership Dominance: The received wisdom is that those who put up the money should call the shots, especially in a pinch – ergo the main purpose of a business organization should be to provide a return to owners. This simplifies making decisions, but an organization that poorly serves other stakeholders, especially customers, poorly serves ownership too. For small businesses non-essential for human welfare, market discipline of managerial competence is sufficient. But for any operation on which we all depend, there is no true private ownership. For example, customers utterly dependent on a water company have much more at stake than remote stockholders, despite corporate directors' fiduciary duty to investors. If considering proposals to be bought, and they reject a high bid, the burden of proof is on them to show that the consequences to other stakeholders are unacceptable. And as the bail out of Fannie Mae and Freddy Mac show, when an enterprise important to everyone is failing, no matter what errors were made, everyone (acting as a government) has to step in. When its actions are vital to everyone, no "private enterprise" remains strictly private.

To exercise fiduciary duty to owners, managers need some degree of financial control. In addition, people naturally have an urge to be "in control" of anything important to them. Nature forms hierarchies. Animals do. Humans do. In many situations it is obviously necessary. For example, a ship's captain must issue orders without waiting until everyone comprehends the situation and agrees on action. But managers can't assume control of matters without limiting the judgment of those doing the work.

When things get complicated, managers overload with information. Decision support systems help, but don't increase human information processing speeds. Micro-managers become bottlenecks, so leaders have to delegate responsibility – to people that will “take ownership.” But in turn, are capital markets (or bank covenants) really an impersonal emperor to distant CEOs and CFOs, expecting them to control everything to maximize benefit to them? To assure this, boards want managers to have “skin in the game,” just as venture capitalists funding entrepreneurs want them to have “skin in the game.”

Today, a company need not be gargantuan to be globally financed and have global operations. In each locality in which it operates, people depend on its jobs and money. If its services are crucial to a community's quality of life, its performance of its mission affects *everyone* there, and depending on its environmental performance, it may affect everyone on earth. If so, everyone is a stakeholder in a company, but everyone cannot participate in its governance. If leaders take this seriously, financial viability is merely a necessity to fulfill its mission to *all* stakeholders – which may be all humanity.

For example, any dedicated, veteran worker who has staked her retirement and health plan on a company has invested markers of value into these plans (or had them invested for her), usually through the capital markets. In an industrial society, informal social compacts (kith and kin will care for you if you can't do it yourself) must be augmented with technical processes and formal contracts. Kith and kin may care about you, but they seldom interpret DNA profiles or perform colonoscopies.

We can't let mission-critical work organizations fail, financially or otherwise. For example, we want a fire department to perform to perfection when needed, but we don't want to be an emergency customer, and we don't want fire-fighting to be a growth industry. However, we don't sustain a fire organization in a peak state of readiness if we limit its funds and attention to fire prevention. We're annoyed when fire drills or other prevention measures interrupt other activity. Fire service and fire prevention is a common obligation, easy to neglect, so we drift into our “target risk” zone, taking our chances, assuming that with minimal care, fires won't happen. That's classic quantity-over-quality reasoning, and it appears to be instinctive.

Fragmentation – Tribalism: Fragmenting into tribes appears to be another human instinct. We simply can't form a working affinity with everyone. Many working organizational practices subtly reinforce this: transactional boundaries between companies, intellectual property, budget allocations, and the like. If divided into “functional silo” departments, an organization fosters allegiance to departments that is stronger than that to the whole. Concern for the welfare of others, including customers, may suffer. In isolation, a work group not only is cut off from information, but is emotionally self-centered too.

Isolation may have advantages, like Toyota developing TPS away from pressure to conform to business concepts prevailing elsewhere. However, it's more common for innovation to emerge from a confluence of new ideas from many different directions.

Dysfunctional tribalism inhibits full, open communication between customer and supplier companies. For example, fear of losing “intellectual property” truncates communication needed to both innovate and integrate the design of a vehicle, while today the design of all components must complement each other. A collection of parts hung on a common chassis can’t achieve the necessary vehicle performance. However, this assumption is embedded in the reward system based on purchase price variance for purchasing agents negotiating supplier contracts, but collective learning is more vital to success. For instance, Chrysler once formed suppliers into a “virtual design company” to develop the instrument panel for a new vehicle. All participants “took off their company hats and donned the virtual company one.” This design team was a big success, but so far as is known, never repeated. It violated the instincts of independent, competing companies.

Trust in working relationships is hard to create and easy to undo. Teams must sustain the level of trust needed to share innovative ideas and admit mistakes. To do it, they must surmount the tribal instinct to show loyalty by everyone covering for each other’s mistakes, especially if they fear the wrath of bosses or public opprobrium. Unless this fear is dispelled, police departments observe their “blue code of silence,” the Sicilian Mafia, their omerta. Just being a close-knit group is not enough.

Any work organization resembling a vigorous learning enterprise depends on trust – trust in the professionalism of others to seek and abide by facts and data, wherever they may be, no matter what their ethnicity or religion. If wariness of outsiders or fear of tribal retribution trumps seeking facts, learning is stifled. Anyone seriously questioning a process is ostracized as a “whistleblower.” Leaders don’t have to exile them. Loyal tribalists banish whistleblowers from their midst.

This tribal instinct still pervades both for-profit and non-profit work organizations of the 21st century. Jeffrey Wigand is a well-known whistleblower, which is rare. He “ratted on” the tobacco industry as told in the movie, *The Insider*. Most whistleblowers are ostracized, banished, and warned not to speak out. If they go public, employers not only fire whistleblowers, they blacklist them to all society, especially media. *Anything* they say or do must be discredited. Right or wrong, sane or not, many whistleblowers, disowned even by their families, are consigned to a lonely existence in a land of the living dead. Very few would do it again. A vigorous learning enterprise has to preclude this insanity.

Historically tribal cultures were reinforced by myths and storytelling. Public Relations, or PR, uses technology in almost the same way to influence public perceptions. A science underlies it, a science of manipulating engram shifting, independent of facts, but paradoxically, PR can promote anything, including problem solving by seeking facts. It’s not intrinsically anti-learning unless used with the intent of discrediting knowledge based on substantial evidence – or to distract attention from non-performance. Promotional messages tap into emotion, and self-interest and tribal loyalty are easy to draw on for this. Ads not limited to facts transform into infomercials and product placement. The intent of PR is action favorable to its sponsor, so of course it is a staple of political lobbying.

