

DRAFT

**A SYLLABUS FOR
PERMACULTURE DESIGN
IN
SOUTH EASTERN
AUSTRALIA**

VERSION 9.3 as at 2 February 2016

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for the

Permaculture Educators Guild

1. DEFINITIONS & HISTORY - Introductory material on basic concepts and historical context.

1.1 Definitions and Guiding Principles of Permaculture

- Pc as a process of **design** for sustainable human settlements
- derivation from PERMANent agriCULTURE and permanent CULTURE
- combination of traditional tribal wisdom & practices with modern technology and understanding of natural processes
- **originally** based on cultivated ecologies which, through good design, are more productive than natural systems generally are, and based on observation of how natural systems operate
- generating lifestyles which minimise our impact on, and restore health to, the planet
- replacing tribal myth & taboos with sensible design of our society

1.2 Historical Moves Towards Sustainability

- transition from hunter-gatherer, to subsistence agriculture, to industrial agriculture
- permanent agricultural systems around the world: rice cultures of Asia, etc.
- the rise & fall of civilisations: overuse of available resources
- Jan Smuts *Holism and Evolution* 1924, developed by Alan Savoury in the 1990's as **(Holistic) Resource Management**
- Rudolph Steiner's Biodynamic system of Agriculture, Germany, 1925
- J. Russell Smith's permanent agriculture based on tree crops
- Yeoman's Keyline water management system developed in south-eastern Australia
- Masanobu Fukuoka's no-till system, Japan
- George Chan's Integrated Farming System based on the fish pond cultures of China
- Club of Rome Report of 1971 - the Limits to World Growth (interaction of population size, non-renewable resources, industrial output per capita, food production & pollution)
- Howard Odum's work on energy & ecosystems in the 1970's

1.3 History of the Permaculture Concept

- Mollison's idea of creating productive ecologies
- development by Mollison & Holmgren through trials of systems in Tasmania during the 1970's
- first publication of ideas in "Organic Gardener & Farmer", 1976
- publication of Permaculture One (1978) & Permaculture Two (1979)
- first Design Course, January 1981
- first international meeting and award of diplomas October 1984
- Mollison's design course handbook "the 1985 curriculum"
- Designer's Manual, 1988
- Introduction to Permaculture, 1991
- other introductory and resource texts that have followed
- Permaculture Principles & Pathways Beyond Sustainability, 2002

1.4 Key Concepts in Permaculture

- Self-managed systems: the result of successful design
- Personal responsibility
- Co-operation, not competition
- Creating order out of chaos: Life Intervention principle
- Order and harmony produce surplus energy
- Resources: natural energies, materials, skills & experience
- Responsible resource management
- Disorder: created by an over-supply of resources
- Yields: products of systems that derive from wise use of resources, with energy value of products exceeding energy inputs
- System yield: the sum total of all products resulting from good design
- Niches as opportunities in space, Cycles as opportunities in time
- Permitted and forced functions
- Stability depends on useful connections, not diversity *per se*
- Source to Sink: capturing, storing and utilising energies/resources as they move through a system
- Guilds: groups of plants and animals that work beneficially together

2. THE ETHICAL PRINCIPLES OF PERMACULTURE - "Earth care, people care, fair share"

2.1 The nested pattern of **Environment, Society, Economy**

2.2 **Care of the Earth**

- Gaia concept
- Stewardship
- Biodiversity and respect for all life forms

2.3 **Care of people:**

- Self – family – neighbourhood – bioregional community – nation/state – global community

2.4 **Sharing of skills, knowledge & production**

- redistribution of our surplus time, resources and wealth for the common good

2.5 **Setting limits to population growth & consumption**

- Our ecological footprint

3. DESIGN PRINCIPLES

3.1 **Development of Design Principles**

- Principles vs Practices
- Reference to principles in Permaculture One (Mollison and Holmgren 1978)
- John Quinney's Guidelines for Designing Sustainable Small Farms (Quinney 1984)
- "Principles" and "Laws" in the Designer's Manual (Mollison 1988)
- The twelve Design Principles of Mollison and Slay (1991) based on Quinney 1984.
- The Principles redefined for the first version of this syllabus 1994 (see Appendix 3).

3.2 **Holmgren's Design Principles (Holmgren 2002)**

Principle # 1 - Observe and Interact

- Observation, recognition of patterns, appreciation of details and interaction with subject – precursors to good design.
- Holmgren's design thinking guidelines (pp 14 – 20)
- Social aspects of learning and communications

Principle # 2 - Catch and Store Energy

- see Topic 6 for detail

Principle # 3 - Obtain A Yield

- Lotka's Maximum Power Principle (survival of the most efficient) : **optimal inputs produce MP in natural systems, optimal loads produce MP in mechanical systems**
- Use of low input species in outer zones, high input species in inner zones
- Utility vs cosmetics
- Numeracy, ecological footprint and Emergy accounting
- Voluntary frugality

Principle # 4 - Apply Self-regulation and Accept Feedback.

- Positive and negative feedback in natural systems, tripartite altruism
- Self-regulation in individuals and systems c/- intervention by managers
- Top-down thinking, bottom-up action
- Personal responsibility, addiction and self-reliance

Principle # 5 - Use and Value Renewable Resources and Services.

- Renewable resources as energy
- Investment of non-renewable energies for system establishment

- Solar cells – salvation or diversion?
- Trees as nature's solar plants
- Sustainable harvest of wild resources
- Ecosystem services

Principle 6 - Produce No Waste.

- Waste & exchange in nature
- Waste minimisation strategies – Refuse, Reduce, Reuse, Repair, Recycle.
- Industrial recycling as a transition
- Maintenance engineering
- Human resources

Principle # 7 - Design from Patterns to Details

- see Topics 10 - 20 for applications of this principle.

Principle # 8 - Integrate rather than Segregate.

- Making connections
- Ecological relationships
- Each element performs many functions
- Each function is supported by many elements
- Simplification & segregation vs cooperation & integration
- Rebuilding community (see community strategies Topic 34)

Principle # 9 - Use Small and Slow Solutions.

- Energetic limits and efficiency
- Slow is sane, optimum scale and speed
- Self regulations and limits to growth
- Industrial scale and speed: small is beautiful
- Corporate growth & lifespans
- Slow growth strategies in agriculture & forestry
- Slow food
- The information economy

Principle # 10 - Use and Value Diversity

- see Topic 21 for applications of this principle

Principle # 11 - Use Edges and Value the Marginal.

- Landscape edges: ecotones
- Edge in cultivated landscapes
- Urban examples of edge
- Alley farming and shelterbelt forestry
- Marginal systems, seeing edges as opportunities, rather than problems.

Principle # 12 - Creatively Use and Respond to Change

- See Topic 44 for applications of this principle

4. The PERMACULTURE DESIGN PROCESS - an introduction

4.1 Strategic Planning - setting the conceptual framework, background to Pc design

- Setting broad **aims**: vision/mission statement/broad goals
- Description of project/organisation
- SWOT analysis: Strengths, Weaknesses, Opportunities, Threats
- Defining specific **objectives**: **where** you want to be at a future point in time (not a process to get there)
- Developing **strategies**: **how** you plan to reach your objective
- **action plans (who)** and **time-frames (when)** to implement strategies and achieve objectives
- Accepting feedback, reviewing and revising plans
- Master Plans as physical plans derived from a Strategic Plan

4.2 The Sequential Steps of Permaculture Design (as developed for site design)

- (1) Development of a **Client Brief** : client's vision, location, legal matters, scope
- (2) **Site description**, inventory and preparation of base maps
- (3) **Site analysis and assessment**: what is and isn't working
- (4) **Conceptual design**: refinement of vision, setting strategic objectives, use of Pc design tools, bubble diagrams, thematic designs, making connections
- (5) **Detailed Design**, including components, with costings and time-frames
- (6) **Design implementation**, in stages where appropriate
- (7) **Ongoing management**, feedback, review.

- Design as an iterative process: at each step it may be necessary to go back to an earlier step and review

4.3 Planning Scales

- landscape planning: land-use patterns, relationship of sites to the wider landscape
- site design: specific property design - the main focus of Pc design
- component design: design of specific elements within a system

4.4 Development Streams

- The physical environment: landscapes, homestead, infrastructure.
- social structures: the people you are designing for
- commercial operations, marketing of produce. etc.

