

ANTHROPOCENE AS LIFE'S STATE OF THE ART IN DISORDER PRODUCTION: A SUSTAINABILITY CONUNDRUM

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ABSTRACT

This paper launches on the proposal by Eric D. Schneider and James J. Kay that life is a response to the thermodynamic imperative of dissipating gradients. Adding a twist to the claim of Jeffrey Wicken that “entropic dissipation propels evolutionary structuring,” Schneider and Kay contend that “evolving life represents *order* emerging from *disorder* in the service of causing even more disorder.” Drawing on Gregory Bateson’s definition of information, a self-organizing system can dissipate a gradient, a “difference that can make a difference,” more efficiently than helter-skelter falling apart. Examples range from transient physical systems (Bénard Cells, hurricanes, tornadoes) and chemical systems (BZ color flipping clocks) to evolving biological (bacteria, trees, ant colonies, coral reefs, brains), and, it is proposed, human/biotechnological systems (automobiles, coal fired power plants, smartphones, apps) passing the baton of Erwin Schrödinger’s “order from order” means for sustainably remembering and capitalizing on what works. The second law of thermodynamics driven trend of disorder to order to even more disorder continues ever more effectively as state of the art in disorder production in the Anthropocene as autocatalytic, “Matthew Effect,” gradient degrading, human impacts on the biosphere, aided and abetted by advancing technology. Human/biotechnological driven gradient dissolution manifests itself not only in the usual tragedy of the commons victims of industrialized human activity—the sixth extinction of species, the toxic smog in Beijing and New Delhi, the vanishing glaciers, the draining of fresh water aquifers...—it manifests itself in and is linked to us. Robert Rosen observed that a “material system [can] change its own behavior in *response* to a force, and...that same system can *generate* forces that change the behavior of other systems.” Under the impress of the escalating force of techno-dependency, our addictive drug, as a system, we, convenience driven, environmentally foggy, smartphone glued to hand, clueless without app, humans are changing our behavior in ways that change the behavior of other systems, biospheric systems not excluded, and, on balance, not for the better. A sustainable future for coupled human/biotechnological systems and the soaring gradient of advancing technology is an oxymoron. The accelerating technical order is producing a deepening skew, a crossing tipping point to out-of-control, global warming scale, disorder of orders. A case-in-point can be seen by extrapolating the fragility of excessive interconnectivity in climax ecosystems, as Robert Ulanowicz pointed out, to the rising order of local and global interconnectivity rendering us, individually and collectively, increasingly vulnerable to looming, potentially catastrophic, collapse. What sustainability needs is the going forward stability of an order of orders. Viewing sustainability in the framework of flows and counterflows, excesses and deficits, concentrations and dissipations, of order as potent, transformable organized energy (exergy), a.k.a, power, this paper offers a possible handle on

Anthropocene as Sustainability Conundrum

robustly overcoming the formidable barriers to gaining and latching a sustainable future, ourselves (hopefully) included.

Keywords: Anthropocene, autocatalytic; convenience; dissipative structure; disorder; ecosystem; entropy; exergy; fractal; gradient; “Matthew Effect;” order; power law; relational self-similarity; Second Law of Thermodynamics; sustainability; technology

INTRODUCTION

“Ultimately, the lesson of biology is that to seek survival through programming [a.k.a., “solutionism”] is, one way or another, a form of suicide.”

Robert Rosen

The conventional wisdom on technology is that technical power is human power. When technology rises, we rise. Doing more for us means better for us. This paper not only questions the conventional wisdom; it proposes that with the, for now, exception of elites, the so called “1%”, not only in wealth but across the board of advantage, including, or especially, technical smarts, under the illusion of benefit, of technology doing it all for us, the rising power in technics is at the expense of human mental, physical, and social powers that, writ large, is a central, if not the central, player in the ongoing, accelerating degrading of biospheric order manifesting itself in the unrelenting dissipation of source and sink resources.

The fundamental order, driving and sustaining life, is the “Goldilocks,” not too hot not too cold, temperature gradient between sun and earth that produces potent but squanderable solar energy. With sustainability viewed as the ongoing, non-squandering of that energy, a dynamic balancing act of reception and consumption, use and replenishment in the cycles that nurture and maintain life in the biosphere, what becomes clear is that as a species, we are consuming available input flows at rates far in excess of that which is sustainable. Our consumption not only includes extremely high and growing proportions of solar energy made available to living processes through photosynthesis, it also includes the wildfire consumption of non-renewable resources of fossil fuels, a primary agent of climate change, the consumption driven (sixth) extinction of countless numbers of species, and the depletion of only partially recyclable resources of raw materials we exploit in the global empires of production. Evidence for this, has become overwhelming. Exponentially growing human numbers alone are compelled to eat, directly or indirectly, ever growing proportions of the Earth’s “net primary production” (NPP), the amount of sunlight captured by green plants and fixed in living tissue.

The consequences of this unprecedented, technology driven, usurpation by our species, is what the late theoretical biologist, Robert Rosen (1934-1998), might have called a “side effect” of the losing it for not using it degrading of inner human mental, physical, and social order being compensated by ever more ravenous source and sink degradation. As Rosen put it in *Essays on Life Itself: Complexity in Ecological Systems*, “a material system [can] change its own behavior in response to a force, and...that same system can generate forces that change the behavior of other systems” (Rosen, R., 2000, 11). The force impinging on us, individually and collectively, is autocatalytic, feeding on itself, technical advance. The behavior it is changing is the addicted, equally

Anthropocene as Sustainability Conundrum

autocatalytic, feeding on itself, selfie consumed, environmentally clueless, convenience catalyzed, smartphone welded to hand, escalating of human helplessness without app. The other attention starved systems the effort dissolving, technology driven degrading of human behavior is changing reside in the biosphere, and not for the better.

TOWARDS FOR THE BETTER

In “Order from disorder: the thermodynamics of complexity in biology” that appeared in *What is Life: The Next Fifty Years: Speculations on the Future of Biology*, Eric D. Schneider and James Kay (1954-2004) claim that living systems are “gradient dissipators” (Schneider and Kay, 1995, 166), with gradient, as I see it, linked to Gregory Bateson’s characterization of “information“, “a difference that can make a difference” (Bateson, 1972, 453). The claim is that a self-organizing system can dissipate gradients more efficiently than helter-skelter falling apart. Though Schneider and Kay focused on living systems, in particular, ecological systems, we extrapolate their contention to advancing technology and its growing impacts on living systems, including us, drawing on the insight elucidated in-depth by Schneider and co-author, Dorion Sagan in *Into the Cool: Energy Flow, Thermodynamics and Life* that “nature abhors a gradient” (Schneider, E. D. & Sagan, D., 2005, 6). Our conceptual framework extends relational biology to what I will call “relational self-similarity” where not only do living systems self-similarly (fractally) evolve as sustainable, ever more effective means for dissipating gradients, so does exponentially advancing technology, with we humans, collectively and individually, not excluded from the gradients being dissipated (techno-elites excepted for now as noted above). This thesis, of course, flies in the face of what innovator, futurist, and now Director of Engineering at Google, Ray Kurzweil, celebrates as the “accelerating returns” of technology, namely that the more technology does for us the better off we are (Kurzweil, 7 Mar. 2001, 2005, 35-110). It also throws a monkey wrench into the resort to what Evgeny Morozov, in *To Save Everything Click Here*, calls “solutionism” where technology is the solution to all problems technology has promulgated, viz., geo-engineering the biosphere to deal with climate change (Morozov, 2013; Morozov, 2 Mar. 2013).

