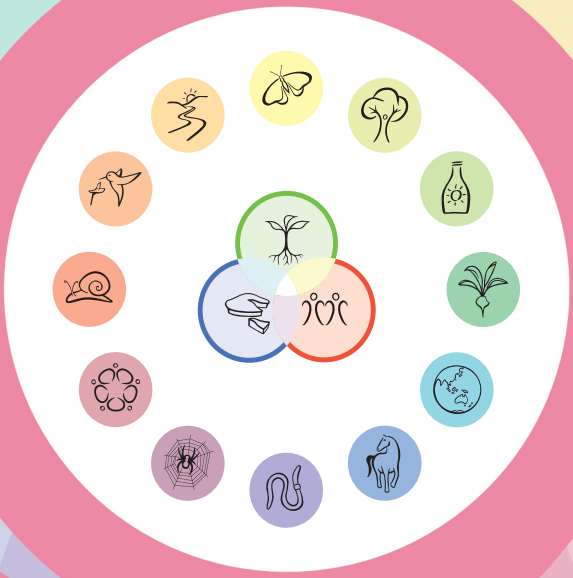


Essence of Permaculture

DAVID HOLMGREN

REVISED EDITION

THE PERMACULTURE FLOWER

BIOLOGICAL FIELD

LAND & NATURE STEWARDSHIP

Bio-intensive gardening
Forest gardening
Seed saving
Organic agriculture
Biodynamics
Natural farming
Keyline water harvesting
Holistic Rangeland Management
Natural Sequence Farming
Agroforestry
Nature-based forestry
Integrated aquaculture
Wild harvesting & hunting
Gleaning

BUILT FIELD

BUILDING

Passive solar design
Natural construction materials
Water harvesting & reuse
Biotechture
Disaster resistant construction
Owner building
Pattern language

TOOLS & TECHNOLOGY

Reuse & creative recycling
Hand tools
Bicycles and electric bikes
Wood stoves
Fuels from organic wastes
Wood gasification
Bio-char from forest wastes
Co-generation
Micro-hydro & wind
Energy storage
Transition engineering

BEHAVIOURAL FIELD

EDUCATION & CULTURE

Home schooling
Steiner/Waldorf education
Reading landscapes
Participatory arts & music
Social Ecology
Action Research
Transition culture
Voluntary simplicity

HEALTH & SPIRITUAL WELLBEING

Home birth & breastfeeding
Complementary & wholistic medicine
Yoga, Tai Chi & other body/mind/spirit disciplines
Spirit of place, indigenous cultural revival
Dying with dignity

FINANCE & ECONOMICS

Ethical investment & Fair Trade
Local and regional currencies
Carpooling, ride sharing & car share
Farmers markets & Community Supported Agriculture (CSA)
WWOOFing & similar networks
Tradable Energy Quotas
Life Cycle Analysis & EMERGY accounting
Frugal hedonism

LAND TENURE & COMMUNITY GOVERNANCE

Cooperatives & body corporates
Cohousing & eco-villages
Native Title & traditional rights
Open space technology & consensus decision making
Sociocracy

Essence of Permaculture was created as an accessible introduction to both the permaculture concept and the principles. Much of the first edition was extracted directly from my book *Permaculture: Principles and Pathways Beyond Sustainability*, which provides a much more in-depth discussion of these topics. This second edition has not changed substantially, but it contains some updates reflecting changes in society over the 19 years since it was originally published, as well as further clarification of some of the principles.

WHAT IS PERMACULTURE?

Bill Mollison and I coined the word 'permaculture' in the mid-1970s to describe 'an integrated, evolving system of perennial or self-perpetuating plant and animal species useful to man[kind].'[1]

A more current definition of permaculture, reflecting the expansion of focus implicit in *Permaculture One*, is:

> *Consciously designed landscapes which mimic the patterns and relationships found in nature, while yielding an abundance of food, fibre and energy for provision of local needs.*

People, their buildings and the ways in which they organise themselves are central to permaculture: the original permaculture vision of permanent or sustainable agriculture has evolved to one of permanent or sustainable culture.

THE DESIGN SYSTEM

For many people, myself included, the above conception of permaculture is so global in its scope that its usefulness is reduced. More precisely, I see permaculture as the use of systems thinking and design principles to provide the organising framework for implementing the above vision. Permaculture draws together the diverse ideas, skills and ways of living that need to be rediscovered and developed to provide for our needs, whilst increasing the natural capital for future generations.

In this more limited but important sense, permaculture is not the landscape, or even the skills of organic gardening, regenerative farming, energy efficient building or eco-village development. Rather, it can be used to design,

establish, manage and improve these and all other efforts made by individuals, households and communities towards a sustainable future.

The 'Permaculture Flower' (depicted inside the front cover) shows the key domains that require transformation to create a sustainable culture. Historically, permaculture has focused on 'Land and nature stewardship' as both a source for, and an application of, ethics and design principles. Those principles are now being applied to other domains dealing with physical and energetic resources, as well as human organisation (often called 'invisible structures' in permaculture teaching). The spiral path beginning with ethics and principles suggests a knitting together of these domains, initially at the personal and the local level, and then proceeding to the collective and global level. Some of the diverse design systems and solutions relevant to each domain are listed under the Biological, Built and Behavioural fields, which I used in *RetroSuburbia* (2018) to simplify the domains framework of the Permaculture Flower.

THE NETWORK

Permaculture is also a network of individuals and groups spreading permaculture design solutions in both rich and poor countries throughout the globe. Until recently, largely unrecognised in academia and unsupported by government or business, permaculture activists are contributing to a more sustainable future by reorganising their lives and work around permaculture design principles. They are creating small local changes that directly and indirectly influence organic agriculture, appropriate technology, intentional community design and other expressions of what is called 'sustainable development' (even if that term is problematic).

Most of the people involved in this network have completed a Permaculture Design Course (PDC). For over 30 years this has been the prime vehicle for permaculture inspiration and training worldwide, acting as a social glue bonding participants to such an extent that the worldwide network could be described as a social movement. A curriculum was codified in 1984, but the divergent evolution of form and content, as presented by different permaculture teachers, has produced varied and localised experiences and understandings of permaculture.

IMPEDIMENTS TO THE SPREAD OF PERMACULTURE

There are many reasons why ecological development solutions reflecting permaculture design principles have not had a greater impact over the last few decades. These reasons include:

- the prevailing scientific culture of reductionism that is cautious, if not hostile, to holistic methods of inquiry
- the dominant culture of consumerism, driven by dysfunctional economic measures of progress
- political, economic and social elites (both global and local) that stand to lose influence and power, through the adoption of local autonomy and self-reliance.

These and related impediments express themselves differently in different societies and contexts.

For the global majority of four billion or so for whom the cost of basic needs is high relative to real income, there are extremely limited opportunities to become more self-reliant. The depletion of local natural resources (through population pressure, innovation in resource extraction technology, ethnic and migratory conflict, and government and corporate exploitation) has reduced the productivity and viability of traditional sustainable systems. At the same time, farm and factory labour in the monetary economy has increased measured income, but failed to fully compensate for declining household and community non-monetary economy (and wellbeing). The lure of opportunities in the rapidly growing cities has enticed country folk to move to the city. This process is as old as the English folk tale about Dick Wittington who went to London in the 14th century as a poor orphan because he thought the streets were paved with gold. Further, government provision of health, education, and other services has been slashed by International Monetary Fund (IMF) and World Bank-imposed structural adjustment. This failed system of economic and social development is extraordinary in its ubiquity and repetition.

