

Entropy and the Second Law of Thermodynamics - May 18 2014

Just as the Law of Cause and Effect explains the consequences of an action, the Second Law of Thermodynamics, explains the necessity for expenditure of human energy. Frequently, energy is defined as the capacity to do work. Further, the energy capable of doing work may be described as free, available, useful or concentrated. But the concept runs much deeper. Energy and matter are interchangeable; energy is the raw material of the universe - the driving force behind the working of the universe. Without energy, there is no life, no universe – nothing but unimaginable chaos.

Energy manifests itself in different forms: namely, heat, sound, light, mechanical, chemical or electrical. Each of these forms can be harnessed to produce work. But for energy to accomplish any useful work, it has to move from an area of higher concentration to one of lower concentration. In so doing, however, energy becomes degraded to a less useable form (practically useless); thus, less concentrated means less useful and vice versa.¹

The transformation of energy from a useable to a less useable form, namely heat, is referred to as entropy. Reduced to its simplest terms, entropy may be defined as a measure of randomness or disorder of a system: it quantifies the extent of degradation that energy undergoes as it changes to its less useable form.

Closely associated with energy consumption are the laws of thermodynamics. The First Law of Thermodynamics states that the total energy content of the universe is constant. That is to say, energy cannot be created or destroyed, only transformed. The Second Law states that energy flows from a state of higher concentration to one of lower concentration; from orderliness to randomness. Moreover, the total entropy of a system is constantly increasing and entropy always tends towards a maximum, or equilibrium.² Unquestionably, since energy and matter are interchangeable, the inescapable conclusion is that the universe, including humans and other animals, is all energy.

The Second Law of Thermodynamics also referred to as the Law of Entropy. Veteran scientists treat this law with reverence for it can be both a simple and a mesmerizingly inscrutable concept at the same time. Professionals in the discipline have often remarked the more they study the field the more mystifying it becomes. One of the reasons for its enigmatic character is that it is expressed in negative terms. Hence for most practical applications, positive entropy is counterproductive whereas negative entropy is productive. There are myriad ways of expressing the ideas surrounding the entropic concept. This fleeting glimpse into the phenomenon attempts to provide the reader with a

¹ Hokikian Jack. 2002. The Science of Disorder: Understanding the Complexity, Uncertainty, and Pollution in Our World. Los Feliz Publishing. Los Angeles. Pp 8

² Hokikian Jack. 2002. The Science of Disorder: Understanding the Complexity, Uncertainty, and Pollution in Our World. Los Feliz Publishing. Los Angeles. Pp 29

passing comprehension of this all pervasive natural law that governs the working of universe and our personal lives.³

As an all-embracing phenomenon of nature, entropy deals with the intrinsic operation of the universe and comparable in significance to other well-known phenomena such as gravity, time and electromagnetism.⁴ Considered the ultimate Natural Law, it explains why time moves from the dead past to the dynamic present; why a drop of dye spontaneously disperses in water; and why money is so easily dispersed. Among other things, it is a disorganizing force; it runs contrary to human effort.

In keeping with the Law of Entropy it is natural for disorder to increase, never the reverse. Consequently, entropy may be intuitively understood as a measure of natural progression from order to disorder. Statistically, it describes the number of arrangements that are available to a system. It also enables one to predict whether a chemical process will occur and the direction it will follow. Since it deals with the initial and final states only, knowledge of the pathway taken for a reaction is irrelevant.

The extent to which energy has lost its capacity to perform useful work is also a measure of entropy. By way of illustration, the notion of a perpetual motion machine is untenable. The functioning of any such system will generate energy losses at each stage of its various processes: friction and dissipated heat, to name two. Thus to keep a perpetual machine functioning, fresh concentrated energy needs to be continuously infused.⁵ Not only is the idea implausible, but the working of such a system would violate both the first and second laws of thermodynamics as it would assume 100% efficiency. To provide you a reference point, the Ford Escort utilizes only 17% of its energy to propel the car, whereas 38% is emitted as polluting exhaust waste.⁶ A system boasting 100% efficiency is operationally impossible, for no system can convert all its working energy into productive work. In this regard, entropy describes the energy changes occurring within a system and addresses the extent to which the energy in the system has progressed from a state of non-equilibrium to a state of equilibrium, or maximum entropy. It is also a calculus of molecular disorder and a measure of the energy spent during transformation from one energy state to another – from heat energy to mechanical energy or vice versa. Eventually all forms are irreversibly reduced to a lower quality more dispersed form of heat energy.⁷

Heat energy is dispersed and thus an irretrievably useless form of energy unavailable for doing work. Ultimately, even solar energy becomes dispersed and unable to perform useful work. Hence entropy measures the extent of energy dispersal. Consistent with the Entropy Law all energy forms move from an ordered to a disordered state. When the energy concentration of a system is highest the available energy is at a maximum. That is

³ Hokikian Jack. 2002. The Science of Disorder: Understanding the Complexity, Uncertainty, and Pollution in Our World. Los Feliz Publishing. Los Angeles. Pp 48-50

⁴ Electromagnetism governs the principles of electricity, magnetism and light frequencies.