When acted upon, whatever people come to believe, even if utterly false, translates to factual behavior. Appeals to fear are easy (“Don’t let them take away ---”). Hot deals are tantalizing (“No money down ---”). But when the intent is merely a “win” by a PR client, it plays on tribal divisiveness, obfuscating facts and slowing public learning. If the leaders promoting duplicitous PR begin to believe their own baloney, they become victims of their own high-tech ignorance system.

To deal with Compression, we must offset the tribalism that promotes dysfunctional competition. Leaders whose primary ambition is alpha-level control of their own tribe (department, company, industry, community) may never see beyond its narrow win/lose interests. The rules of market-based competition don’t help this.

Spacecraft Economics

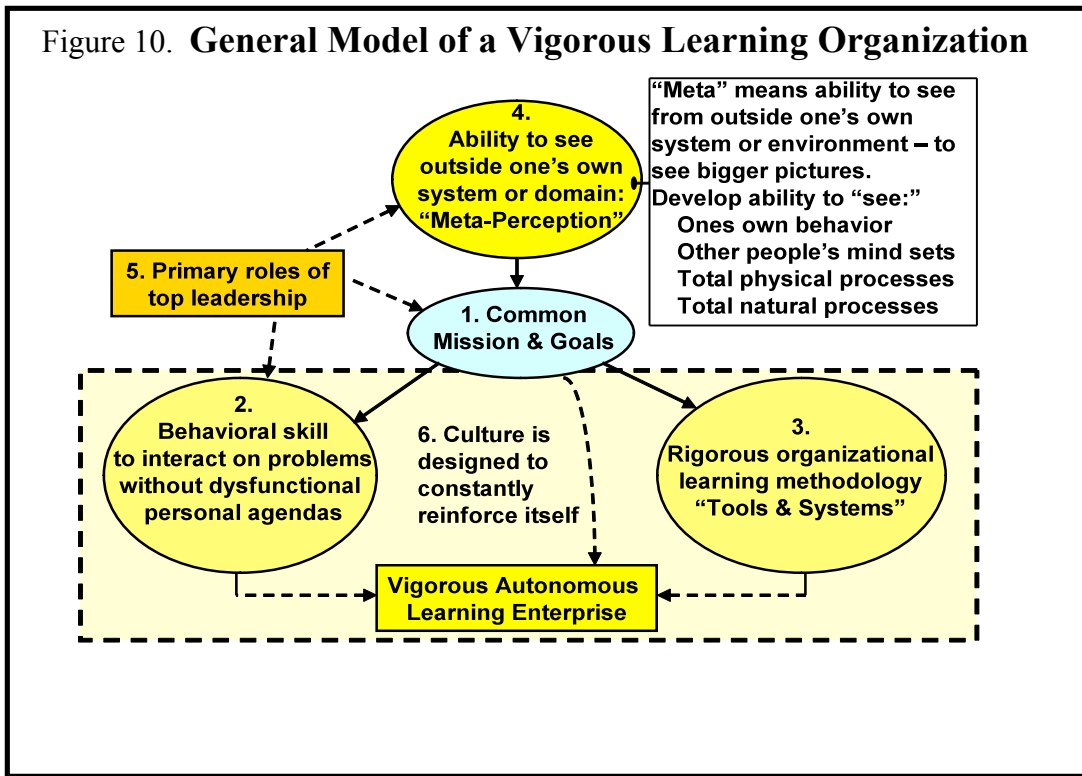
If global resources are acknowledged to be finite, we will have to shuck economic rules that unconsciously assume unlimited expansion. An extreme example to illustrate this is a “permanent, sovereign” colony in outer space. If utterly dependent on itself to survive, it is *not* a short-term space colony resupplied from earth. Remote in space, far from the solar system, humans would need to replicate every detail of earth’s ecosphere necessary for their own survival. Their perils can scarce be exaggerated: weightlessness, radiation flares, obtaining energy, fabricating exotic materials able to protect them – plus assuring supplies of food and water. They also need psychological stamina to endure indefinitely in a small environment (10-20,000 people). This is not trivial. Small groups confined for long periods are known to get testy with each other. And the population would have to limit its size by managing its gene pool to counter inbreeding (using genetic engineering, social customs) in order to literally design their own heritage. Controversial topic anyone?

Present knowledge is insufficient to imagine this in great detail. The sovereignty would have to shepherd a replica of earth’s ecosphere, many of whose processes remain unknown, while few of those known are understood in depth. Cosmic citizens would have to milk external energy from the universe, protect themselves from fatal radiation, and distribute this energy through all the molecular-scale gradients necessary to sustain carbon-based life, maintaining a livable balance of oxygen, nutrients, water, gravitational pull, and other detailed necessities. No corporate control system or transactional market system could do this. A master brain (like HAL) can’t centrally control anything this complex. Like a human brain scaled up too big, the dense feedback traffic required would choke it. This system would have to be largely self-regulating. Human life would be symbiotic with whatever life support system could be “nurtured.” Carefully tending this system would take constant vigilance – and readiness to meet any kind of threat.

In this setting what would private property be: some tools, personal care items, and a share of quarters? Would “ownership” actually mean primary responsibility for a part of operations, with an obligation to pass them on in better shape than they were found? Life and social status would depend more on what people *do*, and help others learn to do, than to how much they *own*.

7. Vigorous Learning Enterprises

To cope with *Compression*, we must escape the self-limiting incompetence of expansion era work organizations. Proposed to do that are “vigorous learning enterprises.” To meet all the challenges, these must be capable of recognizing the challenges in Figure 1 (p.4), seeing more than one “map” of how the world works, as in Figure 2 (p.17), make process improvement routine, as in Figure 3 (p. 21), and make their operations much more symbiotic with nature, as in Figures 7 and 8 (pp. 28-29).



