Sustenance of a Joyous and Leisurely Life

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Abstract: The issue of sustainable development has come-up following intense or hard use of technology (hard-tech). Evaluation of hard-tech vis-à-vis sustenance of a joyous and leisurely life, against the backdrop of The Laws of Nature clearly shows the limitations of hard-tech.. This is a scientific evaluation, based as it is on a "systematic study and knowledge of natural phenomena" (i.e. The Laws of Nature), the dictionary meaning of 'science' [1].

As per The Law of Entropy, every technology is inherently inefficient as regards matter and energy, i.e. "the output is always lesser than the input". At every step, energy efficiency has to obey the Carnot cycle limit. In fossil-fuel based technology (hard-tech) the number of steps is very large and so there are huge losses even at the best possible efficiency. Working for inefficient hard-tech entails huge physical and mental effort (labour), harm (to health), pressures of commitments (loss of freedom), tensions, and risks for the majority of human society. Some have to carry out – **d**ifficult and/or **d**angerous and/or **d**irty jobs – or '3d jobs'.

For hard-tech we draw large quantities of raw materials (from mines) and oil from under the surface of the earth. These then continue to remain above the surface in the form of slag, rubble, scrap, goods, garbage, and other toxic and dangerous pollutants. Unwanted matter cannot be destroyed as per The Law of Conservation, and as per The Law of Entropy it always increases causing degradation of air, water, and soil quality, global warming and undesired effects thereof with the sustainability of the entire human race at stake. As per The Laws of Nature hard-tech can never ensure a joyous and leisurely life for all.

As per The Law of Entropy energy generated by photovoltaic cells, windmills, and hydro-power stations in their whole lifespan is less than the energy spent in making and maintaining them. Or, the energy generated by one photovoltaic cell does not suffice to make another photovoltaic cell of the same capacity. The same is true for windmills and hydro power stations and in harnessing all other renewable or non-conventional or 'green' energy sources. They release more green-house gases for the same job. Hence, they are neither friendlier to the environment nor a real alternative to fossil-fuels.

Automatic machines controlled by silicon-based technologies substitute humans for many jobs but we are not paid for sitting at home. Development of Silicon life is today considered subservient to us doing 3d jobs, but their superior power in data processing can, and is already enslaving humans, and may one day finish unwanted humans! (As we did with animals and other living-creatures.) So it is not just sustenance of a joyous and leisurely life, but also a dignified human life, that is at stake.

Selective use of technology; – selection being based on low cost (in terms of effort and harm) technology (**soft-tech)** and befriending diversity (for better living and beating uncertainty) is the basis of an ecological solutions that are in tune with The Laws of Nature. These will facilitate a joyous, leisurely and dignified life; in other words, sustainable development**.**

Keywords: Ecological-solution; Hard-tech; Laws-of-Nature; Self-reliance; Soft-tech

Introduction

We have started talking about sustainable development in the last few decades. We have put **technology** to **intense or hard use (hard-tech)** also during this period**.** Does this parallel development have any significance?

The study of history aims to make us aware of possibilities we don't normally consider. Historians study the past not in order to repeat it, but in order to be liberated from it. Each and every one of us has been born into a given historical reality, ruled by particular norms and values. We learn history not in order to predict the future, but to free ourselves from the past and imagine alternative destinies. Of course this is not true freedom – we cannot avoid being shaped by the past. But some freedom is better than none [2]. Let us first look at the history of technology.

Technology and its development

The animal kingdom survives and reproduces using bodily ('internal') energy generated through food, and a free supply of energy (solar light and warmth, wind, rain, etc.). In addition, human beings extensively use materials external to the body – soil, stones, and biomass as raw material. Biomass is also used as fuel for illumination and warmth, cooking, protection, processing raw materials for tools and goods, and so forth. Technology is nothing but the art and science of using such 'external' sources.

Over thousands of generations, technology has been an extra-somatic adaptation for -
1) Security – shelter for protection, and storage as 'insurance' against uncertainties.
2) Comfort – tools and processes for reducing bodily effort and burden of work-loads.
3) Entertainment –'toys' for refreshing skills, and communication for sharing joy…in this order of priority;
supposedly for living a joyous and leisurely life.

Technology usage is reflected in anatomic changes in the human body. Compared to other mammals or apes, the human brain has grown in size. It is more versatile and consumes a large part of input energy. Skills and pre-requisites for survival in nature – such as strong muscles and teeth are weakening. Body-hair and acuity of smell, hearing, night vision (by IR), and capacity to digest raw food have reduced. We could survive such changes because technologies such as control of fire, shelters and covers, tools and processing have now merged into human life. This is equivalent to natural selection – survival without them is not likely, just as birds cannot do without wings.

On the other hand, perception of insecurity, comfort, and entertainment is abstract and subjective and hence development in technology towards these ends is a never-ending process. Technologies such as agriculture, animal-use and wheel have pervaded human life but we can live/survive without them. All substantiated history dates from the advent of agriculture, animal-use and invention of the wheel. The entire human history is mostly a record of a series of created problems and attempted solutions in an ever-escalating spiral.

Fossil-fuel based technology leading to hard-tech

Easy and abundant availability of fossil fuel led to rapid development of technology in temperate-climate regions where it proved useful in combating the harsh environmental conditions. Subjectivity in defining comfort and entertainment leads to the use of technology for luxury, novelty and as fashion too. Today, the advancement of technology has gathered a seemingly unstoppable momentum in that direction, and has gone astray.

Today, almost our all necessities are met by the use of hard-tech and all have a monetary price-tag. Only ambient air is *currently* free. Obviously, **earning money** has become an absolute necessity of life. We earn money by putting in efforts and/or bearing harm.'Any activity requiring commitment of time (loss of freedom) for putting in efforts and/or bearing harm (loss of comfort) done for monetary gain' (by way of wages, fees, service charges, profits, etc.) can thus be defined as a profession or employment**.**

The entire employed human population now spends an ever-increasing time in employment and related activities. If advances in technology, sophisticated equipment, and modern management practices are for our benefit then their use should have reduced work-loads, pressures and tensions. We should really be more relaxed and spending lesser and lesser time in employment; machines/robots having taken up all the drudgery. By now, working days per week and working time per day ought to have reduced to once a week and an hour per day or less. Instead, we are busier despite machines/robots being deployed to full capacity.

Despite having technological power at their beck and call, even people at the top of the pyramid in every field – politics, administration, industry, business, media, sports, research, education and entertainment – do not enjoy their position and superiority in any comfort; they too bear crushing work-loads, pressures of answerability and tension of retaining their position and respectability. In fact, I see them as the most insecure and the most discomforted of the

lot, both physically as well as mentally. If even the socially high-ranked ones are not, then who really are the beneficiaries of hard-tech?

Work-related pressures and tensions are mounting. We are expected to work harder, meet tighter deadlines, achieve higher targets, face increasing competition, follow a maze of rules and regulations, and as if this was not enough, keep proving our worth over and over again. We are looked upon as a Resource (the exalted 'HR') just like other matter – raw material, water, and fuel. But unlike these resources, we are dispensable (replaceable by other humans and machines). When automatic machines doing more and better quality work replace us, we should actually be paid for sitting at home, but instead, we are shown the door!

In the hard-tech era some people have to work in coal mines, thermal power stations, high voltage switchyards, on transmission lines, or on tall structures. Some work on oil rigs, in refineries, in transport, handling and production of inflammables, hazardous chemicals, and radio-active materials. Some travel continuously as drivers, aircraft crew or seamen. Hard-tech also produces huge waste, involves accidents, and other emergencies. A good number of people clean sewers, collect, transport, sort and dump garbage, rubbish, debris, and scrap. Some are involved in patient-care or work in hospitals and in the fire-brigade. Army personnel work at extremely remote locations in harsh conditions for securing national borders, or capturing energy and material resources.

All the above mentioned people working at ground level may be working with proper safety-gear and adequate insurance cover, etc. but they carry out – **d**ifficult and/or **d**angerous and/or **d**irty jobs – or **3d jobs**. No amount of monetary compensation is enough for their sacrifice in terms of human-value. They are humans working like robots. Hard-tech necessitated all such jobs in the first place, and *they have hardly been eliminated by advances in technology* over the years. A significant portion of the human population has to do them. No one in the main-stream can assume immunity.

In last few decades, scientists have been reporting degradation of air, water, and soil quality on earth due to activities that are directly attributable to hard-tech. We hear of global warming, greenhouse gases, melting of glaciers and polar ice, etc. Many unpopular books and NGOs predict the potential ill-effects of such changes on our health. Their reports are very disturbing and worrying.

Many ailments are blamed on current foods and life-style. But hard-tech decides about both for us. How can we save ourselves from the toxicity of the foods we eat, the products we use and the huge waste we create around us? Dumping of waste is a major problem; how can we keep away from it?

Despite advances in science & technology illnesses, accidents, and violence are on the rise. Hospitals and pharmaceutical companies are thriving, indicating deteriorating health. Seatbelts & airbags are mandatory, meaning that travel is unsafe. How can anyone assume to always escape? Enormous risks in life inadvertently affect health.

Crowds seen at fortune-tellers' and at places of worship indicate increasing insecurity and loss of peace of mind. Rise in the number of people keeping pets shows emotional insecurity. Crowding at holiday resorts and courts-of-law shows increasing discomfort in normal life. All types of treatment and de-addiction centres are filled to capacity. Anti-depressant medications are among the top selling drugs. More and more people are unwell.

Many thinkers the world over e.g. Henry David Thoreau and Mohandas K Gandhi have objected to hard-tech development theories that do not (and assuming that they never will) address the true concerns and needs of human life and sustainability that we are talking about today. Do their ideas have any scientific validity? Let us examine.

The Economy is about goods and services i.e. matter and energy. Technology also deals with matter and energy. Physical phenomena in nature (that we exploit for our purpose by technology) are explained by science. Hence I revisited science – matter, energy and the universal laws of nature to understand the fallacies & discrepancies if any, as regards the correlation between technology-economy and sustainable living.

Method

My method is *not* based on statistical data (these have time-location limitations) and also *not* on formulae-based calculations (these have limitations imposed by some assumption or frame of reference, or conditions that never exist in reality). I have based it on The Universal Laws of Nature that are valid everywhere, all the time, as have been accepted by contemporary science. I have cited a few examples from real-life experiences, though it may be argued that these are subjective and situational.

I have examined the *basic premise* 'hard-tech for sustenance' on the basis of accepted knowledge in science. My examination is not about *incorrect or inadequate practices and application* of hard-tech.

Materials

Accepted knowledge in science

Matter and energy

The universe is made up of particles such as atoms, molecules, ions, photons, etc. The very existence of particles gives rise to various interactions (gravitational, electro-magnetic and the two sub-nuclear forces acting on each other) between them, that result in their motion as well as bonding. Motion of particles is what we call 'kinetic energy' (energy in use). Energy deemed stored due to specific positions of particles, is 'potential energy' (energy resource). Thus particulate matter and energy are linked to each other.

The Laws of Nature

Humans make observations in Nature. Certain observations remain consistent under similar conditions irrespective of the observer. Observations give us hints. Imagination is then needed to create generalizations from these hints and guess the underlying pattern [3]. The 'laws of nature' are summary statements of such patterns. Of course, the obvious limitation is our ability to observe, imagine and unravel the pattern.