5. ENERGY FLOW in SYSTEMS

5.1 Forms of Energy

- Energy concepts: personal exertion, gravity, electrical, etc
- Definition of Energy: the capacity to do work
- The Law of **Conservation of Energy**: Energy can neither be created nor destroyed
- The Law of **Degradation of Energy**: in all real processes some energy is used up in a move towards entropy; harmony and chaos
- **Kinetic Energy**: energy that is producing work.
- **Potential Energy**: stored energy not performing any work, but capable of doing so.
- Kinetic and potential energy in the electricity grid - **base load and maintenance of potential**
- **Primary (solar radiation, gravity) and Secondary (wind, biomass) forms of energy**
- Howard Odum's contribution to permaculture thinking - systems approach, energy as a currency

5.2 Sunlight as a Primary Energy Source

- **Photosynthesis** - capturing the energy of sunlight in plant matter, creating **biomass**, conversion of radiant energy into chemical energy in molecular bonds
- **Respiration** - unlocking the energy captured in photosynthesis and its use as fuel to drive metabolic processes
- **Wind**: differential heating causing atmospheric pressure cells and associated wind patterns
- **Evaporation and Precipitation**

5.3 Energy Transformations

- Conversion of radiant energy to heat and its transfer by **Radiation, Conduction and Convection**,
- Transformation losses incurred in upgrading the quality of energy, eg sunlight-plants-coal-electricity. Avoiding losses by using lower grade fuels or sunlight
- **Embodied Energy**: the sum total of all energy used in transformations - eg, the development of biomass or the manufacture of a product
- **Embedded Energy**: the energy stored in biomass or a manufactured product that is still available for further transformations
- EMERGY accounting
- **EROEI** - Energy Returned on Energy Invested
- Mollison's rules for energy use
- Holmgren's sustainability test

6. CATCHING AND STORING ENERGY (Principle # 2)

6.1 Renewable Energy Sources

- Sunlight: direct heating, photosynthesis, photovoltaics.
- Wind: sailing, drying, wind turbines, windmills (water & grain)
- Gravity: hydraulic transport, hydro-power, water mills, tidal.
- Biomass: metabolic, combustion
- Animal traction - the original horsepower
- Geothermal

6.2 Non-renewable Energy Sources

- Fossil Biomass: peat, brown & black coals; petroleum; gas (LPG, LNG)
- Nuclear Fission: embedded energy and toxic wastes

6.3 Global Oil Peak and Energy Descent

- Industrial Society's dependence on fossil fuels
- Implications of global oil peak

6.4 Energy Stores

- Natural Capital
- The built environment as a store of energy
- Energy storage in cPatterns of particular elegance to dedesignature
- Appropriate use of non-renewable resources

7. GAIA CONCEPTS & TERMINOLOGY

7.1 The Gaia Concept - the Earth as a self-regulating system

- Atmospheric stability that supports life: feedback mechanisms to maintain stability (homeostasis)
- The **Greenhouse Effect**: how green-houses trap heat, the moderating effect of the atmosphere, consequences of burning fossil fuels & clearing vegetation
- The **Ozone layer**: UV shield, effect of ozone depleting chemicals

7.2 Ecological Terms

- The **Biosphere**: the oceans, land and atmosphere that support life on earth
- **Biomes**: major vegetation types based on structure - rain forests, deciduous forests & woodlands, grasslands, deserts, etc.
- **Ecosystems**: communities of organisms interacting with one another and their environment
- **Communities**: groups of plants and/or animals that occupy specific habitats
- **Plant Associations**: associated species characteristic of particular climates, soils and aspect
- **Diversity, complexity and stability in ecosystems** : complex stable tropical ecosystems, cyclically-stable simple sub-polar ecosystems
- **Succession**: pioneers, seral stages & climax vegetation, disturbance and sub-climax
- Mollisonism: Everything gardens or modifies its environment

8. NUTRIENT FLOW IN ECOSYSTEMS

8.1 Major Nutrient Cycles

- Carbon: Carbon chemistry, photosynthesis, respiration, carbon sinks
- Nitrogen: fixation by bacteria in root nodules and soil, nitrification & de-nitrification
- Phosphorus: accumulation in manures, guano deposits, sediments, role of soil fungi

8.2 Food Webs - energy & nutrient flow in ecosystems

- Food Webs & Food chains: producers and consumers, decomposers, trophic levels, ecological niches
- Energy losses at each trophic level, the trophic pyramid

- **Bio-magnification** - Accumulation of heavy metals, man-made chemicals, etc, in food chains,
- **Bio-accumulation** - selective uptake of nutrients by plants, eg nettles

9. CLIMATE & WEATHER

9.1 Factors that Influence Macro-climates at the regional scale

- latitude: tropical, temperate, polar, boundaries determined by sun angles & earth's orbit, seasonal and day length changes with latitude
- altitude: lowlands, highlands, montane, alpine
- topography: mountain ranges & rain shadows (orographic rain), coastal maritime effects, inland continental effects
- vegetation: trees as climate modifiers
- global wind patterns: tropical low pressure systems, temperate high pressure cells, sub-polar lows, convective and frontal rain, wet equatorial belt, dry sub-tropical latitudes.
- moderating effect of ocean current circulation patterns on nearby land masses
- sea surface temperature effects: El Nino & La Nina, ENSO Index.

9.2 Major Climatic Zones in Australia – Macro-climates

- Mediterranean: 12-16 deg C, winter rain, summer drought
- Humid cool temperate: <12 deg C, most rain in winter
- Humid temperate/sub-tropical: 12-24 deg C, mostly summer rain
- Humid tropical: >24 deg C, mostly summer rain (monsoons)
- Wet & dry tropics: 16-24 deg C, summer rain, winter drought
- Arid Tropical: low & erratic rainfall, mostly in summer
- Arid/semi arid temperate: low & erratic rainfall, mostly in winter

9.3 Meso-climate Factors – modifications caused by topography

- Daytime valley winds, night-time downslope winds, cold air drainage, frosts, fogs
- Aspect: hotter & drier on sun-facing slopes, colder & wetter on shaded slopes
- Tree cover and wind effects
- Sea breezes

9.4 Weather Patterns and Local Climate – interpreting Bureau of Meteorology data.

- Seasonal changes in day length
- Temperature: daily, monthly, annual, ranges and means
- Rainfall patterns & cloud cover
- Frosts: frequency and severity
- Relative humidity

10. RECOGNISING PATTERNS & LEARNING TO READ THE LANDSCAPE

10.1 Review Principle # 1 - Observe and Interact.

10.2 Patterns in Space

- radial & bilateral symmetry in organisms
- circles, spirals, mandalas, the torus
- crystal structures reflecting molecular arrangements
- nested patterns, growth rings in trees
- media properties, flow patterns in air and water
- geometry of boundaries and edges
- dendritic patterns in trees & streams
- orders of branching, number 7,
- fractal geometry
- Fibonacci numbers: a natural series 1,2,3,5,8,13, etc and the Golden Ratio (1:1.618)
- the Tree as general core model for patterns

10.3 **Patterns in Time**

- weather patterns: daily, monthly, seasonal, long term cycles
- breeding cycles in organisms
- succession in plant communities
- growth patterns: linear, organisms, populations limited by carrying capacity, exponential growth

10.4 **Patterns in Human Culture**

- tribal uses of pattern - decoration, art & mythology
- symbols & the evolution of written language
- patterns in gardens, villages, cities, transport systems, etc
- patterns as templates

10.5 **Examples of Patterns as Outcomes of Environmental Influences**

- Stream patterns that reflect underlying geology
- Vegetation associations determined by soil type, climate and aspect
- Altitudinal & latitudinal sequences in plant & animal communities
- Symbiotic associations, eg mushrooms under pine trees
- Stratification in natural communities: vegetation strata in a forest, shellfish on rocks in littoral zone, pond life, etc

10.6 **Pattern Languages for Design**

- Work of Christopher Alexander and associates (Alexander et al 1977)
- Developing a pattern language for permaculture - David Jacke (2005), Peter Bane, (2012)

10.7 **Reading Landscapes as a Design Skill** (Holmgren 1984)

- Wholistic approach of Permaculture *cf* the traditional farmer's understanding of a specific site, and the scientist's understanding of a broad range of facts.
- Developing literacy in reading landscapes: combining skills of identification/classification, natural history skills of observation and recording, intuitive/contemplative understanding, use of indicators/rules of thumb
- skills of observation revealing underlying patterns, past histories and future possibilities