The same system of power that extracts and exploits the less powerful, soothes the billion or so middle class people, mostly in the North, into complacency with low costs, relative to average incomes, of food, water, energy and derived goods. This failure of global markets to transmit signals about resource depletion and environmental degradation has insulated

consumers from the need to develop more self-reliant lifestyles, and disabled the drive for public policies to assist these necessary adaptations. The flood of new and cheap consumer goods has stimulated consumption to a point of super-saturation, while at the same time measures of social capital and wellbeing continue to fall from the 1970s' peaks.

Since the Global Financial Crisis more than a decade ago, the middle class in long-affluent countries has been shrinking, while disparities of wealth have increased and the numbers of people who have faith that their children will be better off than themselves is collapsing. Populist right wing governments have been elected in an increasing number of long-affluent nations as neo-liberal notions of globalisation are crumbling.

This crisis of faith in the economic and political order is one aspect of the unfolding global crisis where geopolitical conflict, radically changing and chaotic climate, biodiversity collapse, and resource depletion create a convergence of apparently unrelated crises.

Policy commitment to economic growth at all costs, and the powerful corporate and government interests that stand to lose power from a low-energy transition, highlight the radical political nature of permaculture.

FOCUS ON OPPORTUNITIES RATHER THAN OBSTACLES

While permaculture activists are acutely aware of these impediments, permaculture strategies focus on opportunities rather than obstacles. In helping the transition from ignorant consumption to responsible production, permaculture builds on a culture of self-reliance and community values, as well as a range of conceptual and practical skills, that have persisted despite the ravages of affluence. In a permaculture project, the identification of these invisible resources is as important as the evaluation of biophysical and material resources.

While sustainable production (of food and other resources) remains the prime objective of permaculture strategies, it can be argued that permaculture has been more effective at pioneering sustainable consumption. Rather than weak strategies encouraging green consumer purchasing, permaculture addresses the issues by reintegrating and contracting the production/consumption cycle around the focal point of the active individual, nested within a household and a local community.[2]

Although permaculture is a conceptual framework with its roots in ecological science and systems thinking, its grassroots-spread in many different cultures and contexts demonstrates its potential to contribute to the evolution of a popular culture of sustainability, through the adoption of practical and empowering solutions.

FUNDAMENTAL ASSUMPTIONS

Permaculture is founded on some fundamental assumptions that are critical to both understanding and evaluating it. The assumptions on which permaculture was originally based are worth repeating:

- Humans, although unusual within the natural world, are subject to the same scientific (energy) laws that govern the material universe, including the evolution of life.
- The tapping of fossil fuels during the industrial era is the primary cause of the spectacular explosion in human numbers, technology and every other novel feature of modern society.
- The environmental crisis is real and of a magnitude that will transform modern global industrial society beyond recognition. In the process, the wellbeing, and even survival, of the world's expanding population is directly threatened.
- The ongoing impacts of global industrial society and human numbers on the world's wondrous biodiversity will be far greater than the massive changes of the last few hundred years.
- The depletion of fossil fuels within a few generations will see a gradual return of system design principles, fundamental to nature and pre-industrial societies dependent on renewable energy and resources – even if the specific forms of those systems will reflect unique and local circumstances.

Thus permaculture is based on an overall assumption of progressively reducing energy and resource consumption, and an inevitable reduction in human numbers. I call this the 'energy descent future' to emphasise the primacy of energy in human destiny.[3] This phrase is a less negative, but descriptive, alternative to what some call 'collapse', 'contraction', 'decay' or 'die-off'. The energy descent future can be visualised as the gentle descent

after an exhilarating balloon flight that returns us to the Earth, our home. Of course, that Earth has been transformed by humanity's 'energy ascent', making the future as challenging and novel as any period in history. In accepting such a future as inevitable, we can choose creative adaptation over fearful acquisitiveness or cavalier disregard.

The conceptual underpinning of these assumptions arises from many sources, but I recognise a clear and special debt to the work of American ecologist Howard Odum.[4] The ongoing influence of Odum's work on the evolution of my own ideas is made explicit in *Permaculture: Principles and pathways beyond sustainability*, as well as articles in *David Holmgren: Collected Writings 1978-2018.*[5]

CURRENT CONTEXT

The early onset of climate chaos from constantly rising greenhouse gas emissions is capturing media and public attention, while depletion of resources (especially oil) has slipped into the background. This is despite the peaking of conventional oil production (in 2008), the massive environmental impact (and financial losses) of unconventional oil extraction, and conflict and economic collapse in oil exporting nations. Meanwhile techno-optimism is being bolstered by the rapid rollout of solar and wind power, although that growth is not keeping up with growing global energy demand; at the time of writing, 84% of which continues to come from fossil fuels.

On the other hand, my hopes around the turn of the millennium that either the peak of conventional oil and/or deflation of the financial bubbles that underpin the growth-oriented world economy would force a restructuring to adapt to energy descent realities have faded.[6] It currently seems the escalating climate emergency is the front runner for such a crunch and restructure. However, mainstream proposals for a way forward assume a green continuation of energy ascent and don't acknowledge that a world of less is coming whether we like it or not.

Despite this bleak context, action informed by permaculture ethics and design principles around the world continues to show how the problem can become the solution if we are prepared to radically change how we think and behave. These thinking tools remain powerful in helping us be resilient, as well as understanding and contributing to the important task of salvaging the

remaining value of a failing civilisation for the future. While Odum's vision of a 'prosperous way down'[7] for humanity looks less likely, permaculture has sharpened the tools that we need for a great diversity of energy descent journeys that await us and our descendants.

PERMACULTURE PRINCIPLES

THE VALUE AND USE OF PRINCIPLES

Permaculture principles are based on the idea that generalised principles can be derived from the study of the natural world and pre-industrial sustainable societies, and that they will be universally applicable to fast-track the development of regenerative use of land and resources, whether in a context of ecological and material abundance or one of deprivation.

The process of providing for people's needs within ecological limits requires a cultural revolution. We have little time to achieve this revolution. Inevitably, a revolution is fraught with many confusions, false leads, risks and inefficiencies. Given this historical context, the idea of a simple set of guiding principles that have wide, even universal, application is attractive.

Permaculture principles are brief statements or slogans that can be remembered as a checklist when considering the inevitably complex options for designing ecological support systems. These principles are universal, but the methods that express them will vary greatly according to place and situation. They are also applicable to personal, economic, social and political reorganisation, as illustrated in the Permaculture Flower, although the range of strategies and techniques that reflect the principles in each domain is still evolving.

ETHICS OF PERMACULTURE

Ethics act as constraints on survival instincts and other personal and social constructs of self-interest that tend to drive human behaviour. They are cultural mechanisms for more enlightened self-interest, a more inclusive view of who and what constitutes 'us', and a longer-term understanding of good and bad outcomes.

The greater the power of human civilisation (due to energy availability), and the greater the concentration and scale of power within society, the more critical ethics become in ensuring long-term cultural, and even biological, survival.

This ecologically functional view of ethics makes them central in the development of a culture for energy descent.