⁵ http://www.ftexploring.com/energy/2nd_Law.html Retrieved May 4, 2014

⁶ Hokikian Jack. 2002. The Science of Disorder: Understanding the Complexity, Uncertainty, and Pollution in Our World. Los Feliz Publishing. Los Angeles. Pp 208

⁷ http://www.physics4kids.com/files/thermo_laws.html Retrieved May 4, 2014

to say, its entropy is lowest. Available energy decreases every time work is performed while the unavailable energy is accumulated in the form of dissipated heat energy and polluting material wastes.

Commercial production⁸ and associated consumption are entropic activities. Quantitatively, raw production materials equal the amount of material waste products that is ultimately returned to the environment, albeit a qualitative difference exists between both. The latter is more randomized. Entropy is the measure of that qualitative difference.

Murphy's Laws are often a comical depiction of entropy: *Anything that can go wrong will go wrong*; or *Left to themselves, things tend to go from bad to worse*. In entropic terms, *left to themselves things spontaneously move to more disordered states*. Murphy's Laws are poignant reminders of the volatility of nature that often stumps human efforts. Collectively, they are a depiction of events inspired by the most fundamental of all natural laws – the law of entropy.

According to the principles of the second law, in a closed system⁹ some of the energy is dissipated and becomes unavailable but entropy can never decrease. The corollary being that in such a system the available energy can never increase.¹⁰ For example, during energy transformation – say, mechanical energy to electrical energy to light energy – invariably energy becomes degraded to unusable heat energy. Like an energy tax, some of it is lost forever. The energy stored in a tire under pressure will spontaneously spread out to an area of lower pressure, given the opportunity. That energy will flow from a higher to a lower concentration until it reaches an equilibrium point.¹¹ It is an inexorable tendency unless a biological or mechanical means is used to contain it.

Consider a system composed of two abutting bodies, one hot the other cold. Heat will invariably flow from the hot body to the cold one, never the other way around. The driving force behind this transfer of heat energy is entropy.

A gasoline-powered combustion engine transforms chemical energy into mechanical energy, heat, and other chemical pollutants emitted in exhaust fumes. Irretrievably lost, these end products of internal combustion cannot be recombined to synthesize gasoline. The simple rationale being that heat energy generated by the combustion of gasoline has achieved an irreversible state of randomization. Combustion has changed a low-entropy concentrated resource into a high-entropy dispersed form and this energy transformation from one state to another is accompanied by a loss of usable energy. Entropy accounts for that loss of usable energy.

⁸ Production is a process using energy to add order to matter.

⁹ There are three types of systems: isolated, closed and open. An isolated system exchanges neither matter nor energy with its environment. A closed system, like the earth, exchange energy but whereas an open system exchanges both matter and energy with its environment.

¹⁰ <http://www.panspermia.org/secondlaw.htm> Retrieved May 4, 2014

¹¹ Thermodynamic equilibrium, the state of a thermodynamic system which is in thermal, mechanical, and chemical equilibrium

It is not only heat energy that flows from a high to low concentrations. Indeed all energy forms naturally flow from a higher to a lower density and ultimately equalize at a point where entropy has reached its maximum, and free energy – the energy to do useful work - is no longer available. For energy to do work, there must exist a differential. For instance, when water at a higher level falls to a lower level its kinetic energy can be harnessed to spin a turbine which in turn can be used to generate electricity. At the lowest possible level, the water has no free energy. Its energy is now said to be randomized, dispersed or in the state of equilibrium and cannot be mobilized to perform work. Similarly, wind moving from a high pressure to low pressure can be used to turn wind turbines and produce electricity. Without a difference in atmospheric pressure this phenomenon would not have been possible. This inability to perform useful work is seminal to understanding the concept of entropy.

In more practical terms, *entropy measures waste produced when work is done for improvement of the quality of human life: [whether it is] the struggle of the species in an ecosystem, the biological reactions of a living organism, even the politics of a societal system.*¹²

Indeed it takes energy to produce energy. But available energy stores are being rapidly exploited and used up. It is morally unjustifiable to consume energy at the current rates without jeopardizing the well-being of future generations. Left unchecked, technological end-products will randomize vital life-sustaining molecules eliminating myriad of species in the process. To enhance human well being and ensure a more livable environment, no effort should be spared to combat the degradational forces of entropy. Protecting existing public buildings, maintaining the highways, power lines, power generating plants and sewer systems without encroaching forested and wilderness areas, are a handful of ways the environment can be protected from the force of entropy. There are others.¹³

THE IMPACT OF A LOW-ENTROPY LIFE ON THE ENVIRONMENT

All life exists by extracting energy from the environment. The dissipated energy is then returned to the environments in the form of toxic waste. A polluted environment blocks the flow of energy causing social disorders including poor health. Yet thanks to technology, humans are living longer and enjoying a better quality of life. At the same time, however, technology has increased traffic congestion as well as biological, physical and chemical pollution. For example, in 1998 US companies mined 7.2 billion tons of gold ore of which only 0.00033% was converted into gold. The rest, including mercury used in processing, ended up as toxic waste products. The ultimate result is general environmental degradation.¹⁴ The proliferation of toxic waste dumps and barren tacks of

¹² Rifkin Jeremy. 1989. *Entropy: Into the Greenhouse World*. Bantam Books. Revised Ed. Pp 180.