11. **LANDFORM PATTERNS**

11.1 **Mountain Building and Erosion Cycles.**

- Tectonic activity, crustal, plate movements and uplift
- Vulcanism, hot spots and the "Ring of Fire" around the Pacific margin.
- Youthful, mature and old stream systems as stages in the erosion cycle

11.2 **Water in the Landscape**

- The water cycle: evaporation, precipitation as rain, snow or hail, dew & condensation, surface run-off, infiltration, snow melt, glaciers
- water tables, streams, lakes & swamps, springs, aquifers, ground water recharge
- artesian basins & time scales for recharge

11.3 **Humid (High Rainfall) Landscapes** - dominated by water

- Young (youthful) landscapes: mountain tracts, V-shaped valleys, rivers in erosion stage
- Mature landscapes: valley tracts, U-shaped valleys, terraces, rivers in transport stage
- Old landscapes: plains tracts, flood plains, rivers in deposition stage, billabongs & chains of ponds, modern problem of incised streams
- Deltas

11.4 **Arid Landscapes** - low precipitation, wind erosion

- evaporation: dry stream beds, saline lakes, wadis and oases
- topography: escarpments, dune systems & stony deserts
- vegetation adaptations: water conservation, dormancy, ephemeral annuals after rain, etc

11.5 **Volcanic Landscapes**

- volcanoes, lava flows, ash beds
- very fertile soils, topography depends on viscosity of lavas.

11.6 **Tropical Landscapes**

- High rainfall, high humidity, uniform day-length, fertility in biomass not soils
- climate varies with altitude.

11.7 **Minor Landscapes** - special characteristics

- sandy coasts: sand dunes, poor soils, exposure
- high volcanic or granitic islands: steep relief
- low coral islands: lack of freshwater, poor soils
- estuaries: highly productive
- wetlands: relationship to drainage, productivity

12. **DESIGN FEATURES OF LANDSCAPES**

12.1 **Humid Young Landscapes** - coping with steep terrain

- Pole-framed housing to avoid excavation
- benches for access to slopes for management and harvesting of tree crops
- terraced gardens
- potential for hydro-electric power generation

12.2 **Humid Mature Landscapes** - Foothills, preferred settlement sites

- high point: cold plateau air/frosts
- upper slopes: water collection sites, forests
- the Key Point & Keylines: change of slope from convex to concave
- lower slopes: cultivation areas
- flatlands: cold air drainage/frosts
- the mid-slope thermal belt: ideal site for homes

12.3 **Humid Old Landscapes** - Valley terraces and floodplains

- restoring the hydrology of floodplains: Peter Andrew's Natural Sequence Farming
- siting of buildings in relation to flood threats
- levees and embankments to control flooding
- access to high ground for livestock
- planting to reduce frost and waterlogging on valley bottoms
- avoiding salination through use of trees and appropriate irrigation

12.4 **The Victorian Volcanic Plains**

- need for windbreaks
- tree crops on slopes, stony rises

12.5 **Arid Landscapes** - low rainfall, high evaporation rates

- need to retain natural vegetation
- trapping and storing water in soil or underground storages
- moisture barriers: stones, mulches, etc
- swales & collection pans to concentrate water for infiltration
- techniques to access groundwater: planting ditches, etc
- planting to slow sand drift

12.6 **Minor Landscapes**

- coastal sand plains: planting to cope with wind erosion, salt spray, sandy soils
- coral islands: windbreaks & foreshore plantings, building soils, water harvesting, protecting freshwater lens
- wetlands: high productivity, chinampa systems
- estuaries: very productive, fish traps, shellfish racks, etc (see also section 26 - Aquaculture)

12.7 Microclimates – site-specific factors that can be influenced by design

- aspect, summer and winter sun angles
- topography, cold air drainage & frost pockets
- winds: the chill factor, drying, etc.
- effects of buildings, crops, cultivated land, etc.
- modifying effects of water bodies, stone walls, rocks, etc
- Sun traps: light reflected from vegetation
- Vegetation: shade, windbreaks, protection from frost

12.8 Applying Zoning Principles to Rural Land Use at the Whole Landscape Level

- Based on population density and intensity of development (1) settlements; (2) hobby farms & market gardens; (3) broadacre farms; (4) pastoral rangelands and production forests; (5) national parks & reserves

13. DESIGN IN FIRE-PRONE LANDSCAPES**13.1 Fire-prone Landscapes of South-eastern Australia**

- Fire as a landscape feature in south-eastern Australia, adaptations
- Factors in fire risk: fuel load, temperature, humidity, wind speeds, topography
- Understanding fire behaviour

13.2 Site Design Strategies to Cope with Fire

- Sector analysis to assess direction and degree of risk
- Planting of fire resistant species as fire shields
- Placement and maintenance of open space (fire-breaks, roads, grazed paddocks/lawns, water bodies), in fire sector to protect buildings, etc
- Water supply
- Reduction of hazards: wood piles, leaves in gutters & sub-floor space
- Protection of livestock
- Need for a fire plan for emergencies
- see Topic 41 for more detail of building design to reduce fire risk

13.3 Landscape-scale Strategies

- Fuel reduction burning: balancing fire risk and conservation values
- Settlement protection: firebreaks and buffers
- Vegetation policies in and around settlements

14. TREES & FOREST ECOLOGY**14.1 Functions of Trees in the Landscape**

- accumulation of biomass and nutrients, release of oxygen
- transpiration & water tables, trees as water pumps
- "air conditioning" effects, modifying temperatures & humidity
- modification of winds, effects of wind on shape & timber strength
- contributions to rainfall through evaporation and transpiration
- condensation of humid air in addition to rainfall
- delaying rain run-off, absorption by tree canopy and leaf litter
- soil formation & protection
- wildlife habitat, enabling guilds of other plants & animals to develop

14.2 Forest Ecology

- Canopy, understorey, shrub and ground layers, epiphytes, emergents
- Role of Nitrogen-fixing species (wattles, casuarinas, pea-bushes)
- competition for light: form of trees growing in a forest compared to ones growing in a woodland or paddock
- dispersal & regeneration mechanisms: wind, animals, fire, water
- development of guilds of other plants & animals in and around trees
- development of tree hollows in eucalypts and use by hollow-nesting species - owls,

possums, parrots, etc.

- effects of short-rotation timber harvesting and fuel-reduction burning on forest diversity
- spread of mycorrhizal fungi by small mammals (potoroos & bettongs)
- response of eucalypts to fire: epicormic shoots; new shoots from ligno-tubers; seedling regeneration
- response of rain forests to fire: death & retreat
- adaptations to fire in other Australian species and importance of appropriate fire intervals, maintenance of heathlands through burning
- "environmental weeds": invasive species not indigenous to the local area (radiata pines, cootamundra wattles, sweet pittosporum, etc)
- Management of environmental weeds vs accepting new ecologies
- Protection of zone 5 patches as refuges for small mammals in droughts (arid zone)

15. VEGETATION AND LAND-USE PATTERNS

15.1 Classification and Naming of Vegetation Types

- Structural classifications: classified by their physical characteristics (closed & open forests, woodlands, etc), relationship to biomes
- Floristic classifications: classified by the species that occur (stringybark forest, ash forest, mulga, mallee, etc), based on plant associations
- Traditional Australian classifications - wet & dry sclerophyll forests, etc
- Classification by Ecological Vegetation Class (EVC's): mapping units of associations determined by climate, rainfall, aspect and soils
- examples of local EVCs

15.2 Major Vegetation Associations and Associated Land Uses

- Australian Biomes and Major Associations: rain forest, open forest, woodland, mallee, mulga, chenopod shrublands, spinifex, etc
- Associations of SE Australia: myrtle-beech rain forests, wet sclerophyll ash forests, peppermint-stringybark, box-ironbark, red gum woodlands, mallee, coastal teatree & banksia, etc
- local examples of plant associations and their relationship to aspect, rainfall and soils