Like design principles, ethical principles were not explicitly listed in early permaculture literature. Since the development of the Permaculture Design Course, ethics have generally been covered by three broad maxims or principles:

Earth care – rebuild nature's capital

People care – nurture self, kin and community

Fair share – set limits to consumption and reproduction, and redistribute surplus

These statements of ethics were distilled from research into community ethics, as adopted by older religious cultures and modern co-operative groups. The third ethic, and even the second, can be seen as derived from the first.

The ethics continue to be taught and used as simple and relatively unquestioned ethical foundations for permaculture design within the movement and the wider 'global nation' of likeminded people. More broadly, these ethics can be seen as common to all traditional cultures that have connected people to land and nature throughout history.

This focus in permaculture on learning from indigenous cultures stems from these cultures having existed in relative balance with their environment and surviving for longer than any of our more recent experiments in civilisation.[8]

Of course, in our attempt to live an ethical life, we should not ignore the teachings of the great spiritual and philosophical traditions of literate civilisations, or the great thinkers of the scientific enlightenment and of current times. But in the long transition to a regenerative low-energy culture we need to consider, and attempt to understand, a broader canvas of values and concepts than those delivered to us by recent cultural history.[9]

DESIGN PRINCIPLES

The scientific foundation for permaculture design principles lies within the modern science of ecology, and more specifically within the branch of ecology called 'systems ecology'. Other intellectual disciplines, especially landscape geography and ethno-biology, have contributed concepts that have been adapted to design principles.

Fundamentally, permaculture principles arise from a way of perceiving the world that is often described as 'systems thinking' and 'design thinking'. Apart from the ecological energetics of Howard Odum, the influence of systems thinking in my development of permaculture and its design principles has not come through extensive study of the literature. Rather, it has been through an osmotic absorption of ideas in the cultural aether that strike a chord with my own experience in permaculture design. Further, I believe many of the abstract insights of systems thinking have more easily understood parallels in the stories and myths of indigenous cultures and, to a lesser extent, in the knowledge of all people still connected to land and nature.

Permaculture principles and ethics may be observed operating all around us. I argue that their absence, or apparent contradiction by modern industrial culture, does not invalidate their universal relevance to the descent into a low-energy future.

Most people will relate to and make use of permaculture as a toolkit of strategies, techniques and examples, however these are specific to each particular system's scale, cultural and ecological context, and repertoire of skills and experience of those involved. To provide guidance in choosing and developing the useful applications, principles are needed to embody more general systems design concepts in language accessible to ordinary people.

I organise the diversity of permaculture thinking under twelve design principles. My set of design principles varies significantly from those used by many other permaculture authors and teachers. Some of this is simply a matter of emphasis and organisation; in a few cases it may indicate difference of substance. This is not surprising, given the new and still-emerging nature of permaculture.

The format of each of these principles is a positive action statement and an icon. The icon acts as a graphical reminder, encoding some fundamental aspect or example of the principle. A traditional proverb is also associated with each principle, emphasising the negative or cautionary aspect of the principle.

Each principle can be thought of as a door into the labyrinth of systems thinking. Any example used to illustrate one principle will also embody others, so the principles are simply thinking tools to assist us in identifying, designing and evolving design solutions.

PRINCIPLE 1

OBSERVE AND INTERACT

'Beauty is in the eye of the beholder'

In nature animals survive and thrive by constantly observing (using different senses) and interacting with their environment. In traditional societies, children learned to become competent adults by observing and interacting in environments shaped by kin and culture.

In the modern world, formal education has replaced self-directed observation to a significant degree, and we have become separated from interactions, which are now mediated through technology and monetary transactions. In the process of gaining new technological skills and sophistication, we have lost much of our innate capacity to learn and look after ourselves, let alone design appropriate responses to emerging challenges.

Good design depends on a free and harmonious relationship between nature and people, in which careful observation and thoughtful interaction provide the design inspiration, repertoire and patterns. Design should not be generated in isolation, but through continuous and reciprocal interaction with the subject.

Permaculture designers use careful observation and thoughtful interaction to make effective use of human capabilities, reduce dependence on non-renewable energy, and consciously and continuously develop systems of land use and living that can sustain people through the era of energy descent.

'Reading the Landscape' to understand the pre-existing and often subtle but persistent patterns created by nature and ancestral use of the land, is the foundation of permaculture design. Designs should emerge from what already exists, rather than be an imposition on the land. With appropriate observation and interaction, we realise that nowhere is a blank slate for our designs. Everywhere has a history, and the proverb '*Beauty is in the eye of the beholder*' reminds us that the process of observing influences reality, and that we must always be circumspect about absolute truths and values.

Although this principle is clearly addressed to our own behaviour, it also applies to our design of systems to facilitate learning by animals and even plants. Animals in free range systems can use their native intelligence to satisfy their food and other needs, maintain awareness of predators and interact with their kind. Plants growing in healthy soil have roots that actively explore for water and nutrients, and develop relationships and exchanges with beneficial microorganisms, and through them, other plants.

In ensuring houses are passively heated or cooled, monitoring and management are part of the equation: passive solar requires active humans! For instance, we need to know when to open and close curtains, doors and windows according to local conditions and the layout of the house.

Observe and interact also reminds us to consider issues in a more wholistic context. The permaculture aphorism 'the problem is the solution' reminds us that playful thought about an issue can help us see creative ways to bypass obstacles – or even how we can learn to love what we previously hated.

PRINCIPLE 2

CATCH AND STORE ENERGY

'Make hay while the sun shines'

We live in a world of unprecedented wealth resulting from the harvesting of the enormous storages of fossil fuels created by the Earth over billions of years. The adverse impacts of this over-harvesting will continue to show up as available fossil fuels decline. In financial language, we have been living by consuming global capital in a reckless manner that would send any business bankrupt. We need to learn how to save and reinvest most of the wealth that we are currently consuming or wasting, so that our children and descendants might have a reasonable life. The ethical foundation for this principle could hardly be clearer.

Through most of human history, the limited and episodic availability of food, fuel, and other useful resources was recognised in the phrase 'feast or famine'. In the modern world a steady supply of essential needs is directly and indirectly underpinned by abundant fossil fuel. This has led us to have less concern for storages, savings or even planning for the future. Ironically, affluence has made us less able to think for the long term.

Catch and store energy highlights the need and opportunity take advantage of surplus energy, food and other resources when they are available – to invest in systems that will sustain us and our descendants through times of scarcity and disruption.

Inappropriate concepts of wealth have led us to ignore opportunities to capture local flows of both renewable and non-renewable forms of energy. Identifying and acting on these opportunities can provide the energy with which we can rebuild natural and human capital. Common but ephemeral sources of energy that permaculture designers aim to catch include:

- sun, wind and runoff water flows
- wasted resources from agricultural, industrial and commercial activities
- knowledge and skills of older people.

Important storages of future value that permaculture designers invest in include:

- fertile soil with high humus content
- perennial vegetation systems, especially trees that yield food and other useful resources
- seed banks and arboreta of useful species and varieties
- water bodies and tanks
- passive solar buildings
- libraries and information systems.

Over time these storages of energy will help sustain modest systems, once the flow of unsustainable energy from fossil fuels is spent or unavailable.