If a sustainable future for the biosphere, ourselves and our progeny included, coarsely keys on the equation order as exergy—the measure of energy’s usefulness, its quality¹ consumed equals order as exergy replenished (mainly by the sun) with no net dissipation of solar driven biospheric gradients, if “nature abhors a gradient” and evolving living systems are ever more efficient gradient dissipators, with untethered technical advance state of the art in multiplying, amplifying human precipitated gradient dissipation, our common future going forward is in peril. What follows aims at solidifying Schneider and Kay’s disorder to order to even more disorder twist on theoretical biologist, Jeffrey Wicken’s (1942-2002) contention that “entropic dissipation propels evolutionary structuring; nature’s forces give it form” (Wicken, 1987, 72, cited in Schneider and Sagan, 2005, 106) while laying a first step foundation for a truly sustainable future.

¹ Formally defined, exergy is a measure of the maximum capacity of an energy system to perform useful work as it proceeds to a state of equilibrium where all differences that can make a difference have been dissipated and no further useful energy transformations are possible. “When energy does work, its quality, its exergy diminishes.” Exergy also is a measure of gradients, of how far a system is out of equilibrium. As James Kay put it, “Exergy tells one about the theoretical limits on what one can do with energy. Exergy is about the potential to do something with the energy and entropy tells you what happened to that energy” (Schneider and Sagan, 2005, 32).

Anthropocene as Sustainability Conundrum

ENTER THE DISSIPATIVE STRUCTURE

The formal name given to the process by which matter self-organizes to more effectively produce entropy, the measure of energy's spread out uselessness, is the "dissipative structure." The essence of a dissipative structure, as the term implies, is that, under the right conditions, it is the natural means by which organized matter and energy, structure, can concentrate in a particular system while dissipated matter and energy is displaced into the system's environment. Dissipative structures can form in far from equilibrium situations where there are significant gradients, the most fundamental being the large (but not too large and not too small) gradient between the very hot sun and the relatively cold earth.

Realize it or not, all living organisms, 7,250,030,000² and counting humans included, are dissipative structures (Gallopín, G. C., Gutman, P., Maletta, H., 1989). Good bacteria in our gut, or mutated "superbug" bacteria evolving resistance to all, or nearly all antibiotics, are dissipative structures. To live we must eat and excrete. What we, the living, eat is the order, the structured / useful stuff in our food and get rid of the rest. Other living things can make good use of what we discard. What's left, after everything usable has been consumed, is totally dissipated, driven to equilibrium, drained of all further utility. It can be usefully transformed no more.

The term "dissipative structure" was seeded in the early 1920s by U.S. mathematician, physical chemist, and statistician, Alfred J. Lotka. It became most closely linked to Nobel Prize winning physical chemist, Ilya Prigogine and his colleagues at the Brussels School. According to Prigogine, dissipative structures can grow increasingly complex over time "by exporting dissipating entropy" (Prigogine, 1955; Schneider & Sagan, 2005; Robbins, 2013).

The reason why entropy has to be produced whenever order is congealed is an ironclad law of nature known as the Second Law of Thermodynamics whose message is nothing ever happens in our universe without entropy increasing. Concentrating order in a system, say, a living organism, shrinks entropy in that system. If the sum total of entropy in the universe always goes up, when it goes down in a particular system it must go up even more in whatever's not included in that system—its environment. Physical chemist, Peter Atkins, captures how this works as follows:

The unnatural may be contrived at the expense of the natural. So long as we can drive one change by another, one change may be constructive and lead to a local reduction of entropy. But elsewhere, and coupled to the first, there must be a process that generates at least a compensating amount of entropy. There may be *local abatements* of chaos, which appear to us as the emergence of structure, but elsewhere there must be generated at least a compensating amount of chaos (Atkins, 1984, 157; Robbins 2008).

A rough metaphor looks like Figure 1:

² As of 13:38 on June 15, 2015, according to the U.S. Census Bureau's U.S. and World Population Clock at <http://www.census.gov/popclock/>. As of 13:38 on July 15, 2015, the population was 7,256,364,700, an increase of 6,334,700 in 30 days, or 211,157 per day, or more than 77 million per year.

Anthropocene as Sustainability Conundrum

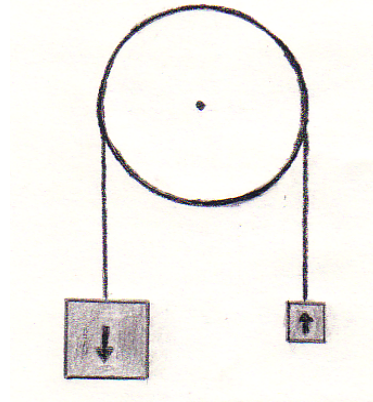


Figure 1

The rising weight represents an escalating gradient in a system that's gathering and concentrating exergy as high quality, available to be usefully transformed, energy. The heavier, falling weight represents dissipation, falling exergy / escalating entropy in the coupled environment whose gradients are being degraded towards the deadness of equilibrium where no further changes of significance are possible.

But if entropy always has to increase, why does the 2nd Law allow it to shrink one place at the expense of someplace else? Why does it allow entropy to shrink at all? The answer is the 2nd Law is a wily cat. By allowing powerful, structured energy to concentrate one place, while displacing useless, spread out, dissipated, drained of exergy, energy someplace else, the law more effectively, more efficiently, produces what it wants, more entropy. The way this happens can be seen on the level of physical and chemical phenomena, including house demolishing tornadoes, autocatalytic chemical reactions like the Belousov-Zhabotinski (BZ) color flipping, chemical clock, lasers, the vast cyclonic order in Hurricane Sandy that devastated the northeastern U.S. on October 29, 2012, and the spontaneous self-organization of what came to be known as Bénard cells (Robbins, 2013).

THE BÉNARD CELL PHENOMENON

The formation of Bénard cells (Nicolis and Prigogine, 1989) is a surprisingly easy to see case-in-point of self-organizing dissipative structures, an order out of chaos phenomenon that is central to the coming about of life. The phenomenon was explored at the turn of the 20th century by the French physicist, Henri Bénard (1874-1939), in a series of experiments conducted in 1900 for his Ph.D. dissertation (Bénard, 15 Mar. 1901). Bénard placed slivers of fluid with different properties (e.g., viscosity, volatility) in a circular metal container. The upper surface was open to the air and the lower subjected to uniformly homogenous circulating steam heating (Aubin, 2008; Westfried, 2006). Before being heated, the fluid was in a bland condition, devoid of significant gradients. While there were small fluctuations from one place to another, the temperature was pretty much the same throughout. But then as Bénard applied heat to the bottom surface, a significantly measurable hot to cold, bottom to top gradient, non-equilibrium situation began to emerge.