16 GEOLOGY and SOIL PATTERNS

16.1 Local Geology and the Soils They Produce

- Geological origins: Plutonic (granites & granodiorites), volcanic (basalts, rhyolites, dacites & tuffs), sedimentary (sandstones, mudstones, shales, limestones), metamorphic
- sedimentary rocks: infertile sandy loams from sandstones, clay loams from mudstones and shales, common east of Melbourne & central Victoria
- basalts: black or red clayey soils, common in central & western Victoria
- rhyolites and dacites: red mountain loams of the Dandenongs, etc
- granitic rocks: gravelly soils, sloppy in winter, hard in summer
- alluvials: silty soils, nutrients replenished periodically
- marine sands: infertile sandy soils

16.2 Structure of Soils

- Soil profiles: A, B & C horizons, duplex and gradational soils
- Minerals: Sands & gravels, silts, clays and solutes bound to clays and organic matter
- Organic matter: humus colloids, breakdown products of organic decay
- Micro-organisms: see the Soil Food Web below
- Water, free in soil pores and bound to clays and humus colloids
- Air: Oxygen for plant root respiration, Nitrogen for conversion to soluble nitrates and ammonia by nitrogen-fixing bacteria

16.3 Difficult Soils

- Cracking clays: hard in summer, sticky in winter
- Laterites: deposits of iron and aluminium under tropical conditions
- Calcretes: deposits of lime in arid or seashore areas
- Saline soils: salt deposits in subsoil, which become mobile when water tables rise

- Sodic soils: highly dispersive clays that contain exchangeable sodium
- Acid sulphate soils in wetlands
- Dry powdery soils that are water repellent in summer due to fungus

16.4 **Assessing Soils**

- Testing soil structure: plasticity, flotation test, dispersion test
- Biological indicators of nutrient status: acid-loving plants, nutrient uptake by bio-accumulators
- Nutrient deficiency symptoms in plants

17. **SOIL ECOLOGY & MANAGEMENT**

17.1 **Functions of Soils in the Landscape**

- Medium for plant growth
- Habitat for micro-organisms and burrowing fauna
- Storehouse of nutrients for plant and animal nutrition

17.2 **Soil Chemistry**

- Major, minor & trace nutrients necessary for plant growth,
- Other nutrients necessary for animal & human health (silica, iodine, selenium, etc)
- pH and nutrient availability in organic and inorganic systems, adjusting pH with lime to raise pH, sulphur, pine/oak leaves to lower
- Cation Exchange Capacity of soils
- William Albrecht's work on balancing elements, eg Ca, Mg, Na and K
- Assessing nutrient status through soil/ leaf analysis

17.3 **Soil Biology - The Soil Food Web:**

- interactions between producers, predators, decomposers: bacteria, saprophytic fungi, mycorrhizal fungi, yeasts, nematodes, protozoans, mites & other invertebrates
- Elaine Ingram's views on bacterial-dominated grassland soils suitable for annual crops and fungal-dominated forest soils suitable for tree and perennial crops
- Mycorrhizal fungi & nutrient exchange
- effect of soluble fertilisers: toxic to micro-organisms & earthworms, uptake of unnecessary or deleterious solutes by plants, loss of structure as organic matter is depleted, pollution & algal blooms from groundwater seepage and run-off to streams

17.4 **Building Soil fertility**

- Building bacterial-dominated soils for annual crops with manuring, mulching, composting
- Composting: balancing Carbon:Nitrogen ratios
- Green manuring
- Building fungal solid with leafy and woody mulches to encourage mycorrhizal fungi
- Supplementation with organic and mineral fertilisers to replace harvested nutrients
- Use of biological activators - BD 500, proprietary bacterial cultures, compost teas
- Encouraging earthworms, use of worm juice and worm castings
- Create diversity by avoiding monocultures, use companion planting
- Use sheet mulching for weed control and soil conditioning
- No-dig Alternatives : Esther Dean's no-dig garden system & layered "lasagne" gardens, CSIRO's "Clever Clover" system using sub-clover & lucerne

18. **STARTING A DESIGN**

18.1 **Step 1: Assessing Client Needs (Client Brief)**

- Use of a checklist of issues to be considered
- Clarify client's vision (subject to refinement during the design process) and scope for the project
- Check legal constraints : planning scheme zoning, covenants, easements
- Identify resources: capital, equipment, skills, labour
- Prepare quotes: scale of fees, travelling time, etc

18.2 Step 2: Gathering Data

- obtain a site map: title or council plan showing boundaries
- observation & deduction from nature: slope, aspect, soils, climate, vegetation & wildlife, history of use, existing patterns and connections
- existing infrastructure: roads, buildings, services, etc
- external influences, eg shade from neighbouring buildings, trees
- structure of social unit to be serviced: household, village, school, etc
- available resources and skills

18.3 Mapping – documenting your data

- conventions: N to top, symbols, keys/legends and scales for use on maps and plans
- interpreting contours
- preparation of base plan
- use of overlays to present design options and choices
- Computer Aids for Design

19. SITE ANALYSIS TOOLS - use at Step 3 (Analysis), Step 4 (Conceptual Design)

19.1 Functions and Needs Analysis - underlying functional design

- needs (inputs): resources required for the element to function
- functions: roles performed by elements in a system
- products (outputs): yields of the element in the system
- intrinsic characteristics of elements that will affect choice

19.2 Sector Analysis: Managing wild energies which are **directional**.

- Sun: summer & winter angles, daily arcs
- Wind: direction of prevailing hot & cold winds, driving rain
- Bushfire: direction of major threat, upslope dangers, wind change effects
- Floods & tsunamis where applicable
- Aesthetics: views, noise, dust

19.3 Topographical Analysis

- land system components and land use capabilities : slope, soil type, drainage, aspect
- taking levels to measure slope: surveying instruments, line levels, water hose (bunyip level), A-frame & plumb bob

20. SPATIAL DESIGN TOOLS - use at Step 3 (Analysis), Step 4 (Conceptual Design)

20.1 Zone Planning: Where to place elements in a system to conserve time & energy. Conceptual zones are based on **relative distance**, depending on:

- intensity of use (the frequency of your need to visit and the element's need for you to visit) - **most useful *within* property zones**
- the function of the element/s in the system, and
- the space required for the element to function - **most useful *between* zones**

Zone 0 - **The Home** - Living space or centre of activity (may be an office) for details see Topic 41 – Design of Functional Buildings

Zone 1 - **Household Support & Utilities**: elements which support the household

Zone 2 - **Intensive Production Areas**: elements which provide surplus for sale or barter, requiring more space and using hand tools, small animals & light machinery

Zone 3 - **Extensive Production Areas**: Commercial farming activities, using draught animals or heavy machinery, including plantation forestry.

Zone 4 - **Managed Habitat**: Local species, existing or re-established, managed to produce sustainable yields including ranged stock, buffer between cultivated areas and zone 5 wilderness

Zone 5 - **Natural Habitat** : conservation/reference areas managed only to restore or maintain original biodiversity

See Appendix 5 for zone descriptions for SE Australia

See Topics XX and YY for the application of zoning concepts to physical and social landscapes.

20.2 **Slope Planning: Taking advantage of Gravity**

- Water storages & reticulation
- Movement of warm and cold air
- Hillside creep of soil & leaf litter
- Siting of access and service roads: unloading to sites uphill of future use, etc

20.3 **Network Analysis** and Planning - where a site has more than one focus of activity

- Identifying nodes, eg homestead and barn or packing shed
- Connections, resource and energy flow between nodes
- Zone and Sector planning for each node

20.4 **Use of Patterning in Design to Make Connections & Integrate Elements**

- Patterns in space: spatial relationships of plants in gardens & orchards, rooms in a house, ponds in an aquaculture, etc
- Patterns in time: succession and intercropping, functional change of buildings over time, etc.
- Patterns as models of function: use of pattern languages to achieve efficient function at various scales, eg windows in a room, rooms in a house, house in a landscape
- Considering options and pathways to create durable systems, making best use of available resources, random assembly of elements may suggest novel solutions.