We can also think of the collective experience, know-how, technology and software derived from generations of industrial affluence as a huge store of wealth that can be redeployed to help create new forms of capital, appropriate for energy descent. Much of the optimism about sustainability relates to the application of technology and innovation. Permaculture strategies make use of these opportunities while maintaining a healthy scepticism based on the premise that technological innovation is often a 'Trojan horse', recreating problems in new forms. Apart from using technology judiciously to build new capital assets, technological innovation is itself a storage of wealth that will progressively depreciate during energy descent, albeit at a slower rate than physical assets and infrastructure.

The proverb '*Make hay while the sun shines'* reminds us that we have limited time to catch and store energy before seasonal or episodic abundance dissipates. Likewise, the icon of sunshine captured in a bottle suggests the preserving of seasonal surplus: a very practical application of this principle. It also reflects the basic lesson of biological science: all life is directly or indirectly dependent on the solar energy captured and stored by green plants through the process of photosynthesis.

PRINCIPLE 3

OBTAIN A YIELD

'You can't work on an empty stomach'

The previous principle focused our attention on the need to use existing wealth to make long-term investments in natural capital. But there is no point in attempting to plant a forest for the grandchildren if we haven't got enough to eat today.

Without immediate and truly useful yields, whatever we design and develop will tend to wither, while elements that generate immediate yields will proliferate. Whether we attribute it to nature, market forces or human greed, systems that most effectively obtain a yield, and use it most effectively to meet the needs of survival, tend to prevail over alternatives.[10]

A yield, profit or income functions as a reward that encourages, maintains and/or replicates the system that generated the yield. In this way, successful systems spread. In systems language these rewards are called 'positive feedback loops' that amplify the original process or signal. If we are serious about sustainable design solutions, then we must be aiming for rewards that encourage success, growth and replication of those solutions.

While this may be self-evident to farmers and businesspeople, in modern affluent society, many people and organisations are subsidised by net wealth from others and by the expenditure of vast stocks of capital, most of it derived from fossil fuels. This has led to dysfunction and cosmetic environments replacing functional and productive ones. The original permaculture vision promoted by Bill Mollison, of urban landscapes full of food and other useful plants rather than useless ornamentals, provides an antidote to this dysfunctional aspect of our culture.

Even in poorer countries, the unexamined aim of the majority of development projects is to enable people to 'escape' the need to maintain functional and productive environments, by full participation in the monetary economy where 'obtaining a yield' is reduced to a narrow and destructive process dictated by the forces of the global economy. The *nouveau riche* model of success – in which the functional and practical are banished – needs to be replaced with honest acknowledgement of sources of affluence and real measures of success. Generations of wage and salary culture in more developed countries under both capitalist and socialist models have led to an extraordinary dislocation between productive activity and the sources of our sustenance.

Yields are not limited to food and other useful harvests. In many rich countries like Australia, houses are empty most of the time with people commuting to work, school and recreation. Home-based lifestyles and working from home are strategies to obtain a greater yield from that most expensive of assets (rather than assuming that rising property values are an automatic yield that will continue in the future).

In assisting middle class urban Australians facing the challenge of a more self-reliant rural lifestyle, I have explained that it's like becoming a businessperson. Although the 'economic rationalism' of recent decades has been largely dysfunctional it did include a kernel of truth, reviving awareness of the need for all systems to be designed to be productive in some way. We need to redefine how we obtain a yield using 'ecological rationalism'.

PRINCIPLE 4

APPLY SELF-REGULATION AND ACCEPT FEEDBACK

'The sins of the fathers are visited on the children unto the seventh generation'

Principles 2 and 3 involve positive feedback to support growth and development, but uncontrolled cellular growth in our bodies is called cancer, while positive feedback through a sound system creates an intolerable noise that can damage the system. *Apply self-regulation and accept feedback* deals with self-regulatory aspects of permaculture design that limit or discourage inappropriate growth or behaviour.

In nature, predators maintain balance when they hunt, kill and eat a proportion of prey animals, while in society the law works to regulate and, where necessary, punish behaviour that would threaten or destabilise the system. This negative feedback is essential in all systems to maintain health and balance. Culling excess plant growth in the garden is often necessary, even though it may seem ruthless from another perspective. However, our goal as designers should be to create plant guilds and animal associations that are more harmonious and self-regulating to reduce our workload in activities such as weeding. Often the pathway to those harmonious guilds requires some culling that tips a balance point – in this way the garden is 'accepting the (negative) feedback'. The fact that we tend to see negative feedback as bad is itself a reflection of a culture out of balance.

Self-maintaining and regulating systems might be thought of as the 'Holy Grail' of permaculture: an ideal that we strive for but might never fully realise. We can go a long way towards achieving it by applying the principles of integration and diversity (see Principles 8 and 10), but it is also fostered by making each element in a system self-reliant and energy efficient. A system composed of self-reliant elements is more robust to disturbance. Use of tough, semi-wild and self-reproducing crop varieties and livestock breeds, instead of highly bred and dependent ones, is a classic permaculture strategy that exemplifies this principle.

On a larger scale, self-reliant farmers were once recognised as the basis of a strong and independent country. Today's globalised economies make for greater instability, where effects can cascade around the world. Rebuilding self-reliance at both the element and system level increases resilience. In the energy descent world, self-reliance will become more valued as capacity for high and continuous input declines and economies of scale and specialisation reduce.

Traditional societies recognised that the effects of external negative feedback controls are often slow to emerge. People needed explanations and warnings, such as *'The sins of the fathers are visited on the children unto the seventh generation'* and the laws of karma. In modern society, we take for granted an enormous degree of dependence on large-scale, often remote, systems for provision of our needs, while expecting a huge degree of freedom in what we do without external control. Our whole society is like a teenager who wants to have it all, and have it now, without consequences. Even in more traditional

communities, older taboos and controls have lost much of their power, or are no longer ecologically functional due to changes in the environment, population density and technology.

One of the challenges of environmentalism is the development of behaviour and culture that is more attuned to feedback signals from nature, to prevent overexploitation. Negative feedback needs to be well-targeted and strong enough to bring about corrective change, but not so strong that it damages further development of the system. For example, rainwater collection and use in a house brings awareness of limits to both yield and quality. If a wood stove flue produces a smoky taste to water, this negative feedback encourages corrective action. The common aim of designing sustainable systems with zero hazard from negative feedback is like trying to raise children without exposure to immunological and accident hazards: it leads to more serious hazards in the future. The open acceptance of hazards from negative feedback must be constrained by ethics and be primarily applied to ourselves, families and communities (in that order), rather than outsourcing regulation to government as occurs in the monetary economy.

The Gaia hypothesis[11] of the earth as a self-regulating system, analogous to a living organism, makes the whole earth a suitable image to represent this principle. Scientific evidence of the Earth's remarkable homeostasis over hundreds of millions of years highlights the Earth as the archetypical self-regulating whole system, which stimulates the evolution, and nurtures the continuity, of its constituent lifeforms and subsystems.

PRINCIPLE 5

USE AND VALUE RENEWABLE RESOURCES AND SERVICES

'Let nature take its course'

Renewable resources are those that are renewed and replaced by natural processes over reasonable periods without the need for major inputs of fossil fuels and mined minerals. In the language of business, renewable resources should be seen as our sources of income, while non-renewable resources should be thought of as capital assets. Burning through our capital assets for day-to-day living is unsustainable in anyone's language.