The laws that have been observed as being valid in the entire (known) universe are called The Universal Laws. All natural phenomena or real things in our life comply with, or are governed by the universal laws of nature. There are no known exceptions to them. Our unawareness of these laws is no excuse; we have to pay the price for not complying with them. The laws of nature have been realised since centuries but were formulated a century ago.

The Law of Conservation of Energy and Matter: The total mass and energy in the universe is always constant; they are neither created nor destroyed; only their form changes.

On earth, matter is grossly constant. We draw raw materials (from mines) and oil from under the surface of the earth. These then continue to remain above the surface in the form of slag, rubble, scrap, goods, garbage, and other toxic and dangerous pollutants.

On a micro-scale, external energy received on earth in the form of radiant energy of the sun is temporarily stored in bio-mass as chemical energy, in clouds as potential and latent thermal energy, in winds and tides as mechanical energy, and so on. But on a macro-scale, almost all the energy received from the sky is radiated back into it. The sub-surface energy (geothermal, fossilised biomass) of the earth is also lost to sky by radiation through volcanic eruptions, burning of coal and crude oil. This energy balance (wherein energy received equals the energy lost) keeps the average temperature of the earth's surface grossly constant.

The Law of Entropy: Entropy of the universe is always increasing [3].

The dictionary meaning of 'entropy' is "lack of organisation" [1]. For almost a century, entropy was assumed to be a measure of 'disorder'. But 'disorder' was not adequately defined. It is not as if 'all that is pleasant is order and all that is unpleasant is disorder' [3].

Technologists expressed entropy as measure of, or indicative of "availability, usefulness, and waste of energy and matter". But it was never stated as to whom and for what "availability, usefulness, waste" referred. Energy available for making bullets may be useful for those who have guns; surely not for those who are shot at. Scrap is a waste but useful to the scrap dealer. Thus the 'human context' (and not physical attributes) often misleads us when trying to understand the concept of entropy.

There is no basis in physical science for interpreting entropy change as being 'one involving order-disorder or available-unavailable or useful-waste'. Frank Lambert [4] recently suggested that "entropy is a measure of dispersal". His very vital contribution to science has been assigning physical significance to The Law of Entropy. The Law reads: 'Particles are always dispersing in space'.

Here is a logical explanation for the dispersal phenomenon –
Entropy: At any given moment, every particle occupies a unique position in the universe. Since one particle is occupying a particular position, there cannot be any other particle in the same position at the same moment. The strength of a force or its effect depends on distance i.e. the position (inverse square law, for example). Since the position of every particle is unique, every particle experiences unique resultant force acting on it and therefore, the motion of every particle is also unique. Thus, identical motions (of particles) are highly improbable. As per The Law of Statistical Behaviour [5], unique or 'un-identical' or indefinite motions of particles result in their dispersal from each other.

Corollary: Unique, 'un-identical' or indefinite motion of particles, or entropy is the reason for -

1) Uncertainty of everything related to behaviour of matter and energy. This corollary is known by different names: Murphy's Law, Fuzzy logic, and phrases like 'God knows'!

2) Diversity in objects: An object is formed by bonding of particles. If the motions of particles are unique, the objects they form by bonding or configurations are also unique. Identical objects or identical configurations of particles are improbable. Even the simplest of all, two atoms of hydrogen are not identical in respect of positions of their electrons.

This diversity or non-uniformity of material composition is the reason for encountering some friction (in the motion of matter) and resistance (in the flow of energy) everywhere.

Despite their unique, 'un-identical' or indefinite motion, dispersing particles are observed to follow a pattern; it is not chaotic as one would expect.

Pattern of dispersal (entropy increase)

Particles are always dispersing in space i.e. moving away from each other. Dispersal is from denser to rarer regions. Wind blows from a high pressure to a low pressure region, solids dissolve in liquids, they wear off and the dust disperses into air, and liquids evaporate.

Dispersal of energy is nothing but dispersal of 'particles in motion' - from more motion to less motion or from higher potential to lower. Heat disperses from higher temperature to lower. Electrically charged particles flow from higher 'concentration' (higher voltage) to a lower one. Mechanical energy disperses to a stationary state (due to friction). All energies finally disperse in air as heat, and radiate to the rarest populated space - sky. When things are left to themselves, automatic concentration of particles and building-up of temperature or voltage (reverse of dispersal) is highly improbable or impossible.

The rate of dispersal depends on the capacity (energy) of particles to overcome constraints. Such constraints are due to forces such as gravitational force, electromagnetic force, or bonding. External restrictions such as containers constrain dispersal of bulk matter, liquids and gases, and barriers restrict flow of fluids. Rails or channel-guides and bearings constrain dispersal of mechanical energy. Laser-guns constrain dispersal of photons.

Constrainers such as containers, barriers, rails or channel-guides and bearings are made up of particles that too disperse, eventually allowing the particles they constrained, to disperse.

For a given set of constraints, the rate of dispersal is proportional to particle density, or potential, e.g. under given conditions, the rate of air-leakage from a higher-pressure-tank is more than that from a similar lower-pressure-tank. The rate of radiation is more from an object at higher temperature than from a similar one at a lower temperature.

Particles and energy always escape and follow the path of lowest constraints. When a fluid is kept in a closed container, particles immediately start escaping from all possible sites of leakage. Thermal and electrical energy disperses mostly through the path of least resistance, such as metal conductors.

Dispersal is uniform when particles experience a uniform constraint on their motion. An explosion in an open field throws out particles and sound-waves uniformly in all directions. Composition of air (oxygen, nitrogen, etc.) at a given height is very uniform. Dust deposition on a plain open surface (table or floor) is very uniform. Intensity of light or heat emitted (photon radiation in the visible and IR range) from a hot source is uniform in all directions.

Here 'entropy increase' is seen as leading to uniformity which is perceived as 'order' by the human mind. The erstwhile notion of 'entropy increase' meant 'disorder'. Thanks to Frank Lambert, we now do not get confused with the terms 'order/disorder'; we see this phenomenon as 'dispersal'.

Entropy increase (i.e. dispersal) continues all the time, under all conditions and does not depend on the type of particles/energy, nor on the type of process that leads to change in the form of the matter and energy. In thermodynamic terms, this particular function of 'entropy' (i.e. **the entropy condition)** depends only on volume & temperature [3] - how much and how quickly particles/energy can disperse.

Entropy in nature
Examples of Increasing Entropy

We now know that the universe is expanding. Matter and energy of stars disperses in space. Entropy increasing on the sun is received by the earth as solar radiation. Denudation of mountains, soil erosion, water evaporation, widespread rainfall, rainwater, and the water from melted glaciers flowing to lakes and sea through streams and rivers, and burning of any matter are all examples of increasing entropy.

We also observe collection, accumulation, gathering or constraining of particles in nature on its own or by actions of living organisms – the opposite of dispersal i.e. **Decrease of entropy**. How does this happen?

This happens as an effect of continuously increasing entropy. Part of the energy released (during increasing entropy) can cause temporary collection or accumulation or gathering (entropy decrease) through various interactions (forces which act on each other) among the dispersing particles. This can result into their bonding and formation of new, diverse objects and/or constraining of their motion - constrained energy such as mechanical or electrical energy. *De novo* decrease of entropy i.e. without a preceding increase in entropy is impossible. Any increase in entropy is greater than decrease, and the net effect is always increase in entropy, as per The Law.

Examples of Entropy Decrease

Matter dispersing on explosion of big stars can come together to form new, smaller stars. Energy dispersal on the sun causing collection of water and electric charge in clouds, high air-pressure regions on earth, and dispersal of geothermal energy causing a gathering of matter (to form continents, mountains, or hills) are some examples.

Living organisms and entropy

A living cell is also nothing but a configuration of particles; a 'living' example of entropy decrease. Effect of entropy phenomenon is diversity in cells. Diversity in the organisms formed by cells is bio-diversity.

Entropic changes in the process of 'living'

Solar radiation reaches the surface of the earth mainly in three frequency ranges. About half lies in the infrared (IR) range, the other half is in the visible range and a small remainder lies in the ultraviolet (UV) range. The frequency band of IR radiation generally matches the natural frequency of many molecules over the surface of the earth. The free motion and/or resonating vibrations of these molecules is the heat on the surface of the earth. Thus most of IR radiation is transformed into heat, in a process that is similar to heating in a microwave oven.

The plant kingdom uses the other half of radiant solar energy – visible light and UV – to synthesise biomass from carbon dioxide in the air, and water and salts mostly from soil, in a process called photosynthesis. For millions of years, *photosynthesis has been the only process of decreasing entropy.* This has not been superseded by any method by any other life-form on earth. *Biomass is the only low entropy energy source available for survival and reproduction of most life-forms on earth. As per The Law, living organisms do decrease entropy (in processes such as reproduction, making goods, etc.) but only by a correspondingly larger increase in the entropy of biomass (food and/or fuel).*

Ageing is dispersing of configured particles in cells of a living organism (entropy increase) with passage of time. Disease is a disturbance in the configuration caused by external factors. Both affect the performance of the 'living'. The dispersal rate depends on the original configuration and constraints such as security, comfort, maintenance and replacement, living environment, hibernation, medical treatment, etc. A configuration that keeps an organism 'living', when disturbed by dispersal or by external factors beyond a critical point turns it into a non-living one i.e. death. *Dispersal can be slow but it never stops and hence no living being is immortal.*

Man-made goods are artificial configurations of particles. They are also an example of entropy decrease. Performance, memory (tendency of configuration-retention) and life-span of such goods depend on the rate of entropy increase, its constraints and external factors as is the case with the 'living'. Entropy increase is marked by continuous degradation of their properties due to weakening of structural bonds - rusting, wear and tear, deformation, chemical changes, etc. These eventually render them useless for our purpose. Thus they have a finite useful-life (whether they are put to use or not). Matter goes to scrap, and rubble i.e. its original form on earth - ore, or in other words to a state where the rate of entropy increase is infinitesimally slow; virtually a stable state.

We face uncertainty and diversity (unique or 'un-identical' characteristics) when using man-made goods and energy-based services. This is because these goods and services are made up of particles having indefinite motion (phenomenon of entropy). Any attempt at data quantification relating to matter and energy, or goods and services is

at best, always an estimate or approximation because of inherent dispersal losses and distortions suffered in the process of data collection, handling, measurement, survey, or comparison.

Technology and the Law of Entropy

As per the law, entropy is always increasing i.e. dispersal is a certainty in every process. Technology is nothing but processing of matter. Thus matter and energy released from fuel always disperse. Hence in every technological processing only a part of the input matter is used. So also, only a small part of energy released can be gainfully used. This is summarily stated as "*the output is always lesser than the input"*.