20.5 **Strategies for Successful Design**

- Ensure that your clients feel they own the design, the best design in the world won't work if the clients aren't part of both the process and the outcome.
- Accept that every design is site specific
- Don't over-design, ensure that your clients get a good return on their investment in your time, a kitchen table sketch may be adequate for a home garden design
- Avoid common errors (Type 1 errors) & minimise establishment costs: water as a first priority, wind shelter for plantings, protection of plantings from browsing animals, allowing for soil rehabilitation

20.6 **Format for a Design Report - Step 5.**

- Property Description: Location, size, ownership,
- Design Brief (Client Needs)
- Site Map, existing infrastructure, sector analysis, land capabilities
- Conceptual Design showing Zoning and connections, allocating areas to specific functions
- Themes (eg weeds, water, pests)
- Development timetables/stages (Gantt Chart useful for this)
- Detailed plans of components: services (water supply, drainage, access), garden layout, orchard plan, etc
- Appendices: resources, species lists, etc

20.7 **Using Pc Design for Communities, Businesses, Associations**

- see Topics 33 - 36 for applications of Pc ethics and design methodology to social structures

21. **BUILDING & PRESERVING DIVERSITY**

21.1 **Principle 10 - Use and Value Diversity.**

- Structural and genetic diversity in natural systems
- Geographic and Cultural diversity
- Economic & social diversity

21.2 Plant Breeding & Origins of Biodiversity in Food Crops

- Cultivars and the evolution of landraces in plants at village level
- European Cabbage as an example of diversity through selection: Kales, collards, cabbages, cauliflowers, broccoli, Brussels Sprouts, kohlrabi
- pollination mechanisms in plants: wind, animals, self-pollination
- benefits of genetic variability in traditional open-pollinated plants: disease resistance, long harvest period, flavour
- Government and commercial breeding programs to produce better-adapted, more vigorous, crops
- development of F1 hybrids & effects of the Green Revolution on biodiversity in Third World countries
- commercial seed company focus on F1 hybrids and loss of traditional varieties from catalogues
- efforts of seed savers to preserve heirloom varieties
- potential effects of genetically modified organisms, "gene-beans" etc

21.3 Selection & Seed Saving Techniques

- Selecting the most productive plants
- Maintaining variability through large sample sizes each generation
- Avoiding cross-pollination by isolating in space or time
- Hand pollination and caging techniques
- Harvesting, cleaning and storing seed

21.4 New Crops and Bush Foods

- potential of wild plants for development of new crops through **cross-breeding and** selection
- traditional bush foods in south-eastern Australia: yam daisies, berries, native peppers, wattle seed, etc.

21.5 Old & Rare Breeds - maintaining biodiversity in farm stock

- advantages of pure breeds over crossbreeds in Pc systems
- breeding specialised varieties for sale as breeding stock
- intrinsic breed characteristics in old varieties

22 ANNUAL FOOD CROPS

22.1 Uses of Food Gardens

- Functions: supplying fresh food, fodder, recycling of household wastes
- Products: fresh fruit & vegetables, culinary & medicinal herbs
- Cultural uses: recreation for children & adults, traditional foods
- Conservation uses: habitat for useful birds, frogs, lizards, etc, preservation of heritage varieties

22.2 Gardening as Agriculture

- Historical progression from subsistence to industrial agriculture, change from vegetables to cereals as energy sources.
- Water usage in gardens of broadacre farming
- considerations : energy returns on labour, freshness, nutritive value

22.3 Diversity in Cool Climate Annual Crops

- **Warm season crops:** sow/plant in Spring, harvest in Summer-Autumn: Root crops (potatoes, carrots, parsnips), Leaf Crops (amaranths, orach), Legumes (bush & climbing beans), Tomato family (tomatoes, eggplant, capsicum, chillis, tomatilloes), Melon family (Cucurbits - cucumbers, squash, marrows, pumpkin, rockmelons, watermelons), Culinary Herbs (dill, fennel, sweet marjoram)
- **Cool season crops:** sow in Summer-Autumn for harvest in Winter-Spring: Root crops (late plantings of summer varieties plus swedes, turnips, oca, sunchokes, celeriac, daikon, yacon), Leaf crops (brassicac - broccoli, cauliflower, brussell sprouts, cabbages, kales, late plantings of leaf beets, spinach, celery), Salads (lettuces, endives, chicories, corn salad), Onions (leeks, spring onions & bunching onions), Herbs (Chervil)
- **Crops for storing:** sow in Autumn-Winter for harvest in Summer: garlic, bulbing onions, potato onions and shallots. Sow/plant in Spring for Autumn/Winter harvest: potatoes, pumpkins, maize,

shell beans, etc.

- **Transitional crops for Spring & Autumn harvest:** temperature sensitive crops affected by frost and/or hot summers: Legumes (green, snap & snow-peas, broad beans)
- **Biennial Crops for Spring planting & year-round harvesting** (parsley, leaf beets, celery)
- Short term crops for successional planting: coriander, rocket, mustards, lettuces, radishes
- **Crops that can be dried, pickled, preserved** : tomatoes, gherkins, capsicum, beets, cabbage are traditional, many other vegies & herbs can be also be processed for storage

23 **SMALL-SCALE ANNUAL CROPPING SYSTEMS**

23.1 **Spatial Arrangements for Zone 1 Kitchen Gardens** - supplying household needs

- zoning patterns within zone 1: working out from the kitchen door or path-side with herbs & plucking greens nearby, staking plants, one-stop crops further out
- planting beds: linear raised beds for improved drainage, with contour beds and terraces as the slope increases, pits and mounds, hay-bale beds
- network of paths, keyhole paths to provide access to beds
- mandala gardens: utilising edge & the energy of circles
- herb spirals: creating microclimates
- plant stacking to maximise use of available sunlight
- intercropping and time stacking
- containers for verandahs, patios, balconies, etc
- connecting elements, locating compost heaps, etc.
- ponds for aquatic plants & animals, waste water treatment (see also Topics 31 and 32)
- **structures** for use of 3-dimensional space: stakes, fences, arches, trellises, pergolas
- Wicking beds : self-watering beds
- Hugelkultur : beds built over buried logs

23.2 **Strategies to Increase Yields in Zone 1 Gardens**

- use species and cultivars suited to the local climate & season
- develop guilds of plants that interact beneficially - companion plants
- select plants that yield well or can be harvested over extended periods, eg silver beet, zucchinis, climbing peas & beans, sprouting broccolis
- breed your own locally-adapted varieties by selecting seed & propagating material from the most productive & healthiest plants
- extend the growing season with greenhouses, poly-houses, cloches, propagation frames
- follow natural rhythms: plant in season, plant by moon phase, etc.
- include composting toilets in system to retain nutrients on site
- use animal "tractors": chickens, guinea pigs, rabbits, for weed removal, fertilising and supplementary yields

23.3 **Additional Strategies for Zone 2 Market Gardens** - change of scale, different strategies, surplus production for sale

- selection of varieties to spread workload and yields
- balancing polycultures with economies of scale for harvesting annual crops
- Crop rotation: legumes, leaf crops, fruit, root crops, fallow
- Alley (Avenue) cropping: alternating beds of crops and fodder/mulching crops
- Specialised tools for propagating, cultivating, weeding & harvesting
- Fukuoka no-tillage systems
- Linda Woodrow's multiple mandala model with portable chook domes

23.4 **Managing Wildlife, Pests & Diseases**

- plan for ecological balance: producers, browsers/grazers, predators, decomposers
- encourage beneficial species by providing habitat, shelter, food, eg flowering natives to encourage honeyeaters, rocks & logs for lizards, food plants for predatory wasps, frog ponds, etc
- discourage problem species with physical barriers, decoy crops, etc
- build healthy soils to give healthy plants that resist pests & disease
- use organic and biodynamic sprays for spot control of problems, eg bacterial sprays (Bt) for cabbage white caterpillars
- see Topic 27 for use of poultry and other small animals for pest control

24 PERENNIAL FOOD CROPS

24.1 Perennial Vegetables

- Herbaceous perennials - summer rhubarb, globe artichokes, mints, sorrel, chives
- Shrubby perennials - sage, marjoram, thymes, rosemary, rococo chillis, grafted eggplant
- Tubers - potatoes, taro, sunchokes, Chinese artichokes, oca
- Climbers - chilacayote, chokos, runner beans

24.2 Berries and Small Fruits

- Cane fruits: Raspberries and Brambleberries
- Bush fruits : Currants & gooseberries, blueberries, cranberries, Ugni, Cape Gooseberry
- Vine fruits: Kiwifruit and other Actinidias, grapes, passionfruits
- Ground covers : Strawberries

24.3 Fruit Trees

- temperate biome pome fruit : apples, pears, nashis, quince, medlars
- temperate biome stone fruit: peaches, nectarines, cherries, plums
- mediterranean fruits: figs, olives, apricots,
- citrus: orange, mandarines, lemons, tahitian limes, grapefruit, pommelo, cumquat, tangerine
- tropical montane fruits with temperate potential: cherimoya, sapotes, tamarillo
mountain pawpaw, babaco
- Others: feijoas, loquats, mulberries, avocados, persimmons, Lilly Pilly