Much is implied in this figure. Key points are:

1. Everyone, especially top leaders, needs to “see” situations beyond the core work organization and even beyond all the stakeholders comprising its total enterprise. Vision must penetrate the fog of financial representations, systemic rules, and even the “value streams” addressed by lean operations.
2. The organization needs *both* A) A rigorous, disciplined learning system (tools, techniques, methods of analysis, common language, and common knowledge libraries). *And* B) Well-practiced behaviors that enable them to effectively use this system to work through problems together.
3. For sub-groups to act in concert while acting autonomously, all need a clear understanding of the organization’s common mission (what is important to do regardless of rewards), plus any current goals for unified change or improvement. Otherwise, people don’t all go in the same direction, and they cannot exercise discretion stretching the system when it is necessary for something important.
4. Working in this way is not impossible, but not wholly natural either. Humans are “political animals” that naturally form status hierarchies. The discipline and behavior to objectively observe work and change processes must be built into the culture and constantly reinforced by it. Otherwise, we quickly regress into recrimination, inventing conspiracies, and “gaming the system.”

Mastering the ability to do all this is counterintuitive to the behavior of expansionary institutions, especially conventional, financially-controlled businesses, structured with status and reward systems based on money and control. Although less money-motivated, budget-obsessed governmental and non-profit bureaucracies are likewise too rigid to attain the proficiency needed to effectively deal with *Compression*. By rough estimate, about 40 percent of the American workforce is in organizations crucial in *Compression*; health care, most manufacturing and distribution, education, construction, etc.

The human revolution necessary to cope with *Compression* is hard to overstate. “Lean,” “Six-Sigma,” and similar initiatives have barely penetrated these legacy organizations, but leaders of such programs frequently describe the experience as life changing. Vigorous learning enterprises leap way beyond that. Our best existing work organizations offer tested ideas for making this leap, so these proposals are not as ethereal as organizing to survive in deep space. But that deep-space scenario helps show why a drastic break from historic concepts of work and work responsibility is needed.

What does “vigorous learning enterprise” imply? “Vigorous” suggests an organization charged with operative responsibility, not purely a study group. “Learning” refers to all kinds of learning: skill-building, leading-edge technology, innovative business or operating models, and routine process improvement. “Enterprise,” in current business jargon, suggests that a core “vigorous learning organization” extends its learning well outside itself, so that its supply chain becomes a “learning relationship network.”

The phrasing used to explain this is deliberately different because almost nothing can remain the same as now. If the concepts actually take off, people will coin better terms for them. A vigorous learning enterprise would be a VLE, or some equally goofy acronym. Hopefully more attractive terminology will emerge.

Figure 10 diagrams the concept of a core vigorous learning organization and implies the leadership necessary to develop one. This concept not only sharply contrasts with most legacy organizational practices, it asks us to further civilize human nature by developing *everyone* to become more responsible in a practical way for human survival and quality of life. The lead role falls on vigorous learning enterprises to create the structures by which most of us as individuals can discharge the responsibility. Key features that a vigorous learning organization should have are:

1. A mission to benefit society that addresses some or all of the challenges of *Compression*. This mission is supported by a cascade of goals that focus action. For example, Ventana has a permanent mission to improve quality of life. It’s now in the histology (tissue examination) field; it’s primary goal is to find cancer faster. Sub-goals target learning and improvement areas on which to concentrate collective attention. If Ventana exceeds its primary goal by “finding cancer before it begins,” it will pursue a new goal under that mission. This directs work toward something other than monetary gain. Guiding a work organization by an operational mission that all can actually “believe in” unifies their collective intent,

which helps corral the chaos of many individuals working toward it semi-autonomously.

2. Patterns of behavior that stimulate and sustain collective learning. Regardless of learning methodologies, vigorous learning organizations have to counter human “political” behavior that disrupts learning. Personal conflict intrudes in rigorous settings, including academic research organizations. Counter-practices to keep it in check start with basic manners and go on. Ability to dig for facts is not enough. One must be willing to abide by them. That is a logical, if somewhat idealistic path to resolving conflict. People have to work to dig out facts and engage in dialog that respects others (open-minded listening as well as talking), in order to emotionally as well as logically resolve their interpretation. Dialog does not come easily to those obsessed with “winning their point.” Indeed, it comes so hard that customs to remind everyone to focus on mission and observe the behavior is needed almost daily. That’s a vital part of building the work culture, for none of us is superhuman, including the leaders. Since they too will have lapses, they actually promote the culture by admitting that they are human, expecting “subordinates” to remind them when these lapses occur.
3. A basic organizational learning format, common to all and based on scientific logic (like PDCA), and more extensive, structured learning systems in regular use. To be effective, elements of this “knowledge system” have to be symbiotic with work processes. Learning is expected. When faced with a new problem, an early action is to use the system to see whether it has been seen before. The last action when working on a problem is to record the logic and countermeasures in the same system. At a minimum, the overall system must support methods to rapidly: 1) improve work processes, 2) evaluate environmental considerations, 3) gather and filter outside knowledge for rapid innovation, and 4) devise and implement alternate “business models.” This methodology must prompt validating new knowledge against reality. It must also support measurements of progress meeting the mission. While a self-similar common pattern may loosely describe these systems, each system must be crafted to the needs of its organization. No “cookie cutter” formula can do this. A system should cultivate holistic thinking by all who collectively use the system in pursuit of a specific mission. The key is not a database of “answers,” but finding effective ways to frame problems. Each new countermeasure, discovery, or innovation just opens more problems.
4. “Meta-perception,” or ability to see the organization’s situation and mission as if one were standing outside it looking in. This ability includes seeing one’s self as others see you. Cultivating this ability is intrinsic to developing professional attitudes – ability to consider how every action may affect stakeholders far removed. This is important for everyone, but crucial for senior leaders guiding strategic direction and sustaining the integrity of the organization’s learning processes. Indeed it is necessary for development and constant review of the mission itself.

5. Leadership with a “servant leader” motivation: mission first, development of other people second; my ego last. The military version isn’t called servant leadership, but officer cadets are inculcated with it as soon as they enter a service academy. It’s important because commanders must be confident that others will report the facts (good, bad, and ugly), develop their troops to the max, and carry out their mission with little regard for self-promotion. However, learning to put mission and others before self is one of the most difficult leadership lessons to learn. Any organization undercuts this if performance is considered to be the sum of individual performance, and individuals must self-promote to be recognized. To create a vigorous learning organization, leaders must model the behavior and practices expected, and when necessary, discipline violations of this culture. They lead by asking questions and pushing responsibility to others both to do and to think. Sustaining this is vital, for this rigorous learning discipline replaces the discipline of budgets and money goals just as military, medical, and other organizations obviously have missions other than monetary ones.
6. Customs built in so that this “learning culture” constantly self-reinforces. All cultures have reinforcing features, which is why, once established, they are so hard to change. Expansionist business culture is no exception. Monetary incentives and financial logic reinforce it almost daily. As long as we need transactional systems, those influences are inescapable, so a vigorous learning culture has to constantly offset them. Daily reinforcement is not too often.