Permaculture design makes the best use of renewable, natural resources to manage and maintain yields, even if some non-renewable resources are needed to establish systems.

For example, all forests generate surplus low-value wood as a by-product of sustainable management. When properly seasoned, this by-product can be used as a local fuel source for heating and cooking in well-designed stoves. In the same way that wood does not meet all criteria we might want from a fuel, herbal medicine might not provide a complete pharmacopeia, but we can successfully treat many ailments with botanical medicines that are locally grown and processed with little or no fossil fuel. By doing so, we avoid many adverse side effects from centralised drug production, increase our respect for nature, and feel more confident in maintaining our own health.

Renewable services are those we gain from plants, animals and living soil and water, without them being consumed. For example, when we use a tree for wood, we are using a renewable resource, but when we use a tree for shade and shelter, we gain benefits from the living tree that are non-consuming and require no harvesting energy. This simple understanding is obvious yet powerful in redesigning systems in which simple functions have become dependent on non-renewable and unsustainable resource use.

As well as making use of non-consuming natural services to minimise our consumptive demands on resources, permaculture design emphasises harmonious interaction between humans and nature. The classic example of human prosperity derived from non-consuming use of nature's services is our domestication and use of the horse and other animals for transport, soil cultivation and general power for myriad uses. Intimate relationships to domestic animals, such as the horse, also provide an empathetic context for the extension of human ethical concerns to nature. On the other hand, in cultures where livestock are still prevailing symbols of meaning and wealth, the more fundamental renewable services provided by plants and soil life need to be recognised, valued and used.

Classic permaculture designs using chickens or pigs to prepare ground for planting bypass the use of tractors and rotary hoes, as well as artificial fertiliser and pesticides. In these systems, a modicum of management and fencing allows a more sophisticated use of livestock for multiple functions.

In both rich and poor communities, recognising the value of human waste as a renewable source of fertility – made safe by the ecological service of microbes in a compost toilet – is one of the important and universal applications of this principle.

Calling a clothesline a 'solar clothes dryer' is humorous because we recognise line drying of clothes as miles ahead of an electric tumble drier in the sustainability stakes. In many situations, we have been conned into using unnecessary and complex gadgets for simple tasks.

The proverb '*Let nature take its course'* reminds us of another aspect of this principle – that the pursuit of total control over nature through use of resources and technology is not only expensive, but can lead to a spiral of intervention and degradation in biological systems that already represent the best balance between productivity and diversity.

PRINCIPLE 6

PRODUCE NO WASTE

'Waste not, want not'
'A stitch in time saves nine'

Generations of cheap energy and resources have led to wasteful and inefficient ways of living and land use. *Produce no waste* brings together traditional values of frugality and care for material goods, concern about pollution and resource depletion, and the more radical perspective that sees wastes as resources and opportunities. By creatively redesigning how we provide for ourselves we can make large efficiency gains with benefits for individuals, society and nature.

The industrial processes that support modern life can be characterised by an input-output model, in which the inputs are natural materials and energy, while the outputs are useful things and services. However, when we step back from this process and take a long-term view, we can see all these 'useful' things end up as wastes (mostly in rubbish tips) and that even the most ethereal of services required the degradation of energy and resources to wastes. This linear model needs to be replaced with a circular model to recycle essential materials in the way that nature does. This is symbolised by the earthworm icon: earthworms live by consuming plant litter (wastes), converting them into humus that improves the soil environment for itself, soil microorganisms, and plants. The earthworm, like all living things, is a part of a web where the outputs of one are the inputs for another.

Bill Mollison defined a pollutant as 'an output of any system component that is not being used productively by any other component of the system.'[12] This definition encourages us to look for ways to minimise pollution and waste through designing systems to make use of all outputs. In response to questions about plagues of snails in gardens dominated by perennials, Mollison was in the habit of replying that there was not an excess of snails but a deficiency of ducks.

Similarly, plagues of grass and forest trees lead to devastation by bushfire in some regions, while plagues of herbivores overgraze others. Innovative and creative ways to use these upwellings of abundance is one of the characteristics of permaculture design.

The proverb *'Waste not, want not'* reminds us that it is easy to be wasteful when there is an abundance, but that this waste can be the cause of later hardship. This is highly relevant in a context of energy descent.

'A stitch in time saves nine' reminds us of the value of timely maintenance in preventing waste and work involved in major repair and restoration efforts. Although this is far less exciting than finding creative ways to use unwanted abundance, maintenance of what we already have will be a huge and ongoing issue in an energy descent world. All structures and systems depreciate in value over time, and all ecological and sustainable human systems devote resources to timely maintenance.

Recycling is the most overemphasised of the strategies for preventing waste. With recycling, an input of energy is needed to actively degrade a material to its more basic constituents. For example, recycling a glass bottle requires energy to melt and remould the glass into a new bottle. Reusing the existing bottle, or not buying the bottle in the first place, are superior options.

A focus on reducing waste within a household, or any system, naturally leads us to see the waste all around us produced by others – the opportunities to reduce waste, and even meet most living needs from waste, are historically unprecedented. Whether we buy clothes from op shops, salvage waste from the side of the road or get food from supermarket skips, we are *Obtaining a yield* from the waste of others. In the past only the most destitute made a living from waste. Today we should acknowledge those who creatively reuse waste as the very essence of living lightly on the earth.

PRINCIPLE 7

DESIGN FROM PATTERNS TO DETAILS

'Can't see the forest for the trees'

The first six principles mostly consider systems from the bottom-up perspective of elements, organisms, and individuals. The second six principles tend to emphasise the patterns and relationships that emerge through system self-organisation and co-evolution.

Modernity has tended to scramble any systemic common sense or intuition that can order the jumble of design possibilities and options that confront us in all fields. This problem of focus on detailed complexity leads to the design of white elephants that are large and impressive but do not work, or juggernauts that consume all our energy and resources while always threatening to run out of control. Complex systems that work tend to evolve from simple ones that work, so finding the appropriate pattern for that design is more important than understanding all the details of the elements in the system.

By default, reductionist science and modern thinking attempt to understand and redesign the world around us by pulling things apart to see 'what makes them tick'. Systems thinking and many traditional ways of knowing and acting in the world start by zooming out to see the boundaries, inputs and outputs of the system. This big-picture perspective may leave the details a bit fuzzy but helps us see the commonality of patterns observable in nature and society. This allows us to better understand and appreciate what is already working and how we might sensitively intervene as designers.

Sometimes we can apply a pattern from one context and scale to design in another. Pattern recognition is an outcome of the application of Principle 1 *Observe and interact*, and is the necessary precursor to the process of design.

The spider on its web, with its concentric and radial design shows a clear pattern even though the details always vary. This icon also evokes zone and sector site planning – the best known and perhaps most widely applied aspect of permaculture design. Designating zones of intensity of use around an activity centre, such as a farmhouse, helps place elements and subsystems. Similarly, environmental factors of sun, wind, flood, and fire can be considered in sectors around the same focal point. These sectors have both a bioregional and a site-specific character which the permaculture designer carries in their head to make sense of a site and help organise appropriate design elements into a workable system.

The proverb '*Can't see the forest for the trees'* reminds us that the details tend to distract from our awareness of the nature of the system; the closer we get, the less we are able to comprehend the larger picture.