When the temperature difference was small, heat was transferred through the fluid by random, molecule bumping molecule, thermal diffusivity (conduction) of energy. Because heat transfer by way of thermal diffusivity is relatively inefficient, it cannot keep up with the energy pouring in

Anthropocene as Sustainability Conundrum

from the bottom surface. As Bénard continued to apply heat, the gradient began to increase. Suddenly something startling happened. At a critical point when the temperature difference became great enough (the Marangoni number, a measure of the balance between destabilizing surface tension gradients driven by temperature difference and opposing thermal diffusivity, density, and viscosity forces, crosses a threshold), the fluid became unstable. Slow, inefficient, molecule bumping molecule heat transfer was spontaneously transformed into far more efficient, self-organized, rotating, highly structured, hexagonal patterns of cellular vortices (tourbillons cellulaires) that came to be known as Bénard cells.³

The spontaneous appearance of coherent patterns involving more than ten trillion billion (10^{22}) molecules of swirling liquid is a remarkable uptick of structural order (Schneider and Kay, 1995, 165). That order of vast numbers of linked molecules acting in concert that together form a system, represents a shrinking of entropy in the universe. But since the 2nd Law will not allow entropy to shrink all by itself, the environment of the Bénard cell system must more than compensate. In fact when Bénard cells form, the heat being transferred through the fluid sharply increases. Since the heat transfer after Bénard cells form is much more rapid, a lot more heat has to be produced by the fuel, consuming it much faster, producing entropy much faster. Thus the formation of order as Bénard cells more efficiently gives the 2nd Law more of what it wants. This is why the 2nd Law not only allows the formation of dissipative structures like Bénard cells, it wants them to form and not just to ephemerally form (when the heat is removed, the Bénard cells, along with the bottom to top gradient, quickly disintegrate) but to sustainably form as a reliable means of producing what it wants. That self-organizing sustainable means of maximizing the production of entropy, concisely expressed by Rod Swenson, in “The Law of Maximum Entropy Production [LMEP] or Why the World is in the Order Production Business”, is life (Swenson, 1998; Robbins, 2013).⁴

NATURE ABHORS A GRADIENT

Schneider and Kay captured the thermodynamic drive towards life by claiming that “nature abhors a gradient” (Schneider and Kay, 1995, 170; Schneider and Kay, 1989, 19-23). A gradient,

³ In 1916, John William Strutt, Lord Rayleigh, provided a theoretical foundation for a variation on the phenomenon—the sliver of liquid is contained between two plates—in which the destabilizing force is buoyancy and the critical threshold for the onset of convection is the Rayleigh number. The experiment Bénard conducted came to be known as Bénard-Marangoni convection (Schatz, 7 July 1995).

⁴ A simple illustration for both children and adults illuminating the power of a dissipative structure in the form of a vortex to more effectively degrade an existing gradient is the “Tornado in a Bottle” demonstration in which two soda bottles are connected, one on top of the other. When the upper bottle is partially filled with water and allowed to drop by drop disorganized drain into the lower bottle, it takes many minutes to fully empty into the lower bottle (if it drains at all). But give the upper bottle a little shake and twist and a highly organized whirlpool forms that completely drains the upper bottle in seconds, thus degrading the elevated water gradient far more effectively (Schneider & Sagan, 2005, 131). Just as a heated bottom plate produces the hot to cold gradient in a sliver of fluid, elevated water in the upper bottle represents a not-in-equilibrium (NET) system. It possesses exergy as high quality energy that, when extrapolated to a waterfall or dam, can be usefully transformed into electricity that can, via technology, run a train or charge your smartphone. And just as self-organizing Bénard cells, as dissipative structures, radically escalate the rate of heat being transferred that in turn far more effectively burns up the fuel that’s producing the heat, likewise, the vortex that drains the upper bottle of water much faster than glug glug draining, also far more efficiently drives the water in upper bottle gradient towards equilibrium in the lower bottle where it can no longer produce useful work (unless a still lower bottle is connected). Though the two processes on the surface seem to have little in common, they are in fact relationally self-similar manifestations of matter self-organizing to degrade existing gradients, whatever form those gradients, those differences that can make a difference, take.

Anthropocene as Sustainability Conundrum

as defined above, is “any difference that makes a difference.” The 2nd Law not only allows gradients in particular systems, as organized patterns of matter and energy like living cells, or organisms as organized patterns of cells, or ecosystems as hierarchically organized patterns of organisms and their sustaining environments “in which every organism either supports or is supported by other organisms in the system” (Sayre, K. M., 2010, 56), to rise up, to self-organize, it *wants* them to rise up as a more efficient means of dissipating the sum total of differences that can make a difference in the universe than is the random drift towards equilibrium, the state of maximum entropy where there are no gradients, no differences significant enough to make a difference.

According to Schneider and Kay, the reason why dissipative structures like Bénard Cells form is that when exposed to a driving force—a gradient like the hot to cold temperature difference produced by heat—systems do not like being driven away from equilibrium. They want to remain inert. In their words:

As systems are moved away from equilibrium, they will utilize all avenues available to counter the applied gradients. As the applied gradients increase, so does the system's ability to oppose further movement from equilibrium [italics in the original] (Schneider and Kay 1995, 165).

Schneider and Kay call this the “restated second law;” manifested in chemical systems as irritation at being disturbed from the comfort of equilibrium, it is known as Le Chatelier’s principle and is a version of the 2nd Law as it applies to open systems that exchange energy and/or matter with their surroundings. So if a chemical system is subjected to a temperature increase, say from a reaction that produces heat (exothermal), the system will organize itself to resist the temperature increase (the reaction will move in the direction of absorbing the heat). If subjected to a change in pressure (at constant temperature), “the chemical equilibrium of reactions [will adjust] to oppose the pressure change.” The late, great, Brown University thermodynamicist, Joseph Kestin, called it “the principle of spite,” (Schneider & Sagan, 2005, 76) one that parents, trying to get their kid to not do something, might recognize (Robbins, 2013).

NO LONGER A SURPRISE

What Schneider and Kay (and Schneider and Sagan in depth in their book) contend is that despite the universal slide to equilibrium, to ever increasing loss of differences that make any difference, given the right conditions, under the impress of a gradient of some kind, temperature difference, pressure difference, concentration difference..., the 2nd Law not only allows order as potent, useful, transformable configurations of matter and energy (Erwin Schrödinger’s negative entropy), (Schrödinger, 1944, Ch. 6) to self-organize in a particular system, it, as we said, *wants* it to self-organize. The system, like the spontaneously forming Bénard Cells in a sliver of fluid subjected to a temperature gradient, self-organizes to try to move the system back towards equilibrium more effectively by dissipating the applied gradients. “The stronger the applied gradients,” Schneider and Kay write, “the greater the effect of the equilibrium attractor. The more a system is moved from equilibrium, the more sophisticated are its mechanisms for resisting being moved from equilibrium...” With respect to the emergence of life, they contend that “No longer is the emergence of coherent self-organizing structures a surprise, but rather it is an expected

Anthropocene as Sustainability Conundrum

response of a system as it attempts to resist and dissipate externally applied gradients which would move the system away from equilibrium. Hence we have *order emerging from disorder* in the formation of dissipative structures” (Schneider and Kay, 1995, 165).