A vigorous learning organization needs a multi-stakeholder perspective. Government and non-profit organizations may have one, while for-profit organizations assume that ownership is both “more equal” and “more responsible” than other stakeholders because financial failure wipes them out. Lone entrepreneurs usually do stand to lose a lot, but clever ones try to protect a few assets if they fail, and large-scale financing and corporate limited liability spreads a potential loss among diverse investors. In addition, it is assumed that those who save money to invest are more likely to see a “bigger picture” and bear greater social responsibility than those who do not. As long as the primary risk is financial, that expansionist logic holds; a lone gold-panning miner going broke hurts very little but herself. But in Compression, everybody has “skin in the game” of work organizations on which we all depend, and recognition that resources are finite makes it a new kind of game.

Recognition of this is coming slowly, but evidence of it is increasing. More companies now use Balanced Scorecards. Many issue Corporate Social Responsibility Reports. What corporations should put in such reports may be fuzzy, but they issue them. And in the United States, there’s little reluctance to seek legal redress if a company has issued shoddy products, made false promises, and so on. Like it or not, those directly injured (or who think they are) want to hold them “accountable,” a transaction-based term that presumes that those who made a mistake should literally pay for it. Responsibility to anticipate performance injurious to various parties is expected, even by those who otherwise expect a company to also maximize profit for them if they hold stock in it.

Finding a suitable legal structure for a vigorous learning enterprise is apt not to be as big a problem as transforming attitudes and culture. Legal charters have precedents in non-profit corporations, mutual companies, cooperatives, employee-owned companies, and the like. But no legal charter magically endows an organization with superior ability to learn or superior capability to perform. While creating a vigorous learning organization has many aspects including mastery of technology and techniques, two crucial ones are:

1. Development of *all* people in the organization to be professional in attitude, and to strive to be that way in performance (even if they “just” do cleaning work). “Professional” is a much-abused term that may mean no more than being well-paid for skilled work, which may or may not be well-rendered or accompanied by a public-service attitude. For instance, almost any full-time, paid athlete is now called a professional.

By contrast physicians long struggled to earn social acceptance as professional, professional not only in the sense of having specialized skills, but for assuming a social obligation to serve their fellows above all else. For centuries, physicians have taken an oath do their best to keep you alive and in good health, even if they lacked the highest skill and the best equipment. In that same sense, Toyota for example, regards all employees as professionals, or at least potential professionals. In actual practice, this may fall short, but it makes a huge difference if leaders respect all employees’ potential, expect them to develop themselves and others to the max, and expect them to contribute everything they can for the public good, not just Toyota’s.

Becoming “professional” in this sense takes on social obligation. It has little to do with a person’s compensation or market value. If professionally motivated, a person tries to benefit everyone they serve – all their organization’s stakeholders, beginning with the customers it primarily serves. This obligation takes priority over maximizing profit or milking the maximum income from overtime, an attitude necessary to deal with the challenges of Compression. But this is so contrary to human nature, and so easily rationalized away, that to be seriously observed, leaders of any vigorous learning organization must embody this attitude and model it if they expect others actually behave the same way.

2. Keeping an autonomously-functioning learning organization concentrated on a common mission and its subordinate goals. Current management jargon for this is “alignment,” needed when empowerment of employees is no more than that required for practices such as Six Sigma and lean operations. In organizations from Raytheon to the Department of Energy this became such an issue that some management consultants specialize in it. Attention first gravitates to structural solutions, assuring that the organization’s cascades of performance indicators and reward formulas are consistent with its strategic intent. After that, alignment messaging is too often relegated to human resources. But if professionals are to exercise autonomous discretion discharging their responsibilities in a vigorous learning enterprise, this is inadequate. It is a senior leadership responsibility.

One would think that missions and goals that obviously affect life and death should take little reinforcement. However, medical device companies like Medtronic remind people that lives depend on their work, which is easily forgotten when doing seemingly routine work far removed from direct medical intervention. That's why people doing such work are asked to reflect on why they do what they do; it inspires ideas to help do it better. Creating an inspiring mission for garbage collection may seem far-fetched, but public health depends on it. The only unimportant work is that which does not need to be done, regardless of how well one is paid for doing it. For example, in *Compression*, recovery of materials is important so collection and sorting – reverse distribution – will become vital, less of a low status job.

If a clear linkage between a mission for a company and the challenges of *Compression* cannot be established, there's no point forcing one. People will see through it. We'll still need haircuts, flower shops, music, sports and other activities that make life worth while – but without wasting our substance to have them.

A vigorous learning organization is not a for-profit company, but a hybrid with a non-profit mission motivation. We already have many working examples of non-governmental, non-profit organizations today, differing in legal form and intent from for-profit companies. All have their flaws, and some for-profit organizations have excellent precedents. If unified on the purpose of an organization, we can learn from all to create working organizations of unprecedented competence. Fair warning: this is not an exact science, but a proposed learning experience, and a bottom-up revolution.

One of an individualist's first thoughts about a vigorous learning organization is apt to be its pecking order (how do I get ahead?). Status systems are inevitable, but aggrandizement systems inflate egos and deflate respect for the contributions of everyone else. Huge top management pay packages undermine confidence of other stakeholders that leaders identify with them, or intrinsically care about either them or the mission – overlooked when paying “market price for top talent.” In a vigorous learning organization, the status differentiator is the quality of servant leadership supporting mission, human development, and process development. Status criteria become mushier. It emphasizes superiority helping others develop themselves, individually and collectively, and superiority mastering process innovation and process development.

Given all its counterintuitive aspects, developing vigorous learning organizations to deal with *Compression* is a bigger challenge than any piffling war one can think of. But if we cannot step up to this, the most likely alternative is wars and disputes over whatever resources remain until humanity either wearies of its own conflicts or finishes stripping the earth until it can't support all of us – or any of us. Difficult as it may seem, taking a path toward a more advanced civilized state is much to be preferred over regressing to that. To do it, we need a stronger “constitution.”