Conversely, if there is no dispersal, there cannot be any 'processing'. For example, if an engine's exhaust is blocked (i.e. the dispersal of matter is stopped) or the engine cooling system fails (i.e. the dispersal of energy is stopped) the engine halts (seizes). *Technological processing cannot proceed without dispersal of matter and energy*. From the user's point of view, dispersals are losses or wastage. In other words, losses or wastages are not preventable; they are inevitable. Thus, *on an input-output basis, every technology is inherently inefficient as regards matter and energy.*

Entropic changes in technological processing of matter

Converting raw materials into goods is 'decreasing entropy'. This is made possible by using part of the energy released by burning fuel, i.e. artificially accelerating 'entropy-increase' of fuel. The human effort-cost to carry out this process depends on the entropy condition of raw materials available i.e. the volume and the temperature. On earth, temperature of most matter is close to that of ambient air (except may be that of water in hot springs) and hence temperature is not relevant here; volume is the only criterion. For the purpose of use in technological processing, materials on earth fall into three categories based on their entropy condition:

a) Low entropy: large number of particles in low volume or high population density.
Energy in this form as available on surface of the earth: none.
Fuels: High energy matter in small volume - coal mines, crude oil wells and wood-stock.
Raw materials: forests, stone quarries, ore deposits, sandy river-beds, soil in flood plains.
Our effort-cost of using them by technology is low at places where they are available.

b) High entropy: low population density of particles or matter held by weak constraints.
Energy in this form as available on surface of the earth: solar radiation, wind and water flow, geothermal.
Fuels: Low energy biomass such as grasses, herbs, shrubs, leaf-litter, bio- and natural gas.
Raw materials, goods and energy that is spread out (dispersed) or at a long distance is of high entropy (transportation is equivalent to gathering of scattered matter and energy). Our effort-cost of using them by deploying technology is very high.

c) Equilibrium: the rate of entropy increase is infinitesimally slow or virtually no further dispersal is possible. Particles are uniformly distributed with very low constraints: ambient-air, sea-water and soil useful for dumping technology-generated waste such as hot exhaust gases, pollutants, heat and radiation, scrap and rubble.

Example: Crude oil molecules are constrained (do not disperse) when stored. Entropy of such crude oil is low and, therefore, it is useful as an energy source. If the storage tank leaks and oil spreads on soil or sea, the entropy of the oil increases and reaches a state of equilibrium. *This oil is not useful practically although its calorific value remains the same as before.* If a container of coal overturns, larger pieces (low entropy) can be recovered but only after spending energy in recovering them.

We first convert the sole low entropy energy source available, viz. biomass to thermal and radiant energy. We then use the liberated heat and radiation through **three basic technological processes** viz.:

1) Release of heat & light: Entropy of any biomass is increased by burning. Released thermal energy is used for roasting and cooking in earthen pots, and also for protection from harmful animals and micro-organisms. Released radiant energy is used for warming and illumination. Dispersal of smoke is almost automatic. Dispersal of ash takes little effort.

2) Making of goods & tools: Entropy of wood, coal or crude oil is increased by burning. Released energy is used for thermal processing of raw materials - for refining fuels, pyrolysis or for making tools, components in products (metal refining, forming, etc.). Refining, forming, tool making is nothing but 'temporarily changing raw materials to useful forms and properties by retaining/collecting desired matter and removing or dispersing away the unwanted. This process is 'decreasing entropy'. It is obvious that, more is dispersed (heat/radiation/evaporation and waste matter) than collected or concentrated. In other

words, the 'entropy increase' is more than the 'entropy decrease'. The net effect is entropy increase as per The Law.

Further, entropy increases again by way of wear and tear, rusting, breakage, etc. during the usage of goods. Dispersal of flue gases may be automatic or takes little energy. Ash and other residues are generated in considerable quantity and their dispersal requires additional input of energy.

3) Converting Thermal to Mechanical Energy: Entropy of fuel of high energy-density is increased by ignition. A small part of the released thermal energy moves a piston, rotates a turbine or moves a vehicle by recoil (e.g. jet or rocket propulsion). Less than half of the released thermal energy is converted into movement of the piston or turbine or vehicle. A major part of energy released is wasted through the cooling system, hot exhaust and IR radiation. This conversion from thermal energy to mechanical energy – decrease in entropy – is always less than half of the increase of entropy due to fuel-burning and the net outcome is increase of entropy as per The Law. As per Carnot cycle, slower the conversion rate, better the efficiency of conversion but in any case the conversion efficiency is always less than 50%.

Expression for maximum achievable conversion efficiency in mathematical symbols -

If Q_1 is heat at the start of conversion process at temperature T_1 °K,
Q_2 is unconverted heat (dispersed to atmosphere as exhaust) at temperature T_2 °K and
W is the work done (mechanical energy), then

$W = Q_1 - Q_2$ (As per the Law of Conservation of Energy)

$W < Q_2$ (As per the Law of Entropy)

Maximum achievable conversion efficiency $\frac{W}{Q_1}$ works out to $< \frac{1}{2}$

Maximum achievable efficiency as given by Carnot cycle $\frac{T_1 - T_2}{T_1}$ is also then $< \frac{1}{2}$

And so, T_2 is always $> \frac{T_1}{2}$

Text books on thermodynamics incorrectly assume T_2 to be ambient temperature, thereby giving an efficiency higher than 50%; this is impossible as per The Law of Entropy.

The generated mechanical energy is used for mechanical machines such as pumps, vehicles, machine-tools, compressors and for generation of electrical energy. Entropy increases again during movement (used to run machines) by way of frictional heat, electrical energy converted back to heat and radiation, wear, deformation, breakage, etc. Dispersing of flue gases, soot, ash, etc. requires sizable energy thus reducing overall efficiency of the process to a very low value.

Effect of the number of steps in processing

At every step in the processing energy and matter, dispersal or losses are suffered. Total dispersal losses depend on efficiency of each step and the number of such steps. Energy efficiency has to obey the Carnot cycle limit. If number of steps is large, there are huge losses even at the best possible efficiency.

In current hard-tech, a large number of interrelated processes are involved in converting thermal energy into mechanical, electrical, and many other forms of energy. Matter also undergoes several transformations. Here is a list (non-exhaustive) of various operations and processes:

- Locating resources - crude oil (wells), coal, ores (mines), wood and other organic matter (forests and plantations) – and assessing quality and quantity for their intended use.
- Creating infrastructure for extraction and transportation, setting up fuel processing units (refineries or coal washing, grinding).
- Transporting ready-to-use fuel and providing storage facilities for the same or generating electricity and transmitting it up to the place of utility. Machinery, tools, vehicles, equipment, gadgetry and instruments

are required for all the above processes and operations: making and running them, up-keep and maintenance, for safety and health measures, etc.

- Disposal of waste generated, environmental protection, peripheral services such as management systems, finance, communication, R&D, HR.

Uncertainty increases with complexity; the list lengthens due to errors, failures, redundancies, accidents and calamities.

Thus, out of the total energy extracted from resources, a very large quantity is used-up in footing the huge bill of energy-dispersal for the above processes in hard-tech. Only a little remains for our use. Dispersal of energy and matter is in the form of heat (most of it radiated to sky but a little trapped in a green-house like atmosphere), pollutants, ash, slag, rubble, garbage, rubbish, scrap harming us directly and/or indirectly by affecting the environment.

Effort inputs and harm suffered by humans in using technology

Operations and processes in every technology entail physical and mental effort (labour), harm (to health), pressures of commitments (loss of freedom), tensions, and risks. These costs of technology ultimately cause discomfort and insecurity. A cost-benefit analysis is easy if they are direct and obvious. But if costs are indirect it is very difficult to perceive their worth against benefit.

> **Example**: I see benefit in availability of free, ready, and nutritious food at some distance from my residence. My cost is the effort and risk of harm I bear in walking to that place. I am able to easily judge that the free food is worth going for if I perceive the benefit to be larger than the effort and harm cost to me.
>
> My friend is a smarter guy. He takes up a job and earns money to buy a tiffin-carrier and also pay for a courier service to deliver that same free, ready, and nutritious food to him. But he is not able to judge if the free food is worth the indirect cost of effort, and harm he bears in his employment, and unreliability of the courier service he faces!
>
> If the food quantity diminishes or the serving-counter moves further away, my effort and possible harm (due to consuming that food hurriedly for fear of shortage, and also due to an occasional stampede!) will keep increasing. It will then become obvious to me at some point that the benefit of free food is not worth the effort and harm I am bearing. I shall have to look for alternatives such as collecting local food and cooking it myself. My friend too has to slog longer in his job to pay for rising charges of the courier service and yet face uncertainty despite paying more. He keeps slogging; the need for evaluation doesn't occur to him.
>
> Coal and crude oil is a high calorie fuel and available for free (no 'making' cost to us). But it is not in our backyards and even if it were, it would have very little direct use. As in the case above, it is available at great distances and many human-unfriendly activities are involved in making it useful. The total effort put in to use this free energy and bearing the harm in its usage is large as compared to the very little that remains for our use after huge dispersal losses. As in my friend's case, hard-tech benefits and costs are neither direct nor obvious for us to realise and judge if the benefits are worthwhile. We keep slogging away.
>
> Coal and crude reserves are reducing and we have to go deeper; untapped reserves are already far away. How long can we sustain suffering efforts and harm, including harm that may occur due to claims on a limited resource to be shared by a large number of users? Increasing complexity in accessing energy resources reduces overall reliability, with uncertainty taking its toll; providing surpluses and redundancies increases losses further.

Energy sources for current pattern of usage

Easily accessible fossil fuel - coal and crude oil - reserves are exhausted by very high dispersal-loss processes of 'Converting Thermal to Mechanical Energy'. Effort and harm costs of accessing fossil fuels is now very high and their rampant usage damages environment. But we cannot imagine life without this energy. We want electricity, petrol, diesel, LPG, oil (or equivalent) as most of our gadgets work on them. Mainstream society is now desperate for energy supply. Most scientists and researchers are tapping all imaginable energy sources with no cognizance of The Law of Entropy.

Solar radiation, wind, nuclear, hydro (rain and tidal) and natural gas are harnessed for electricity generation. Farm produce is converted to high density fuels as alternative to petrol and diesel. Biogas, hydrogen and geothermal are also thought to be energy sources. They are claimed to be renewable, environment friendly and named 'green' energies.

But are they really so?

Intensity of solar radiation received at any location on earth's surface varies greatly and continuously, throughout the day and year. Solar radiation also diffuses or disperses while passing through earth's atmosphere. Due to high dispersal and no constraints, solar radiation as received on earth's surface is high entropy energy, similar to crude oil spread on soil or sea. IR part of solar radiation is converted to heat. Differential heating of earth's surface produces winds, clouds and rain (water flow/fall). These energies also are high entropy entities.

Conversion of high entropy solar radiation, wind, cascading water and tides, to low entropy electricity or trapping of heat involves decreasing entropy. *This is not possible as per The Law of Entropy.* Then how do photovoltaic cells, windmills and hydro-power-stations produce electricity, or solar water heaters and cookers trap heat? This is made possible by burning coal and crude oil (increasing entropy) for making, installing and maintaining photovoltaic cells, windmills and hydro-power stations or solar heating units.

As per The Law, increase in entropy by burning coal and crude oil is always more than decrease in entropy made possible by photovoltaic cells, windmills, and hydro-power stations. In other words, energy generated by these power stations in their whole lifespan is less than the energy spent in making and maintaining them. Or, the energy generated by one photovoltaic cell does not suffice to make another photovoltaic cell of the same capacity. The same is true for windmills and hydro power stations.

Natural gas

Gas trapped underneath the earth's surface and bubbling out is unconstrained, free gas and therefore, high entropy. Energy density of natural gas as available on the earth's surface (STP) is 39.6 kJ/litre as compared to 37300 kJ/litre of crude oil. *Using coal and crude oil energy*, natural gas has to be first compressed to 250 bar pressure (CNG) or liquefied (LNG) by further compression to increase its energy density to 11160 and 25780 kJ/litre respectively. Only after that can it be used as fuel that is closer to petrol and diesel (34920 and 38520 kJ/litre respectively) in terms of energy density. As per The Law of Entropy, energy spent (increase in entropy) in compression is always more than the energy compacted or condensed (decrease in entropy) in compressed or liquefied natural gas.

