Permaculture Briefly Explained

Version 1.8

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***Note**: In June 2022, Bob Randall, a board member with the Permaculture Institute of North America (PINA) and this essay's principal author, gave a live 45-minute interview about permaculture before a Houston audience. He was asked, 'What is it?' 'How and why did it come about?' and 'Please give some examples of it in action.' This was a very tall order to do well in such a short time since the subject is taught over many hours, is contained in many books, and examples are worldwide in forests, deserts, cities, farms, and organizations. The questions and answers in that interview however sparked an effort to create a longer, more accurate, but still concise presentation by PINA permaculture designers of what we think permaculture is today.*

Hopefully, this document will help curious permaculture newcomers who are open to exploring the subject further. Because this essay condenses and organizes what we think are the main ideas of permaculture, this essay may also be a useful resource for permaculture teachers, designers, and course students.

This is intended as a living document: there is much room for self-reflection, feedback, and improvement. If you have suggestions to make this better, please respond through info@pina.in.

***Part One** below derives from topics in that first interview. It provides brief answers to frequently asked questions: the vexing problems permaculture is particularly good at addressing, why and how it happened, and its scope and importance. It also broadly explains permaculture's concept of designing permanent culture and explains how to develop permaculture skills. **Part Two** describes the main ideas we use to create long term human well-being: the close linkage between sustainable ethics, science, cooperative groups, and well-researched energy-efficient design.*

Part One: About Permaculture

Q. Some people aren't familiar with permaculture. Before we get into specifics, can you give us an overview of what it is?

A: Permaculture is a 50-year-old global effort to teach people how to make important decisions sustainably. This means making those decisions in ways that support the present and future health and prosperity of humans and other living beings. To do this, we must ensure that all life - trees, fish, bears, soil microbes, etc. - thrive, as we humans meet our food, water, energy, housing, and security needs. That means supporting their habitats and ecosystems, as well as our own. It is an ecological approach to whole-systems design and an effort to empower individuals to create positive change.

Permaculture holds that important decisions should be based on ***principles*** known to sustain and regenerate living systems, because all life is connected. By taking care of living landscapes, with their plants, animals, and beneficial microbes, we uphold human life and foster prosperity. These decisions are made in part from an evolving set of design principles deduced from the study of intact natural areas, or which have been practiced by long-stable indigenous societies. But we also embrace examples of successful effort from recent decades across the planet, and welcome new technology if it furthers these goals without causing new harms. ***When we use the term "sustainable," we mean ecologically sustainable human well-being indefinitely. By definition, sustainability means the ability to maintain economic, social, and environmental well-being over time and to successfully adapt to change.***

In permaculture, good decisions *simultaneously* enhance nature, regenerate food- and fiber-growing landscapes, and create farms, villages, and cities that make future life more enjoyable, less costly, more economically profitable, and easier for everyone. Permaculture is thus a valuable tool for homeowners, homesteaders, farmers, educators, landscapers, architects, bioregionalists, city planners, foresters, reclamation specialists, neighborhood organizers and anyone interested in sustainable living.

We believe that the use of any energy, materials, land, or labor—resources that come from people and the Earth—should get the most long term benefits possible, but we know this won't happen unless people and social systems use good permaculture design. Please remember that permaculture design principles described below derive from successful natural systems and enduring human cultures. They have been carefully analyzed, tested, and described. Now practiced in over 100 countries, they aren't arbitrary; they are universal to life on our planet.

Q: Why is Permaculture a Compelling Choice for Humanity?

A: Each of the last several centuries created big problems and counter-efforts to mitigate them. These forces continue to shape our world. The 17th century strengthened the power of monarchs and other autocrats. It brought a tidal wave of imperial colonization from Europe to the rest of the world, a social tsunami whose effects still plague humanity: slavery, racism, the spread of diseases, and the destruction of natural and indigenous systems in pursuit of resources. Pushback included checks on royal power, diversified expressions of conscience, and communities choosing exile over subjugation.

The 18th century saw the rise of industrialism and the spread of global commerce, and with these forces a growing destruction of traditional lifeways. It also spawned a

movement for individual human rights through representational democracy that to this day, and despite many efforts, is far from realized across the planet.

The 19th century was a period of mass migration, technical innovation, growing literacy, and burgeoning populations; these engendered a movement to abolish slavery, and more broadly to promote economic justice. These efforts advanced labor and education rights for both adults and children, as well as food, housing, and health benefits for working people and elders. These important issues are still with us in every form and in virtually all societies.

None of these continuing struggles, however, deals with the new problem arising in the 20th century: *Homo sapiens'* increasing technical and industrial capacity to destroy most life on Earth. Nuclear weapons and other lethal technologies are widespread, manufactured poisons and other chemicals are everywhere in the biosphere and in our bodies, natural soil fertility has plummeted, fresh water supplies are dwindling, ocean life is collapsing, forests are falling, and climate change is making it all much worse. Meanwhile, people by the billions consume resources without much understanding of their ecological impact and have little understanding of how to do better. There is thus a growing awareness that ecocide may well end all the preceding historical processes.

For all of us and our descendants, permaculture proposes a different course for the next decades and centuries. Permaculture is a scientifically rigorous effort to counter this capacity for the willful ignoring of ecocide with better ways of thinking and acting. At its best, permaculture applies proven principles of human ecology to how we build, work, and live, so that we can avoid what could be the near extinction of our species. Moreover, permaculture design solutions not only reduce threats that would destroy life, but also address the injustices and inequities of earlier historical challenges. What could be more compelling than that?

Q: If this works so well, why isn't it more mainstream?

A: To understand this, it may be best to explain a little about how permaculture developed. Permaculture was one of many responses to the environmental threats posed by the 20th century's ever increasing technological capacities and the destruction they have brought about. But it is a far more comprehensive approach than those embodied in, say, organic gardening, the EPA, recycling, conservation, the atomic weapons test ban, or LEED architecture.

Permaculture began as a collaboration between a human ecology professor, Bill Mollison, and an environmental design student, David Holmgren, at the University of Tasmania in the early 1970s. Permaculture focuses on *designing the long-term sustainability of humans and other species by regenerating and restoring the major systems needed to do this.* It is a positive approach employing decisions that take the

whole system and its future into account. Permaculture is particularly helpful and effective when used by individuals and small groups, whether or not the wider society agrees.

Over the last half-century, it has gone around the world many, many times. An Internet search for “permaculture” plus some location like “Michigan” or “Kenya” or “Toronto” or “Hong Kong” or “Des Moines” will often be fruitful.

The foundational short text by these men was *Permaculture One* (1978). This was followed by Mollison’s much more comprehensive *Permaculture: A Designers’ Manual* (1988), Holmgren’s seminal *Permaculture Principles and Pathways Beyond Sustainability* (2002), and many excellent books since (Books, CDs & DVDs | permaculture-design).

Mollison, as a wildlife biologist, was impressed with the long-term stability and productivity of mature forests as well as the long-term survival of both indigenous societies and as well the agrarian civilizations of North Asia. His research led him to believe that humans could observe ecological processes in nature, then copy and apply them to farms, gardens, homes, damaged ecosystems, communities, and cities by the use of abundant, locally available materials, and that this knowledge could avert the long term consequences humanity faced otherwise. Holmgren contributed the orderly processes of environmental design that made it possible to realize this vision. They first looked at farms, but farms are just part of much larger systems, so they began to design communities.

Mollison left his teaching position in Australia, and for the next two decades taught permaculture worldwide. Mollison created an intensive course−the Permaculture Design Certificate courses (PDC) that he could teach in a few weeks as he visited various parts of the world. He taught the course in several areas of North America and these spawned many similar permaculture courses by his students and students of his students, reaching uncounted numbers in the hundreds of thousands.

By international agreement, that PDC is now taught over at least 72 hours, but teachers are encouraged to add additional material that contextualizes the course in the region where it is given. The internationally recognized core curriculum is published at https://pina.in/permaculture-design-course/. The modern PDC runs from 72-100 hours, depending on where you take it. There are three types of PDCs: on-line, in-person, and hybrid. Each has its advantages and disadvantages. Some are led by a teacher with a permaculture diploma verified by the Permaculture Institute of North America (PINA). Some aren’t.

PDCs are often advertised here or here. See Appendix A for more information. Beyond the PDC, there are often short permaculture courses in Advanced Design, Teaching Pc, and others listed at ***Permaculture Courses (PDC's)***. And, with

substantially more work, various diplomas can be had: ***Diplomas - Permaculture Institute of North America*** . You can find some **Permaculture Resources** here and **Permaculture Links** here.

Despite this spread of ideas and opportunities to learn, permaculture hasn't yet become fully mainstream, although some of its original ideas have. Permaculture began outside the centers of power; it does not so far own social or mass media networks or endow university departments. Nor does it run political campaigns or lobby candidates with cash. It has spread as a grassroots movement without central direction, rather depending on the insight and initiative of millions of people trained to understand the big picture and think holistically. It has aimed to empower and support ordinary people in regions all over the planet. Many corporations however benefit economically from these ecocidal practices and use their influence to shape policies and media, so objectors to ecocide often do not have as strong a voice as elites in either wealthy or low-income countries.

Permaculture designs, and the myriad sound decisions they embody, are proven at least partially by impressive worldwide results. These designs, which are rooted in respect for long-term consequences, often run counter to decisions made for short-term goals like profit, jobs, political power, popularity, greed, and other limited or selfish motives, the kinds of decisions privileged by our economic and political systems. Some poor decisions are made because of ignorance, others from deliberate confusion sown by propaganda, the lack of forethought or care, or fossil social structures, and these weighty factors, however deficient, take time and organizational effort to dispel.

In addition, to gain a basic understanding of complex systems takes some study. School systems at all levels have only recently expressed interest and begun to teach it. Most of the required study and subsequent practice to manifest permaculture design have taken place as a result of individual initiative and with private funding.