8. A Constitution for Vigorous Learning

A political constitution codifies a set of rules by which people agree to make decisions that all can abide by. Similarly, whether for-profit or non-profit, corporations have charters. In addition, most organizations in industrial societies establish by-laws codifying their system of governance.

Tribal governance has no constitution in this sense; instead, all tribal members accept a wisdom hierarchy of “elders” (not all may be creaky with age) to decide matters based on tribal lore and history. If a society becomes dependent on written scripture and religious tradition, clerical elders interpret its teachings for practical matters.

Tribal forms of governance clash with transactional societies. Tribal councils and religious groups select trustees to transact legitimate business, but commercial culture continues to encroach on old tribal cultures, as it has for centuries. Tribes may respect their past, but it seldom helps them navigate the workings of a commercial world.

But now, rationalist constitutions, laws, and regulations aren't serving us well either. Legislation is often too complex for representatives to personally digest. Staff must do it for them while wondering which lobbyists to trust. Agencies have to interpret and administer the complexities, and if issues come to court, interpretation of case precedents poses quandaries. Litigation constipation is a wasteful way to settle issues, much less ferret out root causes of tragedies like serious medical errors. Neither internal consistency nor perfect anticipation being possible, rational determinism reaches a limit in legal systems too, or as Charles Dickens long ago noted, “The law is an ass.”

A new “constitution” for the 21st century has to recognize this century's realities: finite global resources limiting the historical means of physical growth, rapidly changing conditions, lots of technological prowess, and no permanent solutions to problems. If sources of physical largesse poop out, politicians can't resolve differences by divvying slices of pie (or pork). Someone must exercise real leadership changing what people do. Our concept of globalization has to grow beyond global trade, and our concept of human responsibility run deeper than a system of self-interest. This changes our basic concepts of work and work responsibility. It upends economic thinking. It affects all organized work. When large scale use of resources conflicts with the welfare of all of us, private property can't be used exclusively for private interest. If physical growth only exacerbates our problems, “competitive” motivation needs to be redirected so that it doesn't work against us. Conspicuous consumption, that symbol of expansionary success, becomes instead, a symbol of mindless profligacy. But people addicted to it from birth may regard voracious consumption as a birthright, and consign poopers of their party to the same fate as whistleblowers.

Of all the mind-benders of human transformation learning to deal with Compression, two stand out: A process theory of value (to offset the labor theory of value and the market theory of value); and the concept of a global tribe to offset everyone's tendency to cling to their own tribal affinities.

Historical Theories of Value

Transactions are the blood flow of industrial economies. Most of us think little about routine transactions, like buying a drink from a vending machine, but they mold how we think. Mentally we translate everything bought or sold, even services, into an object to which we attach a price or cost. Transactional data feeds precise accounting models and is the basis for valuing almost everything appraised or collateralized.

The two primary theories of value support this structure; the labor theory and the market theory. Both have well-criticized flaws. In essence the labor theory of value is that a thing is worth the accumulated human labor necessary to provide it. The market theory of value is that a thing is worth whatever a buyer (or buyers) will pay for it.

The differences between these theories helped provoke bloody wars. Communist economics rely on variants of a labor theory of value. Capitalist economics rely on variants of a market theory of value that today underpin the complexity of the global capitalist business system.

Although no real economy conforms to a single theory, economists seeking mathematical simplification long simplified the market theory as value being determined by exchanges between rational people all acting in their self-interest, an assumption often called Economic Man. Unfortunately, Economic Man is difficult to distinguish from psychologists' definition of a sociopath. Fortunately, we are not always rationally self-interested. For example, if a marriage contract is entered into strictly on self-interest, it really does match up a pair of sociopaths.

Although behavioral economists are weaning mainstream economics from Economic Man, it continues to influence business behavior. For example, it buttresses the efficient market hypothesis: that new information spreads so quickly that most buyers and sellers are equally informed; ergo markets are fair. That has been used to justify markets in derivative instruments and trading by computers at microsecond intervals. In addition, if buyers are knowledgeable, profit-maximizing companies should have minimal obligation to correct things gone wrong, or even to disclose errors. True, claims from catastrophic errors or events may bankrupt companies, and maybe even governments, but even when they are held liable, payments after the fact can't compensate for all errors. If all of us suffer from this non-performance and pay the consequences, Economic Man reasoning amounts to a heads-I-win, tails-you-lose rationalization. But when trapped in this mental fog, proponents can't comprehend that the system is incompetent serving *all* society.

In 1997, the absurdity of market theory valuation was epitomized by an attention-getting project to value the entire world ecology. A series of estimates averaged \$33 trillion, about double the global GNP. Since all life depends on the global ecology, analysts knew that valuing it in dollars had no meaning, did it anyway because many executives (and economists) can only recognize the importance of anything if it has a dollar value. A more competent system has to escape the trap of a market theory of value.

A Process Theory of Value

Refer back to the three “model maps” in Figure 2 (p.17). The economic model dominates business thinking. We all mentally imprint some form of behavioral model to navigate the “politics” of almost any working organization. However, the culture for a vigorous learning enterprise is a human-centered system intertwined with their work practices. The cultural behavior necessary for this is very different from Economic Man.

Vigorous enterprise learning is a process, not a thing. Humans are not objects to be assigned value on a balance sheet (sometimes advocated by empowerment enthusiasts). Doing so implies that they are slaves, on the balance sheet of an old plantation. Indeed, schemes that assign people a property value have been defined as denial of freedom.

Instead, the people with their learning system are the organization. They are more important than its property. Property, including intellectual property, is what dedicated professionals use. Money is simply a property exchange medium needed to work with things, use them, or consume them. Some things, like diamonds, have intrinsic aesthetic value. Business models can be developed to supply this value, but to execute this model, things are processed, and not all processes can be monetized. Any process view that omits its non-monetized elements, including people, is incomplete.

Both work and learning are processes. Developing a vigorous learning enterprise to improve both work and learning processes is an adventure in symbiotically developing both ourselves and systemic changes in our work environment. Some of us may be leaders of this adventure, but the leaders are also part of the migration, developing with it. The purpose is to develop maximum mission capability – including ability to deal with unknown, surprise challenges when they occur.