Farm produce

Energy density of 16000 kJ per kg of spread-out biomass is raised to 40476 kJ per kg in bio-fuels. As per The Law Of Entropy, crude oil and coal energy spent (increase in entropy) in cultivating, collecting farm produce from a very large area, processing it, making and operating equipment for the same is always more than the (decrease in entropy) energy compacted in bio-fuels.

Nuclear energy and hydrogen

U-235, the isotope of uranium is the only fissionable substance naturally available on earth, and it is always found much diluted by the heavier 'un-fissionable' isotope U-238 (0.7% of U-235 and 99.3% of U-238). This hinders the development of the progressive chain reaction in natural uranium. It is in fact only because of this dilution by the inactive isotope that the highly fissionable atoms of U-235 still exist in nature. Without it they would have all been destroyed long ago by a fast chain reaction [5]. Since natural energy dispersal from the raw material (minerals) used for nuclear energy has virtually stopped, the 'resource' is at equilibrium. The entropy is the highest and therefore, it is not at all an energy resource. Same is true for hydrogen separated from water and used as fuel because water is at equilibrium and therefore the entropy is at the highest.

Enriching uranium or separating hydrogen from water is done using coal and crude oil. As per The Law of Entropy, energy from this coal and crude oil is always more than the energy liberated from fission of the enriched uranium, or burning of the separated hydrogen.

Other non-conventional sources

Sources for biogas are spread-out. Human/animal-generated mechanical energy is obtained from food that is spread-out on a farm. Geothermal energy and wastages such as methane from sewage, garbage as fuel, energy in exhaust-gas etc. that are products of a hard-tech life-style are also spread-out. They are all high entropy energy sources and hence their conversion to low entropy electricity is not possible without first spending more energy (from coal and crude oil).

Conclusion

Renewable or non-conventional or 'green' energy sources actually use more of coal and crude oil energy than the energy they deliver during their life time. They release more green-house gases for the same job. Perhaps that is why they are called 'green'! Hence, they are neither friendlier to the environment nor a real alternative to coal nor crude oil.

Machines and gadgetry converting high entropy energy into low entropy energy with no external energy input are called perpetual machines of the second type; they are impossible as per The Law of Entropy. By observations over several generations, humans are subconsciously aware of the effects of The Law of Entropy. Hence no individual human generates 'green' energy, thereby becoming self-sufficient as far as energy is concerned. The call for 'green' energy is being made by non-human bodies (governments and corporations); there is no question of them being aware of The Laws of Nature!

Solar direct

We use solar energy through the plant kingdom (decreasing entropy by photosynthesis). Can we not genetically modify ourselves for photosynthesis? Theoretically yes, but then we will be plants, not humans!

Scientific reasons why we cannot live as humans on energy through photosynthesis –

To live as humans we require mechanical energy for movement of the body and its internal organs such as the heart, and electrochemical energy for physiological processes, data processing, internal communication, memory, etc. as adjuncts to body-movement. Both these energies constrained within our body are low entropy. Solar energy is of low power (energy per unit time) and high entropy. We will have to stand for a very long time in the sun and/or require a very large surface area to gather solar energy for our use. This means we will have to be practically stationary. So we use nutritious (low entropy) food as our input energy source and convert it into mechanical and electrochemical energy. Energy dispersal or entropy increase necessitated (as per The Law of Entropy) by the process of conversion is in the form of heat we give off to ambient air; this in turn is made possible by keeping our body temperature slightly above the ambient air temperature.

The plant kingdom synthesizes biomass by being spread out over a large area and/or at a very slow rate, using solar energy. But plants cannot move even to defend themselves!

Can we not invent technology that is better than photosynthesis and use solar energy directly? Yes, theoretically we can! But since biomass – a photosynthesis product – is easily available to us (plants neither run away nor put up any resistance, except through thorns when we draw biomass from them) it is easier to invent better (low effort and no harm) technology to use available biomass and live a joyous and leisurely life than direct efforts towards inventing such technology and further worrying about its long-term effects.

Results

Cost-benefit of technology governed by The Laws of Nature

Cost of Technology

Every technology demands a cost in terms of effort and harm, before we can reap its benefits. The cost for benefits from technological processes 'Releasing of Heat & Light' is small; for those from the process 'Making of Goods & Tools' is low – in both the cases a small group of individuals can bear them. Costs start rising from the process 'Converting Thermal-to-Mechanical Energy'. The costs rise rapidly with further transformations of matter and energy; many more people are then required to share them. Some people can (or are made to) share some efforts and/or harms better/more than others. They are glorified as 'skilled and professional' so that they carry the burden of those efforts and harm with dignity! But professionalism or skills divide human beings unequally giving rise to undesirable social repercussions.

Sharing of costs then takes the form of exchange of human services. Exchange of services by barter can work only with friends, relatives and within a neighbourhood. Metal coins and paper money systems linked to a finite resource (gold) assumed importance as area of operations grew larger. Costs kept rising due to depletion of low-entropy-resources and proliferation of **'**Inherently Inefficient Technologies' necessitating an increase in the number of people to share the costs.

Any 'activity for employment generation' results in more people sharing the effort and harm costs of hard-tech. Most employees do have a share in the products and services made available, though this share in unequal. This leads to a multiplier effect. Technology→ more people to share costs and benefits→ hard-tech→ global human population grows to share the rising costs. Current hard-tech provides an avenue for remote exploitation. Regions

out-sourcing their needs and using guest-workers' services can keep their native population low or under control at the cost of large population growth in supplier-regions, that require a lot of effort and bear huge harm.

Scale and interrelations of operations and rising number of processes increase these costs and so technology comes to pervade all areas of human life. The rising cost of hard-tech necessitates either shut-downs or further growth; small enterprises merge into medium scale ones, corporations merge into multinational corporations. Growth also happens through out-sourcing of all needs. Even in the distant past, society chieftains had to eventually grow into bigger governments.

Organisation and its growth is nothing but 'lowering entropy', achieved and maintained through external energy supply on a continuous basis. Governments and corporations are subjected to various unequal, imbalanced interactions within them, and external forces such as limitations to the supply of resources. Unwieldy structures start collapsing. Then we hear about 'downsizing', 'sticking to core businesses and such phrases. *Every growth limits itself at a certain point when the rate of decrease of entropy matches that of increase.*

If we wish to not increase the number of people, then those in employment will have to share all the rising 'effort and harm costs'. Hard-tech reduces physical labour but increases mental labour and psychological problems - pressures and tensions due to risks. People hoping that they will somehow get rid of the problems with money, are willing to put in more mental effort/time and bear increasing harm in exchange of more money. Money linked to finite gold does not suffice and therefore, money is de-linked from it. Thus rise in number of people (growth) and/or rise in money supply (inflation) become a necessity for sustenance in a hard-tech society.

Costs are unevenly divided over human society; time-wise, location-wise and situation-wise. Some bear effort and harm physically, others bear it mentally and psychologically. Who bears what, when, how much, and also what one feels about it can only be surmised. Hard-tech is sustained because the majority of cost sufferers feel that/are made to feel that they are better-off than the rest, or would soon be so!

Expected benefits of hard-tech

Security

There is no improvement in security in the hard-tech era. Earlier we feared natural environment; now we fear artificial environment given by hard-tech, sometimes even more than the natural environment.

Comfort

Societies with more of hard-tech-made things (with adjectives - complex, fast, large, latest, tall/high/deep/grand, automatic, exotic, luxurious, lavish, fashionable, etc.!) suffer much more hard work, 3Djobs, more hassles, pressures, tensions and hardship.

Uncertainty in Nature is countered by technology but its complexity makes it unreliable. Countering unreliability by providing a lot more than what is necessary (redundancy) further increases our effort and harm costs.

Entertainment

Yes, we do have far more avenues for this but peace of mind, freedom and leisure necessary for enjoying our entertainments are missing.

Compromises and social engineering

Many people inevitably adapt themselves to this situation and begin to enjoy their insecurity and loss of freedom/comfort. They go for the enjoyment of possessing gadgetry, vehicles, real estate, investments, etc. by hard work, busy time schedules and clockwork discipline, which they enjoy. When they do it at others' cost they create a security problem for themselves and 'enjoy' insecurity. Enjoying 'rising numbers, competition, power-over-others, taking risks and adventures, consumption of unhealthy or unsafe stuff' is actually to blank out the insecurity and discomfort (created by hard-tech) they feel inside themselves. In other words, they *enjoy* the loss of 'freedom and peace of mind'. Education, media and social policies engineer such enjoyments that are then perceived as status symbols. For example getting a bypass surgery at a 'Corporate Hospital' becomes a status symbol!

Limitations of hard-tech

All observations on the current hard-tech model are explained on the basis of The Laws of Nature. The laws clearly indicate the limitations of technology. Hard-tech can never work like a magician's wand/mantra ensuring a joyous and leisurely life for all.

False Perception

Local and immediate convenience makes us opt for energy-inefficient technologies. The convenience of using electricity is: easy and precise control by switch, no pollution or noise at users' end, and availability on demand by (little) storage in battery cells. But, heating by electricity requires many times more fuel (coal and crude oil derivative) than heating by burning the same fuel directly. Motion by electric motor requires many times more fuel than motion by fuel-run heat engine. Illumination by electricity takes a lot more fuel than a fuel-lit illuminator. We do not perceive the disproportionately heavy effort and harm costs we pay (for setting-up of the electricity generation, distribution network, etc. and by way of pollution due to excessive consumption of fuels) for a small convenience. Energy in electrical form is used efficiently only for data processing and wireless data transmission; their energy-demand is so low that it can be easily met by a local engine-generator set.

Activists ignorant of The Law of Entropy think that new technologies such as superconductivity, nanotechnology, hydrogen from water by photosynthesis, etc. will help reduce burning of fossil fuels. They do not perceive that these will actually increase fossil fuel consumption. The same is true for most of the pollution-reducing activities such as capping carbon dioxide underground, etc.

We do not perceive that the disposal of huge waste generated by hard-tech also entails use of energy, creating more waste in a different form, at a different location. Burying this waste (landfills) causes soil damage, floods and water pollution. Dumping this waste into sea affects seashores and fish-catch. Hard-tech cannot address this self-created problem without creating a different and bigger problem. As per The Law of Conservation and The Law of Entropy, waste cannot be destroyed. It always increases. The only solution is 'not generating it'.

Very rich societies are the highest consumers of resources; their richness is indicated by the huge filth they generate out of resource-use. They keep their working territories clean by hiding filth. But they do not perceive that a "**n**ot **i**n **m**y **b**ack**y**ard" (**nimby**) policy is no solution; in fact, hiding filth delays the realization of reality and only aggravates the problem.