Permaculture might seem unrealistic, but it isn't any more utopian than the compelling ideas of anti-colonialism, democracy, universal literacy education, slavery abolition or old age pensions were in previous centuries. Yes, to implement permaculture will require a big lift across the planet. However, the work of introducing permaculture to the mainstream has taken decades to prepare for, and it is well underway. Will it be in time? We can't yet know.

So, permaculture may well not alter the path to human extinction down which we seem to be headed. It amounts to whether people care enough to change their ways of life… a lot…to guard their descendants' future and that of other animals and plants. Our decision-making horizon must shift forward by many generations. We need to value and practice ***future care***.

Q: Could you say a little more about how permaculture works?

A: In addition to the prime directive of nurturing permanent culture, there are ***three core ethics and many principles of design*** we believe everyone needs to use to get sustainable—that is, healthy, balanced, natural, and enduring—results. The core ethics can be shortened to **People Care, Earth Care,** and **Fair Share**. Together, they are the hallmarks of ***Future Care****,* or ensuring the perpetuation of healthy life*.* We think important decisions should grow from these ethics if humans and our kin are to thrive.

The permaculture design principles are very widely applicable. By wide, we mean that we can use permaculture to design a trip across town, a kitchen remodel, a new building, a farm, garden, park, or even a town or city. And by very wide, we mean they can also be used effectively to create more sustainable organizations—non-profits, religious congregations, businesses, communities, even government agencies.

Part 2 below explains the necessity of the ethics, our understanding of design, and briefly explains the major design goals with some examples. To understand how permaculture works, however, we need to first explain what we mean by design, why the permaculture ethics are important, and the principles used to solve important problems.

Part 2: Permaculture's main ideas

Permaculture's most important intellectual contribution to the modern world is that *for important decisions*, the welfare of future generations should be given priority. Briefly, all forms of human settlement, culture, land use, and social organization can be made better if *important decisions*—those with long-lasting implications and consequences—are made using a set of universal design principles based in nature and often found in the practices and traditional knowledge of societies with millennial-long longevity. These principles thus draw on the insights of long-lasting tribal societies and state societies that achieved complexities parallel to those of our modern world, but did so without the aid of fossil fuels.

In its broadest sense, permaculture means **Permanent Culture** but the coinage is more specific than this broad term. It refers to an *ecological design approach* to achieving this goal. This has given rise to many admirably short but too often inadequate internet explanations of permaculture that are insufficient for newcomers to use productively. By contrast, hopefully the explanation below explains in enough detail to entice readers to further study.

Ethical Ecosystem Engineering (EEE)

Future Care

"We are guilty of many errors and many faults, but our worst crime is abandoning the children, neglecting the fountain of life."-- Gabriela Mistral

Permaculture (Pc) is an ecological, holistic, and sustainable design system, problem-solving algorithm, and philosophy for shaping human living spaces, both the buildings and the landscapes that hold and the organizations that support them. Pc aims to design lasting balance between the needs of the present and the needs of the future. We permaculturists think this lasting balance will not happen unless impacts on nature, food supply, and the fair needs of all beings—human and non-human alike—now and in the future—become a priority consideration everywhere. Mollison called this ***The Prime Directive*.** We usually call it **Future Care:** *"The only ethical decision is to take responsibility for our own existence and that of our children. Make it NOW."*

To do that, in every significant decision, we need to demonstrate the fundamental permaculture ethics: ***Care for People, Care for the Earth Ecosystem***, and we need to ***Share Resources Equitably***.

People Care

As a society and as individuals, we need to make it easy for people to access those resources they truly need for their well-being. To do that, we have to build an ethos of mutual support for the needs of others. This helps them to provide future care for all while giving them the opportunity to cooperate with us to fulfill both our own needs and those of others.

People Care includes yourself. Part of people care is self-care. Ensure that you are getting useful rewards as part of the work that you do. Activities like gardening, skill sharing, nutritious eating, loving relationships, gifting and doing favors, and exercise generate positive feedback loops of learning, capability, and goodwill. These can feed more beneficial activity, nurturing growth that strengthens our lives.

Earth Care

Earth is our only home and it is highly interconnected across hemispheres from poles to equator. **We must keep our home livable**. This means providing for all life systems to continue and regenerate. Ecosystems have evolved over eons into complex and dynamic communities exquisitely responding to their environments. Each part is necessary for the whole to work well, and we are integral to that whole. Biology gives us food and oxygen, and it plays a major role in the water and carbon cycles. It therefore strongly influences our climate. Our lives would be impossible without our fellow creatures and Earth's intricate life-sustaining systems.

Fair Share

Each of us needs to govern our own consumption as well as that of our descendants and those we influence so there will be enough resources for all life, *both now and for generations to come*. The decision to have children carries with it a responsibility to help them live well into a sustainable future.

Not just Ethics

Although these precepts above are described as ethics, they are really engineering ***requirements*** for sustainable design. These are moral principles that should govern a person's behavior, but they are more than that. A strong scientific case can be made that these ethics are needed for long-term survival. In this regard, they are more like a civil engineer's valuing of bridges whose supports are all on land and whose construction is many times stronger than the code requires. If you want it to keep working, follow these guidelines. Culture too won't last unless permaculture ethics are valued and followed.

As permaculture now passes its fifth decade, it is being used successfully around the world. It can multiply food production, regenerate springs and groundwater, heat homes from the sun or cool them without air conditioning or with much less of it, green the deserts, rehydrate hillsides, grow forests where there were none, revitalize neighborhoods and towns, reduce and clean up pollution, and much else. It can transform lives, and it usually does.

These ethics help guide the basic permaculture ***Design Principles***. When used together, they catalyze problem-solving plans that give us high benefits with low costs and little to no waste.

There are many written versions of the design principles and many ways of talking about them. Holmgren's principles are widely published in his writing and on the web. Mollison's design insights are found mostly in his writing and teaching, and others have outlined them. Taken together, and using known permaculture practices, these principles yield impressive results. They are explained in more detail below.

Permaculture design is easiest to apply in discrete, small-scale, physical landscapes and in buildings. But the design principles are applicable and useful in designing large spaces such as cities and nature preserves, and for the structures and functions of organizations and governments that support society. These principles can be realized as strategies and applied anywhere in the world using locally appropriate techniques.

Whims, plans, and designs

A design is more than a whim, a concept, or even a plan. Doing things on a hunch often works and all of us do it. A plan is a recipe for action connected to a vision with

goals, sub-goals, and specified means for achieving them. Some plans are routine, and some are novel. When a course of action is the least bit complicated or the consequences of failure important, we all plan. Some of us do it in detail and some more casually. But **a permaculture design** is much more than that. It is *a plan built on and guided by principles that work, as confirmed by substantial experience*.

One of us might *plan* to cross a bridge to go into the city, but most of us wouldn't try to *design* such a bridge without expert help. In a *permaculture* design, the principles supporting the plan should be proven for the goals envisioned. Achieving permanent culture requires us to use principles known to promote it.

Designs are information and imagination intensive. Typically, the quality of thought and the information we use are what determine the benefits of the design, not the size or quality of the land or investment. It is easy to point to systems that took enormous investments but gave few or negative lasting yields. Indeed, the availability of cheap energy has often led to poor decisions when better ones were at hand that cost much less. NASA, the US space agency, spent $2 million developing a pen that would write under zero-gravity. The Soviets sent their cosmonauts aloft with pencils to do the same thing.

Bill Mollison amended the cartoonist Walt Kelly's *Pogo* saying about insurmountable opportunities with,

"We are surrounded by insurmountable opportunities, but the system's designer is the limiting factor in realizing them."

Although this last statement may be exaggerated, it still holds a core of truth. Each of us has a finite design ability (training, experience, insight, access to knowledge, information, and the help of skilled and willing advisors); together these factors pose a potentially huge obstacle to good results. Even professionals are bound in this way. History is littered with many very costly bad designs.

The limits on imagination and knowledge are a key reason we encourage teamwork in design, and why we recommend very careful design work before implementation.

Design elements

The designs we create prior to implementation have many elements. They include:

- **The Design** – the harmonious integration of land, resources, and people
- **Site Components** – climate, landform, water, plants, animals, soil
- **Energy Components** – sources, structures, technologies, flow, connections, neighborhoods

- **Abstract Components** – ethics, information, attitudes, laws, timing, history, prior decisions
- **Social Components** – people, culture, trade, finance, legal aid, education, organizations

Permaculture Design Principles

Permaculture is a system for shaping the world around us, including our personal and collective behaviors. It is thought-intensive, aiming for the best long-term results, which conserve labor, energy, money, and resources. *Learning the right way to do this takes significant study of design principles and practice in their application*.

A "principle" is a guiding belief. Over the decades, various arguments have been made about permaculture principles and depending on the viewpoint a dozen or several dozen. The guiding beliefs of permaculture have been described as "principles" by David Holmgren, and explained either as principles or in other ways in the extensive writing and teaching of Bill Mollison. They have been written about and spread by the efforts of countless others, including Peter Bane, author, instructor and Executive Director of PINA, to make these ideas accessible to the widest audience. To help bring the forest into view without ignoring the trees, we have uniquely grouped the many principles into six broad sections below. In what follows, principles that Holmgren highlighted are labeled "principles", but there are many more ideas in the founders' work that have sometimes been labeled "principles." More importantly, it is not the broad statement of the principle that is important, but it's ecologically sustainable interpretation that makes it permaculture.

The explanation here is by Bob Randall with feedback from many in the PINA community. It is based on his experience of teaching permaculture design over decades and informed by his studies in ecological cognition. Broadly, all people (and mammals, probably other vertebrates) plan actions to fit purposes and sub-purposes. Bob thinks we create and remember plans based on the purposes we consciously or out of awareness subconsciously hold. This means that permaculture principles are most easily learned if the general purpose of them and any sub-purposes are clearly understood and labeled. It is better to teach first the purposes of the activity (providing motivation) and then the activity to achieve them. Design principles match actions to purposes.