“CAUSING EVEN MORE DISORDER”

Schneider and Kay propose that not only can gradient degrading, exergy dissipating, entropy producing, self-organizing order spontaneously emerge from disorder in physical or chemical systems, the same self-organizing processes apply to living organisms to ecosystems, to Life. “Life,” as Schneider and Kay put it, “can be viewed as a far-from-equilibrium dissipative structure that maintains its local level of organization at the expense of producing entropy in the environment...

[It] is a response to the thermodynamic imperative of dissipating gradients. Biological growth occurs when the system adds more of the same types of pathways for degrading imposed gradients. Biological development occurs when new types of pathways for degrading imposed gradients emerge in the system. This principle provides a criterion for evaluating growth and development in living systems... [Biological] systems develop so as to increase their energy degradation rate, and that biological growth, ecosystem development, and evolution represent the development of new dissipative pathways... This emergence of organized behavior, the essence of life, is now understood to be expected by thermodynamics. As more high quality energy is pumped into an ecosystem, more organization emerges to dissipate the energy. Thus we have *order emerging from disorder* in the service of causing even more disorder (Schneider and Kay, 1995, 167,168, 170).

All living organisms, including ecosystems of living organisms are dissipative structures self-organized to more and more effectively degrade gradients. For plants the bottom line gradient is the sun to earth temperature difference.⁵ For animals that eat plants and other animals the gradient is the exergy, the ordered, available, useful energy and materials that can be degraded via consumption. It bears repeating that to go on living we have to eat. What we eat is the exergy in the food that we need and excrete the rest that we don't. Our food suffers the dissipative hit that allows us to move uphill, or just stay in place by maintaining our inner order, against the rising tide of universal entropy (Robbins, 2013).

ENTER TECHNOLOGY / THE ANTHROPOCENE

Order emerges from *disorder* in the service of causing even more disorder. This matter of fact claim has profound implications going forward as the exponentially concentrating order in technology emerges from the disorder of state of the art not yet realized. The truth as matchup between reality and claim can be seen in our accelerating collective human impact on the biosphere

⁵ As Schneider and Sagan note in *Into the Cool*, “The real gradient [being degraded] is between Earth and outer space; that is the gradient to be minimized. The Earth’s ecosystem (the biosphere) extracts exergy from the sun’s input while reducing the gradient between earthbound living systems and the 2.7 K background heat of the universe. The ecosystem must be viewed as an active element with processes and structure, configuring itself to capture and degrade as much exergy as possible. In the rain forests, multiple canopies of leaves collect energy all the way to the forest floor, where broad-leaved ground hugging plants extract as much of the remaining exergy as possible” (Schneider & Sagan, D., 226).

Anthropocene as Sustainability Conundrum

during the Anthropocene.⁶ Case in point: climate change thanks to our technology enabled and driven flash fire consuming of the concentrated solar energy in fossil fuels. The innovated order in fossil fuel extraction, manipulation, distribution, and use technology (as in SUVs, power plants, container ships, cruise ships, central air conditioning, circuit boards, televisions, laptops, smartphones...) emerges from the disorder of unrealized technical means causing the disorder of both irreversible consumption in a tiny sliver of time of accumulated exergy that took millions of years to form and the global scale production of heat trapping greenhouse gas.

As everyone knows, or should know were it not for powerful vested interest organized climate change denial, the earth's climate is changing (Gillis, 15 June 2015). In fact, it is changing a lot faster than computer models predicted. According to the National Snow and Ice Data Center (NSIDC), on September 16, 2012, the extent of Arctic sea ice hit a record summer minimum of 1.32 million square miles, 300,000 square miles less than the previous low measured in September 2007. According to NASA Goddard Space Flight Center climate scientist Claire Parkinson, "Climate models have predicted a retreat of the Arctic sea ice; but the actual retreat has proven to be much more rapid than the predictions." In the middle of July 2012, satellite data analyzed by scientists confirmed that 97% of Greenland's surface ice melted. "Glaciologist, Lora Koenig, a member of the Goddard Space Centre research team analysing the satellite data says melting events of this type occur every 150 years or so. However, if the trend continues, it will be very worrying" (Bishop, 2012).

So what does the massive melting of arctic sea ice do? It opens up opportunities for delighted fossil fuel exploiting corporations to drill baby drill, offering our species a quantum leap in the direction of consuming and pumping more of what the biosphere doesn't need, risking what concerned climate scientist, James Hansen, says could be a crossed tipping point to out of control global warming (Hansen, et al., 2008). That tipping point may be getting closer as on Thursday, May 9, 2013, carbon dioxide, for the first time, reached an average daily level above 400 parts per million at the oldest monitoring station in Hawaii, a level U.S. federal scientists say has not been seen since the Pliocene epoch, at least three million years ago.. According to Maureen E. Raymo, a scientist at Columbia University's Lamont-Doherty Earth Observatory, there was a lot less ice then, and a lot more water in the ocean, with sea level estimates ranging "from 10 meters (33 feet) to 40 meters (131 feet) higher than today" (Kunzig, 9 May 2013). In an interview with *The New York Times*, she said that "It feels like the inevitable march toward disaster" (Gillis, 10 May 2013; Robbins, 2013).⁷

⁶ Anthropocene (Anthropo for "man" and cene for "new"), popularized by atmospheric chemist and Nobel laureate Paul Crutzen in 2000, is continuing to stir dispute between geologists and environmental advocates over when the epoch began or, as some stratigraphers argue, if it began. Officially, "according to the International Union of Geological Sciences (IUGS), the professional organization in charge of defining earth's time scale, we are in the Holocene ("entirely recent") epoch, which began 11,700 years ago after the last major ice age. But that label is outdated, some experts say...because humankind has caused mass extinctions of plant and animal species, polluted the oceans and altered the atmosphere, among other lasting impacts." *New York Times* reporter and blogger, Andrew Revkin, who coined a similar term ("Anthrocene") that didn't quite stick back in 1992, captures the need for this new epoch best, claiming that "Two billion years ago, cyanobacteria oxygenated the atmosphere and powerfully disrupted life on earth...But they didn't know it. We're the first species that's become a planet-scale influence and is aware of that reality. That's what distinguishes us" (Stromberg, J., 2013). (Given that influence can be gathered, to a major degree, under the umbrella of planet scale production of entropy, Entropocene might be a better term.)

⁷ "The year 2014 ranks as Earth's warmest since 1880, according to two separate analyses by NASA [National Aeronautics and Space Administration] and National Oceanic and Atmospheric Administration (NOAA)

Anthropocene as Sustainability Conundrum

ACCELERATING RETURNS (But to Whom? To What?)