¹³ Hokikian Jack. 2002. *The Science of Disorder: Understanding the Complexity, Uncertainty, and Pollution in Our World*. Los Feliz Publishing. Los Angeles. Pp 165-168

¹⁴ Hokikian Jack. 2002. *The Science of Disorder: Understanding the Complexity, Uncertainty, and Pollution in Our World*. Los Feliz Publishing. Los Angeles. Pp 49-50

land are evidence of the adverse effects of technological advancement on the environment. Natural flora, contaminated by waste, induces unwanted genetic alterations, eliminate entire species, and threaten others with extinction. In brief, the air, water, soil, and food are all vectors of chemical pollutants. In this chemical matrix, humans and other species are supposed to live and thrive. The empirical evidence suggest otherwise: the impact on human existence are manifested in accelerated aging, disease proliferation and general organic decay. By comparison to rural areas, cities with higher waste generation have higher incidences of suicides, schizophrenia, neuroses, crimes, cancers, heart diseases, bronchitis, and personality disorders. People are more hostile, more selfish and crimes are more abundant.^{15,16}

Problems of Rapid Urbanization

For a variety of reasons, more than 50% of the world's population lives in urban areas. However, many aspects of rural living support a healthier lifestyle. Among some of the benefits are dense social networks, strong social bonds, shared life experiences, higher quality of life, neighborly reciprocity and a cleaner environment.

In the distant past, most deaths were caused by infectious diseases, degenerative diseases, and violence. People did not survive long enough to be afflicted by chronic conditions such as heart disease, diabetes, Alzheimer's and cancer. Today, people are afflicted with a double burden of both infectious and chronic diseases mostly found in areas of rapid urbanization - the reason being that low population densities are unable to sustain the transmission a contagion over long periods. However, in urban areas of increased population densities, people are living in closer proximity and in often unsanitary environments; hence an enhanced probability of disease transmission. In addition to higher rates of infectious diseases, poor air quality, rapid urbanization has led to poorer living and working standards, and thus a greater prevalence of chronic and infectious diseases.¹⁷

In one of the largest study to date, from 2000 to 2007, researchers have found an association between reductions in fine particulate matter from exhaust emission and improved life expectancy in 545 counties in the U.S which suggests that exhaust emissions are responsible for a host of death-inducing ailments.¹⁸

A comparison of urban and rural Puerto Rican men found that rural residents had a lower average blood pressure, serum cholesterol, blood sugar, heart rate and body weight compared to their urban counterparts. They were also more active physically and the incidence coronary heart disease (CHD) for urban residents was 1.5 times that of rural

¹⁵ Rifkin Jeremy. 1989. *Entropy: Into the Greenhouse World*. Bantam Books. Revised Ed. Pp 170-171.

¹⁶ Hokikian Jack. 2002. *The Science of Disorder: Understanding the Complexity, Uncertainty, and Pollution in Our World*. Los Feliz Publishing. Los Angeles. Pp 59

¹⁷ http://www.uniteforsight.org/global-health-university/urban-rural-health#_ftnref20 Retrieved May 13, 2014

¹⁸ <http://www.sciencedaily.com/releases/2012/12/121203163538.htm> Retrieved May 13, 2014

men; that the more rural the area the lower the rate of CHD; whereas the greater the urbanization the greater the incidence CHD.¹⁹

Apparently, rural residency positively impacts mental health as well. A 12-month cohort study conducted in England, Wales and Scotland found that rural residents had better mental health than their non-rural counterparts.²⁰ In general, large cities have a higher incidence of crime, physical and mental disorders. According to published data, when cities grow to more than 100,000 residents' physical and mental disorders proliferate alarmingly.²¹

Global warming is but another symptom of the entropy catastrophe. According to a Canadian press release of May 2014, the glaciers of British Columbia are losing 22 cubic kilometers of ice a year, or about 22 billion cubic meter of water. The global decline in glacial and ice-sheet volume is predictably one of the largest contributors to global rise in sea-levels and attributable to rising temperatures.²² These concerns needs be addressed urgently. Pandering to big oil, the current Canadian Government, however, has made effete attempts at addressing the pernicious effects of climate change.

Without awareness of the detrimental effects of entropy, the masses will continue to unknowingly squander precious resources that even they can ill afford. Awareness of the earth's peril would encourage individuals to consume less. For a start, people have to learn that every day is Earth's Day; that they should turn off lights, water, radio, TV, computer etc. Consumerism is not the answer; rather it is the cause of present day environmental tragedy. It is an assault on the environment. Learning to live with less should be a national obsession.

Obesity, diabetes and cardiovascular disease have reached epidemic proportions. As indicated before, most Americans have a BMI bordering on obesity. Infrequent physical activity is a major contributor to these pathologies. The automobile should be the option of last resort. They are expensive, inefficient, consume massive amounts of energy and pollute. The enormous energy expenditure required to manufacture a single automobile is itself mind-boggling. Moreover, their disposal contributes enormously to soil, air and water pollution.