24.4 Nuts

- Hazelnuts
- Chestnuts
- Walnuts, Pecans & Hickories
- Almonds
- Native nuts : Bunya, Macadamia

25. SPATIAL PATTERNS FOR PERENNIAL CROPS

25.1 Perennial Vegetable Beds

- Dedicated beds for tuberous perennials away from root zones of trees and shrubs.
- Herbaceous and woody perennials suitable for planting in spaces between trees

25.2 Fruit Trees in Zone 1 Gardens

- Espaliers, dwarfing rootstock, step-over hedges, cordons for tight spaces.
- multi-grafted trees: management to match vigour
- providing warmer microclimates for oranges, mandarines, avocados, etc: planting in sun-traps, against walls
- fruit trees and chook runs in outer zone 1
- the banana circle for tropical gardens

25.3 Forest Gardens in Zone 1 - small scale multi-layered intensive perennial systems

- Robert Hart's model of 7 (really 5) storeys in his Shropshire "forest garden": canopy trees, dwarf trees, shrubs, climbers & ground layer (herbs, creepers, rhizosphere plants)
- David Jacke's 3-layered Micro-forest Garden pattern for small urban spaces
- relationship to areas devoted to Kitchen Garden annuals
- need for high maintenance in small spaces, using highly domesticated & productive cultivars

25.4 Food Forests for Zone 2 - low-maintenance systems that mimic natural tropical forests or temperate woodlands and require more space

- use of less domesticated, low-maintenance varieties
- Dave Jacke's five elements of forest garden design: vegetation layers, soil horizon structure, vegetation patterning, vegetation density, community diversity
- Martin Crawford's 2 acre Shropshire Forest Garden at Schumacher College
- inclusion of medicinal herbs and bushfoods in your guilds

25.5 Forest Farming at Zone 3 Scale - cultivated crops in a woodland setting

- the home gardens of Kerala in India: income from cashews, pineapples, pepper, cloves, etc
- Fungi: truffles, shiitake, oyster mushrooms, etc
- Ginseng
- Coffee gardens in tropical areas

25.6 Forest Farming at Zone 4 Scales - harvested crops from natural forests & woodlands

- coffee production from forest gardens of the Chagga, Tanzania
- brazil nut harvesting in the Amazon rainforests
- Kakadu Plum (Gubinge) in the Pindan woodlands of the W A Kimberley
- Bunya nuts in SE Queensland
- Bush Tomatoes, Quandong in Central Australia

25.7 Mixed Orchards for Zone 2

- suitability of the Orchard pattern for deciduous cultivars in SE Australia that respond to intensive management
- spatial patterns: maximising density with alternating rows
- need for cross-pollination in many fruit & nut trees
- interplanting with legumes (tagasaste, wattles, etc) and ground covers to provide nitrogen
- propagating from seedlings & grafting to maintain varieties
- choosing rootstocks to suit the soil conditions and tree size, eg dwarfing rootstocks for apples, pears & plums
- spreading the harvest with early, mid-season & late varieties
- choosing varieties to provide a succession of yields year round
- see Topic 27 for use of grazing animals for grass and weed control in orchards

25.7 Large-scale Orchards for Zone 3

- fewer varieties, greater numbers for commercial production
- access for machine harvesting & transport
- modern trellising systems (high in embodied energy)
- combining with animals: free-range chooks, geese, sheep

26. URBAN AGRICULTURE**26.1 Benefits of Gardening-scale Agriculture**

- economic: minimal labour & transport costs
- cultural: traditional, ethnic foods & cultural techniques
- social: personal involvement in food production, grower-consumer links, food swaps and bartering
- environmental: water-use efficiencies, minimal chemicals, less transport, biodiversity, productive use of under-utilised space
- Urban agriculture and retrofitting of the suburbs
- the Cuban experience

26.2 Private Food Gardens

- traditional kitchen gardens on suburban blocks
- door-step, balcony and rooftop gardens
- attached greenhouses
- cooperative urban garden plots - remove fences and combine spaces

26.3 Food Production on Communally-managed Land

- Community Gardens: private and/or communal plots
- City Farms & Community Environment Parks
- School Gardens and School Kitchen Gardens
- Hospital and Healthcare Program Gardens
- Edible streetscapes: rather than ornamental plantings
- Community Orchards

26.4 **Commercial Food production in urban areas**

- Work-place Rooftop and Restaurant gardens
- Aged care gardens
- Peri-urban Orchards and Farms - preserving green wedges with protective zoning, within and on the fringes of cities

26.5 **Urban Forestry**

- Potential for productive rather than ornamental plantings in streets, parks and public open space in urban areas: fruit & nut trees, timber species
- Wildlife habitat
- Strategies for local harvest festivals, etc

27. **ANIMALS IN PERMACULTURE** - choosing appropriate species and breeds and understanding their requirements

27.1 **Functions of Animals in Designed Systems**

- Producers of food, fibre and manure
- Control of weeds and invertebrate pests
- Converters of waste to useful products
- Pollination of crops
- Soil cultivators
- Haulage and traction power
- Stock control and protection from predators

27.2 **Needs of Animals in Pc Systems**

- Food & water: provided from within the system
- Shelter from the elements
- Protection from predators and parasites
- Behavioural needs: dust baths, swimming ponds, rubbing posts, etc
- Personal care and attention: interdependence of domestic animals and humans
- Pat Coleby's ideas about soil minerals and animal health
- Ethical issues around animal slaughter

27.3 **Intrinsic Characteristics of Animals that affect choice**

- poultry: light (layers), dual purpose and heavy (meat) breeds
- cattle: beef or milking, heat tolerance and tick resistance
- sheep and goats: meat, milking or fleece breeds

27.4 **Animals for Zone 1:** Small animals for fixed or portable caging, limited free-range in the Home Garden

- Bantams, pheasants, pigeons and quail
- Ducks: garden friendly and miniature varieties
- Rabbits and cavies (guinea pigs)
- Worm farming to process organic waste

27.5 **Animals for Zone 2:** Pens & Yards (with some access to Zones 1 & 3)

- Poultry: chooks, turkeys, guinea fowl, ducks & geese
- Pigs, house cow, milking goat
- Bees
- Miniature breeds for small scale systems: lowline cattle, etc

27.6 **Paddock Animals for Zone 3** - Pasture & Agroforestry plots

- Traditional breeds of sheep, goats, horses, cattle and pigs
- Bison, water buffalo, highland cattle
- Ostrich and emu
- Deer, antelope & alpacas

27.7 **Rangeland Animals for Zone 4**

- Traditional stock, but ranged at low stocking rates
- Harvesting wildlife and feral animals as a resource and population management technique
- Kangaroos versus sheep & cattle in pastoral rangelands

28 HARVESTING & STORING WATER

28.1 **Functions of Water in Pc Systems**

- Essential ingredient in life processes: nutrient exchange, transpiration in plants, water balance & excretion of toxins in animals
- Medium for productive systems (aquaculture)
- Source of energy
- Modifier of local climate
- Recreation (in combination with other functions)

28.2 **Water Harvesting**

- Freshwater as a relatively scarce commodity: limiting factor in both croplands & cities
- Sources: rainfall, streams, ponds, groundwater, artesian water, dew & mist condensation
- Collection: roof gutters, ditches, drains, diversion weirs, pumps (see Section 39.1 for pump options), vegetation
- Accessing groundwater with wells and bores

28.3 **Structures for Storing Water**

- Recycled containers: bath tubs, fuel drums, etc for small scale systems
- Transportable tanks: galvanised steel, fibreglass, plastic, concrete, 500 - 20,000 L capacity, above ground on stands or slabs, or below ground
- Large capacity: concrete poured on site, steel assembled on site
- Earthen dams: gully, ridge, saddle, turkey-nest, etc (see Section 27.5 for construction requirements)
- Diversion of initial polluted roof run-off in domestic systems

28.4 **Promoting Soil Storage and Minimising Run-off**

- Maximising vegetative cover and increasing organic matter in soils
- Swales for absorption of overland flows in arid landscapes
- Keyline ripping to distribute water from gullies to ridges in mature landscapes
- Natural Sequence Farming on old (floodplain) landscapes
- Permeable paving to allow penetration on roads and paths in urban landscapes