Latest threat by hard-tech

The carbon atom has four electrons and four vacancies in its outermost shell and hence it is outstanding among all the elements in its ability to form large molecules; silicon comes next. If we disregard water, nearly all the molecules in a cell (of which all living creatures on earth are made of) are based on carbon, and hence life as we know it can be called 'carbon-life'. Cells have chromosomes consisting of DNA and proteins. A DNA molecule consists of two chains composed of four types of nucleotide subunits namely A-Adenine, G-Guanine, C-Cytosine T-Thymine. The nucleotides are covalently linked together in a chain through sugars and phosphate which form the backbone of DNA strands. DNA is a complete life-program or algorithm and each cell has it. A DNA sequence makes 20 types of amino acids through RNA. The different types of proteins are nothing but amino acid chain arrangements [6]. Diversified cells make up organs performing different functions.The brain coordinates functioning of organs, responses to external stimuli, and also processes and stores information. The human brain can be thought of as having an inbuilt 'general intelligence' (operating system for data processing) and four modules, which I have termed 'Apps' viz. language, biological, technical, and social. Many human brains can come together to form a social body which can enslave living-creatures of use to humans, and can eliminate the unwanted ones. Evolution took about 3 billion years for humans – more intelligent (data processing capacity) than all other animals – to do this.

Within just the last 3 decades (compared to 3 billion years!) humans have experimented with the next-best element silicon, which can form large molecules. This has given rise to 'silicon-life'. A chip has four types of subunits (similar to nucleotides) viz. resistor, capacitor, inductor, and semi-conductor connected through a substrate or active printed circuit board (PCB) which forms the backbone (similar to the sugars and phosphate of DNA) of a circuit. A chip has a program or an algorithm.The chip along with other materials makes units (similar to cells). Just like the human brain, the CPU of computers, etc. coordinates functioning of units, responds to externalities, and processes and stores information.The CPU also has an operating system and Apps. Unit chain arrangements assemble to make a subsystem (similar to organs in the human body). Subsystems can work through Internet to form a sort of system.

This silicon-life has far better data processing capacity (intelligence), speed, accuracy and precision, very large memory, communication range, diversified inputs/outputs from sensors/actuators than humans have. We lack many features such as an upgradable operating system, unlimited Apps, multi-tasking, switch-off mode (survival without energy supply, or death only because of entropy-increase), quick replication and up-bringing, etc. Today we consider Si-life subservient to us but their superior power can, and is already enslaving humans useful for their requirements, and can one day finish unwanted humans! So it is not just sustenance of a joyous and leisurely life, but also a dignified human life, that is not a slave, that is at stake.

Discussion

The on-going hard-tech system of humans, robots and Si-life is part of the evolutionary process that is objectiveless, directionless and subject to mutation and natural selection. In such a system human individuals (of any rank or calibre) are like cells 'forming' and 'working' for the body, say, the human body; it is beyond their purview to fundamentally change a system that they are a part of. But unlike body cells, human individuals are free to live out of, or on the edge of a hard-tech virtual body system or in a dispersed civilisation. They stand better chances of escaping hard-tech induced struggles and suffering, as well as ensuring survival in case of a total collapse (higher the entropy, lower the rate of entropy increase towards equilibrium). Virtual bodies – corporations, governments and civilizations - have collapsed many times throughout the course of history but every time individuals on the fringes have survived. So how do we sit on the fringe of a hard-tech system?

Exploring sustenance of a joyous, leisurely,and dignified life-style (Up-gradation)

We (the interested) need to first look comprehensively at how we live on earth. What are our necessities, how do we get them with the least (effort and harm) cost and enjoy a secure, comfortable and entertaining life for generations?

We have evolved with and therefore, adapted to live by breathing air (the phenomenon of entropy ensures a uniform composition of air at every place on earth), and drinking rain water. Both are available for free. Bright sunlight for day-time chores, auto-dimming to sleep-time comfort levels, solar warming and wind cooling too are all for free. But today depending on the way we live & where we live, we have to work hard to pay for fresh and clean air (fans and filters), for water (storage and transport, disinfection and filtration, distribution and management services), for bright light (lamps) and for a comfortable ambient temperature (warmers/coolers).

The sole low entropy energy source – biomass, i.e. ready-to-eat or raw foods, fuels and raw materials are available from plants that neither resist nor run away from us, nor demand payment. Micro-organisms decompose (again, for free) waste produced by us into salts for reuse by the plant kingdom to synthesise new biomass (completing the material cycle necessary as per The Law of Conservation). Today we work hard to pay for management and transport of food supplies, cooking fuel, wood, and disposal of wet-garbage.

The reasons for heavy effort-and-harm costs and little freedom in hard-tech are:

1) High entropy resources - long distances travelled by raw materials and finished goods.

2) Large number of steps in processing, with loss at every stage (poor energy efficiency).

3) Hard-tech necessitates large operational systems that cannot meet diverse demands.

The reasons why benefits of hard-tech are short-lasting (non-sustainable):

1) Security, comfort, and entertainment are not sought in that order of priority.

2) Availability and affordability of fossil fuels is limited.

3) Rising effort and harm costs reach a 'human self-limit'.

Selective or soft use of technology (soft-tech)

As per the Law of Entropy, *every technology is inherently inefficient i.e. output is always lesser than the input in energy terms.* Despite this limitation we have to use technologies already adapted by us and pay their costs because now we cannot live without them. Up-gradation is selective use of technology; selection being based on the cost-benefit analysis. Even in this hard-tech era we are selective; many of us do not use guns, explosives, 'recreational' drugs and chemicals as their harm costs are perceived as being more than the benefits. We have to choose low (effort and harm) cost technology, ensuring security, comfort and entertainment in that order. Soft-tech automatically makes for a package of ample freedom that can last for generations.

The role of technology

is to convert a given problem to one that is more convenient to face vis-à-vis our capability, e. g. putting in effort and bearing harm to build a shelter of say, stone or wood is more convenient than subjecting our body to face the environment head-on. The effort of cooking food by burning wood is more convenient than digesting uncooked food. The effort in making and maintaining clothing using cotton or wool is more convenient than 'wearing' body-hair. Also, hairless bodies radiate body-heat easily. Bald-headed people are cool-headed (by temperature). We have hair only to the extent necessary for some protection and useful for other near-vestigial purposes. Effort put into making tools, artefacts, and protective gear is offset by convenience and safety through their use.

Technology also increases reliability or reduces the impact of uncertainty e.g. strong shelters, storages, processing food for a long shelf life, protecting goods from the environment. But all this convenience and reliability is worthwhile only if we use low entropy matter: biomass such as wood, cotton or wool (of grass-fed sheep), and stones soft enough to sculpt, etc. Heating is convenient only by burning biomass and not by rubbing stones on each other. *The crux is to balance benefits and costs (effort and harm).*

Effort and harm cost is low if we,

Use free natural services to the maximum extent possible, thus -

1) Use low entropy local materials, mainly biomass to the maximum extent possible.
2) Use non-local resources in quantities inversely proportional to the distance of transporting them.
3) Use gadgetry requiring low energy input in making, maintaining and running them.
4) Use technologies involving fewer processes, and based on self-help or locally available skills.
5) Use only bio-degradable and recyclable materials e.g. wood and steel.
6) Procure material by barter or purchase from small, local producers.
7) Use industrial materials only to the extent of necessity - such as cast iron, mild steel, stainless steel, glass, rubber, synthetic matter only where their special properties are required (and where such requirements are few).
8) Work for fulfilling local needs of goods and services, not for export.
9) Learn carpentry and smithy, masonry and pottery, thread-drawing and weaving, domestic work-skills, and understand palliative and symptomatic medicines.

Many soft-tech models have been in use for a number of generations. But not all are in tune with The Laws Of Nature. Emulate, modify or develop new models (based on knowledge from hard-tech) as per local requirements.

Examples

Energy source and usage

- Local biomass and products thereof, not useful otherwise: burn for warming and cooking.
- Non-edible seed oil: lamps as a continuous-flame source and as a night-lamp.
- 'Self-energy': Mechanical work (with the help of hand-tools) and local transport.
- Coal: only for heating to high temperatures.
- Crude oil derivatives: only for electricity generation and long distance transport.
- Electricity: only for data processing & transmission, portable and emergency lighting.

High entropy solar, wind and geothermal energy can be used at negligible cost but only in the direction of increasing entropy**:** drying/germicidal effect of IR radiation (solar), separation of light and heavy particles, evaporative cooling (wind), hot water or natural gas (wherever geothermal is available). Examples of wind and solar energy that can be used at a little higher cost are: Sail boats (wind) and passive house warming (solar radiation).

Conditions apply!

The measures stated above, to reduce effort and harm costs are possible subject to favourable environmental conditions and perennial local availability of low entropy resources. An ecological perspective enlightens us about how to ensure this.

A scientific approach to an ecological perspective

Natural growth of plants is diverse and scattered. Human effort of concentrating certain grasses (agriculture) or plants (horticulture) means decreasing entropy. Our effort and cost in terms of harm due to uncertainty of weather, water supply, timely availability of labour, fertilisers, pesticides (crop is an *en masse* food for pests too), etc. is much more than the benefits.

A very small part of any crop (seed, pulp, oil or juice) is used as food and a large chunk (stalks, oilseed-cake, shells and remains of fruits, sugarcane, etc.) is removed from the field and transported for processing which requires huge

energy. Agro-waste, left-over and undigested food (faecal matter) is disposed of elsewhere and not returned to the same soil for reuse by the subsequent crop. Thus, soil is continuously depleted of nutrients necessitating their replenishment by fertilisers (as per the Law of Conservation).

Grains are individually packed. Efforts involved and dispersal losses in handling of grains and due to large number of processing operations (collecting from the farm, unpacking, segregation, storage and grinding, etc.) are high when compared with bigger-size food (large size seeds, roots, fruits and leaves). The only advantage of food grains is that long-term storage is possible; it is longer if stored in the original de-husked form.

Animals generate mechanical energy and 'make' things (e.g. milk, wool, silk, and honey) for their own survival and that of their next generation, not for human needs. Unlike plants, animals react against human actions. Redirecting animals for human cause is a technological process of decreasing entropy. Effort and harm costs to keep, tame, breed, train and maintain animals or insects are always more than the benefits obtained through goods (food, wool, milk, silk and honey) or services (labour or entertainment by pets) delivered by them. The same is true for human services unless constrained intentionally - no benefits are possible by force or through slavery.

Current times

Any system performs the best only under the conditions for which it is designed,e.g. a vehicle is made to run on a specific fuel, a proper road, etc. It runs at its best under the designed set of conditions. But it huffs and puffs, or performs below par on adulterated fuel or off-the-road and fails under conditions beyond its tolerance range.

Human bodies have adapted –

1) Mostly, to the conditions that have existed since a very long time, around 9500 generations.

2) A little, to conditions that changed slowly over the past 500 generations, and

3) Not at all, to rapidly changing conditions in contemporary times (spanning a few generations).

Even after a few hundred generations, many of us still struggle to digest agro-technology products: grain, oil, sugar, salt and milk. Today, processed foods using these ingredients are available in plenty but books on nutritional health include them in the list of foods not-good-for-health. This list runs longer than the list of foods good-and-safe-for-health. These are mostly less-processed organic foods. These books advise consuming our daily food requirement divided in smaller portions (as did our 'gatherer' ancestors), many times in a day, rather than two or three large meals. Our body has not yet adapted to digesting heavy gorging at lunch & dinner.

Our bodies react against synthetic materials: clothing or shoes, body cleansing chemicals and cosmetics, drugs and medicines. Dermatitis, diminishing immunity (due to over-cleanliness) and many systemic ailments in youth are due to the changed environment such as night shifts/life, sedentary/'robotic' jobs, multi-tasking, road acrobatics, and artificial (enclosed, noisy and congested) work places.