Using forests as design models for agriculture was the idea that initiated permaculture. Although many critiques and limitations to the forest model need to be acknowledged, especially in temperate and semi-arid climates, it remains a powerful example of pattern thinking that continues to inform permaculture and related concepts, such as forest gardening, agroforestry and analogue forestry.

While traditional land use systems provide many models of whole system design, people embedded in cultures of place often need new experiences to help them to view their landscape and communities in new ways. In some of the pioneering Landcare projects in Australia in the 1980s, aerial overflights of their farms gave landholders both the big picture and the motivation to begin serious work to address tree decline and associated land degradation problems. From the air, the patterns of land ownership were less visible, while the catchment patterns of nature stood out.

Similarly, the larger social and community context, rather than technical factors, can often determine whether a particular solution is a success. The list of overseas development projects that have failed due to ignorance of these larger-scale factors is extensive. The focus on context in holistic decision making[13] is useful in starting with the big picture before diving down into the details.

PRINCIPLE 8

INTEGRATE RATHER THAN SEGREGATE

'Many hands make light work'

Integrate rather than segregate focuses on the relationships that draw elements together in more closely integrated systems, and on improved methods of designing communities of plants, animals and people to gain benefits from these relationships. As Mollison puts it: 'the purpose of a

functional and self-regulating design is to place elements in such a way that each serves the needs and accepts the products of other elements.'[14]

In every aspect of nature, from the internal workings of organisms to whole ecosystems, the connections between things are as important as the things themselves. But the industrial mindset of our culture often defaults to segregating elements as a design strategy, to deal with relationship complexity and conflict. This arises partly from our reductionist scientific method that separates elements to study them in isolation; any consideration of how they work as parts of an integrated system is based on their nature in isolation.

This segregation is also a response to abundant energy. For example, the adverse impacts of early smokestack industrial cities were addressed by zoning laws segregating residential housing from factories. Abundant energy made commuting between home, work and other functions the default way of dealing with land use conflict. Permaculture design seeks to reintegrate living and work functions, most dramatically by making our low-density residential landscapes agriculturally productive and reinvigorating the household and community non-monetary economies to reduce dependence on commuting and transport.

The ability of the permaculture designer to create closely integrated systems depends on a broad understanding of the range of jigsaw-like lock-and-key relationships that characterise ecological and social communities. As well as deliberate design, we need to foresee, and allow for, effective ecological and social relationships that develop from self-organisation and organic growth.

The icon of this principle can be seen as a top-down view of a circle of people, or elements, forming an integrated system. The apparently empty hole represents the abstract whole system that both arises from the organisation of the elements and gives form and character.

By correct placement of plants, animals, earthworks and other infrastructure it is possible to develop a higher degree of integration and self-regulation without the need for constant human input in corrective management. For example, the scratching of poultry under forage forests can be used to harvest litter to downslope garden systems. Herbaceous and woody weed species in animal pasture systems often contribute to soil improvement, biodiversity, and medicinal and other special uses. Appropriate rotationally grazed livestock can often control these weedy species without eliminating them and their values completely.

In developing an awareness of the importance of relationships in the design of self-reliant systems, two statements in permaculture literature and teaching have been central:

- Each element performs many functions.
- Each important function is supported by many elements.

The connections or relationships between elements of an integrated system can vary greatly. Some may be predatory or competitive; others are co-operative, or even symbiotic. All these types of relationships can be beneficial in building a strong integrated system or community, but permaculture strongly emphasises building mutually beneficial and symbiotic relationships. This is based on two beliefs:

- We have a cultural disposition to see and believe in predatory and competitive relationships, and discount co-operative and symbiotic relationships, in nature and culture.
- Co-operative and symbiotic relationships will be more adaptive in a future of declining energy.

Permaculture is part of a long tradition of concepts emphasising mutualistic and symbiotic relationships over competitive and predatory ones. Declining energy availability will shift the general perception of these concepts from romantic idealism to practical necessity.

PRINCIPLE 9

USE SMALL AND SLOW SOLUTIONS

'The bigger they are, the harder they fall'
'Slow and steady wins the race'

Systems should be designed to perform functions at the smallest scale that is practical and energy-efficient for that function. Human scale and capacity should be the yardstick for a humane, democratic and sustainable society. *Use small and slow solutions* reflects the pioneering work of E. F. Schumacher who wrote the book *Small is Beautiful* (1973). Whenever we do anything of a self-reliant nature – growing food, owner building, maintaining our health – we are making powerful and effective use of this principle. Likewise, purchasing

from small, local businesses or contributing to local community and environmental issues, is also applying this principle.

Cheap energy works as a subsidy favouring large-scale centralised systems. The end of cheap energy will shift the natural economies of scale in favour of small systems but relative differences in economies of scale between different functions will continue. For example, expensive energy for transport of raw materials and finished products will make household vegetable production competitive with large-scale monocultures, but backyard steel smelting is unlikely to ever be a practical alternative, even if national steel industries may again become competitive with globalised ones.

Although the 'small is beautiful' meme has been growing in status for decades, the idea that 'slow' is also cool has been slower to emerge. However, backlash against the extreme mobility and speed in affluent countries has led to movements such as 'Slow Food' and 'Slow Cities'. The convenience and power from increased mobility and information technology has been a 'Trojan horse', destroying community and increasing energy demands. The communications and computer revolution has given new impetus to the idea that speed is good, but again characteristic downsides are emerging such as the storms of spam which threaten the amenity of email and social media, creating storms of rumours and paranoia.

Many practical examples provide a more balanced view to counter the natural attraction of fast-moving processes and large-scale systems. For instance, the fast response of crops to soluble fertilisers is often short-lived; manures, compost and natural rock minerals generally provide more sustained and balanced plant nutrition. And a good result from a small amount of fertiliser does not mean better results from more.

In forestry, fast grown trees are often short-lived, while some apparently slow growing but more valuable species accelerate, and even surpass, the fast species in their second and third decades. A small plantation of thinned and pruned trees can yield more total value than a large plantation without management.

In animal nutrition, rapidly grown livestock fed concentrated nutrients are often subject to more disease and have a lower life expectancy than more naturally raised animals. Overstocking is one of the most widespread causes of land degradation, and yet small numbers of managed livestock are beneficial, if not essential, to sustainable agriculture.

In crowded cities the apparent speed and convenience of cars stalls movement and destroys amenity, while much smaller, slower and more energy efficient bicycles allow freer movement, without pollution and noise. Bicycles can also be more efficiently manufactured and assembled in smaller and more local factories than the economies of scale necessary for the automotive industry.

The proverb *'The bigger they are, the harder they fall'* is a reminder of one of the disadvantages of size and excessive growth, while the proverb *'Slow and steady wins the race'* is one of many that encourages patience while reflecting a common truth in nature and society.

PRINCIPLE 10

USE AND VALUE DIVERSITY

'Don't put all your eggs in one basket'

The spinebill and the hummingbird both have long beaks and the capacity to hover – perfect for sipping nectar from long, narrow flowers. This remarkable co-evolutionary adaptation between birds and flowers symbolises the specialisation of form and function in nature.