Citing Amish models, several studies have indicated that labor-intensive agricultural practices are more productive than high-energy based mechanical farming. An ox and plow is much more efficient per unit of expended energy than are the highly mechanized

¹⁹García-Palmieri, Mario et al. 1977. Urban-rural Differences in Coronary Heart Disease in a Low Incidence Areas: The Puerto Rico Heart Study. *Am. J. Epidemiol.* 107 (3): 206-215.

²⁰Weich, Scott, Liz Twigg, Glyn Lewis. 2006. Rural/non-rural Differences in Rates of Common Mental Disorders in Britain: Prospective multilevel cohort study. *The British Journal of Psychiatry.* 188: 51-57

²¹Rifkin Jeremy. 1989. *Entropy. Into the Greenhouse World.* Revised Edition. Bantam Books. Toronto. Pp. 250

²²Canadian Press. May 18, 2014 (<http://www.cbc.ca/news/canada/british-columbia/unprecedented-b-c-glacier-melt-seeps-into-u-s-climate-change-concerns-1.2646742> Retrieved May 18, 2014)

farms in the US. Whereas a peasant produces 10 calories for each calorie of energy expended, the American farmer expends 10 calories for every calorie he produces.^{23,24,25}

Wherever necessary, it may be helpful to cultivate organically grown fruit and vegetables. It has been established that the yield per acre derived from organic farming is comparable to that of chemical farming. While organic farming consumes 6,800 BTUs for every dollar output conventional methods devour 18,400 BTUs.²⁶ By reducing dependency on highly mechanized chemical based agriculture and substituting with human labor will no doubt reduce reliance on imported non-renewable energy and reduce green house gas emissions.

Consumption of organic products protects the air, soil, water and fellow creatures from exposure to insecticides, herbicides and fungicides. Of the more than 700 chemicals used as pesticides, 90% ends up in the soil and water or become airborne. Almost 500 are found on tomatoes, apples, grapes, lettuce and other vegetables.²⁷ The indiscriminate use of pesticides is inimical to the biosphere. The Sierra Club of Canada estimates that more than 34 million kilograms of pesticides are used annually across Canada. Neurotoxins from the pesticides have been linked to memory loss, learning disabilities and neurodegenerative diseases such as Parkinson's disease. Widespread pesticide use has also been associated with leukemia, lymphoma, brain, kidney, breast, prostate, pancreas, liver, lung, skin cancers, birth defects and fetal death.^{28,29}

Consumption of raw and green fruit and vegetables whenever practical conserves energy. These are not only environmentally friendly practices but the right thing to do. Whole grains, fruit and vegetables have been amply demonstrated to be healthful; whereas meat consumption is economically, environmentally and nutritionally unsound.³⁰ According to the WorldWatch Institute,³¹ *[m]assive reductions in meat consumption in industrial nations will ease the health care burden while improving public health; declining livestock herds will take pressure off pastures and agricultural lands. Lowering meat*

²³ Daly, H.E and Cobb Daly. 1989. For the Common Good. Beacon Press. Boston. Pp. 272.

²⁴ Rifkin Jeremy. 1989. Entropy. Into the Greenhouse World. Revised Edition. Bantam Books. Toronto. Pp 154.

²⁵ Hokikian Jack. 2002. The Science of Disorder: Understanding the Complexity, Uncertainty, and Pollution in Our World. Los Feliz Publishing. Los Angeles. Pp 221-223

²⁶ Rifkin Jeremy. 1989. Entropy. Into the Greenhouse World. Revised Edition. Bantam Books. Toronto. Pp 248

²⁷ Rifkin Jeremy. 1989. Entropy. Into the Greenhouse World. Revised Edition. Bantam Books. Toronto. Pp 194.

²⁸ <http://www.sierraclub.ca/national/programs/health-environment/pesticides/index.shtml> Retrieved May 13, 2014

²⁹ http://en.wikipedia.org/wiki/Health_effects_of_pesticides Retrieved May 17, 2014

³⁰ Hokikian Jack. 2002. The Science of Disorder: Understanding the Complexity, Uncertainty, and Pollution in Our World. Los Feliz Publishing. Los Angeles. Pp 221-223

³¹ The Worldwatch Institute: An environmental research organization. The Institute's objectives are: access to renewable energy and food; creation of environmentally friendly jobs; transformation of cultures from consumerism to sustainability; and reduction of population growth.