If the purpose of a vigorous learning enterprise is maximum work process performance and learning effectiveness, bigger is not necessarily better. Excessive system structure can obstruct communication, but so can diseconomy of scale. A vigorous learning organization may be a hierarchy for some purposes, but foremost, it is a problem-solving network. Mere connectivity is not enough. Effectiveness depends on that mysterious effect, “bandwidth,” ability to quickly analyze situations and knife through problems at all points in the network. Humans need time to absorb, react, study, adapt, take action and transmit what is done. Even if quick and deft, they can still be overloaded.

For example, think of a hospital emergency room. If too small, it may not be able to handle every case it should. If too big, it wastes energy in internal communication, and maybe just in movement distances. If more capacity is needed, start up another properly sized emergency room operation; don't just add on. Although everything in the world is not an emergency room, each vigorous learning enterprise has size itself to constantly improve its effectiveness meeting its own mission.

Figure 11 (A). **“Radar Chart” of Process Compression from Kaizen**

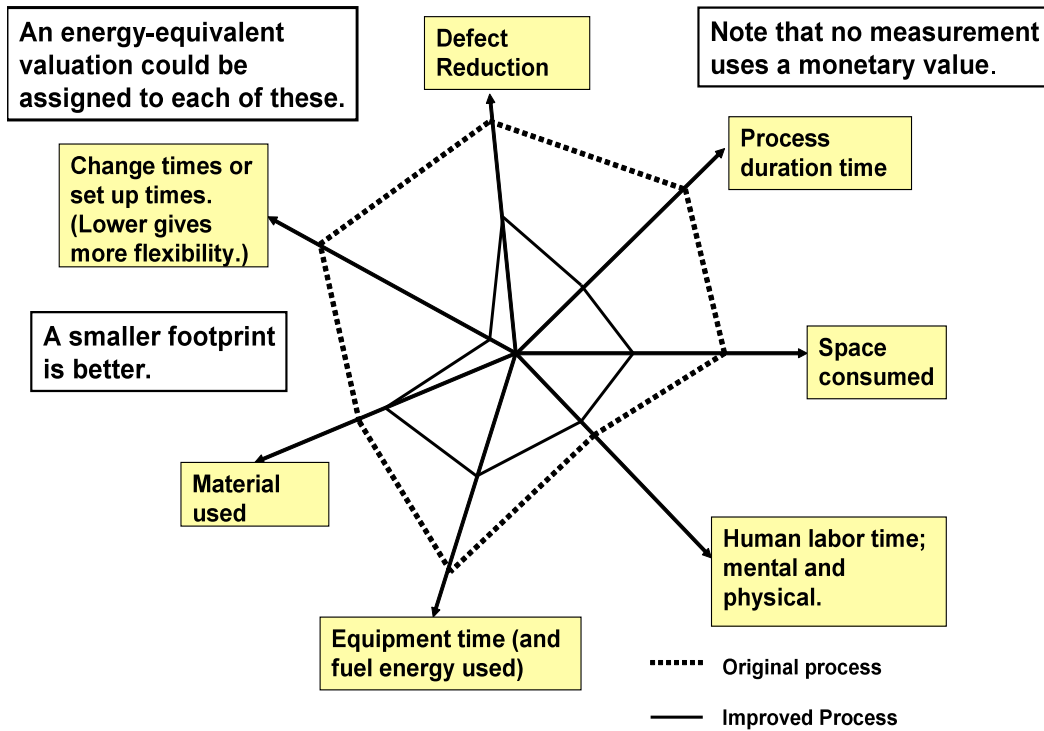
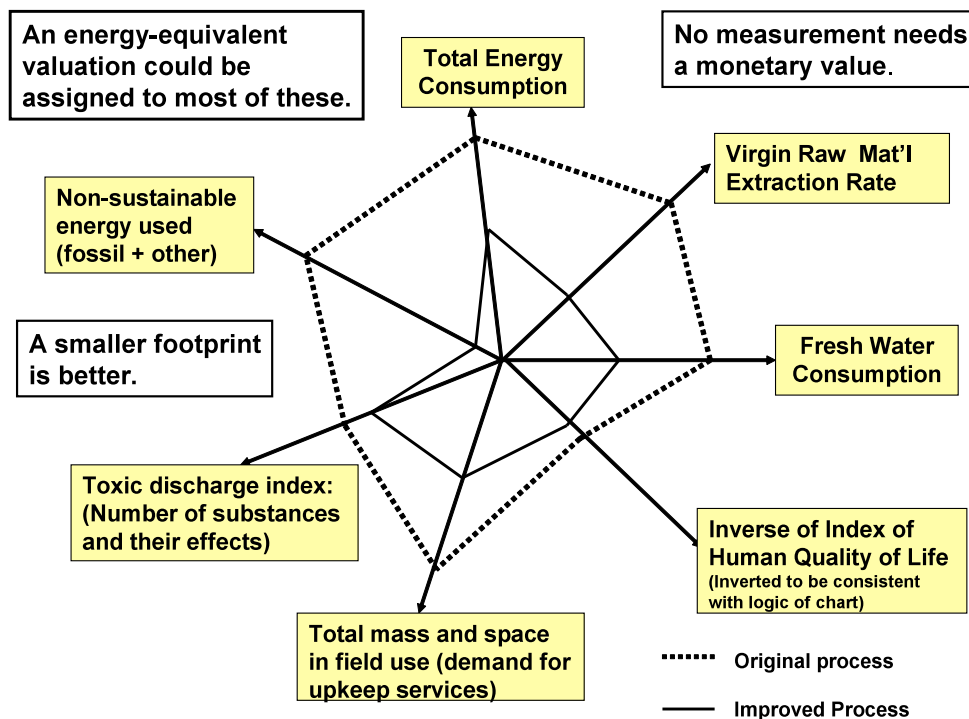


Figure 11 (B). **General Compression by a “Process Theory of Value”**



But the most different aspect of a process theory of value is making operations as symbiotic as possible with the natural environment. See Figures 11(A) and 11 (B).

Readers familiar with kaizen improvement of work processes may have seen something like the radar chart in Figure 11(A). Improvements eliminate activity that need not be performed at all – waste. By definition, a process improvement is a reduction in waste by at least one of the criteria on the “spokes” with no decrement on any other criteria. That’s a total resource compression to accomplish the same ends. And measurements need not include any dollar valuations. Strictly physical measurements or process performance ratios describe just us and nature, and they are good anywhere in the world. No currency exchange variations or market shifts in valuations need be incorporated.