Equally, they reflect well understood processes embraced by designers of all sorts. And they are rooted in ecological processes as old as nature.

At their core, permaculture designs try to achieve high long-term yields, limit risk and dysfunction, and leverage all uses of energy, labor, and material for high efficiency, while using natural resources and human potential wisely and well. A good design can be easily adapted to new challenges and circumstances.

We have grouped the many principles into six overall main goals that permaculture designs should try to achieve:

A. Adapt to new information, insights, and changes.

Design implies ***conscious change*** and ***a conscious response to change.*** It is a high form of taking responsibility, which is why Permaculture design is rooted in ethics.

Creatively use and respond to change (Principle)

Vision is not seeing things as they are but as they should, could, or will be. Change is inevitable, but in our epoch of intensive energy use, the pace of change is rapid, often uncomfortable. We may understandably seek to limit its impact on our lives. Ironically, this often comes easiest not by resisting, but by flexing, accepting, and adapting. Change presents new possibilities, and in a time filled with intolerable suffering for many, change may open a window to a better life in a better world, or offer an escape from oppression.

Each of us can have a positive impact on change by carefully observing, then intervening at the right time in the right way. This requires preparation, a store of insight, resources, and a positive attitude. Understanding change is much more than assuming a past trend will continue indefinitely; change is intrinsically non-linear and often abrupt. The obstacles and frictions preventing change collapse all the time, and new ones can just as suddenly spring up.

Life is a journey with bumps, sharp turns, and sometimes bad weather. Circumstances can change quickly, dramatically, sometimes with acute trauma, and because the world is complex, unexpectedly. People make their own history, but not entirely under circumstances they choose. We each start on our journeys from different places and move at different rates, but we all want a satisfying life, and permaculture can support that goal as few other problem-solving means do.

“You have to go the way your blood beats. If you don't live the only life you have, you won't live some other life, you won't live any life at all."
—James Baldwin

None of us know where we’ll be in the years ahead. We might create a children’s garden, or aid people in disaster recovery, or develop an amazing food forest, or help build a useful organization, or contribute to slowing or reversing climate change. And we might do it with people we don’t yet know, and in the process build a much healthier and wiser self. We might enjoy helping others on their parallel journeys, and they might benefit from helping us.

If you look carefully in the right direction, you can sometimes see what’s coming, prepare wisely, and intervene in a useful way. Protracted and thoughtful observation can

minimize protracted and thoughtless labor, or the soul-crushing feeling of failing at something you tried hard to do.

As you ***observe and interact (Principle)*** with systems in your life, note what works well and what doesn't. ***Self-regulate and accept feedback (Principle).*** Be attentive to observations and results. Redesign as problems become evident; replace systems that don't work and, as James McMurtry sings,*"Walk between the raindrops, dry as a bone."*

Design from pattern to detail (Principle)

When people fashion clothing, they work from patterns. Buildings, parks, roads, budgets, landscapes, organizations, and meetings commonly are fashioned from sub-plans that are known to work. In a design, *a pattern provides an elegant solution to a recurring problem*; it resolves tensions economically. Each pattern in a design is part of a larger pattern, connects to other patterns, and also enfolds smaller patterns. If a big pattern changes, patterns within the pattern do also.

For example, a **gate** is a **portal** in a **fence** or **barrier wall.** It often crosses a **path**. In a residential neighborhood, **fences** and **barrier walls** form **edges** between areas such as **front yards** and **backyards, alleys,** and **streets**. Each of the above in bold is a *design pattern*. We could put these in a design we envision if we wish. A **gate** could be part of a bigger pattern such as **a garden** and might consist of smaller patterns such as **arches, posts, hinges, latches,** and **welded art**.

A **gate** naturally functions as both a portal and a closure to the **fence** or **barrier wall,** but it could have other uses as well, such as a **privacy screen,** a **welcome sign,** an **outdoor room divider**, a **theft protection device,** a **trellis,** and more. A **gate** has a shape and dimensions, is made a certain way out of particular materials, in one or more pieces, and may or may not be planar or flat. Above all, except when **locked,** it needs to function by opening and shutting over decades without much human energy expended. If this works easily, it contributes to system harmony, and if not, then to system stress. Permaculture designers likely have ideas about sustainable (well-made, intuitive, durable) **gates** and all the other patterns highlighted in bold above.

As we design, we move from 1) *big goals* to *2) supporting strategies* to 3) *techniques and resources for implementation.* The closer we get to something, the more we can be distracted from the big picture. Do we need one gate or two of them? Do we need a fence, a hedge, a wall or a moat? Where? What are we separating, and what are we connecting - and why? Yet the larger goals must remain paramount. By stepping back, we can observe the flows of energy and resources around us, and by the same token, patterns in nature and society, allowing us to harness these flows to accomplish our aims. Patterns form the backbone of our designs, with the details to be filled in as we go.

Our lives are contained within many big patterns, themselves nested within larger ones. They all impact our designs. Life and family goals are big. With whom do we share them? How do we support them? Where do they play out? Do we need a house,

a business, a farm? These questions point to the nesting of our life and family goals within community: should we live here, there, or somewhere else: city or country, village, town, or metropolis, east or west, north or south, mountains, plains, woodland, island, or seacoast? Communities, in turn are nested within larger patterns of domination, economy, government, and climate, and these yet further enveloped within the ethos and historical context of our civilization. To design is to choose how and where to apply one's life energy and influence. To adapt to change, we especially need to respond to these big patterns since they influence all patterns contained in them.

Urban communities attract an increasing proportion of humanity because they concentrate resources and rural areas face lots of economic barriers. But North American cities use too much space for automobiles and parking, use slow and inefficient transport, don't produce enough food, water, and biomass to sustain themselves, and thus require road, rail, and other infrastructures of questionable durability and energy cost. Even worse are the megatons of waste generated daily, and its irresponsible disposal. Are humans making good conscious choices, and from which level of understanding? Can we creatively adapt to the changes coming toward us from climate change, pollution, resource depletion, and in wealthy nations growing populations of heavily consuming humans?

B. Catch, store, use, and conserve energy by design.

Design for leverage.

Make the least change for the greatest effect. The smaller the change you need for a given effect; the less energy will be used. Closing a door is easier than re-cooling or reheating a room; putting out a campfire is easier than putting out a wildfire; spreading runoff is easier than repairing a gully; recruiting a co-worker can be easier than doing it alone.

Directing our energy and attention to key leverage points enables us both to amplify and to conserve our resources, to achieve greater harmony by understanding the logic of the forces in play, and to make needed changes that might not otherwise be possible. This can take the form of supplying a missing element (including information, alliances, nutrients, or species), relieving circulatory congestion, conflict, or other dysfunction, or capturing a valuable resource leaking out of the system.

Understand net energy and use renewable energy

Sustainable systems are ultimately fueled by renewable energies: sun, wind, tides, currents, and geothermal energies. They should meet not only their own needs, but also the needs of those creating and managing them locally. A sustainable and successful design produces a surplus, thus giving to the future and the larger community.

To measure the surplus or deficit accurately, we have to account for the inputs and outputs of all the elements. We can borrow stored energy including fossil fuels to build

these systems, providing that in their lifetime, they capture or conserve more energy than we use to build and maintain them.

Biological systems produce plant and animal organic materials that can be harvested and consumed by humans as well as other living beings. For a biological system to last, it needs some or all of these biomass materials for maintenance. So, there is a strong limit to how much can be consumed or exported from the system. In general, ***don't consume or export more organic material (biomass) than carbon fixed by the solar budget***. In designing systems, try to follow the dietary fitness advice of *One Calorie In/More Calories Out*. That is, the ***E****nergy* ***R****eturned* should be "over" or greater than the ***E****nergy* ***I****nvested*. In short, the E.R.O.E.I. is positive.

Determine Footprints honestly, and measure life cycle energy invested.

Everything created or used by humans has sources and sinks. In permaculture design, we internalize all costs, evaluate the life cycle, and do careful accounting. *Embodied energy* (or "eMergy" for short) is the sum of the energy used to produce something from nature, move it to where it will be used, transfer ownership, wear it out, and then dispose of it when it's no longer functional. If tools, equipment, manufacturing facilities, trained employees, sales brokerage, or transportation are involved, energy used for them is also part of total eMergy. To measure embodied energy honestly, do a Life Cycle Assessment (LCA).

Thus, the energy and resources we use are not just what we consume directly, but also what we consume indirectly to produce, transport, and dispose of wastes from what we consume. The wastes we cause are not just what we discard, but include wastes from making and shipping what we consume. Together, these mark the system's total *ecological footprint.*

Since some items like concrete and steel function for decades and others like tissue for just days, in comparing eMergy of potential consumables, it is best to measure eMergy expended per year.

Match the system needs with its yields.

A successful design creates a balanced and self-managing, or *sustainable* system. Extra work (a deficit) results when inputs are not readily provided by another component of the system. A landscape with a tree can provide some shade. But shade also could be created by pitching a tent canopy. The tree provides shade as part of its function and requires minimal investment. The tent provides shade too, but with much extra work and resource use. Minimize such extra work by introducing self-maintaining low-cost elements to fill unmet needs. Harness natural energies to do most of the work. To gain efficiency, devolve power and control. The systems we construct should last as long as possible and take the least maintenance.

<u>Place each element to benefit others</u>.

Permaculture designers try to place elements where they will produce the most benefits and the least dysfunction. This ***Principle of Relative Location*** is a crucial part of any effort to minimize energy expenditure. Elements in a design do some things easily or naturally and others only with lots of effort. **Connect design elements thoughtfully.** Place a fruit tree where it will create habitat, and privacy, and where you can gain from its shade and mulch. Place a person in an organization where their skills, interests, and personality will give the most benefit. Place a road where it can serve as a fire break, a water catchment device, and an escape route. If paved in limestone gravel, its runoff will provide calcium to nearby soils. Design organizations that accomplish a lot with a little (so that it would be difficult to explain their mission in an elevator. :)

Elements placed in a system should be viewed i*n relationship*, not in isolation, since everything influences its environment, and everything is connected to everything else, either directly or remotely. In a design, try to ***integrate rather than segregate elements (Principle)***. Where for example should a culinary herb garden be in relation to a kitchen? And if its blooms attract insects beneficial to a vegetable garden, where should the vegetable garden be? And for that matter, where should a food farm be in relation to a city?