The role and value of diversity in nature, culture and permaculture is complex, dynamic, and at times seemingly contradictory. Diversity needs to be seen as a result of the balance and tension in nature – between variety and possibility on the one hand, and productivity and power on the other. This principle, along with several others, acts to balance the tendency in nature and society for powerful elements to come to dominate systems.

It is now widely recognised that agricultural monocultures are a major cause of vulnerability to pests and diseases, and therefore the widespread use of toxic chemicals and energy to control them. Polyculture is one of the most important and widely recognised applications of this principle, reducing vulnerability to pests, adverse seasons and market fluctuations. Polycultures[15] also reduce reliance on market systems, and bolster household and community self-reliance by providing a wider range of goods and services. However polyculture is by no means the only application of this principle, and permaculture designers acknowledge that the concept of diversity extends beyond the species level.

For instance, a diversity of different cultivated systems reflects the unique nature of site, situation and cultural context, while a diversity of structures, both living and built, is also an important aspect of this principle. Temporal diversity manifests through examples such as forest trees providing different ecological roles at different ages, and the successive planting of salad vegetables in home gardens to spread yields throughout the year.

Diversity within species and populations, including genetic diversity, is also critical to the long-term stability of systems. This also extends to human communities; the conservation of at least some of the great diversity of languages and cultures on the planet is arguably as important as the conservation of biodiversity.

That said, the concept of biodiversity is not limited to wild species in natural environments – it also encompasses the extraordinary diversity of cultivated crops and livestock varieties developed over the course of human agricultural history, as well as wild species in novel ecological communities.

Although inappropriate and destructive responses to energy descent will have knock-on impacts on both human and biodiversity, in the longer-term, energy descent will slow the economic engine of diversity destruction, and stimulate new local and bioregional diversity. While many environmental and social movements only recognise prior biological and cultural diversity, permaculture is just as actively engaged in creating new bioregional diversity from the melting pot of nature and culture we have inherited.

The proverb *'Don't put all your eggs in one basket'* embodies the common sense understanding that diversity provides insurance against the vagaries of nature and everyday life.

PRINCIPLE 11

USE EDGES AND VALUE THE MARGINAL

'Don't think you are on the right track just because it is a well-beaten path'

The icon of the sun coming up over the horizon with a river or road in the foreground shows us a world composed of edges, even if our cultural preoccupation with the field rather than the hedgerow, the daylight rather than dusk, and majority politics rather than the creative fringe blinds us to what is coming around the corner or over the horizon.

Self-organised design in nature tends to increase the interface between different ecosystems. Edges are dynamic and productive parts of all natural systems where exchange of materials and energy take place. For example, tidal estuaries are complex interface ecologies between land and sea that can be seen as a great ecological trade market between these two great domains of life. The shallow water allows penetration of sunlight for algae and plant growth, breeding areas for fish, and forage areas for wading and other birds. The fresh water from catchment streams rides over the heavier saline water that pulses back and forth with the daily tides, redistributing nutrients and food for the teeming and diverse life.

Within every terrestrial ecosystem, the living soil is a three-way edge or interface between the non-living mineral earth, the atmosphere and the biosphere. For all terrestrial life, including humanity, this is the most important edge of all. Only a limited number of hardy species can thrive in shallow, compacted and poorly-drained soil, which has insufficient interface. Deep, well-drained and aerated soil is like a sponge, a great interface that supports productive and healthy plant life.

This principle works from the premise that the value and contribution of edges, as well as the marginal and invisible aspects of any system, should not only be recognised and conserved, but expanded to increase productivity and stability.

In garden design, keyhole designs increase the easily accessible edge of beds and optimise our observations and interactions. In aquaculture, increasing the edge between field and pond can increase the productivity of both. In broadacre farming, shelterbelt forestry increases the edge between field and forest with gains in productivity and resilience for the whole farm.

In commercial precincts, shop frontage is the most valuable space. It can be increased by the construction of arcades and semi-public places that encourage potential customers to linger.

In rural development work, the focus on staple crops, prime agricultural land and clearly articulated aims and values within communities frequently leads to undervaluing, ignorance and destruction of wild species and marginal spaces, and the less visible needs of women, the disadvantaged and landless are often undervalued or ignored. Similarly, in economic policy the focus of big business

and thriving cities ignores the fact that these systems apply the fruits of past innovation, and that small business and smaller, less affluent places and systems are the sources of future innovation.

Eastern spiritual traditions and martial arts regard peripheral vision as a critical sense that connects us to the world, quite differently to focused vision. Whatever the object of our attention, we need to remember that it is at the edge of any thing, system or medium that the most interesting events take place. Design that sees edge as an opportunity rather than a problem is more likely to be successful and adaptable. In the process, we discard the negative connotations associated with the word 'marginal' in order to see the value in elements that only peripherally contribute to a function or system.

The proverb *'Don't think you are on the right track just because it is a well-beaten path'* reminds us that the most common, obvious and popular is not necessarily the most significant or influential.

PRINCIPLE 12

CREATIVELY USE AND RESPOND TO CHANGE

'Vision is not seeing things as they are but as they will be'

This principle has two threads: designing to make use of change in a deliberate and co-operative way, and creatively responding or adapting to large-scale system change which is beyond our control or influence.

The acceleration of ecological succession within cultivated systems is the most common expression of this principle in permaculture literature and practice, and illustrates the first thread. For example, the use of fast-growing nitrogen-fixing trees to improve soil, and to provide shelter and shade for more valuable slow-growing food trees, reflects an ecological succession process from pioneers to climax systems dominated by long-lived valuable tree crops. The progressive removal of some or all of the nitrogen-fixers for fodder and fuel as the tree crop system matures is part of the process. Seeds of pioneer species in the soil provide insurance to re-establish the system in the future, after natural disaster or land use change (e.g. to an annual crop phase).

The adoption of successful innovation in communities often follows a pattern similar to ecological succession in nature. Visionary and obsessive individuals often pioneer the solutions, but it generally requires more influential and established leaders to take up the innovation before it is widely seen as appropriate and desirable. Generational change is sometimes necessary for radical ideas to be adopted but this can be accelerated through the influence of school education on the home environment. For example, children bringing home trees they have grown in school nurseries can lead to successful establishment and care of valuable and long-lived trees, which might otherwise be neglected or eaten by livestock.

Permaculture is about the durability of natural living systems and human culture, but this durability depends on flexibility more than armoured rigidity. While all twelve principles make contributions the system characteristic of resilience, this is the principle which contributes most explicitly. In any particular system, the small-scale, fast, short-lived changes of the elements actually contribute to higher-order system stability. Many stories and traditions have the theme that within the greatest stability lie the seeds of change. Science has shown us that the apparently solid and permanent is, at the cellular and atomic level, a seething mass of energy and change, similar to the descriptions in various spiritual traditions.

We live and design in a historical context of turnover and change, in systems at multiple larger scales, and this generates an illusion of endless change with no stability or sustainability. On the other hand, larger-scale and longer-lived systems such as nation states and institutions give an illusion of stability and permanence. Appreciating the dynamic balance between stability and change, rather than accepting these illusions at face value, contributes to design that is iterative rather than random or rigid. We need to accept that current larger-scale systems around us are unsustainable, and must rapidly design and develop new systems in the shadow of failing ones, rather than seek to patch up or demolish existing ones.

The proverb *'Vision is not seeing things as they are but as they will be'* suggests that understanding change is much more than the projection of statistical trend lines. It also makes a cyclical link between this last design principle about change and the first principle about observation.