What Ray Kurzweil's accelerating returns of the technical order, "the technium", as *Wired* "senior maverick", Kevin Kelly calls it in his latest book, *What Technology Wants*, (Kelly, 2010) represents is the, autocatalytic, feeding on itself ("Matthew Effect")⁸, cascading S-curve, doubly exponential ("the rate of exponential growth—the exponent itself—grows exponentially") (Kurzweil, 2005, 41, 43, 44) focusing of power as radically rising differences that make a difference in technical systems and techniques. But since the 2nd Law will not allow the sum total of differences that make a difference to escalate, the racing rising of technical power must and will be compensated by even more radically degrading of gradients in the environments of the powering up systems.

- An environment that not only includes "the sixth extinction," (Weisman, 2013; Kolbert, 2015; Ceballos, 19 June 2015; North, 23 June 2015), as in other species being driven to extinction at 1,000 times pre-human levels (Wilson, 12 Dec. 2001), as in the ongoing slaughter of thousands of elephants by poachers for the ivory in their tusks (Christie, Oct. 2012).
- An environment that not only includes Beijing, where the density of dangerous PM2.5 "airborne particles small enough to deeply penetrate the lungs" rises to 40 times the World Health Organization's recommended concentration limit (Conner, 13 Jan. 2013) and New Delhi, which, according to the World Health Organization, has the most polluted air in the world (Harris, 8 May 2014; World Health Organization, 2014; Harris, 29 May 2015).
- An environment that not only includes that record summer minimum of Arctic sea ice and 97% of Greenland surface ice melted coupled to an average daily CO₂ level that for the first time in three million years exceeded 400 parts per million.⁹
- It's an environment that includes us; our shrinking hippocampi (Robbins, 2011; Carr, 2014); illness from obesity threatened bodies (Nestle, 2002; Critser, 2003; Kessler, 2009; Barrett, 2010;

scientists...The 10 warmest years in the instrumental record, with the exception of 1998, have now occurred since 2000. (NASA, NOAA Find 2014 Warmest Year in Modern Record, 16 Jan 2015).

⁸ "The "Matthew Effect" draws on a verse in the Gospel of Matthew 13:12: "For whosoever hath, to him shall be given, and he shall have more abundance: but whosoever hath not, from him shall be taken away even that he hath." The term was coined by Columbia University sociologist, Robert Merton, and captures "cumulative advantage," the commonly observed tendency for initial advantage to feed on itself autocatalytically. Citing Jared Diamond's remark in *Guns, Germs, and Steel* that 'technology begets more technology,' Daniel Rigney writes in *The Matthew Effect: How Advantage Begets further Advantage*, that "the history of technology offers numerous examples of this 'autocatalytic process,'" a process that catalyzes itself (Rigney, 2010, 31). The autocatalytic advancement of technology ties in with what Robert Ulanowicz termed "ascendancy" as the measure of autocatalytic selection in evolving systems (Schneider and Sagan, 2005, 99-102). The Matthew Effect has deep seated links not only with doubly exponential advancement in the "creative destruction" of technology driven gradients but in how the universe works at the deepest levels, as in the gravitational accruing of matter into larger and larger bodies (the greater the mass the greater the attraction), including moons, planets and stars. In fact, the successful recent flyby of Pluto and its moons depended on the Matthew Effect to scoop up "space-dust", tiny particles that could destroy the New Horizons spacecraft zooming through the system at more than 30,800 mph (almost 50,000 kph).

⁹ In 2015, the Arctic sea ice *maximum* extent "was the smallest on the satellite record and also one of the earliest. While the record maximum "does not necessarily lead to a record low summertime minimum extent" the winter maximum "gives you a head start." <https://www.nasa.gov/content/goddard/2015-arctic-sea-ice-maximum-annual-extent-is-lowest-on-record/>

Anthropocene as Sustainability Conundrum

Moss, 2013);¹⁰ lead poisoned children, with increasing cancer rates, neurodegenerative disease, reproductive disorders, diabetes tagging along, thanks to 100,000 synthetic chemicals in the environment and food chain (Robin, 2011, 2014); “Alone Together” (Turkle., 2011) texting ‘till you drop, absent presence degrading social structures (Greenfield, S., 2015); rich getting richer, middle class eviscerating, cumulative advantage capitalizing, artificial intelligence / robotics driven, long tail / Zipf’s law, with increasing exponent, distributed (Zipf, G. K., 1949, 1965), economies without jobs (Kroft, 13 Jan. 2013; Condon and Wiseman, 23 Jan. 2013; Ford, 2015, Nourbakhsh, July/Aug. 2015; Brynjolfsson and McAfee, July/Aug. 2015)...

THE ILLUSION THAT HOOKS

Realize it or not, gradients are what we are. As an algorithm for the creation of power churning order, technology can be viewed in the frame of gradients. With respect to we humans, that power is both sustained and grown by feeding on extractable gradients in our environment – food – and deploying the acquired exergy in the building and maintaining of internal power enabling structures of brain, body, and relationship through mental, physical, and social exertion. Effort maintains and raises inner gradients. When a technology comes along eliminating that effort, pandering to the Principle of Least Effort (Zipf, 1949, 1965; Tétard and Collan, 2009; Robbins, 2006), the deep-seated urge to minimize calorie consuming exertion that once made survival sense in a world sans food-on-demand, what it is in effect doing is degrading the exertion generated difference that makes a difference. Thanks to increasing reliance on technology to do more and more of the work, the advancing sum of losing it for not using it exertion removal, is weakening our mental, physical, and social muscles by rendering their exercise unnecessary, enfeebling us through ever increasing loss of the need to use, rendering us ever more dependent, collectively and individually ever more deeply in the grip of addiction to the promise of convenience, the dependency that consumes, the illusion that hooks, (Robbins, 2013).

If we look back on the argument of Schneider and Kay “that life is a response to the thermodynamic imperative of dissipating gradients” and throw in that the evolving technium is, as both Kelly and Kurzweil claim, the accelerating returns of evolving extending, we can substitute revenue growth (money as proxy for access to order, to exergy acquired, controlled, and sold) and technological development in their contentions. So then:

[Revenue] growth occurs when [the, say, online/casino gambling industry] adds more of the same types of [hooks and schemes] for degrading [gambler wallet] (Dow Schüll, 2012; Robbins, 2007). [Technological] development occurs when new types of pathways for degrading imposed gradients [boss assigns job as gradient, the difference between idea and realization, between need and fulfillment, between to be done and done, is removed] emerge...[as in plain vanilla rotary phone, now apps for all in ubiquitous smartphone; as in plain vanilla, black and white, now TV on-demand, anywhere, anytime; as in plain vanilla, pull the handle, now video poker, in “the zone” anywhere, anytime] (Dow Schüll, 2012; Streitfeld, 17 Feb. 2013; Martinez, 18 Feb. 2013)...[Technological] systems develop so as to increase their [human] exergy [and money] degradation rate, and that [technological]

¹⁰ From an energy perspective, one might view globally rising obesity as an epidemic scale squandering of the exergy in food and health.

Anthropocene as Sustainability Conundrum

growth...[represents] the development of new dissipative pathways...As more high quality / high exergy energy is pumped into [technology] more organization emerges to dissipate the [exergy in the multitudes clamoring for next new new's exertion removal]. Thus [we can see technology as] "*order* emerging from *disorder* in the service of causing even more disorder [in us and the children and the worlds we and they will carelessly touch] (Postman, 1985; Postman, 1992; Robbins, 2013).