By putting the right things in the right place, relationships can develop or be built between them, and they can support each other. How you place elements in a design strongly affects energy consumption and yield. All living things seek out yields and everything, living or not, affects its environment. This key idea is summarized as “Everything Gardens.”

Example 1: A good example might be using gutters and tanks to collect and store rainwater from your roof. During Houston’s 2001 tropical storm Allison, Nancy and Bob’s 1,200 square foot house shed 16,000 gallons of rainwater in just three days. The surrounding yard took in nearly 10 times as much. The house foundation pooled with water, some of which entered a corner of the building. Just two months later, they were drawing city water for the garden, with all its costs for purification and pumping.

If they had collected some of the roof runoff in tanks, and released the overflow in a controlled way downhill, they would have saved themselves money, and spared the city added costs. They would have reduced greenhouse gas emissions and would not have been flooded. Going forward, they used permaculture design, built the tanks, and when in 2018 Tropical Storm Harvey dumped 50% more water in four days than Allison did in three, they did not flood. They have also had a lot of free irrigation water, since the cost of the tanks was paid off in ten years by lower water bills.

Rainwater is what permaculture designers call a sector energy: a free or low-cost resource that can be used productively if we only figure out how. Wind can cool

us when we're hot but ruin us if it's too strong. We design to move sector energies we like to where we can use them, and to deflect or alter sector energies we don't like so they aren't a bother. For example, metal rainwater tanks, besides storing water, can deflect strong winds, and by radiating heat in cold weather, make a nearby lemon tree less likely to die. Thus, a house roof can direct rainwater into a tank, the tank can buffer hurricane winds hitting the house, and *the connection* between the two can benefit fruit production. By good design we can get benefits, not just by connecting things, but also out of the connections themselves.

Example 2: In a northern climate with a short growing season, greenhouses are a way to get a jump on the spring garden, and to extend food production into the autumn and winter. PINA's Executive Director Peter Bane, who contributed to this article, together with his partner Keith Johnson, built a greenhouse attached to their passive solar home near the Lake Michigan shore. Placed on the SW side of the building (the warmest exposure), it's well sheltered from cold north winds, but also connected on two sides to the insulated and heated spaces, reducing heat loss. A sauna room inside the home abuts the otherwise unheated greenhouse, so that surplus heat from its stove can be dumped into the greenhouse when winter skies are gray. The sauna doubles as an occasional clothes dryer on inclement days when line drying won't work. On sunny days the solar warmth captured by the greenhouse can be vented into the adjacent living space, sparing fuel. Also, adjacent to the kitchen, the greenhouse absorbs the warmed cook-stove exhaust, prevents undue cold backdrafting from the outside, and provides a space to dispose of greywater (and thus water plants) when the outdoor garden soils are frozen. It's a recreational space that expands the home, a source of fresh food in the cold seasons, and always a buffer against harsh weather.

In this example, we again see the design working to harvest a free sector energy (ambient solar gain) to grow crops but also to protect and warm the home, thereby replacing fossil energy and reducing dependence on wood fuel and imported food. This saves money and labor in many ways. Connected placement enables heat, wherever generated, to move easily from one space to another. Materials as well as energy can be shifted back and forth too: food moves in from greenhouse to kitchen with little fuss, while waste heat, water, food scraps, wood mulch from the stove fuel, and gasses (including carbon dioxide, which plants use) are returned to benefit the indoor gardens and help keep the home clean. This is only possible with thoughtful planning, but with that design input, the costs to have and operate a greenhouse, sauna, clothes dryer, and indoor year-round food garden—all superb amenities—are almost nothing or may indeed be negative compared to similar but separated systems. If the intelligent application of design can recycle wastes, save us time, money, labor, and materials, and also improve our quality of life, why would we not do it everywhere, and in every way?

Example 3: These principles apply not just to the design of homes and landscapes, but also to organizations—what permaculture designers call Invisible structures. Take for example mission driven organizations like non-profits. They have distinct free sector energies they can potentially collect and use in addition to natural energies like sunshine hitting the office roof and walls and rain water pouring into the street. Such could also happen for any home, business, or government office.

Rather, a non-profit has *supporters* and *allies* who are super valuable. Supporters, if you can collect them, in return, want benefits for their support. But the benefits aren't goods or services for themselves. If they are good supporters, they will be a source of usable skills, knowledge, funds, and access to diverse communities. How do you collect and retain donors, volunteers, and hard-working staff? That is a design problem.

One way to solve this problem is by doing a detailed benefits analysis. Your programs should generate many benefits, and some of them need to be the ones potential supporters want, whether these be community, education, identity, purpose, safety, or mission accomplishment. One way to increase what supporters provide is to get multiple benefits from each program, such as connecting programs so that each benefits the other, and like the two examples above, the connection itself brings new

A school gardening program, for example, could connect to a farmers' market with children selling some produce they grew or displaying garden art they made. Farmers would benefit from parents and children learning to shop at the market and the children would benefit from the active learning they got. The general shopping public benefits from the connection because they meet and learn to support children, often of different demographics and ages from the ones they know.

Clever design can engage supporters for the long-term. We can't tell you how to do this—it varies by situation, but we can tell you that permaculture design can help you do non-profit work better because it builds better benefits and wastes fewer resources.

Make frequent activities easier using permaculture zoning

One of the easiest ways to evaluate energy costs is by measuring our time spent doing something. Do we commute hours to a job daily? On large pieces of land do we walk or drive often from one end to the other? Do we need to rummage in our kitchen or closet or desk for things we use regularly? It is not always possible to design away these problems, but an effort should be made. We need to know what we do often versus rarely, then place the components of these frequent tasks close by to make them faster and easier. By making less trips we use less energy. By convenient placement of every-day tools, we waste less time.

Zoning labor by frequency of use is not the most important part of a permaculture design, but it is often one of the simplest and cheapest steps to implement, and is useful in building an energy-efficient design.

In non-profit organizations, for important activities, design to have *skilled and reliable* staff perform them. It is often easier and more effective for skilled staff with dedicated time to do complex important tasks compared with less skilled people doing important tasks in their spare time. But volunteers are a free sector energy that should certainly be used if they can reliably and effectively substitute.

Use on-site resources and wild sector energies

One corollary of using Zoning and eMergy analysis in design is the effort, where possible, to use on-site and local resources. Determine what potential resources are available or entering the system on their own and maximize their use. Dozens of sounds, views, creatures, seeds, spores, pollen, microbes, materials, liquids, and gasses enter sites all the time. Blown or waterborne plant matter, sunlight, noise, bugs, trash, animals, and wind are just some of the "wild energies" that pulse. Encouraging or discouraging them and designing for their use can make a system much more energy efficient.

Catch and store energy (Principle)

Don't waste the energy you or the system could harvest just because you can't use it immediately. Bank it. Figure out how to catch, store, and later use solar energy, wind currents, gravity and rainwater, the growth of trees, the movement and wastes of birds, livestock, and beneficial creatures, the yields of food plants and animals, the decay of compost, and more to increase available energy in the system. For example, trees, earthworks, and grazing animals can create soil fertility. If placed high in the landscape, their activities hold water higher up and allow plant growth on upper slopes where it is especially valuable. Yields increase, soil is improved and absorbs more water, and this increases water supply downhill and allows even more plant growth. Use gravity rather than pumps to move and disperse water and other materials. On a smaller scale, gravity can move water with less labor than a bucket, so it's more efficient than your heart's pump.

C. Derive Benefits, Uses, and Yields (B-U-Y Time).

Good permaculture designs accomplish a lot with a little. These accomplishments are forms of harvest, but we refer to them in various ways. In permaculture, the terms 'benefit', 'use', 'yield', and 'function' are somewhat interchangeable, though in English they have slightly different meanings. ***Benefits*** describe a gain, usually to another element: citrus leaves, for example, are of benefit to a Giant Swallowtail butterfly as forage. ***Benefits*** tend to be described qualitatively. But **yields** are usually assigned to the designer: we get beauty and pollination from the butterflies; squash vines give us food. ***Yields*** are often thought of as quantities, such as "lots of beautiful butterflies" or "an ample squash harvest."

Uses, on the other hand, can be thought of as the purposes for which an element is deployed. The main *use* of a water pipe is to deliver water. Its ***yield,*** by contrast, might be gallons or liters of water where it is needed, for the ***benefit*** of irrigation.

All these examples point to ***designed functions***. A permaculture function is the purpose or purposes for which an element, edge, or connection is placed in the design. Benefits, uses, and yields are some of the functions that elements commonly have by design. Elements also have functions naturally: a tree grows upward making shade, so it has that function even if we don't benefit from it, use it, or get a yield. But good permaculture design optimizes the benefits, uses, and yields of every element. What matters is not the number of elements, but the *complexity* of their functional relationships.

Elements in a design can also be dysfunctional. Shade can make a tomato produce poorly and it can make solar energy panels unproductive. Everything works both ways. Every element offers either an advantage or a disadvantage, depending on where it's placed, the use made of it, and the designer's forethought and skill.

Living things are needed to get a yield.

People and other living things, which maintain and reproduce themselves on solar energy, are the only effective means on this planet to capture resources. -They do this through the conversion of energy to matter, and, as a result, produce a yield for the benefit of people, society, and landscapes. Even inorganic elements that support a harvest of energy (e.g., houses, solar panels, windmills, water tanks) require human ingenuity and effort (part of eMergy) to deploy, manage, and maintain. Thus, it is the sum and capacity of life forms that determine total system yield and surplus. Yields for people are just part of total yields.