The butterfly or moth, which is the transformation of a caterpillar, is a symbol for the idea of adaptive change that is uplifting rather than threatening.

CONCLUSION

To provide for human needs, within ecological limits, requires a cultural revolution greater than any of the tumultuous changes of the last century. Permaculture design and action over the last forty years has shown that revolution to be complex and multi-faceted. While we continue to grapple with the lessons of past successes and failures, the emerging energy descent world will adopt many permaculture strategies and techniques as natural and obvious ways to live, within ecological limits, once real wealth declines.

On the other hand, energy descent will demand real-time responses to novel situations, incremental adaptation of existing inappropriate systems, and creative innovation applied to the most ordinary and small design problems. All this needs to be done without the big budgets and kudos associated with current industrial design innovation.

Permaculture design principles can never be a substitute for relevant practical experience and technical knowledge. However, they provide a framework for the generation and evaluation of the site and situation specific solutions necessary to move beyond the limited successes of 'sustainable development' to a reunion of culture and nature.

REFERENCES

1 B. Mollison & D. Holmgren, *Permaculture One*, Corgi 1978. Facsimile edition available from holmgren.com.au

2 My book *RetroSuburbia: The downshifter's guide to a resilient future*, Melliodora Publishing 2018, provides much discussion on reintegrating the production/consumption cycle into the household economy, as well as practical strategies for implementation.

3 Much of my writing over the last two decades has focused on the concept of, and the implications of, an energy descent future; see for instance 'Futures framework for RetroSuburbia' (2016) available from retrosuburbia.com, *Future Scenarios* book and website (2009), and other articles in *David Holmgren: Collected Writings 1978-2018*, (e-book, Melliodora Publishing).

4 H.T. Odum, *Environment, Power and Society*, John Wiley 1971 influenced many key environmental thinkers in the 1970s and was the first listed reference in *Permaculture One*. Odum's prodigious published output over the three decades since, as well as the work of his students and colleagues, has continued to inform my work.

5 *David Holmgren: Collected Writings 1978-2018*, (e-book) Melliodora Publishing. 'The development of the permaculture concept' and 'Energy and EMERGY: revaluing our world' are especially relevant in explaining the influence of Howard Odum's work on permaculture. For a recent evaluation and comparison of Odum's EMERGY concept to other sustainability tools see *Ecosystem Properties and Principles of Living Systems as Foundation for Sustainable Agriculture: Critical reviews of environmental assessment tools, key findings and questions from a course process*, S. Doherty & T. Rydberg (eds) 2002.

6 See 'Money vs fossil energy: the battle for control of the world' in *David Holmgren: Collected Writings 1978-2018*, (e-book) Melliodora Publishing.

7 H.T. Odum & E.C. Odum, *A Prosperous Way Down*, University Press of Colorado 2001

8 For an exploration of the evolutionary limitations of tribalism in the modern world see 'Tribal conflict: proven pattern, dysfunctional inheritance' in *David Holmgren: Collected Writings 1978-2018*.

9 For a current articulation of the value of indigenous culture and value in a eco-spiritual response to energy descent see T. Hartmann, *Last Hours of Ancient Sunlight: Waking up to personal and global transformation*, Harmony Books 1999.

10 This is a rephrasing of Lotka's Maximum Power Principle. Howard Odum has suggested the Maximum Power Principle (or at least his EMERGY-based version of it) should be recognised as the fourth Energy Law.

11 See J. Lovelock, *Gaia: A new look at life*, Oxford University Press 1979.

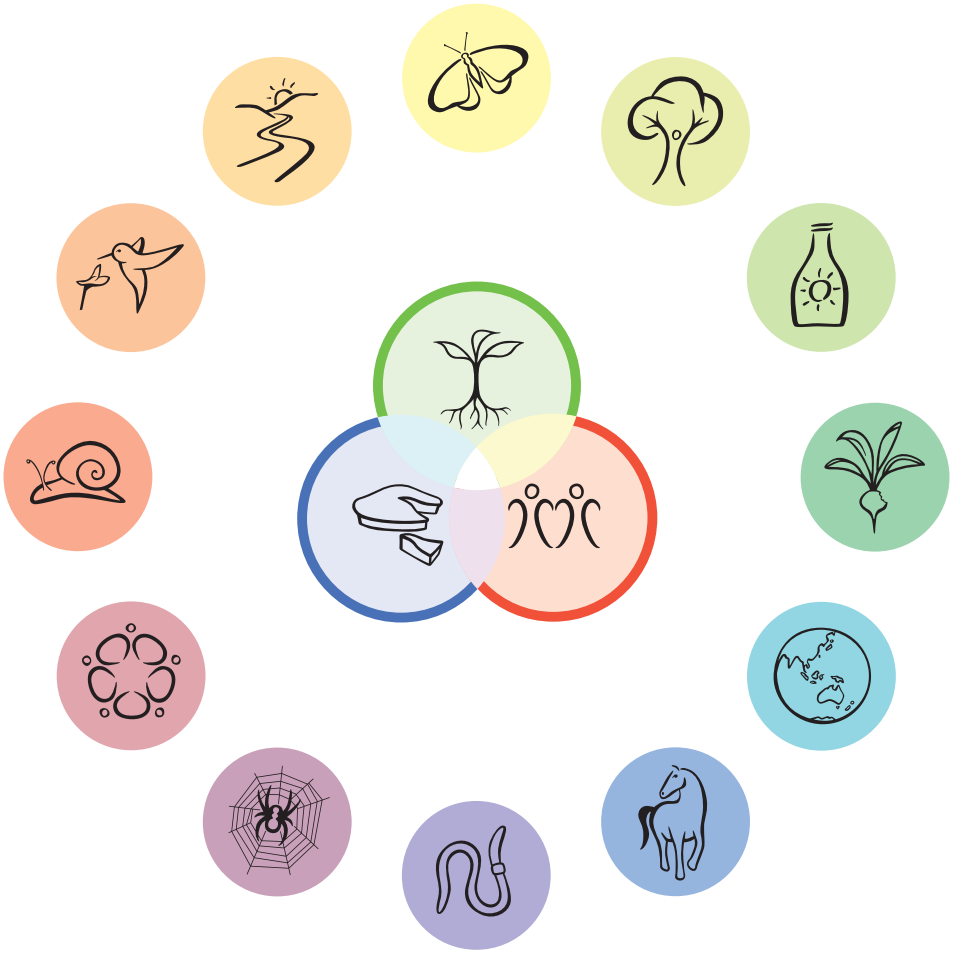
12 B. Mollison, *Permaculture: A designer's manual*, Tagari 1988.

13 Allan Savory pioneered this approach to design (see *Holistic Management: A commonsense revolution to restore our environment* 2016). More recently Dan Palmer has extended this thinking with a strong permaculture focus (see www.holisticdecisionmaking.org)

14 B. Mollison, *Permaculture: A designer's manual*, Tagari 1988.

15 Polyculture is the cultivation of many plant and/or animal species and varieties within an integrated system.

NOTES



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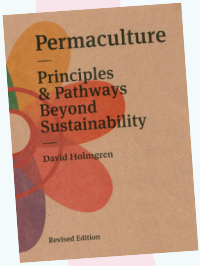

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