28.5 **Preventing Erosion**

- Maintenance of vegetation cover on stream banks & hillsides
- Diversion channels to avoid fragile areas
- Cultivating on the contour
- Gabion boxes (wire baskets filled with rocks)

28.6 **Components of Irrigation Systems**

- Water source: dams, tanks, bores
- Energy source for distribution: gravity, pumps, effects of pressure
- Distribution network: channels, pipes, buckets, portable tanks
- Emitters: floodgates, driplines, sprinklers, sprayers, misters

29 WATER CONSERVATION & RECYCLING

29.1 **Water Conservation Strategies**

- Retention of vegetation and use of windbreaks
- Xeriscaping using drought-tolerant plant species
- Soil cultivation and surface mulches
- Good irrigation design and equipment to get water where plants need it

- Water-saving devices: aerating taps, low volume shower heads, dual-flush toilets, dry composting toilets

29.2 **Treating & Recycling Wastewater**

- Direct household diversion to toilets and gardens-
- Primary treatment to remove solids: grease traps, fabric, sand filters
- Secondary treatment to remove pathogens & nutrients: reed beds
- Tertiary treatment for polishing before discharge to environment: stabilisation ponds with algae azolla, etc , flowform aeration
- Irrigation of tree crops and gardens
- Dairy shed and piggery effluent to biogas digesters
- Coping with neighbour's wastewater

29.3 **Natural Swimming Pools**

- Use of biological filtering systems
- Zones for swimming, plantings, fish refuges

30 **AQUACULTURE** - Food production in aquatic systems: the ecology of edges

30.1 **Traditional & Commercial Systems**

- Paddy rice in Asia with fish & other by-products
- Chinampa system in Mexican swamps and lakes
- Chinese fish ponds: high yielding, but with species and nutrient levels not suitable for Australian conditions
- Farm dams stocked with fingerlings: trout, etc
- Harvesting wild yabbies from farm dams
- Trout & Salmon Farms: high energy input, imported food
- Aquaponic systems: combining aquaculture and hydroponics

30.2 **Small Scale Aquaculture for Zone 1 Gardens**

- Tyre ponds: limited uses and productivity
- Old wash troughs & bath tubs: useful for growing small quantities of water chestnuts, watercress, etc
- Aquatic plants in small ponds with goldfish or Galaxias for mosquito control, or frog breeding for insect control in gardens
- Fish in swimming pools over winter

30.3 **Productive Polycultures for Zones 2**

- Freshwater polycultures: ecologically balanced systems with components chosen for their productive yields (Romanowski 1994)
- Elements of aquatic systems: phytoplankton, zooplankton, fodder animals, main-crop animals, submerged plants, floating plants, shoreline plants, planting shelves and terraces
- Water: sources, surface:volume ratio & gas exchange, pH & salinity
- Stocking rates & potential yields: usually exaggerated, up to 3 tonnes/ha in cold climates, plus some incidental yields
- Provision of shelter and refuges
- Useful aquatic plants in cool areas: rice, taro, water chestnuts, saggitaria, kang kong, watercress, wild rice, lotus
- Useful aquatic crustacea in cool areas: Yabbies, Marron
- Useful cold-water fish: Brown & rainbow trout, Silver and Golden perch, Catfish, Blackfish, eels

30.4 **Large Scale Systems for Zone 3**

- Separating trophic levels, fodder production ponds, breeding ponds, rearing ponds, for intensive production.
- Fodder production: algae and invertebrates
- Potential for saltwater aquacultures in inland salt-affected landscapes

30.5 Pond Construction and Configuration

- manual labour or machinery depending on scale
- optimum depth at 2 m
- materials: artificial liners for small scale, natural materials for larger ponds
- pond layouts: series, parallel, nested, isolation ponds for new stock
- siting in relation to climate and microclimate: wind, sun
- Jetties: useful adjuncts for work space, observational platform, attachment of underwater holding cages, etc
- provision of shallows, deeps, rock/tyre reefs, islands

30.6 Furono's Duck-Rice System

- Planting sequence and introduction of ducklings
- beneficial effects of ducks on the rice
- Addition of fish and azolla

30.7 Mariculture - Farming the sea

- Traditional harvesting techniques: fishing lines, nets, etc
- Increasing productivity with shellfish racks, artificial reefs, etc
- Farming salmon, tuna, etc in cages - sustainability issues
- Harvesting of marine algae (seaweeds) for food
- Need for sustainable-yield harvests of seafood and reduction of incidental catch
- Applying zoning concepts to marine resources: intensive farming (3), sustainable-yield harvesting (4), no-fishing conservation areas (5)

31 RURAL LAND USE PATTERNS

31.1 Functions of Agricultural Landscapes

- Yields of food, fibre, fuel, etc for human consumption - local, regional urban, export
- Water catchments in densely populated countries
- Support for ecosystem stability: rainfall, air quality, carbon sinks, maintenance of biodiversity
- Landscape values, recreation & tourism

31.2 Some Perspectives on Australian Agriculture & Forestry

- Displacement of indigenous cultures
- Failure of European-style farming on Australian broadacres: soil degradation & erosion, salinity & lowered rainfall due to tree clearing, overcommitment of water for irrigation
- Effects of pastoral agriculture on Australian rangelands: changed fire regimes, massive species extinction, replacement of natural vegetation with unproductive woody weeds (see also Topic 15 (Vegetation & Land-use Patterns))
- Large proportion of primary production feeds secondary production - livestock feed, processed food such as cornflakes, biofuels
- Effects of clear-felling practices in Australian forestry - loss of habitat, biodiversity, increased fire risk

31.3 Planning Regulations and Land-use

- Sub-division and multiple occupancy restrictions
- Intensive and Extensive Agriculture
- permits to harvest native vegetation for farm forestry

32 (A). RURAL STRATEGIES

32.1 The Permaculture Approach to Farm Planning

- Identify the eight Land Classes used in Whole Farm Planning based on risk of soil degradation, extend with Holmgren's use of Land System classification: subdivisional fencing according to soil type and drainage, etc, in addition to topography.

- Use of Network planning, determining relationships between activity nodes
- Combined functions: roads as firebreaks, roads on dam walls, etc
- Zoning patterns on farms.

32.2 Strategies for Sustainable Broadacre Farming

- Maximise harvesting and use of rainfall: vegetation, swales, and dams (see topic 26 for water harvesting techniques).
- Move from monocultures to polycultures where practical and diversify and rotate crops to reduce incidence of disease by growing disease-inhibiting crops in rotations, eg mustards after potatoes
- No-till, minimal tillage systems, direct drilling of seed, retention of stubble
- Wallace plough tillage to increase soil aeration
- Keyline systems of cultivation and water management
- Biodynamic preparations to enhance soil fertility and plant health
- Alley cropping/intercropping: alternating strips of different crops and/or shelter belts
- Establish and managing perennial pastures to ensure deep rooting, with rotational cell grazing to increase pasture productivity
- Supplement pasture with perennial fodder crops for livestock: tagasaste, carob, kurrajong, etc
- Agroforestry: tree crops and livestock to give multiple yields
- Timing the sowing of crops to minimise pest attack

32.3 Earthworks on Rural Systems

- Planning considerations: siting, soil testing, taking levels, pegging site, topsoil storage for later replacement
- Design of roads, culverts, bridges, table drains, batter drains to minimise erosion and maintenance
- Ground tanks & dams: need for compaction, lock-pipes, overflows, design to maximise amount of water stored per unit of earth moved
- Swales & diversion channels
- Interceptor ditches in saline areas - WISALTS system in Western Aust
- Earth berms for wind protection
- Revegetation after earthworks to minimise erosion & invasion of weeds

32.4 Fencing and Gates

- Traditional low embodied energy systems: hedgerows, ha-has, ditches, picket fencing, post & rail, dry stone walls
- Modern post & wire fences, high & low tensile wires, strainer systems
- Electric fencing, batteries and solar panels
- Specialised fencing for deer, kangaroos, etc
- Gates: timber, steel, slip rails, grids
- Styles and wombat gates

32.5 Sustainable Rangeland Strategies

- Pastoral agriculture as a Zone 4 activity
- Maintain appropriate stocking rates to avoid habitat degradation
- Manage for multiple yields - bushfoods, essential oils, wildflowers, medicinal plants, [craft-wood](#), etc