Once a system has access to the resources it needs for growth, reproduction, and maintenance, any additional energy is *in surplus*. The system's design *yield* is the sum of surplus energy produced, stored, conserved, reused, or converted.

The yield of a system is in principle theoretically unlimited ("infinite yields"). The only limit on the number and range of possible uses of a resource is the limit of available information, and the imagination, understanding, and ability of the system designer or manager. In general, a better design is likely to increase long-term yields.

At a planetary level, Earth's ecosystems capture some 4,500 Quads (quadrillion BTUs) each year from the sun through photosynthesis. This is the great bulk of energy available to fuel life, but it is less than 1% of the solar energy falling on the Earth's surface. If limits on vegetative cover, nutrient availability, and water resources could be lifted (by human design and intervention), even the gross photosynthetic capacity, also known as primary productivity, of the planet could be increased. To bring this home, envision the millions of acres of pavement and barren roofs in our cities that could be growing food, harvesting solar kilowatts, heating water, or attracting songbirds. That

they don't do this now is a failure of imagination and of understanding the energy basis of our society. We ignore these fundamentals at our peril.

Instead, what we do is burn climate-wrecking, non-renewable fossil fuel. According to a peer-reviewed 2003 University of Utah study by Dr. Jeff Kent, one gallon of gasoline uses 98 tons of prehistoric plant material and a 20-mile drive burns the equivalent of 40 acres of wheat! See Bad Mileage: 98 tons of plants per gallon | EurekAlert!)

Each element should perform multiple functions.

The basic permaculture rule of *Energy Conservation* asks that every plant, animal, group of people, or structure be placed so that it serves three or more functions, and has zero or few dysfunctions.

Stack and pack functions vertically, horizontally, and over time.

"Stacking" functions means to get many functions (benefits, uses) out of an element or space or activity. In *Temporal Stacking*, a design gets different uses out of a space or element over time. A vine for example might shade a wall in summer and shed its leaves to allow sun heating the wall in winter. A room in a house might be an office most of the time, but a guest room when needed or a seed drying operation seasonally. A school yard might be an education and exercise area for school children during the week, but a public playground or community garden or farmers' market on weekends and during vacations

In *Vertical Stacking*, one gets by design several functions out of the same vertical space. Putting a grape or kiwi trellis over a path for example, gets several functions out of the same vertical space–access between two locations via a path, fruit, shade, and easy access for harvesting and pruning. Putting cupboards both above a kitchen counter and below it is a common example also. Trees in forests do this naturally with *layers* of plant matter as well as creatures at many different levels. Trees, because they grow large and expand as the cube of the radius in 3-dimensions, develop many times the biomass of a similar space packed with plants a foot high.

In *Packing,* one designs to get many functions at the same time out of the same space, element, or activity. Bookshelves are an obvious example of packing since books can be used for many purposes. Rooms can be used for one purpose–like eating or sleeping, but one function is a poor use of energy and resources. Gardening and house building provide multiple benefits–weights, aerobics, cost-savings, and personalized production while many common types of exercise have just one. One is certainly better than none because a lack of exercise is dysfunctional. But why settle for one?

Connection Stacking refers to getting multiple functions from the interaction of different elements and *Edge Stacking* is getting multiple benefits from borders. How many uses can we get out of the connection between two elements? The more functions we can get out of connections we build among elements, the more energy

efficient we become. If a tree or house produces shade, or a hill or roof provides an opportunity to use gravity in rain catchment, why not connect something to the hill or roof to use its shade or gravity?

Almost everything has edges. Can we get multiple functions from them by designing different edge shapes, materials, heights? How many uses can you get out of a rose hedge for example? How many can you get from a house roof? How many from a tarp? How many from a forest edge? How many from an international boundary?

Mind and exploit "Edge" within a system; value the marginal (Principle)

In nature, edges (*ecotones*) are the most diverse and fertile areas: more action and interactions happen there. Where two ecosystems overlap they form a third which has more diversity and therefore *more possibility* than either of the others. Examples include the edges of ponds, lakes, oceans, and the stratosphere. Bayous, swamps, and estuaries are filled with edges. Forests form edges with all of these, and also with meadows. Nearer to home, house walls, paths, and the drip line of trees all offer promising edges to exploit.

In what we design, edges often host the most valuable, diverse, and productive elements of the system. Lots of food trees, for example, blossom and fruit on new wood on the outer edge of the canopy where there is sunlight to fix carbon. The interior walls of a house are typically used for elements like closets, shelves, cabinets, electrical outlets, pipes, and pictures that are unsuited to the center of any room. International borders could be opportunities for education and cultural exchange.

Unique and fruitful microclimates occur at the edge: exterior house walls may shelter and benefit from vines. Similarly, a water tank warms or cools the area immediately surrounding it. Edges also reveal unseen connections: amphibians show subtle changes in water chemistry, a roof channels skywater into ground storage, and parents link schools to the community. The transition to a new technology, say an energy system, or a new paradigm such as holism, is an edge between what was (memory) and what will be (dreams), where new forms can emerge. Historic epochs are bounded by edges when all sorts of change and creativity occur.

But, as Rosemary Morrow, a renowned permaculture practitioner and author, observes, the edges and margins are sometimes difficult to see clearly, especially if we are looking elsewhere. In big and complicated systems, it is easy not to notice them. We do well to hunt for edges and study them because they embody and often debut the most vulnerable, emergent, promising, or dangerous aspects of a system.

Permaculture itself is an 'edge culture.' What is most popular now may be dismissed or impossible tomorrow. The popular is not necessarily the best path, and what is unpopular or marginal today may be in great demand in a bit.

Change is almost always found first at the margins, revealing the direction and potentials of any system.

Aim for yields dispersed over time.

Those fortunate enough to know in their own lifetime both their great-grandparents and years later great-grandchildren know that knowledge, investments, events, and decisions seven generations apart may make a big difference. So, long-term yields are important. We can use energy to build out our designs, providing that *in their lifetime,* they store or conserve more energy than we use to build and maintain them.

This is especially true when we have abundance. If you have more than you need of water, food, land, or other things, figure out how to store it for the future, or share, gift, or loan it to someone else or to other life forms who lack abundance. This respects nature's (and permaculture's) ethic of Sharing Surpluses. Especially, **avoid waste in times of abundance because** it can lead to hardship later.

Long-range planning for descendants worked better in earlier times when personal involvement in design and implementation helped people understand better what worked and didn't. Likewise, in earlier times, there were less 'middlemen', people understood geographically where their food, energy, building materials, clothing and medicines came from and what was needed to ensure the sustainability of those elements. Also, descendants' lives didn't change as much over generations as they do today. But change in recent centuries has made such slow and deliberate planning and learned wisdom increasingly difficult to apply. As Robyn Francis, a veteran permaculture teacher, reminds us,

> *"The pace and rate of change is exponential and it is becoming increasingly difficult to see even two generations ahead, let alone seven."*

Permaculture can't guarantee what outcome your long-range planning will have, but not using it will certainly produce much worse results faster. With application of permaculture principles (stacking functions, obtain a yield, catch and store energy, etc.) designs can be adapted over time to suit changing conditions. Designs that do not consider these principles are typically irretrievable commitments of resources, not adjustable and rely on unsustainable systems and practices. When change is required in the latter circumstance, the only option is to destroy the installation and start over. We need to do better by designing for resilience in the face of change according to timeless permaculture principles. .

Summary: Accomplish a Lot with a Little

Place each element to benefit others and get multiple functions out of each element. Get many functions out of the same space and over time, and still more uses out of edges and connections. If resources, energy, and labor are designed well, maximum benefits are possible.

D. Study Nature's processes to mimic its structures and functions.

The plant and animal world has been evolving and adapting over many millions of years. In that time, structures and functions that worked well have survived, and those that led to extinction disappeared. In intact nature, there are countless structures and functions that provide advantages for those that incorporate them. At the same time, physics has its own structures and functions which like gravity and the day-night cycle are constant realities. Most animals protect and teach their young. Clever adaptations help creatures and plants conserve energy and maximize advantages through physical or behavioral designs; there are no pointless activities or appendages in nature. Likewise natural ecosystems mature over time in similar ways across the planet.

Patterns abound throughout nature because of highly-evolved efficiences. Our arterial system within our bodies has many similarities to lightning in the atmosphere and rivers in their deltas. If we look at the reasons for such patterns, they often show efficiencies in energy and resources. If we study carefully, we can use this wealth of nature's experience to design a smaller ecological footprint. If mimicking natural systems achieves their natural functional efficiencies, such biomimicry always produces more functional, sustainable designs.

Use and value renewable resources and services (Principle)

Increase water storage, soil fertility, diversity of adapted species, and biomass. Make the best use of nature's abundance to reduce our consumptive behavior and dependence on non-renewable resources. A non-consuming use of a resource, harvesting a service, for example, is preferred over a consuming one.

Work within Nature.

Aiding the biogeochemical cycles of nature results in higher yields and less work. A little support goes a long way. Live within a solar energy budget. Capture carbon and bank it in soils and biomass. Protect and regenerate material sources on which you depend: timber, food plants, clean water. Respect plant and animal population growth rates to protect species. Emphasize materials harvested sustainably from nature. There should be zero un-recycled wastes. Return all organic wastes to soil. Reduce consumption of industrial materials and repair, reuse or recycle any remaining. These goals apply to cooking, lighting, transportation, heating, sewage treatment, water, and other utilities as well as consumptions of goods.

Keep a small footprint and apply appropriate technology.

Control over nature through excessive resource use and high technology has a footprint. Tools and technologies that are easily built, maintained, and repaired cost less over their lifetime, and they respect natural and human limits. Natural systems demand a return for every gift received. The user must pay. So, if we take, we must return. Every object, including technology, must responsibly provide for its replacement.

Observe and replicate natural patterns.