STEREOGRAM

You can think of it as the conceptual equivalent of a stereogram. When you first look at the stereogram it's just a blur of disconnected shapes. But then, if you look at the meaningless muddle in a particular way, a strange 3-D image congeals. The key to seeing the 3-D image in the stereogram is a technique of viewing that helps the brain create order, or better, to see the order that's been built into the apparent disorder. But, here we're not looking at seemingly random shapes in a stereogram, we're trying to congeal an image, a shape, a pattern that motivated Pope Francis to claim in his recent Encyclical Letter, *Laudato Si'*, that "The Earth, our home, is beginning to look more and more like an immense pile of filth" (I.21), a claim that meshes with the observation by ecological economist, Herman Daly, that "[t]here is something fundamentally wrong with treating the earth as though it were a business in liquidation" (Daly, 1977). It points to more than the conventional earth. We are the earth, though pitiful few recognize the linkup; how we treat the earth today zooms around full circle and becomes how we long term treat ourselves and vice versa. While, as recent research confirms, Chief Seattle never uttered the words "All things are connected. Whatever befalls the earth, befalls the sons and daughters of the earth," Ted Perry did, the misattribution does not negate the truth. The by and large unseen dissolution now underway, as per the title of Paul Krugman's *The Great Unraveling: Losing Our Way in the New Century*, is not only an inconvenient reality in the biosphere, with its mounting litany of ills attributable to its convenience as a pump for human consumption and a dump for human wastes, it is the truth inside of us, especially the offspring of us, as we become the willing, indeed, eager, participants in an ongoing process of boarding up the windows on ourselves. We don't see what's going on not only because we're all so wrapped up in our own cubicles, so bedazzled by the glossy promises of the next new new, so otherwise engaged thumbing, flicking, clicking, selfie sticking, but also, or mainly, because distraction central goes all out to see to it that there's no one upstairs uninterrupted long enough to begin connecting the dots.

As Langdon Winner, Thomas Phelan Chair of Humanities and Social Sciences in the Department of Science and Technology Studies at Rensselaer Polytechnic, put it in *Autonomous Technology: Technics-out-of-Control as a Theme in Political Thought* back in technology's ancient past, 1977:

[Members] of the technological society actually know less and less about the fundamental structures and processes sustaining them. The gap between the realities of the world and the pictures individuals have of that world grows ever greater. For this reason, the possibility of directing technological systems toward clearly perceived, consciously chosen, widely shared aims becomes an increasingly dubious matter. Most persons are caught between the narrowness of their everyday concerns and a bedazzlement at the works of civilization. Beyond a certain point they simply do not know or care about things happening in their surroundings. With the overload

Anthropocene as Sustainability Conundrum

of information so monumental, possibilities once crucial to citizenship are neutralized. Active participation is replaced by a haphazard monitoring. Thus, the technological order and its major subcomponents, through paths already traced, are free to take on a character of their own, which determines their destination. What one finds therefore, are highly developed systems of control, which are themselves beyond intelligence, beyond control...

The most important consequence of this situation is that, in a fundamental way, the whole society runs off track. The idea that civilized life consists of a fully conscious, intelligent, self-determining populace making informed choices about ends and means and taking action on that basis is revealed as a pathetic fantasy (Winner, 1977, 295-296).

The central difference between then and now, more than 38 years downstream, is that the gaps between world realities—ongoing climate change, mass extinctions, draining aquifers, 40 times WHO recommended concentration limits of PM2.5 airborne particles—and the pictures members of the technological society have in their heads, have grown at the pace of Kurzweil's accelerating returns, not exponentially, exponentially-exponentially. If the overload of information was so monumental, if our everyday concerns were so narrow, if we were so bedazzled with technology – the works of civilization – back in '77 – no Internet, no personal computer, no cell phone, no smartphone, no social robots (Guizzo, 16 July 2014)..., when text followed by ing was just bad grammar and an application was a form you filled out for a job, when people talked to each other over dinner and children imagined their way out of boredom, inventing games in vacant lots, when people knew phone numbers, consulted maps, consulted locals, stored routes in their hippocampus and didn't need the refrigerator to order more milk, how narrow in our concerns, how bedazzled, how helpless without an app, how ignorant of the fundamental structures and processes sustaining us are we now?¹¹

Langdon Winner believes Mary Shelley's quotation from *Paradise Lost* at the opening of *Frankenstein* captures its essence: "the plight of things that have been created but not in a context of sufficient care" (Winner, 313). The plight of Victor Frankenstein, Winner argues, is the plight of us, his problems "have now become those of a whole culture." Frankenstein discovers, but refuses to ponder implications. "He is a man who creates something new in the world and then pours all of world with no real concern for how best to include it in the human community" (Winner, 313).

Like today's scientists at the leading edge, engaged in the bringing about of artifacts that mimic living processes, artifacts on nano-scales that will, given the right breakthroughs, self-assemble through living cell like reproduction, or artificial natural organisms that give us what we want, or think we want, or have been convinced to want, thanks to innovation luminaries such as Craig Venter and crew's menagerie of genetically twisted, gradient resurrecting, 2nd Law conquering, bugs released into "the air and the water, into smokestacks and oil spills, hospitals and factories,"

¹¹ One of the barriers standing in the way of enabling a sustainable future (Robbins, 2010) is recognizing where most people's heads are at, what concerns them, what draws their attention, what hooks their attention. Out of curiosity, mainly, since 2009 (2/8/09-7/16/15), I have been logging approximately daily, the top ten search terms on Yahoo's "Trending Now." Though this is by no means a rigorous scientific longitudinal investigation, out of more than 18,000 search terms logged, the number of times "global warming" was in the top ten was two (2/10/10 and 11/7/11, none after 2011). "Climate change" appeared three times (6/18/09, 9/22/09, 6/25/10, none after 2010). "Rihanna" appeared 27 times, "Miley Cyrus," 47 times, "Kate Gosselin," 36 times, "Taylor Swift," 36 times, "American Idol," 24 times, "Kim Kardashian," 60 times, Barack Obama, 9 times...

Anthropocene as Sustainability Conundrum

sucking up pollution, “soaking up sunlight and urinating automotive fuel,” cleaning up toxic wastes, fighting global warming, living in “factories and farting fresh air” (Hylton, 30 May 2012)—Victor Frankenstein brought to life an artifact with powers previously only associated with humans. He is terrified when his creation manifests an autonomy he didn’t count on, an autonomy that exacts vengeance for being dealt the hand of injustice by his creator, whose only wish is to wake up from the nightmare, and all will be as it was. But it is too late, as one by one all that he loves is taken from him.