*consumption will allow more efficient use of land and water resources, while at the same time making grain more affordable to the world's chronically hungry.*³²

*Animals fed on grain and those which rely on grazing need more water than grain crops. According to the USDA, growing crops for farm animals requires nearly half of the U.S. water supply and 80% of its agricultural land. Animals raised for food in the U.S. consume 90% of the soy crop, 80% of the corn crop, and 70% of its grain. The result is that producing animal-based food is typically much less efficient than the harvesting of grains, vegetables, legumes, seeds and fruits, though this might not be largely true for animal husbandry in the developing world where factory farming is almost non-existent making animal based food much more sustainable.*³³

Studies have found that city water is as safe as bottled water. In addition, water purification systems consume enormous amounts of energy. Filtration, bottling, transportation, refrigeration and disposal of plastics unnecessarily increase waste and global entropy. Diethyl phthalates are used as plasticizers in the manufacture of consumer plastics. They leach into the very products they are meant to protect. Studies have indicated that diethyl phthalates can damage the nervous system and the reproductive organs in males and females.³⁴ No one questions the health benefits of water consumption. It hydrates, flushes away noxious metabolites and reduces the cravings for sugary drinks such as soda pops, tea or coffee. If the consumption of city water provides a health benefit, then the benefit to the environment is even greater. Consider the energy required to manufacture, transport and dispose of cups, plastic stirrers, paper napkins, sweeteners, coffee makers, milk dispensers and refrigeration systems. This indiscriminate expenditure of energy becomes most startling considering that the greater the energy flow through the environment the greater the chaos; the greater the disruption to the flora and fauna of the biosphere.³⁵

But there is more to high entropy living; it affects all facets of our lives, including very structure of the society in which we live. As dissipated energy flows through society, *there is degeneration in its moral force, its spiritual stamina, the vigor of its character, the effectiveness of its character, the effectiveness of its religion and the sense of law and order*, observers proclaim.

Cancer villages

Current estimates are that more than 60% of all cancers in the US are environmentally induced.^{36,37} The situation is worse in developing countries. Consequent to its high

³² http://en.wikipedia.org/wiki/Environmental_vegetarianism Retrieved May 18, 2014

³³ http://www.new-age-guide.com/new_age/environmental_vegetarianism.htm Retrieved May 18, 2014

³⁴ http://en.wikipedia.org/wiki/Diethyl_phthalate Retrieved May 18, 2014

³⁵ Rifkin Jeremy. 1989. Entropy. Into the Greenhouse World. Revised Edition. Bantam Books. Toronto. Pp 168

³⁶ Rifkin Jeremy. 1989. Entropy. Into the Greenhouse World. Revised Edition. Bantam Books. Toronto. Pp 204-205.

pollution levels, China's cancer mortality rates have risen 80% over the past 30 years, making it the country's leading cause of death. In cities, toxic air is the primary suspect; in rural areas, it is the soil and water. More than 70% of the country's rivers and lakes are heavily contaminated; almost half contain water that is unfit for human contact.³⁸

The 1,000-kilometer Huaihe River runs through Henan, Anhui and Jiangsu provinces. Since the 1980s these provinces have experienced rapid growth but at a steep human cost. Leather, paper and plastic industries have polluted the ground water creating a rising epidemic of cancer along areas of the Huaihe, Henan Province. Piles of accumulated toxic waste on the banks of the Shaying River, the Huaihe biggest tributary, are the cause. Several villages along the Shaying have been savaged by cancer as a result contaminated water. In one of the most severe cases, the lung cancer mortality rate of local women increased twenty-fold from 1973 to 2005 in Shenqiu County, Henan Province. The cancer incidence in affected areas of the Huaihe was found to be 50 percent higher than the national average in 2004-05.³⁹

Conservatively, the estimated number of cancer villages is as high as 400, the Chinese Government has reluctantly admitted. China's water pollution is visibly rampant - a cursory stroll through any of China's cities will be enough convince the worst skeptic. Of China's 40,000 chemical plants, 23% of the hazardous plants were situated within five kilometers of drinking water sources. In an attempt to clean up its water, the Government authorities has spent \$112 billion from 2005-2010, yet 43% of the monitored water is still toxic. Reports on factories dumping massive quantities of toxic waste into groundwater supplies made groundwater pollution an issue, especially after internet-users started posting photographs of polluted rivers. Even Government figures acknowledge more than 300 million people regularly drink polluted water. The adverse impact of environmental pollution is clearly visible in the cancer village of Xiditou, near the port city of Tianjin, where the cancer rate is 30 times the national average, due to water and air contaminated by a spate of chemical factories.⁴⁰

China's smog-filled cities regularly make headlines in the Western press. As of 2011, Beijing's lung cancer rate leapt 60% higher than the 10 years prior. Chinese researchers looking into the 2011 winter's smog epidemic found that 800 million people were affected over an area of 540,000 square miles – about half the size of Argentina.⁴¹ The net entropic effect is that cancer is the cause of 25% of all deaths; moreover there has been an 80% surge in the mortality from cancer over the past 30 years. Experts predict that lung cancer rates will continue to soar because of air pollution.⁴²

³⁷ <http://www.cancer.gov/cancertopics/understandingcancer/environment/AllPages> Retrieved May 12, 2014

³⁸ <http://www.theguardian.com/world/2013/jun/04/china-villages-cancer-deaths> Retrieved May 11, 2014

³⁹ http://usa.chinadaily.com.cn/china/2013-08/08/content_16878735.htm Retrieved May 11, 2014

⁴⁰ <http://www.telegraph.co.uk/news/worldnews/asia/china/1519927/Villages-doomed-by-Chinas-cancer-rivers.html> Retrieved May 11, 2014