Energy moves in cycles, circles, spirals, vortexes, whirls, pulsations, waves, and rhythms—rarely if ever in straight lines.
—Starhawk, *The Earth Path*

Use the engineering and artistic strengths of natural patterns and webs. There are reasons spirals are found not just in giant galaxies, but also in sunflowers and lacewing egg-laying. Using natural patterns can help us regenerate, restore, and protect soil, water, climate, and ecosystems. Should a path be straight, curved, nested, or coiled? It depends, but usually winding from point to point. Nature follows the path of least resistance while connecting points where resources can be found or best utilized. How should a windbreak be created (multi-row imitating a forest), where (along ridges, riparian zones, contours, and property and field edges where it is most effective), and in what shape? (perpendicular to the wind; crenellated for variable winds, in the profile of a bird's wing.) What is the best pattern for bringing nature and food production into a city? Interdigitation, that is finger-like nodes of farm and nature extending into the urban setting. How do you manage water on steep slopes where runoff typically flows in rocky, meandering channels? Nature uses trees and fallen logs to slow its pace, but we can add linear contour ponds, check dams and swales.

Use and conserve biological intelligence - honor the wild.

We know living things reproduce and build up their interconnections over time, assisted by their interaction with other compatible elements. Land left alone will often grow an increasing diversity of plant species, develop and fill more niches, generate a richer microbial soil web, and improve its mineral availability. With good design and enough time, plants not selected by people can, by themselves, produce many yields. We can observe and use the same processes nature does by using biomimicry to capitalize on the successes of nature. After all, nature has had over 3.8 billion years to adapt and perfect its systems!

Adapted perennial plants and especially trees and prairie grasses increase their biomass both above ground and especially in the soil. Large numbers of them alter the environment in many important ways, and make it more habitable for us and many other beings. In our managed landscapes, these high biomass, deep rooted species are typically better able to survive climate extremes. Once established, they also take less labor to manage and require fewer resources to flourish. Those that produce fruit, nuts, vegetables, spices, herbs, fiber, or wood– what for us is a valued yield– are especially useful because they create many benefits while substantially cutting long term costs.

Promote natural plant succession and diversity.

Recognize that certain elements prepare the way for ecosystems to support other elements in the future, i.e., using a succession of species, growth rates. densities, and

maturation cycles. Ruderal species (weeds) give way to pioneering shrubs, which in turn nurture long-lived canopy species. A good design facilitates and plans ways to take advantage of this process.

As sustainable systems mature, they become increasingly diverse in both space and time. So, design for polyculture and nurture diversity at the edge. But succession in cultivated systems also has a limit, and can sometimes, like nature, require directing disturbance to reset parts of the system for higher yields and greater diversity.

Some indigenous societies used the principle of *Honorable Harvest.* If the plants are reproducing themselves because you saved the seeds or the plants are wild, don't take the first fruits or the last, and leave some for other living things. Biological diversity in human-designed systems works best if some plants of a species bloom and fruit early, some bloom and fruit late, and whatever eats them gets some too.

Select and stock plants to balance the ecosystem.

In adding plants beyond familiar and adapted food crops, the first priority is for proven native species. These benefit native animals, insects, and birds. The second priority is for proven exotic/non-native species that fill a similar niche as natives. They pose few problems of invasiveness and potentially have been bred for higher quality and quantity yields. The third priority goes to unproven exotics and marginal species. For these latter, a careful design that provides many microclimates could make them viable with lots of observation. In a rapidly changing climate, these marginal species are worth experimentation. Where space is not an critical issue, species that typically require a warmer growing zone might excel with some winter protection and produce well despite increasing temperature over time.

How much of an element is required to meet the needs of the whole system? When adding or deleting elements, find the balance to keep each from overpowering the others over time. Observation will tell you when certain plants need to be cut back, moved or removed to maintain ecological harmony.

E. Limit risk and dysfunction.

> "We stand now where two roads diverge. But unlike the roads in Robert Frost's familiar poem, they are not equally fair. The road we have long been traveling is deceptively easy, a smooth superhighway on which we progress with great speed, but at its end lies disaster. The other fork of the road — the one less traveled by — offers our last, our only chance to reach a destination that assures the preservation of the earth."
>
> — Rachel Carson, Silent Spring (1962)

Design with Future Care foresight.

Assess the biosocial impact of your design's long-term effects on society, and act to buffer or eliminate any negative impacts.

Preserve and protect ecosystems and all their habitats and species.

Oppose further disturbance of remaining natural areas, regenerate and rehabilitate damaged ecosystems, and keep plant systems for human use in the smallest areas possible.

Leopold functions are those aspects of an ecosystem that are essential to the web of life, but which are not understood by some or all of us. As naturalist Aldo Leopold explained in the 1930s, the first rule of tinkering is, “Don’t lose any of the parts.” His point was that if you destroy a part of nature, you unleash consequences for its functioning that you may not understand, and which may cause you or your descendants grief.

Don’t make poorly understood ecological interventions, and ***don’t cause extinctions.***

Attitude: Turn problems into solutions.

If humans caused the problem, humans most likely **can** find a solution. ***As an attitude***, turn constraints into resources. Mistakes are tools for learning. As Einstein noted, on-the-ground crises are opportunities for creativity, as are failures in problem-solving.

Avoid designs that need continuous or excessive energy inputs (System Stress).

System Stress may be defined as either the prevention of a natural function, or of forcing a function inappropriately. Forcing a design element to function takes lots of energy, material, and labor. Pumping sewage uphill to be treated, growing plants in the wrong climate, eating food grown in other places or “fresh” out of season, disturbing the soil surface every year, most mowing, putting carbon in the atmosphere without sequestering an equal amount, letting water run downhill without getting yields and then pumping water in water systems, all introduce system stress. Better design is to arrange things so the functions these serve are done passively without net energy loss.

Elements in a design do some things easily or naturally and others only with lots of effort. Trying to grow orange trees in a Chicago greenhouse inevitably involves more resources and labor than growing them in a more tropical place. Putting a subtropical building in the middle of a parking lot inevitably requires more cooling than a similar one in a grove of trees or even on a large lawn.

Work with Nature, not against it, create system harmony, and replace systems that don’t work.

System harmony and order may be defined as the integration of chosen and natural functions with ***the easy meeting of essential needs***. This design approach permits components to do many things without exerting effort to force functions. Minimize stress, maximize harmony, and you get the most done with the least effort.

Living things are functionally “anti-entropic.” They concentrate rather than dissipate energy. In complex systems, disorder is an increasing result of the absence of energy to regenerate it. Living things help keep systems harmonious by tapping solar energy.

Such systems are stable only because they are partly unstable. That is, living systems change, adapt, and evolve over time to stay organized. In general, for a complex system to remain stable, there must be small pockets of disorder that allow it to be flexible and, through feedbacks, to adapt.

Order in permaculture is not the same as what we might call ‘order’, for example, in suburbia today. Neatness, tidiness, uniformity, and straightness are uncommon in nature. In these human-influenced systems, these manicured landscapes usually stay that way because of energy-enforced unnatural order. That is, ***energy is consumed to no useful end***.

This energy needed to maintain these designs is out of balance with the energy produced. Such a design does nothing useful, and keeps an energy-wasting aesthetic alive. Rather, use an energy-efficient, sustainable design, and locate it where there is or can exhibit a reasonable tolerance for sustainable but evolving design. It’s not that you should never straighten or tidy or beautify, but that you should keep an energy balance—whatever you invest in should be balanced with yields.

Order and harmony produce energy for other uses. In nature, as Rachel Carson long ago pointed out, everything is in a relationship. Placing a design element so that its natural or everyday behaviors accomplish the desired function provides a surplus that benefits other parts of the system and reduces overall costs and waste.

In organizations, it is more harmonious to get people to do what is easy for them and they want to do. It is more stressful to get them to do what for them is hard to do, or what they don’t want to do, don’t understand, are being forced to do, or have no interest in doing. Thus, a resilient, well-designed organization naturally allows employees (elements) to fit well, to interact and to support other elements, with all benefitting from the highest and best contributions from each element. This harmony creates conditions where individual elements are much better able (and willing) to endure temporary stress, as their energy (effort) will contribute to the whole organization and thus benefit the individual parts, creating more energy.

People often wonder why desired change often seems so difficult to accomplish. Partly this is because many easy-to- make desirable changes have probably already been made. What’s left are the difficult ones. But even if there are few benefits to the status quo, making a successful change happen is typically more difficult than doing the familiar. Designing and implementing a new action or system is labor and materials intensive even if there are both few obstacles and a harmonious energy-efficient design. As well, the benefits of the change must be seen to outweigh the effort expended to change; risks must seem low and manageable; and new pathways must be forged and

learned along with new relationships and responsibilities. All of this takes labor, resources, time, and above all a quality design.

Use small and slow solutions (Principle)

Small, slow, and space-intensive systems are easier to maintain than big and sprawling ones. They make better use of land and local resources, and give more sustainable outcomes because these choices match human capacities to the systems they are asked to regulate. Systems that start small and intensive, lead to rich, manageable outcomes, affording a high yield. Negative feedback can be slow to emerge, but its cause is easier to discern and understand in a compact system. So, keep the new system small at first. Small errors are easier to correct.

As anyone knows who has tried to prop up a crooked banana or papaya trunk, lost a road to an avalanche or who has seen giant corporations or even colonial empires like the UK and the USSR collapse, the old proverb "*The bigger the tree, the harder it falls"* reminds us of the disadvantages of excessive size and growth. More broadly, it means that when something massive fails, the consequences are more damaging, and efforts to keep it from failing are more risky, difficult, and energy-intensive. After it fails, there likely will be extensive damage and loss of function to rectify.

Therefore, before it collapses, completely replace any system that over time is clearly failing. Even big systems "too big to fail" might need to be replaced. But it takes lots of resources and energy to topple big trees too, including the space for it to fall/fail with the least damage. Judo has some lessons for us all. Whatever is out of balance can be pushed easily at the right moment, and perhaps in the right direction, hopefully without much damage. As Maya Angelou has said, *"All great achievements require time.*" But optimally, the time to start the replacement design is well before the existing system fails so, keep an eye out for precarious functions.