Winner asserts that Frankenstein’s problems “have now become those of a whole culture.” Today, 38+ years of accelerating returns are beginning to reveal that the consequence of extreme specialization coupled to blind faith in the automatic benevolence of where technology is taking us, a kind of mass sticking of heads in the sand, is creating a technical order that, one by one will take from us all that we love. Thanks to “a pervasive ignorance and refusal to know, irresponsibility, and blind faith...toward the technical,” we are releasing “powerful changes into the world with cavalier disregard for consequences.” We use apparatus, technique, and organization “with no attention to the ways in which these ‘tools’ unexpectedly rearrange” us. We “willingly submit the governance of [our] affairs to the expertise of others.” We “participate without second thought in megatechnical systems far beyond [our] comprehension or control.” We “endlessly proliferate technological forms of life that isolate people from each other and cripple rather than enrich the human potential.” We “stand idly by while vast technical systems reverse the reasonable relationship between means and ends.” Above all, we have “come to accept an overwhelmingly passive response to everything technological. The maxim ‘What man has made he can also change’ becomes increasingly scandalous” (Winner, 314).

A LEG UP ON WHAT’S STANDING IN THE WAY

Expressed in the conceptual frame of order (Arnheim, R., 1971; Kuntz, P. G., ed., 1968; Sayre, K. M., 2010, 14-25), its flows and ebbs, concentrations and dissipations, excesses and deficits, inequities and maldistributions, our “pervasive ignorance and refusal to know, irresponsibility, and blind faith...toward the technical,” as we release “powerful changes into the world with cavalier disregard for consequences” with apparatus, technique, and organization and little to no attention to the ways in which these ‘tools’ unexpectedly rearrange” us, what we see is a disorder of orders. In the absence of an impending sense of crisis, focusing on the ups and downs of local orders takes precedence, i.e., business as usual. People collectively and individually define the spheres into which they will pour their attention and effort, bracketing off impacts and consequences as externalities swept off the table of concern. The clash of local and global orders is a major panel in the portrait of unsustainability. Whenever local order is created the 2nd law goes to work creating chaos someplace else.

As Tim Allen and Thomas Hoekstra point out in “Toward a Definition of Sustainability,” “Defining sustainability is not simple because it must apply to many ecological and social situations” (Allen and Hoekstra, 1993). What is sustainable for one vested interest, say sustained maximizing of profit for an oil company, is not for another, say the fate of indigenous peoples living on islands in the Pacific Ocean threatened by rising sea levels as side effect of oil company profiting handsomely from fossil fuel consuming. This clash of vested interest based orders—ecological, social, technological—is, at bottom, a manifestation of vying dissipative structures, on all scales, local and global, in all contexts, within us, among us, and thanks to us.

Anthropocene as Sustainability Conundrum

Across the board of scales and apps, an ongoing, exponentially threatening clashing of competing vested interest orders is creating, an ongoing, doubly exponential threatening disorder of orders one of whose manifestations is what Garrett Hardin (1915-2003) called “the tragedy of the commons” (Hardin, 1968), where competitors, acting in their own apparent self-interest destroy a commons that everyone needs, and everyone loses, only with a twist. In a variant proposed by mathematician, Daniel Fife in “Killing the Goose” (Fife, 1970), a commons, as a far from equilibrium gradient, is being degraded to equilibrium, as in, say, a species of fish rendered extinct thanks to industrialized overfishing, a rainforest being wiped out thanks to clear cutting to make way for cattle ranches, a biodiversity sustaining biosphere crossing a tipping point to runaway global warming, thanks in no small degree to the flash fire burning of fossil fuels, or, for that matter, human mental, physical, and social order thanks in no small degree to technology removing the need for mental, physical, and social exertion, but someone, some vested interest, some powerful business interest, is making a killing, releasing “powerful changes into the world with cavalier disregard for consequences.”

In this paper what I am proposing is that advancing technology in all of its myriad instantiations is what might be characterized as a meta-dissipative structure, a nested, networked, hierarchical collection of dissipative structures, concentrating order, and the power that order confers, in its hardware and software and in those on whom it depends (for now) for further development – the creative disruptive innovators, engineers, scientists, elite technologists, venture capitalists, mega-multinational corporations, cutting edge startups... - while discharging entropy, degrading gradients into its/their environment(s) to meet the demand of the classical statement of the 2nd Law that the sum total entropy in the universe always goes up, never down. If it goes down one place, as in, say, a smartphone, or GPS app, it must and will go up in the environment of the smartphone, the environment of the app. What is the environment of the smartphone? What is the environment of the app, the totality of apps? Answer: it is the brain of the user of that smartphone losing the neural connections that would have been made had the brain done the work; it is the user of the GPS app that does the navigational work, dissipating the “cognitive map” order that would have been created in the hippocampus had the traveler found his or her way without turn by turn (Robbins, 2011).

What does this have to do with a sustainable biospheric future, a future not excluding us? The answer is the tie-in is fractal, it is relationally self-similar up and down the scales of escalating techno-dependency in the Anthropocene. If we, in our own lives, are strongly drawn to taking paths that minimize food energy consuming exertion, letting the technology do more and more of the work for us, we are also collectively, on all levels, drawn to take paths that minimize exertion. And that’s the problem. We are failing to successfully and sustainably reduce greenhouse gas emissions because it would take more effort to reduce the emissions than just carrying on business as usual. It is also easier to rely for most of our energy on fossil fuels than it is to make a concerted, global, effort to slow and then stop using coal, oil, and natural gas, than to seriously embark on the non-least effort path of total overhaul to renewable sources. Why do we rely on and use fossil fuels? Because extracting and consuming fossil fuels, as concentrated, high exergy, solar energy gives the 2nd Law more of what it wants, more efficiently, more conveniently. Entropy. The entropy of irreversibly degraded fossilized solar energy. The entropy of spread out, eviscerated, degraded solar energy in carbon dioxide emissions on a vast and still growing global scale.

Anthropocene as Sustainability Conundrum

SO THEN

If Schneider and Kay are correct in their claim that “nature abhors a gradient,” life both came about and autocatalytically evolved on all its myriad trees, branches, stems, and leaves... as open thermodynamic systems, with order “emerging from *disorder* in the service of causing even more disorder.” To sustain the process, unlike such transient phenomena as the formation of Bénard cells, or tornadoes, and thus sustainably carry on gradient destruction more and more effectively and efficiently, there was Schrödinger’s “order from order” as the passing on of the gene means from generation to generation of what works.

Before the Anthropocene, the complex cycles of energy, and material flows in the biosphere were so efficient at capturing high quality solar energy that exergy in the form of fossil fuels accumulated over millions of years in vast amounts. What the order from disorder to even more disorder process, sustained by the order from order passing on of success,¹² did was sustainably extract maximal amounts of solar energy by re-emitting energy as close to usefulness exhaustion as possible.¹³

So far so good. Aeons pass until one day we humans come along with our big brained cleverness. We capture fire, we organize food production in agriculture, allowing specialization, the exponential increasing of our numbers along with the concentrating of populations in towns and cities, we create science based medicine, and then discover and techno-extract the accumulated exergy in fossil fuels. Thanks to the doubly exponential rising accelerating returns of techno-gradients, our numbers and per capita consumption soars as we irreversibly degrade the concentrated solar exergy in a truly tiny fraction of the time it took to form.

So then, what was once a complex, ongoing, sustainable, extracting of solar exergy so efficient that biospheric exergy increased over vast stretches of time, has now been flipped on its head by our species at an accelerating pace in the Anthropocene. Instead of gathering and accumulating exergy, our collective grabbing and degrading of existing sources of exergy becomes too fast for sources of replenishment to keep up. We have become the agents of entropy in the Entropocene. We give the 2nd Law what it wants.