⁴¹ <http://qz.com/55928/china-now-has-up-to-400-cancer-villages-and-the-government-only-just-admitted-it/> Retrieved May 11, 2014

⁴² <http://www.telegraph.co.uk/news/worldnews/asia/china/9887413/China-admits-pollution-has-caused-cancer-villages.html> Retrieved May 11, 2014

The entropic effects of waste accumulation impact the environment, personal lives and social institutions, including the health care. According to Rifkin, 75-80% of medical conditions will heal spontaneously or are unresponsive to drug therapy. The FDA has a list of approximately 800 active ingredients that are combined to produce more than 100,000 over-the-counter (OTC) drug products. Of these, more than 50% have no scientifically demonstrable merit.^{43,44}

Drugs are not benign chemicals. Each year in the US, adverse drug reactions (ADRs) are the cause the death, hospitalization, or serious injury of more than 2 million people. Of these there are more than 100,000 fatalities. In fact, ADRs are one of the leading causes of death in the US. It is estimated that in addition to the 1.5 million people a year who are admitted to hospitals because of ADRs, 770,000 additional patients develop ADRs post-admission annually: that is, 2,000 patients a day. The life-threatening reactions included irregular heart rhythm, kidney failure, hemorrhaging, and hypotension. Patients with these adverse reactions had a twofold higher risk of mortality compared to other hospitalized patients without ADR. Significantly, close to 50% of these ADRs were preventable. Among some of the preventable problems were drug-drug interactions (from drugs that should not have been prescribed together in the first place) and known allergies to the drugs. Pooling the numbers, would mean that more than 2.2 million people a year, or 6,000 patients a day, suffer adverse reactions.^{45,46,47}

In addition to ADRs, approximately 1.3 million people are injured annually in the United States through medication errors. An FDA-sponsored study of fatal medication errors from 1993 to 1998 revealed that the commonest errors involving medications were related to administration of improper dosages, accounting for 41% of fatal medication errors.⁴⁸ Lucian Leape, a former surgeon and professor at the Harvard School of Public Health who began studying unnecessary surgeries after a 1974 congressional report estimated that there were 2.4 million cases a year, killing nearly 12,000 patients. Unfortunately, as of 2013, things have not changed much, he claimed.⁴⁹ And the US does not have the monopoly in the commission of medical errors. A report by the Canadian Institute for Health Information (CIHI), indicate that the chances of patients receiving the wrong medication or wrong dose was about 1 in 10 in 2005 and an estimated that 9,000

⁴³http://en.wikipedia.org/wiki/Food_and_Drug_Administration_%28United_States%29#Scope_and_funding Retrieved May 11, 2014

⁴⁴Rifkin Jeremy. 1989. Entropy: Into the Greenhouse World. Revised Ed. Bantam Books. NY. Pp 200-205

⁴⁵http://www.worstpills.org/public/page.cfm?op_id=4 Retrieved May 11, 2014

⁴⁶ Lazarou J, Pomeranz B.H., and Corey PN. 1998. Incidence of Adverse Drug Reactions in Hospitalized Patients: a Meta-analysis of Prospective Studies. JAMA. 279(15):1200-5.

⁴⁷<http://truedemocracyparty.net/2014/01/american-holocaust-adverse-drug-reaction-adr-preventable-death-public-health-crisis-100000-preventable-medical-deaths-per-year-1-million-deaths-over-10-years/> Retrieved May 19, 2014

⁴⁸<http://www.medicinenet.com/script/main/art.asp?articlekey=55234> Retrieved May 11, 2014

⁴⁹<http://www.usatoday.com/story/news/nation/2013/06/18/unnecessary-surgery-usa-today-investigation/2435009/> Retrieved May 11, 2014

to 23,000 Canadian patients die yearly owing to preventable medical and surgical errors.^{50,51}

My own cynicism of the medical profession stems from my belief that it has been hijacked by Big Pharma. They ghost write scientific papers, produce textbooks, are quick to medicalise seemingly innocuous conditions (e.g. restless leg syndrome), corrupt scientific research, distort findings as befit their needs, overdose our medical professionals with drug literature of dubious value, and resort to monetary inducement to ensure their brands are prescribed. In prescribing, Canadian doctors rely on the CPS – a compilation of monographs produced by, you guessed it ...the drug companies. In a recent news report, the head of the Canadian Medical Association chastised its membership for relying too heavily on the data provided in the CPS. One has to wonder why. The story of Australian Nobel Laureate, Barry Marshall would convince the reader that the pharmaceutical companies and the established medical profession do not always work in the best interest of patients. Despite verifiable evidence of the causative role of *Helicobacter pylori* in gastric ulcers, Dr. Marshall was roundly ridiculed by the big drug companies and the medical profession. Today countless lives and dollars are being saved as a result of his pioneering work.⁵²