Achieve functional redundancy.

Good design ensures that all important functions can withstand the failure of one or more elements. ***Design multiple backups*** for all major functions. This means, each function should be supported by two or more elements. Major functions in a household include labor, shelter, water, food, fire and weather protection, and income, as do communities. They both need backup design elements too.

Passively deflect or disrupt noxious sector energies.

Many uninvited sector energies can enter a system. Some are typically unwanted, like pollution, noise, hurricane force winds, ants in the kitchen, sun in the summer, or arctic fronts in the winter. Good permaculture design asks whether they are truly unwelcome, or if there isn't an easy way to benefit from them. Summer sun, for example, can heat water, provide electricity, and grow food.

But if you can't ***turn the problem into a solution,*** consider implementing a passive design that renders the energy harmless. In nature, the genetic intelligence of plants

and animals has evolved to deflect harm passively. For example, blackberries and other plants have spines or thorns to protect themselves. You can design to deflect or lessen the energies you can't use and don't want.

Make no waste (Principle).

By valuing and making use of all the resources available to us, nothing need go to waste. Waste is just another name for lost resources, abandoned energy, and typically lost labor and money. Waste is an output of any element not being used productively by any other component of the system.

Don't use things that permanently reduce the yields of sustainable systems or cannot be converted to something useful. Thus, don't allow or create pollutants, persistent poisons, or radioactive materials. People who create large areas of concrete, or send untreated wastes from city to sea, or pollute neighborhoods, or destroy forests are making future life harder.

Most of us live with dozens of items we could not manufacture in the cities or ecosystems where we live. These things come from all over the planet at great cost to energy and the environment. Even though we live in a throwaway society with limited sustainable choices, we should try our best to avoid technologies and consumer items that are difficult to manufacture, repair, or renew. Timely maintenance prevents waste. If it appears to have lost its function, and you are about to trash it, think again:

If it can't be reused, refinished, repaired, refurbished, rebuilt, resold, repurposed, recycled, or composted, then it should be refused, reduced, restricted, redesigned, or removed from production. —Pete Seeger

Meanwhile, find another way to perform the function so you don't just buy a new one.

Design to reduce damage from potential disasters.

Excessive human energy use has pitched up the kinds and frequency of all disasters, not only "natural" ones (storm and drought), but those purely human-caused (war, terror attacks, chemical spills, riots), and those of combined sources (flood, fire, and famine). Of course, these are also interacting. Human-driven climate change has spawned new and fearsome changes in weather, while these changes are making already rickety human systems ever more fragile. Fossil energy use (producing pollution and using power) destabilizes the climate, leading to more extreme events; in turn, weird heat and cold waves crash the power system, storms destroy roads and bridges, wash out farm fields, and wreck homes. Humans suffer coming and going. The infrastructure of our bioregions, communities, and homes is increasingly out of sync with the climate because these investments were based on assumptions now superseded by changes we have wrought but not acknowledged, including depletion of fossil energy reserves and, in parallel, the unhinging of the climate. A time of reckoning is at hand.

Disasters not only cause lots of trauma and suffering, but also waste enormous amounts of resources. These make systems of all sorts less functional and the people in them less able to function. Little of this is easily preventable, especially in the short run, but we can make preparations now to lessen damage and to recover more quickly. Disaster responses can be designed with the view of minimizing system dysfunction, pollution, pain, trauma, and resource waste.

The consequences of failing to respond, on the other hand, will be catastrophic. On a personal level, most of us would have trouble if we or someone in our family were seriously injured, fell ill, or lost a paycheck for a month or two, and yet these misfortunes are a routine part of modern life for millions. Most of us don't take seriously the possibility that everything around us is or could soon be endangered. We already see that whole towns and regions, to say nothing of neighborhoods and homes, can be swept away, burnt up, plunged into cold and darkness, or blown apart within hours.

If we accept this feedback from the natural world, more and more highlighted by knowledgeable human voices, then we should act sensibly to adapt our lives, and also work to mitigate the causal forces in play. This means not only repairing landscapes to cool the climate, resist fire, and lessen flooding, but also changing the way we use energy. It means redesigning our homes, farms, cities, and their respective economies for greater resilience. And crucially, it means talking about these issues with those around us: family, friends, neighbors, youth, and public officials.

Design offers us a methodical and reliable process for evaluating and limiting our exposure to risk, danger, and even large-scale disasters. In dry regions, excessive fuels can be reduced while improving soils and sequestering carbon; landforms can be easily modified in small ways to check and absorb runoff, increasing soil moisture. In regions prone to high rainfall, low-lying areas can be converted to non-critical uses like woodlands, sports fields, and parks. Home and public landscapes can be provided with green roofs, rain gardens, swales, and detention basins to absorb flood surges, while the natural function of wetlands and marshes should be restored in riverine and coastal zones.

Current emergency response systems and personnel are often inadequate in the face of extensive disasters. Individuals and neighborhoods must prepare for self-rescue and care. At a household level, we can build up stores of food, water, and emergency response tools and supplies to enable ourselves not only to weather disruptions in communications, heat, and power, but to aid those around us while broader civic responses can be organized.

We can name dozens of types of disasters, but are prepared for very few of them. If we understand that our lives depend on increasingly vulnerable systems, then we must respond now, while resources, energy, help, and stability are available to make a transition to more resilient systems.

Future care means ensuring that we and our communities can survive to make life better.

F. Learn cooperation from our human cultural evolution.

Ethic: Fair Share for Future Care

In the course of 10,000 human generations, our myriad cultures have evolved and tested countless systems for adapting to life on earth. Many have endured for centuries and even millennia. From this playbook, we should draw the most powerful and enduring lessons. Perhaps the most fundamental human quality, one that we take for granted or even disparage in the modern world, and one absolutely essential to our future survival is small-group cooperation. What goes with that is a keenly felt sense of fairness and mutual respect based in sharing.

Sustainable societies establish structures for community cooperation.

Organizations and events ought to be permaculturally designed. For example, organizations ought to make important decisions using the ethical ecosystem engineering principles. (See pg. 8) This would yield multiple benefits from whatever resources they use and whatever connections and relationships they create. They should zone their labor so that except for training exercises, functions are performed by those who are skilled and can most easily do it. An effective organization's goals are for yields to be greater than the energy they invest. Even one-day events could be designed to have temporal stacking.

Our communities can enact sustainability policies that benefit everyone. The *Ecovillage, Ecocity, Smart Growth,* and *Green Nations* movements are efforts to make everyone's lives easier and more enjoyable through much greater energy efficiency. We all benefit when everyone is empowered and cooperating. As the great suffragists remind us, everyone's opinion needs be listened to and considered:

> *…Woman is the mothering element in the world and her vote will go toward helping forward the time when life's Bread, which is home, shelter, and security, and the Roses of life, music, education, nature, and books, shall be the heritage of every child that is born in the country, in the government of which she has a voice.* "Bread and Roses"— Helen Todd, 1910

Use small and slow solutions in groups (Principle)

Honoring this principle always means local choices, so pay attention to scale. Community efficiency works better than self-sufficiency. This is especially true if our community is as locally self-reliant as possible, and we thus minimize the need for and dependence on large or distant organizations. The more that labor is local, and the more major decisions are made with consent, the more design control remains in our hands, and vital feedback is preserved. This helps to protect the community from gross

errors. Small-scale, intensive systems are easier to design and maintain; they employ and empower more people, and they foster cooperation.

Harness and value diversity (Principle) among humans too

It is best for everyone involved in a system to agree on any important proposed course of action, or at least not to oppose it. Therefore, develop decision-making and participation systems that *use and value diversity* in heritages, histories, cultures, life experiences, and identities, as much as in ecosystem functions, species, and habitats. Draw on multiple perspectives and voices. Each of us has two million years of ancestors who learned a lot and some of this we learned too. Value these heritages. With greater diversity, more abundance is available. Diversity increases edges, relationships, skills, qualities, beauty, and potential benefits. Diversity reduces vulnerability to a variety of threats, and takes advantage of the unique nature of the place in which a community lives.

It should also be said that diversity flourishes in more horizontal social settings where free expression is supported, individuals have considerable autonomy, and hierarchies are limited and moderated. As Margaret Mead constantly reminded us,

> *"Instead of being presented with stereotypes by age, sex, color, class, or religion, children must have the opportunity to learn that within each range, some people are loathsome and some are delightful."*

Diversity in human societies can of course be encouraged and shaped by domination systems for the purpose of splintering opposition to plans the dominant ones favors. *Divide and conquer* is a strategy as old as empires. Efforts to force segregation or restrict marriages or enforce gender roles or use hateful stereotypes are often efforts to promote dominant behavior and values, to promote horizontal antagonisms, and to underscore differences. They use diversity negatively to single out and blame specific 'others' to prevent potential objectors to the status quo from working together. This is known as dysfunctional diversity. Diversity therefore can be dysfunctional as well as functional depending on the attitudes about the diversity. It is not therefore diversity itself that needs to be valued, but its relationship to the system it is a part of.

Flatten hierarchical systems.

Domination systems discourage the harvesting of diversity. Social systems of domination discourage the free flow of knowledge about what works and what doesn't, and needlessly torpedo human labor potential. The idea that those with different personal wealth or a certain religion, gender, language, skin color, education, or nationality should have more privileged lives than others needs to be questioned. Steps to flatten hierarchy are movements toward Fair Share. If it's alright for some to dominate

other humans, it becomes alright for others to attempt to dominate nature. Domination systems violate Earth Care, Fair Share, and People Care.

Choose cooperation, not zero-sum competition.

Centuries of warfare among nations and various forms of exploitation have convinced many that competition for resources is the law of the jungle and of human nature as well. And indeed, if one looks, it is easy enough to find many examples of competition in nature for food, mates, and territory. And children in modern times are often taught to compete and rewarded for winning more so than for cooperating.