¹² Though Jeffrey Wicken quibbles with Schrödinger’s “mechanical order-from-order interpretation of [the]connection between information and operation,” he concurs with Schrödinger’s “recognition that the strategy of living systems somehow involved their orderly utilization of informational structures to maintain a remote-from-equilibrium coherence through metabolic pathways of dissipative activity” (Wicken, 1987, 42). Citing Kant’s conception of an organism as “a natural purpose,” as Wicken saw it, that “‘natural purpose’ is an informed autocatalytic system or AO—a system with an internal organization of kinetic relationships able to maintain itself by pulling environmental resources into its own production. The fact that an organism behaves as its own end and means through participation in the dissipative flow of nature...suggests a deep connection between self-organization and the Second Law” (Wicken, 1987, 31). I propose that this AO process is carrying on in the realm of advancing technology, we humans, elite producer and consumed consumer, being environmental resources pulled into servicing technology’s own end and means.

¹³ As Schneider and Kay point out, the temperature of reflected solar energy from a quarry is much higher than it is from the canopy of an old growth forest. Citing research by Luvall and Holbo that measured surface temperatures of various ecosystems using a Thermal Infrared Multispectral Scanner (TIMS)...one unmistakable trend [emerged. When] other variables are constant the more developed the ecosystem, the colder its surface temperature and the more degraded it’s reradiated energy...A quarry degraded 62% of the net incoming radiation while the 400 year old forest degraded 90%.”

Anthropocene as Sustainability Conundrum

But there's more. So ravenous has the concentrating of exergy in technics become that, elites excepted for now, drawing on the knee-jerk¹⁴ equating of technical progress with human progress, ever "smartening" technology is degrading us as it increasingly substitutes for the mental, physical, and social exertion needed to sustain and organize our brains, bodies, and face to face relationship skills. The modus operandi is the principle of least effort under the massively advertised illusion that the more technology does for us the better our lives.

While the degrading of human order is by no means uniform, as technology, the double-edged sword, really does do things for us, freeing us up to do and be and create what we could not do and be and create otherwise, with elites on the high end of the benefit to harm distribution benefitting far more than most because they allow the technical order to translate empowering effort far more than they look to it to eliminate effort, most, unfortunately, take the path of least exertion and let the technology do the work. Since human effort is what sustains and develops brains, bodies, and in-depth relationships, the rising sum of technology that is eliminating those efforts is, in effect, degrading the far from equilibrium gradients in brain, body, and bond.

In terms of the two weights wrapped around pulley metaphor of the 2nd Law, the falling weight, as falling exergy, as degrading gradients, as rising entropy, is pulling up the rising weight of the technical order along with the elite technologists exerting huge efforts to bring about the ever increasing order in technical systems. The result is the accelerating returns of technology is creating ever escalating Matthew Effects, the rich are getting richer across the board of power, access, skill, jobs, money, at the increasing expense of the vast bulk of humanity who only think that their smartphone always at and in hand is doing it all for them. The losing it for not using it dissipation of inner human gradients creates ever deepening addictive dependency that spills into the biosphere driving it, an us, in the direction of no difference that can make any difference. Long run, as Bill Joy warned in *Why the Future Doesn't Need Us*, this is not good (Joy, B, Apr. 2000).

EPILOGUE

If the bulk of humanity communicated and acted with the cohesiveness of a flock of fast moving birds swooping and soaring in concert, sustainability wouldn't be a problem. If overpopulation is the problem, as a species we would get the message and go to work reducing the burden of sheer numbers. If our collective rate of non-renewable resource consumption is the problem, the species would work as a team to phase out its consumption and phase in renewable replacements. If unequal distribution of the support structures for life is the problem, those who have more than they need would immediately set about seeing to it that their less fortunate brothers and sisters around the world began getting their fair share. If the drug of ceaseless economic growth is the problem, concerted measures to reduce frivolous consumption and selective increases in needed consumption would spontaneously arise. Unfortunately, barring global catastrophe, this degree of global cohesiveness in service of sustainability is not going to happen anytime soon. Before any sense of unified purpose, an order of orders,¹⁵ targeting the creation of a dynamically sustaining

¹⁴ "System 1" in *Thinking Fast and Slow* by Nobel Memorial Prize in Economic Science winner, Daniel Kahneman.

¹⁵ In "Global impoverishment, sustainable development and the environment: a conceptual approach," Gilberto C. Gallopin, Pablo Gutman and Hector Maletta adopt a "concept of sustainable development that "does not postulate the conservation of nature in its original state as a primary goal. It implies, instead, a pattern of development

Anthropocene as Sustainability Conundrum

future can even begin to be achieved the forces working against it must be fully entertained and encountered (Robbins, 2010). Humanity is feverishly working at cross purposes with its own survival as a species. We must understand why.

Sustainability implies stability, a dynamic balancing of forces and counterforces, consuming and replenishing. But, advancing technology is a disorder of orders generating force, an inherently destabilizing, much celebrated disrupting power, a thrust whose very essence is at odds with the ebbs and flows and returning cycles of use and replenishment. If advancing technology fueled gradient consumption and the sustainable future are oxymoronic; if the human species has indeed unleashed an apparently uncontrollable force whose primary manifestation is ongoing dissipation of coupled human and biospheric order, why does it seem that so few recognize what's going on? And the answer is: we're so wrapped up in our personal affairs, so overworked in our sliver specialized producer hats, so mentally ad-bottomized in our distraction without letup consumer hat, so flicking and scrolling, texting and gaming, smartphone forever in hand glued, that there's no gap between flicks sufficient for a sustained connect the dots realization that the ship of unbridled autonomous technical advance on which we're partying is sailing on an accelerating current heading for the falls.

There is only one competition and one game the team of life - ourselves not excluded - has no choice but to play. The game is our never ending affair with the 2nd law. As the yet to be discovered existence of life elsewhere should tell us - but hasn't - the game is being played with a heavily stacked deck. On one blue dot in the vastness, where everything fit together Goldilocks right, life, for an impressive number of innings got the edge. With more power than wisdom, we're successfully losing that edge. "The fact," as Kenneth M. Sayres writes in *Unearthed: The Economic Roots of Our Environmental Crisis*, "that humanity at large discharges more entropy per capita into the biosphere than any other species [must figure] prominently" (Sayre, K. M., 2010, 46) in any proposed paths to a sustainable future, paths that must include the technology driven, consumption churning, entropy being discharged into us.

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minimizing (or reversing) the degradation or destruction of the ecological basis of production and habitability." While the goal is on target, given that "development" implies a concentrating of order with its 2nd Law necessitated displacement of degraded exergy that the authors gather under the umbrella of "impoverishment" of people and the environment, achieving that goal, given "that nature abhors a gradient," and the reality of dissipative structures, which they embrace as a conceptual approach to engaging the roots of impoverishment and its role in unsustainable development, requires an order of orders not easily or sustainably realized (Gallopín, Gutman and Maletta, 1989, 394).

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