The Vioxx story is another scandalous misrepresentation by the ethical drug companies. Vioxx, a non-steroidal anti-inflammatory drug (NSAID), was withdrawn over concerns of increased fatal heart attacks and stroke. An FDA-Approved drug, it was used to treat osteoarthritis and acute pain conditions. Over 80 million people were given the drug worldwide. Despite a flurry of complaints by medical professionals and at least one daring FDA scientist, Merck, the manufacturer, only agreed to withdraw the drug after disclosures that it withheld information about risks from doctors and patients for more than five years. Indeed Merck had known of potential lethal side effects even before launching Vioxx in 1999. The net result is that its usage caused between 88,000 and 140,000 cases of serious heart disease of which about 44% died, although some believe the number is closer to 500,000. In the year before withdrawal, Merck had sales revenue of US\$2.5 billion from Vioxx.^{53,54}

Being blessed with good health, and an even healthier dose of skepticism, I steadfastly refused to submit myself to routine medical check ups. In 2011, however, less than three months after my decision to enlist the services of a physician I was diagnosed with pancreatic cancer. Just coincidence, may be. Questioning the results, I ask the attending physician for confirmation. He was as emphatic as he was clear. *This is confirmatory evidence*, he snapped, jabbing his fingers into the lab report for emphasis. The news was devastating, albeit not a proclamation of death. I was given a fighting chance on

⁵⁰http://www.ctv.ca/servlet/ArticleNews/story/CTVNews/20070814/medical_errors_070814/20070814?hub=Canada Retrieved May 19, 2014

⁵¹ Andersen Erin. Friday, Feb. 24 2012. When Doctors Make Bad Calls. The Globe and Mail

⁵² Atwood Kimball. 2004. Skeptical Inquirer. Bacteria, Ulcers and Ostracism. 286.6 Nov/Dec.

⁵³ <http://en.wikipedia.org/wiki/Rofecoxib> Retrieved May 14, 2014

⁵⁴ <http://mathbabe.org/2012/02/15/how-big-pharma-cooks-data-the-case-of-vioxx-and-heart-disease/> Retrieved May 14, 2014

condition that I submit to a 12-hour surgical procedure called Whipple - named after the pioneer of the technique. Assuming survival, I would have been a total diabetic. Post surgical collateral damage would have compromised my pancreatic integrity making me dependent on replacement hormones and digestive enzymes. But how does one argue effectively against laboratory evidence? I was persuaded that before and after diagnosis I felt well. My physical health had not deteriorated. I was into a regular exercise program, and walked regularly. There were no palpable lumps, appetite was normal, no pain and no irregular numbers in the blood work etc. With time, my skepticism of the *confirmed* diagnosis increased. Screwing up my courage, I pleaded my case with the operating surgeon, practically demanding a retest. A reasonable man, he saw through my arguments and agreed. After months of enduring a battery of tests, retests, biopsies, blood samples, X-rays, ultrasounds, CT scans, MRIs, and shouting nurses, the results were in - no evidence of pancreatic cancer. Caveat emptor: visit the doctor only when necessary and never accept the advice of the medical profession at face value. Read extensively on the diagnosis and prognosis and if in doubt get a second or third opinion. The technicians conducting the tests (or reading the biopsy slides) are sometimes poorly trained and can easily misinterpret negatives for positives. The consequences can be disastrous. Contrary to what you may believe, a physician's understanding of pharmacology is pathetic. Their education in this area is derived from monographs delivered by the drug companies. At best, they may be exposed to an introductory course in pharmacology. By and large they are ignorant of the drug mechanisms, pharmacological effects, side-effects, drug-drug interactions, contraindications, or drug-food interactions of the same drugs they so routinely prescribe. Of the laboratory tests they regularly prescribe, they are only trained to read the numbers. Precious few have any understanding as to how those tests are executed, their levels of sensitivity, specificity, frequency of false negatives or false positives. By doing a little homework, it is likely you can save a life – it may very well be your own. Although written more than 200 years ago, there is a startling currency in these words. *Doctors put drugs of which they know little into bodies of which they know less for diseases of which they know nothing at all*, declared Voltaire.

Like other sectors of the economy, healthcare too is subjected to the adverse effects of entropy. The public is subjected to immeasurable numbers of unnecessary medical tests, some of which are harmful to the patient. The society is over-medicated: normal active school children are routinely prescribed Ritalin. As it stands, the healthcare budgets are unsustainable. It is time to re-examine the entire system and eliminate the wastage strangulating the system. It is time to reduce the unnecessary energy consumed by the system – return it to a state of lower entropy. The whole society needs to readjust to a lower entropic living. We owe this much to the planet, to other species and to future generations.

In the words of Rifkin, *a low entropy society would view as an obscenity any economic policy that contributed to the destruction of another species. Every species must be preserved simply because it has an inherent and inalienable right to life by virtue of its existence..... The first law of ecology tells us that everything is connected to everything else.....Any destruction of one part of nature will affect all other parts, including human beings.....[T]he notion of conquering nature is replaced by the idea of harmony with the*

*environment as a whole. Individual humans have a responsibility to preserve nature to the maximum extent possible, so that those yet to come – both people and other creatures - may enjoy life in their own day. All the great teachers of traditional wisdom have embraced the values inherent to a low entropy life. Buddha, Jesus, Mohammed, the prophets of Israel, and the mahatmas of India all led exemplary lives of simplicity, voluntary poverty, and communal sharing. Their teaching expressed similar value for all of society. In our own century, Mohandas Gandhi generated an entire liberation movement base on a low entropy value system. Above all else, the low-entropy world view shows us the physical limits we face – the limits of our planet's resources and the limits we must impose on the use of technology.*⁵⁵

Entropy and human effort

Because matter naturally progresses to a state of randomness in conformity with the great law of nature, things disintegrate, degenerate, shatter, fracture, split, tear, break, break up, break down, rust, die, decay, wear out, rip, or move from a state of order to disorder. That is the natural tendency of the universe.