But as the anthropological literature makes clear, over 95% of human existence on this planet was spent as very small populations of food foragers occupying large territories. In such circumstances, cooperation was at a premium and behaviors like domination or warfare at a minimum. Not cooperating or practicing reciprocal sharing meant not surviving. Also, not appreciating nature and what it needs to flourish (i.e. cooperating with nature) also meant not surviving. So, most exchanges were not to get something directly back in exchange. Rather, everyone and often every being was seen as kin who help us in the long run. If there were ever early humans who didn't think this way, they probably didn't last long.

There is also a growing body of evidence for cooperation in nature among other beings including fungi and plants. Flocks, herds, and groves survive better than lone individuals. Humans however were especially successful in sharing resources and knowledge. And our brains and emotions and communication ability are hard-wired to do it.

Cooperation is the only hope for the future survival of existing life systems. A zero-sum system is any activity where if one group benefits, the other suffers or gets hurt. In many cases, what appears to everyone as a zero sum is actually negative-negative. Both sides in a zero sum ultimately lose because there are revenge cycles, important work not done, windows of opportunity foregone, organizational stalemate, and poor yields. Any place where you find people in zero-sum-like behavior, it is likely there are invisible structures in place that encourage this, and participants who don't realize there will be no long-term winners.

The *Prisoner's Dilemma* is a well-studied ethical conundrum wherein individual decision-makers using zero-sum reasoning are prone to choose in a way that creates a ***less than optimal outcome for everyone in the system***. Classically, each of two innocent prisoners alleged to be smugglers and who are strangers to each other, are offered a plea deal in exchange for secret testimony against the other. There is no outside evidence, but conviction and punishment would be dire. They then offer their testimony to a grand jury, and each rats falsely on the other. If they had both kept their mouths shut, they would both walk. Because there is now evidence against both, they both get time.

Prisoners' dilemma-like situations occur frequently in the modern world and must be replaced if we are to move toward sustainability. Conflict and misdirected blame creates dysfunction by using resources, labor, and investment to avoid defeat, to prevail, or to exact payback. Another outcome, especially in voluntary activities, is that people disengage from heavy workloads with little meaningful accomplishment, and in political maneuvering with no resolution.

You can see it in factions and other aspects of dysfunctional organizations, in economies, in national politics, and in international affairs that sometimes promote ruinous competition by pitting one group against another. Often this is done to distract attention from the root causes and the real instigators of imbalance in unfair systems.

In such prisoners' dilemma systems, each group thinks the only way to get benefits is for their own group to deprive the other. Such a system is unsustainable and hugely wasteful of resources. It is also ruinous for everyone because resources go to the conflict rather than real human or other system needs. Aggressive, dueling advertising is an example of such wasteful zero-sum thinking, and worse products are only one dysfunction of it. But it is easy to find many more.

Whether humanity can overcome dysfunction in time to avert planetary disaster is unknown. The 2022 Intergovernmental Panel On Climate Change (IPCC) says

> *"The world faces unavoidable multiple climate hazards over the next two decades with global warming of 1.5°C (2.7°F). Even temporarily exceeding this warming level will result in additional severe impacts, some of which will be irreversible. Risks for society will increase, including to infrastructure and low-lying coastal settlements….*
>
> *To avoid mounting loss of life, biodiversity and infrastructure, ambitious, accelerated action is required to adapt to climate change, at the same time as making rapid, deep cuts in greenhouse gas emissions. So far, progress on adaptation is uneven and there are increasing gaps between action taken and what is needed to deal with the increasing risks, the new report finds. These gaps are largest among lower-income populations."* (IPCC 2022, Climate change: a threat to human wellbeing and health of the planet. Taking action now can secure our future — IPCC).

The only option is cooperation across the planet with nature and other humans. Even though weak, the climate agreements worldwide are a hopeful start. Cooperation is the key, and the appreciation of diversity is an invisible resource that needs our help to develop. Good permaculture design makes diversity a solution rather than a problem.

Teach and model mutual aid.

Perhaps the best advice for small-scale community success is this. Help people contribute, and engage in gift-giving of goods, services, and favors so they all

appreciate what others can offer, both in ideas and in resources. Exchanges of labor and materials that are motivated by a desire to help can break down invisible barriers, and maximize an important untapped sector energy. In nature, diversity is strength. As Genevieve Vaughn explains in her efforts to show the gift economy is more fundamental to economics than that of exchange:

> ***Unilateral giving and receiving*** *form the basic logical template of communication and community, beginning with the nurturing of young children, which has to be unilateral. This simple but fundamental transitive human action forms a basic theme that is replayed at many levels throughout life, forming the lens through which we understand the world and communicate.* Quid pro quo *exchange itself is only a variation on the simpler theme, a doubling back, which contradicts the other orientation and forms its own template… This 'narrative' that puts the free maternal economy at the beginning of all explanations provides a framework in which humans can choose to behave in a way that ensures the benefit of all instead of destroying the planet. See* Genevieve Vaughn Previous Salons – Maternal Gift Economy .

Adults who as children had good early parenting will understand permaculture ethics better and will with less effort be successful at designing. Future care requires quality care-giving in the present to establish the pattern and conserve resources for future availability.

Design Principles Summary

Work from Pattern to Details. The Biggest Pattern is Future Care. Practice Permaculture Principles to give future life ***a CHANCE.***

Cooperate
Harmonize Functions
Adapt Creatively to Change
Nature Teaches
Counter Dysfunction
Employ Energy-Efficient Designs

Last Thoughts

Designing Future Care

Western cultures have long dwelt on the expected apocalypse, partly because end times make sense if one sees time as linear. Apart from genetic evolution and perhaps the Big Bang, natural time is highly cyclical and repetitious. Old biomass rots, dies, and

falls. It provides starter soil and seedbeds for the next cycle. Such cyclic patterns were evident to many ancient peoples, and they drew lessons from the pattern.

Fire in the Lake

For example, it was noticed early on that the moon rose later and later at night in equal amounts and set later and later during the day in a polar coordinate pattern that has been called yin/yang or the great symbol of complementarity. At the equinox, in exactly half the lunar month's hours, the night is dark and in half the hours it is moonlit, with the moon rising and setting every 12 hours at predictable times and waxing and waning on predictable nights of the lunar month. Moreover, tides change with the moon phase and currents with the tides. Boat navigation is easier if currents and tides are predictable, and fish-catching strategies change with currents too. So, near water, such observations made life much easier and before electricity, moonlight made a huge difference.

Similar cycles are observable as the sun's intensity waxes and wanes over the year. These cycles govern how much heat and cold, and like the moon, dark and light there is. And of course, winter and summer and day and night affect all life in many ways. In pre-industrial days, such cycles dominated life even more than today.

Sunlight warms and rainfall cools. Water evaporates and cools things and water can extinguish fire. But fire heats things and can boil water until it is airborne. So, fire "fights" water and water "fights" fire. Which antagonist will prevail? The answer is important if you want a kettle to boil or a damp cloth to cool your brow; or if you want to put out a fire or burn damp wood.

Ancient people saw these cycles everywhere including amidst the empires and dynastic epochs in which they lived. Old regimes rot because less and less is functional, and new regimes gestate with different people and approaches. In China, over 2800 years ago, the Book of Changes, *YiJing* observed in commentary on Hexagram 49:

> "*Times change, and with them their demands. Thus, the seasons change in the course of the year.*
>
> *In the world cycle also, there are spring and autumn in the life of peoples and nations, and these call for social transformations…*
>
> *Fire below and the lake above combat and destroy each other. So too, in the course of the year, a combat takes place between the forces of light and the forces of darkness, eventuating in the revolution of the seasons." …*
>
> *"People master these changes in nature by noting their regularity and marking off the passage of time accordingly. In this way order and clarity appear in the apparently chaotic changes of the seasons, and people are able to adjust themselves in advance to the demands of the different times."*

We all need clarity and order in our lives and to adjust in advance to the new era. Permaculture has solutions to the main problem of the 21st century: How to design and implement the hard sustainability and regeneration tasks ahead while living a right livelihood and a satisfying life. The founders of permaculture took seriously the slogan of the time: *If you aren't part of the solution, you are part of the problem.* Please work with all of us to adjust to the demands of what are certain to be very different times.

Appendix A: The Permaculture Design Certificate Course

Each of us are the descendants of two million years of ancestors who had very different lives than we do today. The PDC helps you to value whatever is positive in your heritage and contribute to its future unfolding.

> *Permaculture comes out of a storytelling tradition… Taking a permaculture design course is the new beginning of creating your own stories, of understanding that your own story has value.* —Scott Pittman

Permaculture Design Classes run 72-100 hours. Most have scholarships and work-study possibilities. There are all-virtual classes taught in various ways under varied auspices. Oregon State University, for example, teaches Permaculture Institute of North America (PINA) recognized classes. Virtual presentation allows each student to access instruction remotely, so it is less disruptive to family and work schedules. And since it is virtual, food, lodging, and travel costs are eliminated.

For remote, in-person courses, you travel somewhere, staying for up to two weeks, and study almost all day every day. The result is an intensive experience often at a stimulating permaculture site. There is usually an opportunity to observe working systems of cultivation, housing, or renewable energy, investigate your own or a different bioregion, visit informally with teachers and fellow students, and sometimes develop lifelong friendships.

For local in-person or hybrid courses, you typically take classes on weekends half-days or full days. In Houston, for example, the PDC is taught mostly Sunday afternoons, for 2-1/2 months in the fall (food gardens and farms), two months in the winter (renewable communities and housing), and one month in the spring (nature and the ecological crisis). Then students pick a problem they are interested in tackling, and work on it over the summer. There are also sometimes classes taught to school students. This sort of course avoids most expenses for travel, food, and lodging, helps students in a local bioregion get to know each other, and allows more instructors to teach to their expertise while lowering the cost to pay them. In Houston, students with complicated schedules can take different parts of the curriculum in different years.