Eco-systems

The word ecology is derived from *'oikos'*, meaning habitat or a natural home of the living. We humans live in an ecosystem: a natural system comprising of landscape and soil, rainfall and water, flora and fauna, temperatures and humidity. We also live in a man-made social system made up of family and relations, society and economics, science and technology.

Natural (i.e. with no interference by the conscious human mind) ecosystems are diverse due to the phenomenon of entropy. Thus humans live by diverse landscapes and soils such as mountains/hills, plains, grasslands, forests, deserts, wetlands, seacoasts, etc. They live by streams, rivers, estuaries and lakes. They live alongside a large variety of living organisms i.e. plants, animals and micro-organisms. They also live in hot, cold, dry and wet climates.

Humans have evolved, lived with and hence adapted to natural diversity in every respect. The human experience of nature is diversity and uncertainty. For better living and beating uncertainty, humans try to bring in uniformity through hard-tech using fossil fuels; but this is not without human-suffering of effort and harm. Such uniformity is not sustainable due to the phenomenon of entropy. Rate of transformation depends on the constraints imposed by quantity of fossil fuel used and effort and harm suffered. So it is wiser to look for better living and beating uncertainty by befriending diversity.

Befriending diversity for better living and beating uncertainty - Ecological solutions

Diversity amongst the living is biodiversity, represented by 'wildernesses'. Forests provide a variety of biomass useful as food stuffs and spices, medicines and preservatives, wood and leaf-litter as fuel, oils and perfumes, adhesives and cleaning reagents, wood and fibre as raw materials for shelters, storage, hand-tools, artefacts, gadgets,

toys, etc. Everything is bio-degradable and renewable. A good jungle up-stream holds rain-water like a sponge, releasing it slowly into the stream that makes it our perennial water source. Nutrients formed in the forest are carried by water to deposit them on flood-plains making for good quality soils to grow our food. Most of our household necessities can be at a walking distance. The forests provide habitat for insects, birds and reptiles that have a role in pollination and control of pests. Many books give detailed information on this subject.

A natural forest is very useful in reducing uncertainty: reserve food and fuel stocks, resilience against varying natural conditions such as excess/low, concentrated/scattered, early/late rainfall i.e. protection from droughts or floods. Extreme temperatures and hot sun, dusty and dry winds are toned down in their severity.

Landscape and bio-diversity is also recreational. It provides picturesque views, nature trails, flora and fauna for observation and study, open-air theatres and concert halls, playgrounds and painting studios, materials for toys, collections, musical instruments etc.

Thus, living with natural bio-diversity or living by adapting to local conditions, and using soft-tech are the key factors to up-grade the current lifestyle. Restoration and preservation of bio-diversity is an important mantra for optimum human performance, reduced uncertainties and sustenance of a joyous and leisurely life-style extending to future generations.

Implementation of Up-gradation

For the last few generations, our condition is similar to that of animals born and brought-up in stables, zoos or circuses, or like that of caged birds; we are fed, sheltered and cared for. But we have to dance to the rhythm and tune of (hard-tech) masters for most of our life. How can we free ourselves?

Rapid changes in life-style can be traumatic (caged animals are not able to quickly adapt to their natural life when freed). Most of us actually fear true freedom. Changing slowly and steadily is smoother and more effective. However, ecosystems and bio-diversity are getting damaged rapidly and their revival takes a long time. Therefore, a quick beginning towards change is important.

Life-styles depend on micro-climates in places where one wants to live. Due to diversity in micro-climates and aspirations of individuals, there cannot be any standardisation or a formula for change. However, common guidelines can be summarised as under:

1) Our energy source is produced by the plant kingdom and our waste is cleared by micro-organisms. Both kingdoms do their jobs at a time-rate of their own. *Using their services by matching their rate* is the key to sustenance of a joyous and leisurely life.

2) Change in our environment caused by consumption of goods and services should be:

- Small and re-settable in nature, quickly and automatically for our comfort and leisure.

- Local i.e. not causing trouble to others remotely; ensuring our security.

- Affecting us directly to ensure an automatic check on our actions.

To give an example, these guiding criteria can be met by using mainly locally grown biomass as a source of food and energy. Smoke and gases (carbon-dioxide taken-up mostly by local vegetation), bio-degradable matter (kitchen-waste, left-over material, faeces, etc. decomposed back to basic constituents by micro-organisms) and mineral matter (ash, salts taken-up by local plant kingdom for new biomass formation) are recycled usefully. Burning of biomass directly affects us by way of smoke and ash, and can act as a deterrent to excessive use.

Conclusion

Study of ecology suggests a way, an ecological solution, a low (in terms of effort and harm) cost technology development **- soft-tech.** We have the list of negatives from the practice of technology. We can refrain from repeating our ancestors' mistakes. We can make choices for implementing our idea of a joyous, leisurely and dignified life. Up-gradation is a post-modern view for sustainable development.This is what can be called becoming a **conscientious consumer**.

Up-gradations will indeed depend on many factors such as geographical location, i.e. local micro-climate, cultural, social and political conditions, etc. I have developed my up-graded life-style either by direct imitation of existing soft-tech practices or modifying and innovating them to suit my requirements. I am sharing some part of it to indicate how it can be done by anyone in tropical or subtropical area where very large population resides.

This is my slow, steady, step-by-step, non-comprehensive account of up-gradation. Life-style changes are difficult but not impossible. Habits are not congenital; they are formed and hence can be changed; slower the change, the smoother the transition. It is wiser to start taking early steps than having to face fast changes that may become inevitably thrust upon us, and prove to be traumatic. This is a journey of gradual transformation from hard-tech (brilliants') hell to soft-tech (fools') **paradise!**

Examples of soft-tech or low (effort and harm) cost options

The energy source with the lowest cost: 'self-energy'

Spending this energy is equivalent to a work-out in the gymnasium, and is necessary for my fitness. I design my working environment, tools, gadgets, etc. to suit my capabilities, limitations and dislikes, as listed below, for an effective throughput and with minimum inconvenience. This is similar to industrial engineering or work-study practices but with the focus on self, not employee exploitation. I hate drudgery and toil. Safety is of prime importance. I use hand-gloves, shoes, leg or knee pads, sealing-type goggles, filter on the nose, hands-free umbrella etc. as and when necessary.

On a day-to-day working basis I can easily and comfortably -

- Make natural, non-strenuous body movements such as walking and climbing.
- Use hands for tensile load and legs for compressive load.
- Carry loads on shoulders up to 20 kg (a third of my body weight).
- Consume and digest food that yields around 8000 kJ. My inner body temperature T_1 is 310°K and skin temperature of my working limbs T_2 is 307°K. At Carnot cycle efficiency of 1 % I can work @ 80 kJ per day (which is equivalent to my (60 kg body weight) climbing 136 m or 800 steps, or 42 storeys).
- Work up to a maximum of 600 kJ (40 km walk/50 km cycling). But this is done only occasionally.
- Work at a rated power output of 60 W (as many watts as one's body weight in kg) with 50% duty cycle (equal periods of work and rest) e.g. marathon-distance walk in 5-6 hours.
- Deliver 10 times the rated power output (up to 600 W) for brief periods only.
- Achieve a work rate by limb movements, in tune with my normal pulse rate (wherein muscle cells receive extra energy and oxygen through blood, exactly when they need it).
- Work standing for short durations, and sitting on a chair/stool for longer durations. I avoid sitting on the floor because I spend 600 J lifting my own weight every time, in getting-up.
- Work in a ventilated environment, at around 25^0 C ambient temperatureand 50 % RH (relative humidity).

I am not meant for (my limitations) -

- Work involving heavy impacts such as using a hammer.
- High speed actions (Carnot cycle efficiency is better at slower speeds).
- Carrying heavy loads on the head.
- Frequent bending and holding loads.
- Working in hot sun, pouring rain and freezing cold.
- Cumbersome or repetitive work requiring close attention for long periods.
- Working under close supervision. Freedom and leisure are important to me. I do not want to forgo the joy of working differently; this may be viewed as being foolish and stupid.

I get bored

- When I am doing someone else's work.
- Working in enclosed spaces.

Example

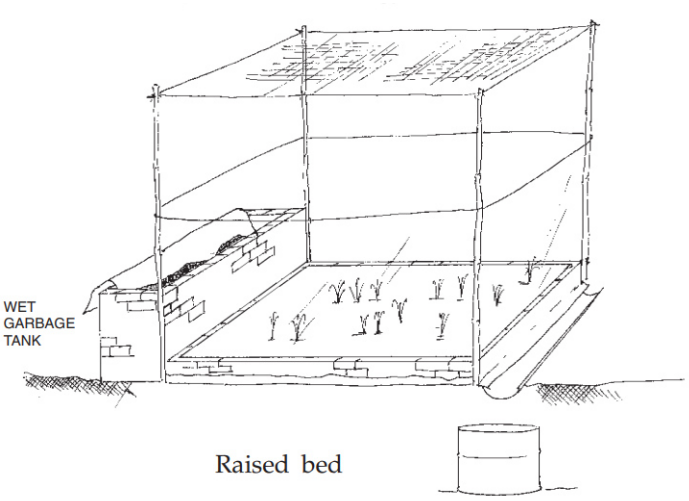
I use a lightweight, portable, height-adjustable, stand-mounted sink with a side-table for my clothes and utensil washing. Sinks can be moved to any place; the verandah being my favourite.

Removing water from washed clothes by squeezing or spinning requires high effort. I save this by hanging them in the open (over plant beds or where dripping-water is no problem) on double-wire hangers for their all-round surface exposure.

I have built a house in a rural setting and provided essential services such as food, fuel and water as below:

Growing food

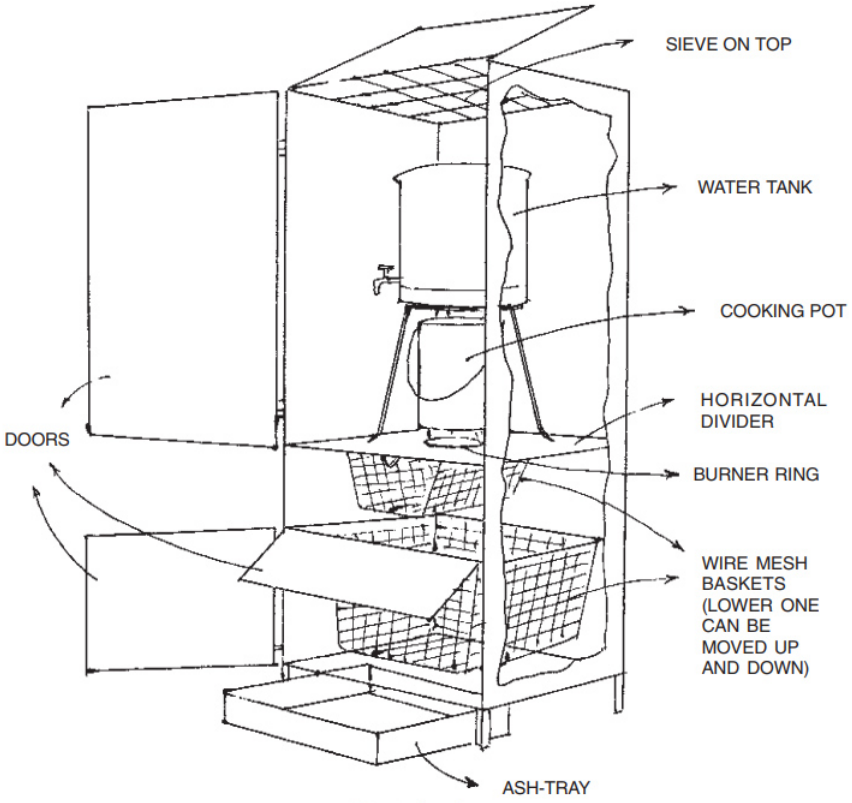
Farming vegetables, pulses, fruits, nuts and spices around one's dwelling is an age-old technology; now revived as non-commercial, multicultural, organic and human-powered activity irrigated by rain and local water (including urine and chemical-free domestic waste-water). New wilderness (for 'wild foods' and other benefits) or plantations for fruits, fuel, fibre and wood take fairly long to become established as per natural processes, hence the need for an early beginning.To start with, 'raised bed' method is an optimal, intensive food-growing technology.