Order demands effort. Building of an automobile requires the assembly of a diverse disarray of about 30,000 components including screws.⁵⁶ The parts have to be ordered, sorted, tested and assembled logically into approximately 25 working systems to form a functional unit. Given time, an unused car will naturally disintegrate. Not only a car but any structure including a new building will crumble. As inane as it may appear, these structures will never reassemble from their component parts. And why not you may query? The answer lies in the second law of entropy. The molecular constituents of the structure will inexorably move to a more randomized state - from a structured entity to disordered rubble. Only through the infusion of new energy either directly or through human ingenuity are such occurrences preventable or rates reduced. Whether building a house, assembling a car, or constructing a nuclear power plant, human energy is needed to organize materials into a structured form.

Entropy works in opposition to human efforts – the reason energy must be applied to overcome the entropic forces. Unless the force of entropy is understood, efforts to counter its sinister effects will remain feeble. Therefore, knowledge of the Second Law can be universally applied to the maintenance of man's well being as well as his ability to earn a living. In short, awareness of the adverse impacts of entropy allows us the opportunity to take effective counteractive measures.

As suggested, life is only sustainable through the infusion of energy. Because living systems evolve through metabolic process they decrease entropy. They extract simple chemicals from the environment and through an anabolic process they build larger and more complex molecules to sustain life. But that requires energy. To protect and improve the quality of human life external energy must be applied to overcome entropic effects. The extent to which that energy is applied determines the degree of success. As an

⁵⁵ Rifkin Jeremy. 1989. Entropy: Into the Greenhouse World. Revised Ed. Bantam Books. NY. Pp 245-246

⁵⁶ <http://www.toyota.co.jp/en/kids/faq/d01/04> Retrieved May 9, 2014

intelligent species, we owe it to ourselves to combat personal entropy through exercise, healthful diets and healthy life style choices. These efforts are anti-entropic: they reduce and reverse the entropy effects. The results are of course better health.

Also, money is a form of energy – it represents labor. Like energy, money has the natural tendency to disperse. Therefore, building wealth requires the expenditure of human energy. There is no other way. Unless there is this continuous infusion of new energy aimed at increasing the odds of success, economic investments are preordained to fail. Strategic planning, astute management, diligent preparation and infusion of new capital are needed. In its absence, like any other natural resource, money too will spontaneously disperse. Established businesses must be innovative as well; for without the additional energy to tailor transactions to attainable goals, all business ventures will fall victim to entropy – they too will crumble. Unremitting efforts are therefore needed to protect and capitalize on financial investments, including personal property.

It is for this very reason that the Japanese have succeeded; the British have failed; the East India Company and Enron have vanished. It is for the same reason that white collar criminals, gangs, criminal enterprises, corrupt government officials and other enterprises based on the premise of easy money without the commensurate effort are predestined to failure.

The misguided efforts – or lack thereof – of all economic criminals are foredoomed. Energy input in the form of old-fashioned hard work is a necessary prerequisite – an absolute must – for building wealth. The earth's energy resources cannot be plundered to serve the greed of a privileged few. The biographies of Conrad Black, Bernard Ebbers, Bernie Madoff, Dennis Kozlowski, John Gotti, Al Capone, Pablo Escobar and John Dillinger, Robert Clive, Paul Benfield and the Enron posse are ample proof. Their activities have violated the Law and for that they paid heavily.

The anti-entropic effect of human labor is widely recognized. The Amish model is but one notable example. Looking at it from a global perspective human labor is more abundant than fossil fuel; this renewable resource should be substituted for fossil fuel.⁵⁷ It is Martin O'Connor, however, who has encapsulated the quintessential idea by his observation that *the economic activity, intended to satisfy human needs runs against the general tendency of the universe to move toward a state of greater disorder, of higher entropy. Human labor runs against this tendency toward increasing disorder of the physical world. It sets into motion the energy sleeping within nature, converts 'wild' energy into 'domesticated,' useful energy. But to make this useful energy available, a certain amount of human energy must be expended, either in the form of energy stored in machines or in the form of living human labor.*⁵⁸ To work is an opportunity to be embraced, never shunned.

⁵⁷ Daly, H.E and Cobb J.B. 1989. For the Common Good. Beacon Press. Boston. Pp. 296

⁵⁸ <http://dieoff.org/page17.htm> Retrieved May 12 2014

To close in a self-indulgent note, I share with you the wisdom of my unschooled father as he was about to thrash my sorry behind. *The easiest way to succeed*, he would bark, *is to work hard!* I wished I had listened to the old man.