This differs sharply from 20th century process improvement measures based on either market theories of value or labor theories. During the industrial revolution we focused on labor productivity and slighted other measures of performance. Industrial improvement of labor productivity substituted fuel-powered equipment and automation for labor. Both theoretical microeconomics and actual business decision formulas emphasized trade-offs to achieve an optimum profit. Much of that optimization assumed plentiful fuel energy.

We’ve operated by that line of thinking long enough that the logic of Figure 11(A) may seem strange. No more than 100 years ago, before nitrogen fertilizer and the green revolution, it was the natural way to think in agriculture. A farmer had to wring out the best yield considering conservation of land, seed for future crops, feed for work animals, weather, and many other variables. In today’s jargon, they were process thinkers or systems thinkers. That’s why Adam Smith considered a resourceful farmer’s judgment to be superior to that of specialized craftsmen. And one need do little physical labor to see that it is smart to work with nature and the laws of physics, not against them. Technical possibilities now are much greater, but wasting their promise overpowering nature is still a pretty arrogant use of them.

Figure 11(B) is a more conceptual, general version of Figure 11(A). In practice, no one is known to do something exactly like it, but companies like Interface, Inc. are close, so it’s not a cloud nine fantasy. The ideal objectives of Compression are – again: improved quality of life *with* zero use of virgin raw material, zero use of non-renewable energy, and zero toxic releases.

Figure 11(B) depicts these ideas as something measureable – and doable – in practice. In principle all important factors can be quantitatively reduced to a common denominator, like energy, measured with a common thermodynamic currency. Everything can be characterized by the energy it uses, or by the energy history that brought it to its current state. At present, lack of data makes this impractical for popular use, but it can be done for some cases, and with learning, data will become more plentiful. Thus expressing everything in “nature’s currency” would replicate the comparability inherent in accounting and economic models that express all variables in dollars. This faux consistency makes accounting and economics models convenient, but also helps deceive

us into thinking that they that they are more complete and encompassing than they are. But they seduce us into irrationality because they are used as human reward systems.

A process evaluation is negligent without qualitative evaluation as well as quantitative. For example, suppose a process uses perfluoromethane (potent greenhouse gas; some health hazards). Its risks in use are well beyond just a waste of resources. If one can't immediately "design out" such a chemical, conservation to minimize its use is a move in the right direction; then work hard to find a substitute. We need vigorous learning enterprises digging persistently on such problems using both technical ingenuity and fundamental questioning of our basic needs. Solutions are apt to require changes in business models that moribund organizations typically find almost impossible to execute.

A key difference between Figures 11 (A) and (B) is that the measurements in (B) go beyond evaluating the internal efficiency of a work process, or seeing waste as a customer might see it. They evaluate the effects of internal processes on external processes – both human processes and natural ones. This inside-out evaluation and action is a big jump for which data needs to be acquired quickly – another reason for vigorous learning enterprises. Especially for manufacturing organizations, vigorous reviews should evaluate the effects of a full product life cycle, not just making products to be sold; then forgotten.

By a process theory of value, process evaluation and reconstitution should consider a couple of other often-overlooked effects:

1. Accumulative effects. Slow working toxins, for example, build up slowly. Initial effects may hardly be noticed, so we assume an unmerited level of risk. Tobacco smoking and dioxins are merely two well-known examples. This is not simple. For instance, long-term side-effects of prescription drugs are not easy to project.

But not all cumulative effects should be difficult to discern. For example, what kind of road network, fuel demand, and toxic releases is a vehicle company loading on the world by continually increasing its population of vehicles sold? The real test of Toyota or Honda becoming vigorous learning enterprises will come when they recognize their duty do something beyond warranty service to the fleets of vehicles that their market success let them put on the road.

2. Chains of effects and effect multipliers. In the 1950s very few people could have anticipated the catalytic multiplier effect of Freon destroying the ozone layer over Antarctica. Stratospheric chemistry was barely beginning to be studied. Since then our knowledge of natural processes has grown, but it can never be complete, so the only approach to mitigating this risk is by striving to thoroughly understand the life cycle physics and chemistry of processes and the products associated with them, including:

- Uses and likely misuses (like taking incompatible drugs in combination).
- Required extraction of materials from the earth (and ancillary activities).

- Assimilation of used materials back to nature (molecular breakdown sequences of discarded materials).

Doing this stretches the horizon of technical learning. Besides chemistry, real issues – and scares – arise in genetics (“Frankenmonsters”), nanotechnology (“gray goo phobia”), and radiology (mutant misfits). To deal with this, a Green Chemistry Institute founded in 1997 is growing rapidly, but we’re learning too slowly.

A process theory of value holds that processes vital to our existence and welfare may only be valued by rating their priority of importance to our existence, but safeguarding and improving them must take precedence over market systems of value.

Reconstituting Health Care in the United States

Reforming health care is loaded with emotion: ethical, political, and economic. Some improvements may require divisive social decisions. When do heroics to save a life only prolong misery a few weeks? What to do with people who have debilitating addictions?

Criticism ranges from Michael Moores’ *Sicko* to charges that authors with commercial ties submitted biased research to the *New England Journal of Medicine*. Health care became a conflict-riddled, technology-laden system poorly delivering service that costs too much. By 2082, American health care expenditures are projected to consume 100% of GNP (Congressional Budget Office). Obviously, a different path must be taken.

Underway are procedural improvements in health care, like quality and lean initiatives that reduce medical process errors and waste. That’s a start but does not address the core issues: how health care decisions are made and what procedures actually accomplish. These are strongly influenced by market and profit growth incentives that fragment the system into mazes of insurance plans and specialized physicians, clinics, and labs, most of which focus on recuperative care – where the money is. They don’t communicate well. (Almost every non-wealthy citizen that has run medical care gauntlets can attest that processes are complicated and confusing.) Financial incentives urging doctors to prescribe quantity of remedial care (“our unit needs the money”) do not add up to quality of life despite almost everyone working in this system meaning well.

The system needs a mission – strong commitment to a quality-of-life mission, beginning with sustaining wellness; not where the money and high-tech “toys” are. It has to become more operationally integrated. When patients are impaired and medicine complex, shepherding by a primary care physician (or the equivalent) becomes even more important. Patient trust in a medical advisor is formed by a relationship, not by a transaction.