Raised bed

<u>Girish stove</u>

Trees have no excretory system. They dump all unwanted mass into their trunk, distal twigs, leaves, etc. and shed it as bark, finger-thick sticks, yellow leaves, etc. This and other waste wood, biomass is a no-harm-to-plants and no-cutting-effort-to-me fuel for my stove. This stove is for use in a verandah or in the open.



Girish Stove

Construction

It is a modified steel-cupboard (500 mm wide, 350 mm deep and 1800 mm tall) standing on 100 mm tall legs. It has a horizontal divider at the centre, three front doors but no top or bottom. An undersized ashtray at the bottom lets in air through the openings above. A wire-mesh basket - LL (300 mm wide, 300 mm deep and 300 mm height) is kept at a suitable height from the ashtray. Another front-open wire-mesh basket - W (225 mm wide, 350 mm deep and 150 mm height) is placed 150 mm above the LL basket. Horizontal divider with a hole is for keeping the cooking pot on the stove-ring.

Operation

I fill the LL-basket with leaf-litter (or any inflammable bio-mass) and W-basket with high calorie woody bio-mass. I use two pots – water filled outer with a lid and inner, for food to be cooked. I fire the leaf-litter and close the doors. The leaf-litter burns out in few minutes, sufficient time for woody stuff to start burning. Smoke escapes from the top; the cupboard-height serves as a chimney. I can add fuel, 'on-line', by opening the lower doors momentarily. Fire is extinguished by closing off air supply.

The outer pot is blackened but is 'left as it is' and can be used again and again. Pot is less blackened if it is placed after the leaf-litter is burnt out but then some heat would be wasted. Ash, soot and litter drop into the ashtray. A water filled tank with a tight lid placed above the cooking section gives hot water as a by-product, recovering some of the waste-heat. A sieve placed at the chimney top serves as wood-drying platform for the next day's fuel supply, and also filters the rising smoke.

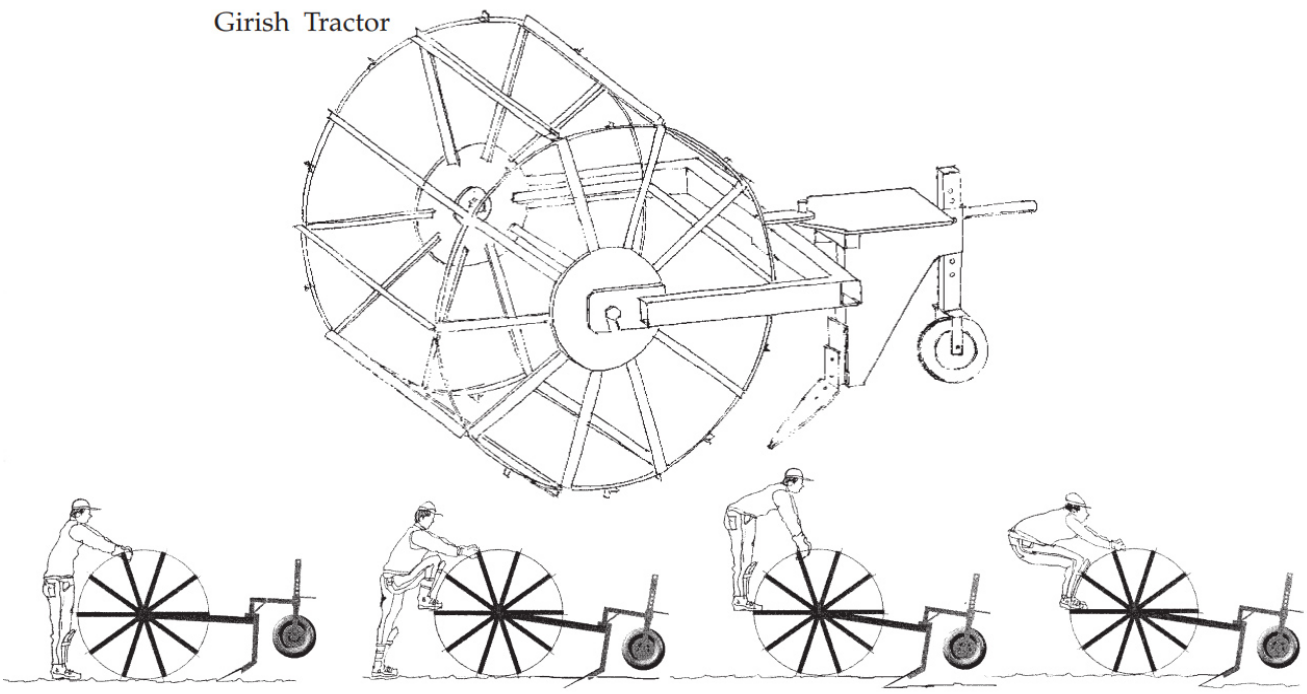
I neither need a blower nor wind-pipe nor inflammable fossil fuel like wax or kerosene. I face no hassle in switching this stove on and no problems due to smoke or ash.

Low (effort and harm) cost field-gadgets

I am not capable of some field operations such as digging, ploughing, transporting loads, etc. through age-old tools or gadgets. I have devised new ones that suit me.

Girish tractor

It converts my downward-acting self-weight force into a horizontally-acting hauling force.



Schematic of Girish Tractor in use

Construction

It is a caged wheel (as if a ladder is progressively bent into a full circle) of 900 mm diameter and 750 + mm wide. A U-shaped frame connected at the axis and supported by a trailer wheel carries many types of tools.

Operation

When I stand on a rung which is at about half-cage-wheel-diameter height from the ground, my self-weight forces the caged wheel into rotational motion. The tractor starts moving in the backward direction (with respect to my face). Traction is achieved because the rungs keep locking into the soil. Force equivalent to my weight is sufficient for ploughing. My effort is equivalent to (jerky) ladder-climbing.

Transporting loads

By removing the U-shaped frame and supporting the axle on a stationary stand, the Girish tractor can be used for lifting or pulling loads by rope, wound around the caged wheel.

A rucksack is the most ergonomic way of carrying loads; I use a jerry-can, harnessed as rucksack for ferrying water to vegetable beds and saplings - about 20 litres per trip.

I load ‘long’ items such as crow-bar, hoe, spade, shovel, etc. on a bicycle and walk with it. I load stones, soil or sealed water-can in a hemispherical-bottomed steel bucket with a belt-hole near the top rim and drag it by belt on grassy soil.

Sources and management of water for domestic use

Domestic-use water is classified into four categories (distinguished by colour coding).

1. Potable (blue)
2. For washing purposes (grey)
3. For use in urinal (yellow)
4. For use in latrine (brown)

Girish tank

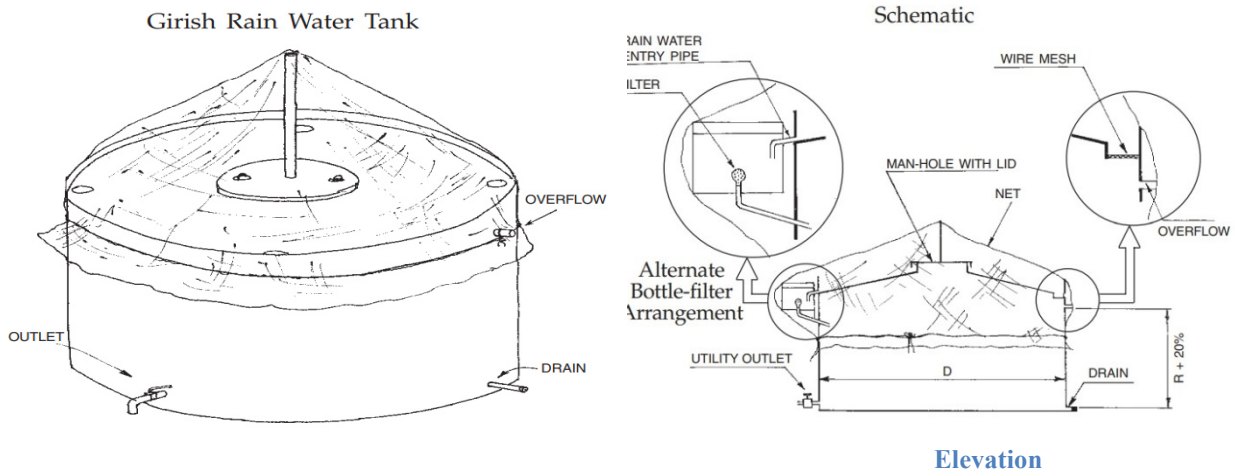
Harvesting rain-water for drinking

Rainwater (falling on the roof and floor) collection systems have been in use. These systems carry the risk of water contamination because the catchment area is not free from human and animal use. Pathogens have been reported and hence such methods are not suitable for potable-grade water collection and storage. My system collects rainwater (or snow) fallen on the tank-top (that can be kept free from human and animal use) and stores it in the tank such that no 'food' can be formed in it by photosynthesis.

Principle: Clean rain water collected and stored carefully in a container devoid of any 'food', remains free of microbial growth and hence potable for a long time.

Quantity requirement

I use potable grade water only for drinking, cooking, washing of vegetables or fruits and final rinsing of food containers. I require 800 (Q) liters annually.



Construction (Please refer to drawing)

"Girish Tank" is a cylindrical Ferro-cement tank with gently-sloping inverted-cone shaped top. Cylinder wall is raised above the sloping top by about 10 cm to form a skirted rim. Four equally-spaced holes on lowermost part of the top adjacent to the rim are fitted with stainless steel wire-mesh strainers (right side) or an anti-choke strainer (left side) as shown in elevation. This arrangement ensures that all rainwater falling on the tank-top is drained into the tank.

Leak-proof, anti-moss paint ensures a sealed and food-free inside. An overflow channel prevents accumulation of water on the tank top if the tank is full. Stainless steel wire mesh at the rainwater entry holes and at the overflow channel prevent entry of mosquito females. Tank top is covered by a net raised at the centre and stretched lightly over the rim to prevent accumulation of leaf-litter and other debris on the tank top, as well as discouraging birds and animals from using it. In seasonal (monsoon) rainfall areas, a rubber stopper placed in entry-holes or covering the top completely protects the water collected in the tank from dust and other particles during the dry season.

Dimensions

The height of the tank should be about 20% above the average annual rainfall of the area.

The diameter **D** in meters can be calculated as, $\mathbf{D} = \sqrt{\frac{4NQ}{\pi.R}}$

N = Number of beneficiaries

Q = Quantity requirement in liters per person per year

R = Average annual rainfall in mm.

A family of 5 requiring 800 liters each per year, living in an area that receives an average annual rainfall of 500 mm will need a tank of 3.2 m diameter and 600 mm height.

Alternately, a tray fitted with a waste-coupling at the bottom, placed on a container suitable for potable-water-storage, also serves the purpose. Care is to be taken that the tray does not rust or gets blown away in the wind. Covering by net, etc. is the same as above.

Height of the tray edge: 50 mm is adequate.

$A = \frac{NQ}{R}$ A = Area of the tray in square meter

Location

The tank should be placed such that rain (and nothing else) directly falls on the tank top.

Water quality

The tank fills to capacity during the monsoons. Initially, samples were collected from the harvested rain-water by opening the manhole lid of the tank intermittently throughout the following year. The coliform counts were monitored using the standard MPN (Most Probable Number). No coliforms or mosquito larvae were found in any of the samples. This tank water has always met the accepted quality standards set for potable water.

Limitations

This system is unsafe where air is not clean, e.g. in the vicinity of mills, where organic particles are suspended in the air. They are likely to accumulate in the tank leading to growth of pathogens. Chlorination or other suitable method is necessary in such cases. Acid rain or other local problems, if any, are to be dealt with as necessary.

Maintenance

The tank-top is to be maintained absolutely clean all the time, by wiping and not by washing. The tank is to be drained, cleaned and repainted with anti-moss and leak proof paint every five years. Net and rubber stoppers are to be replaced as and when required. Ferro-cement tanks last over 50 years if maintained properly.

Additives

Minerals (powder, tablet or solution) may be added to the water before consumption.

Water for washing purposes

Water for bathing, washing clothes and utensils, or for wiping floor, etc. is colour coded grey. Water sourced from another Girish Tank suffices by conscientious use/recycling.

Body

Sponging for cleaning, shower for freshness and dipping or bath for pleasure! The bottom platform of my body/foot-wash cubicle is raised such that I can collect the drained water from sponging or a shower (this contains body-fluids, dust and dirt as contaminants). I do not use soap. I can safely reuse this water after treatment for *my* sponging and shower.

A Girish Tank with a removable top, and 750 mm diameter, 1000 mm height, modified for an inside-seating arrangement can serve as a vertical rain-water bath-tub.

Hands and face

I use a two or three bowls (old European) system. Water can be reused.

Cleaning process for clothes and utensils, etc.

I use a sink for the purpose. Soaking the objects to be washed in water for a longer duration dissolves and loosens the particles to be removed. They are dislodged by the relative motion between objects and water through agitating, rubbing, and brushing (soaking-and-squeezing for fibres). This requires less effort. Chemicals, and synthetic materials are not necessary for dissolving oil/sticky matter, and disinfection; plain hot (above 60^0 C) water (Girish Stove by-product) serves the same purpose. I wear thick cotton gloves, and cover them with elbow-length rubber

gloves to protect my hands when washing things in hot water. Alternatively I use biodegradable cleaners. Grey drain water is collected for reuse.

Reuse

Water containing organic matter in large quantities (food/utensil, and hand or mouth wash waste-water) has a high Biological-Oxygen-Demand (BOD) and is used for watering plants.

Water containing inorganic matter such as dust and inorganic dirt, body fluids (low BOD) can be reused for the same purpose. Thus waste-water left after clothes and non-food articles have been washed, can be re-used for a similar purpose; that left after wiping the floor, and can be reused for wiping. For this, the waste-water is collected separately for each cleaning activity.

Treatment of waste-water

Separation by gravity: Used wash-water has some insoluble matter. Storing this water overnight in a tall container separates the insoluble matter; the heavier matter sinks and the lighter matter floats. My container has an arrangement to draw water from the middle layer.

This water is either filtered by readily-available low-cost, non-chemical, non-electrical filters (such as sand, or coal-based ones) and/or aerated. Aeration of water helps aerobic bacteria consume dissolved organic matter within a short time and the water can be reused for washing. The remainder in the container is used for watering plants.

I treat water for reuse (cumbersome process requiring many containers) only in the case of water-shortage. Untreated drain-water can be safely used for watering plants.

Girish urine disposer

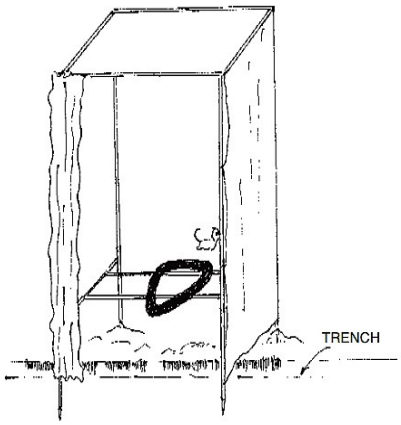
I urinate about 2000 times (a total of 500 litres) annually directly into a large-mouth bottle (females to use an attachment; separate unit for every individual). The bottle comes with a double sealing lid and a hanger-handle for holding it conveniently. Urine of a healthy person is sterile as excreted and remains so in the sealed bottle for over a day or longer. I dispose of the collected urine without dilution and along with some cleansing-water, into my plant beds. It acts as manure. The odour quickly disperses in the open.

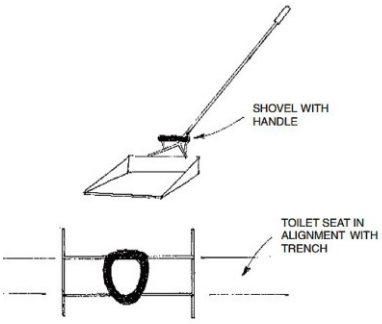
Many people raise objections to watering plants with undiluted urine. But I have tested this. Soil alkalinity neutralises urine-acidity, no harm is caused, and plants thrive.

Girish trench latrine

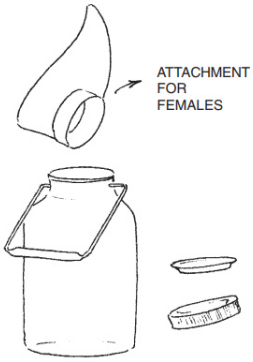
Domestic cats dispose of their excreta scientifically, correctly. I use the same principle.

Using Girish tractor, I dig a trench 300 mm wide, and about the same depth, and a meter or two long on a dry patch of land near my house or shelter. The excavated soil is heaped on one side along the length of the trench. I use a portable, canvas-screened cubicle of size 1000 mm x 1000 mm and 2000 mm height as my latrine. A toilet seat is fixed on bars attached to the inside of the cubicle. The bars serve as guides to visually align the seat with the trench such that the excreta drops exactly into the trench. Instead of toilet paper I use a soft cut-to-size waste cloth. I cover the excreta and the used clothwith ash (another Girish stove by-product). A large spoon comes handy for this.





Girish Trench Latrine



urine disposer

I shift the cubicle along the trench-length as it fills up. Using a shovel I cover the ash in the trench with the soil heaped next to it. The filled-up trench containing manure and loose soil can subsequently be used for planting trees. Girish trench latrine cannot be used during heavy rains and during water flooding. For those few days I use a watered latrine connected to a small overhead Girish Tank, and to a septic tank below.

Thus waste matter, faeces, urine (for decomposition by soil micro-organisms) and partly decomposed biomass (ash) is returned back to soil for reuse by plants. My annual yellow and brown water requirement is down from 25000 L to a few litres. Also, I neither generate nor release any sewage.

Low (effort and harm) cost illumination

I use sunlight for almost all my work requiring intense illumination. We are adapted to rest (whether dozing or awake) from sunset to sunrise. Fasting during this period ensures complete digestion and some rest to the digestive system. Our performance and health is optimum when we are in tune with this circadian rhythm. Artificial light considerably reduces the rest that our body gets.

I meet my occasional requirements of bright light by a portable, and intensity-controllable LPG-mantle and that of dim light by an oil-lamp. In an emergency, I use a light source powered by a battery.

Low (effort and harm) cost electricity

I use electricity only for running my laptop and charging batteries of my mobile phone, etc. A small petrol engine-driven alternator (part of my two-wheeler engine) is sufficient for this.

Healthcare

Prevention is better than cure. Safety and health is the topmost priority for me. In case of any ailment, the body's self-healing system is supported by symptomatic and palliative medicines. I prefer to treat my ailments on my own, except of course, surgical procedures if any, including dental problems. Professional medical practitioners have to undergo prolonged training and study to treat patients. My job is simpler; I have to study only to treat myself. I know my symptoms and I am the best judge of my body's response to the treatment. No communication gap!

Self-reliance

I am the only provider that meets *my* standards of desired quality and reliability in services. This is the most efficient way because my direct handling reduces the number of processes and thereby, corresponding losses. This is as per the Law of Entropy. But the disadvantage is that I have no one to blame in case of the inevitable occasional failures (due to uncertainty, a phenomenon of entropy)!

Free natural goods and services accessed from the wilderness, learning carpentry and smithy, masonry and pottery, thread-drawing and weaving, using palliative and symptomatic medicines, practising low-effort and no-harm domestic work-skills, etc. can achieve 80% self-reliance. 15% of the remainder can be met by a barter system, and only 5% may require cash.

Education, entertainment and pastime

A self-reliant life-style keeps me occupied without too many compulsions. There is plenty of scope for leisure and study, research and innovation, restoration and protection of wilderness and biodiversity, soft and liberal arts, etc.

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Bibliography

1. Collins Gem English Dictionary
2. Yuval Noah Harari, *Homo Deus* (Penguin Random House, UK. 2016) p. 59
3. Feynman Leighton Sands, *The Feynman Lectures on Physics,Volume 1* (Narosa publishing House 1997)
4. p. 566, 568, 588
5. Frank L. Lambert, Ex-Professor Emeritus Occidental College, Los Angeles, CA.
6. George Gamow, *One Two three...Infinity* (Bantam Books, 1979) p. 200, 186-7
7. Alberts, Bray, Johnson, Lewis, Raff, Roberts, Walter, *Essential Cell Biology* (Garland Publishing Inc.1997) p. 185, 186

About the Author

Girish Abhyankar (residing at A304 Athashri, Forest Trails, Bhugaon, Pune 412 115 India Ph: +91 9860547471 email: girish.abhyankar@gmail.com) is a self-styled independent researcher, just like everyone else.

The research papers and the articles published by him in several scientific journals and periodicals of national and international repute and the acclaimed and bestseller books written by him are nil. (He is poor at writing.)

His participation as an organiser, a speaker, and invitee in several local, national and international conferences, symposia and workshops is zero. (He dislikes travelling.)

The honorary degrees, fellowships, decorations and felicitations awarded by highly rated universities, and research and social institutions to him number nil. (When did The Vatican recognise Galilean theory?)

Chair or position in apex bodies (previously held by renowned personalities and also) held by him, is none.

Chairmanship, trusteeship and the board membership of several acclaimed social organisations bestowed on him is nil (who wants a leg-puller in their midst?).

In social activism, he is always in the ”rearfront””or absent (he is a ’passivist’).

He holds a degree in engineering and in management. Vital contributions and grand successes in high-tech domain and spectacular corporate achievements to his credit are nil.

He lives a joyous and leisurely life.