More technology – or more “suits” with money, clout, and PR – can’t fix a health system broken at the green-gown level. Divided camps, each maximizing its own financial wealth, distract attention from its quality-of-life mission. A much clearer case for vigorous learning enterprises can scarce be imagined. They must constantly re-assess

what patients and their families need, and not only develop deeper biological and understanding and medical technology, but continually re-define work processes and refine organization of work to deliver it. This is a bottom-up revolution to improve quality of health and quality of practice, not to create something to “sell.” To do this, almost everyone in these vigorous learning organizations must become professionals engaged in process learning, and capable of coaching their patients to stay healthy too. And to be effective, every financial payer has to participate in this enterprise, not just the service providers.

Tribalism and a Constitution for Vigorous Learning

Perhaps our greatest impediment coping with *Compression* is not our legacy of expansion and the business system that promoted it, but something here labeled “tribalism.” To Westerners, “tribe” conjures small non-Western ethnic groups like the Yanomamö of the Amazon who occasionally attacked other tribes. Wording a “politically correct” definition of tribe is tough. No label dispels resentment if the hearer regards it as inferring inferiority. And readers of any such definition may remain smugly unaware that the description also fits them. “Tribalism” is instinctive to us all.

To distant observers unaware of their histories and myths, conflict among foreign tribes is incomprehensible. An incident, seemingly trivial to outsiders who wonder at the irrationality, can reignite old revenge cycles, reverting civilized people to savagery. And tribalism is easy to invoke as a tactic to resist almost any kind of change.

“Tribe” is also occasionally used to describe ethnically diverse groups sharing deep convictions about ideology, politics, religion, economics, or work roles. A department in a company may behave as a tribe, regarding themselves as either a bit superior or inferior to all the other tribes.

If everyone agrees to live by a constitution – a framework of rules for making collective decisions and resolving conflicts – tribal conflict cools, but it doesn’t disappear. If tribes lose confidence in the constitution’s administration, or don’t see that injustices are resolved by it, tribal conflict may take the form of protests and riots, for example, Watts (Los Angeles), Paris, Islamabad, and Oaxaca. Constitutions are ever under tribal attack.

Tribalism is primal allegiance to a group’s beliefs. It shapes how we frame “problems” while remaining unaware of the bias. If bias is exclusionary, tribalists think that if only everyone else thought as we, all problems would be solved. By contrast, allegiance to a constitution is abiding by a set of principles whereby diverse people can live without some being subservient to others. Under a constitution, trials and debates are supposed to seek evidence and weigh it. In practice this falls short. Overtly and covertly, tribes try to undermine a constitution or bend it to their own beliefs, either to give their tribe an “inside track” or to deny it to others, perhaps without realizing it. It’s called politics.

Some debates may be rational, for example pointing out impracticalities in one-size-fits-all laws and regulations, but debate being a win/lose game, it is hard to back down when

someone else's logic has more substance. Dialog, an exchange of logic, is impossible. If each tribe frames all problems by its own belief system, tribes can never agree on how to agree. Taboos may even prohibit tribes from seeking facts, or even agreeing that a problem exists. (Such a problem is aptly named a "wicked problem," and speculatively, this emotional gridlock leads to banning whistleblowers.) Gridlocked tribes can work or live together only if conflict is never discussed. Problems never admitted and never discussed are rarely resolved. The roots of tribalism probably reside in how our brains learn, so it is no simple thing to overcome. However, tribal biases can be manipulated by "propaganda" that re-frames problems to fit tribal preconceptions, which is the primary methodology of inflammatory politics.

Obviously, nothing like vigorous learning enterprises can survive in an environment suffused with tribalism. Even on a small scale, the culture has to be open, so everyone can question. The difficulty of this can hardly be underestimated, and expecting the general public culture to suddenly become a serious dialog on matters of substance is a pipe dream. For that, vigorous learning enterprises need a genuinely accepted global "constitution" based on scientific methodology, observation, and dialog. Pioneer work organizations have to prime this revolution because many people will only understand it by seeing the practices and behavior in action.

Once we accept that the purpose of crucial work organizations is professional performance toward a mission on behalf of everyone, many divisive legacy issues melt away. And adopting professional attitude means putting the welfare of the human race above that of any of its contentious tribes. *If this is done, how a work organization is financed becomes almost irrelevant. Distinctions between public and private property, personal and social obligation, economic and social progress, and economic and environmental progress start to melt away.*

Given all the human instincts opposing anything like vigorous learning enterprises, why be optimistic that something like them can come about. Because, despite the mythical powers of laissez-faire competition, private businesses have begun to practice collective learning. The base is small, but it's a start. For example, Vistage International consists of 14,000 company CEOs that regularly meet in small groups for exchanges and mutual advice. Network collaboration like open system software and "wiki" systems typified by Wikipedia are beginning to mature. Non-profit organizations engage in pre-competitive collaboration on research (like the National Center for the Manufacturing Sciences). Companies partner with university faculty and government laboratories. And a few "consortia" in North America engage in organization-to-organization nitty-gritty exchange for performance improvement. A well-known "consortium" in Kalundborg, Denmark called an industrial symbiosis has begun to seriously collaborate on environmental issues.

The Vigorous Learning Challenge

We have started. However, an aggressive vigorous learning enterprise has yet to emerge from the competitive corporate culture of industrial society. None are strongly

committed to a social mission or have a “learning constitution.” These enterprises may organize around product or service life cycles, or around joint local environmental improvement, as in Kalundborg. The same core working entity may belong to several vigorous working enterprises. Our embryonic initiatives have to begin jelling into something of more substance soon.

Stalwart pioneers taking on this vigorous learning challenge have to define their core mission. They have to devise both learning methods and behavioral rules to live by. They have to create a working environment in which counterintuitive thinking comes easily. They have to find (or develop) like-motivated counterparts to form multi-unit enterprises. They must initiate common learning networks and common learning databases. They may need to find investors and financial institutions committed to their missions. Performance expectations would exceed almost anything done today. And they would have to develop people for this, beginning with themselves.

It can be done. We can further civilize ourselves. We can use technology beyond our forefathers’ dreams. We can be more aware of the total physical world and of our own behavioral challenges. It is past time to organize ourselves to deal with Compression.