32.6 Design Considerations for Managing Vegetation on Farms

- Inclusion of all vegetation types in zones 4 & 5 to conserve biodiversity
- Retain trees on steep slopes, ridges and watercourses to prevent erosion
- Plant structured multi-purpose shelter-belts/windbreaks that form wildlife habitat
- Restore & maintain wetlands
- Design and maintain plantings as quality wildlife habitat: structural diversity, presence of litter, logs, etc
- Patch size effects on wildlife diversity: minimum 20 ha to overcome edge effect (edge species such as miners are dominant), need to co-ordinate plantings with neighbours, etc, with linear strips along roads, fences & streams as wildlife corridors, connecting larger habitat patches

32(B) FARM FORESTRY**32.9 Functional Analysis of Trees in Rural Systems**

- **Needs:** water, soil, sunlight, protection from browsing, wind and weed competition while young.
- **Functions:** carbon storage in food, fodder & timber, shelterbelts, windbreaks, shade trees, animal barriers, fire shields, dust barriers, frost diversion, salinity control, maintenance of ecosystem services, wildlife habitat & wildlife corridors.
- **Products:** fuel, food, forage, structural materials, water, mulch
- **Intrinsic characteristics:** drought/frost/salt tolerance, growth rates, climate suitability.

32.10 Functional Patterns for Trees in Permaculture

- multi-purpose plantings; shelter, timber, fodder, wildlife, mulching materials for zone 1 & 2 gardens
- shelter belts and windbreaks: semi-permeable to wind & multi-layered
- hedgerows & ditches as animal barriers
- fire shields: fire resistant & fire-retardant species strategically placed in fire sector: some wattles, photinias, deciduous trees, etc
- **Forage trees and shrubs for livestock:** tagasaste, wattles, carob, kurrajong, Photinia, etc
- climate modification around buildings (see also Section 36)
- plantings in saline areas to lower water tables
- planted funnels to increase wind speed for wind pumps & wind turbines
- hedgerows to divert cold night air in frost prone areas
- shading out weedy species

32.11 Strategies for Timber Production in Zone 3

- Establishing woodlots & plantations for firewood, logs, poles & timber
- Management through pruning, thinning, pollarding & coppicing to increase yields
- Integrating trees and livestock in agro-forestry plots: multiple yields from poultry & fruit trees, sheep or cattle with timber trees, etc
- Choosing suitable varieties for cool temperate conditions, benefits of indigenous varieties
- Analogue forestry: plantings that mimic natural forests
- Utilising wastewater to provide nutrients (see also section 24)
- Portable sawmills for on-site harvesting & processing of timber

32.12 Re-establishing & Managing Forests in Zones 4 & 5

- Fencing out browsing animals to allow in-situ regeneration
- Selecting from local gene pools for ex-situ propagation and replanting
- Direct seeding techniques: soil preparation and seed dispersal
- Use of pioneers as nurse species
- Suppressing weeds and browsing animals

33. PATTERNS IN COMMUNITY - the Social Landscape**33.1 Functions & Needs of Individuals in Communities**

- **Social Needs:** protection, affection, understanding, participation, creation, recreation, identity and freedom (Max-Neef)
- **Functions:** providing for the needs of others, contributing according to capabilities
- The concept of "Right Livelihood": work that provides for creativity, diversity and satisfaction
- The wisdom of the elders

33.2 Aspects of Community Organisation

- Traditional Social organisation: clans, villages, tribes, totem groups, etc., relationship to bio-regions
- Socio-economic classes in Western industrialised societies: working class (wage-earners), middle class (salaried & professional), upper class (inherited wealth)
- Holmgren's pre- & post-industrial social structures, top-down thinking, bottom-up action
- The globalisation of culture
- Social Capital

- networks and hierarchical systems
- Legal Structures for community groups - Incorporated Associations at State level, non-profit companies limited by guarantee at Federal level

33.3 **Developing Urban-Rural Links** - reconnecting people with nature

- The city as a farm: gleanings in the suburbs
- City Farms, eg CERES & Collingwood Children's Farm in Melbourne
- Community Gardens
- Subscription farming, community supported agriculture
- Farm & garden clubs: leasing rural land
- WWOOFing (Willing Workers on Organic Farms)
- Conservation Volunteers Australia
- "Friends" Groups (Friends of National Parks, etc)
- Greening Australia - training

33.3 **Community Groups and Decision Making**

- Optimum size for meetings, delegation and specialist working groups
- Meeting procedures: speaking in turn with the talking stick, etc
- Rotating & sharing responsibilities to avoid hierarchies
- Setting goals and objectives, measuring performance
- achieving consensus and resolving conflicts
- Getting jobs done: use volunteers for jobs that satisfy, rosters for routine maintenance tasks, contract out for difficult jobs
- The Holistic Resource Management approach to decision making: setting goals and testing each decision against your goals
- The Natural Step: a Scandinavian approach to corporate decision making
- Edward De Bono's Six Thinking Hats: co-operative exploration of ideas to reduce adversarial argument - **White** (information & data processing), **Black** (caution, logical negative), **Yellow** (benefits, logical positive), **Red** (emotion, hunch, intuition), **Green** (creativity, alternatives, possibilities), **Blue** (control, central processor)

34. **STRATEGIES FOR BUILDING SOCIAL CAPITAL**

34.1 **Zoning Patterns Applied to Society**

- Applying zoning concepts to social hierarchies, seven levels of organisation: Self (0), family/household (01), neighbourhood (02), urban/rural community (03), bioregion (04), nation/state (05), global community (06).

34.2 **Developing a Functional Bioregion**

- The need for a Sense of Place, reconnecting with the land, becoming "indigenous"
- Defining bioregions by natural boundaries, eg water catchments, vegetation associations, etc
- Working with bioregional resources to satisfy basic needs, reversing the modern push towards a global economy
- Re-developing cultural identities through local festivals, etc.
- Developing local seasonal calendars
- Establish a Bioregional Association and develop a Bioregional Resource Index: Food supply, Housing & shelter, Livelihoods & Finance, Communications & Information, Security & Disaster Planning, Social Support, Health Services, Transport, Future Planning.
- Borrowing ideas from similar bio-regions

34.3 **Community-based Rural Land-use Models**

- Commonworks (UK) model for multiple use of rural land
- Re-establishing the Commons - The Tilbuster Commons model in northern NSW
- Eco-villages & other intentional communities (see Topic 38 for detail)
- Landcare: cooperative, catchment-based community action groups
- Community Forests

35. ECONOMIC SYSTEMS and COMMUNITIES

35.1 Models of Environmental, Social and Economic Relationships

- The **overlapping sets** model often used by corporations
- The **nested pattern** model with the economy nested in society and society nested in the environment
- Triple Bottom Line accounting – is it really practised?
- The concept of a Steady State Economy

35.2 The Function of Money in an Economy

- Traditional systems of bartering & accumulating wealth
- Introduction of monetary systems by the Romans
- Money as an exchange medium, not a commodity
- Max-Neef's studies of the relationship between GDP and standard of living
- Capitalism & Communism - both economic failures

35.3 Capitalism and the Growth Economy

- Exponential growth *cf* natural growth patterns
- The effect of interest on all goods & services
- The re-distribution of wealth caused by the interest system
- The relationship between interest & inflation
- Creation of wealth through debt - the fractional reserve banking system

35.4 Historical Efforts to Change the System

- The Brakteaten system of Medieval Europe
- Silvio Gessel's proposal of 1890, published in 1904
- The Worgl experiment in Austria, 1933

36. STRATEGIES FOR ECONOMIC REFORM

36.1 Creating an Interest-free and Inflation-free Monetary System: three-point plan of Margrit & Declan Kennedy - a **revolutionary** approach (Kennedy 1995)

- Replacing interest with a circulation fee, as proposed by Silvio Gessel in the 1890's
- Land reform: moving to communal ownership
- Tax reform: replacing income tax with taxes on processing/consumption

36.2 Strategies for developing Economic Systems that serve Communities - an **evolutionary** approach -

- Bartering your surplus production - **the Gift Economy**
- Local Energy Trading Systems (LETS)
- **Local currencies: Totnes Pound, Ithaca Hours, etc**
- Vouchers, coupons, tickets
- Co-operatives: food-buying, producer & producer-consumer co-operatives, equipment-sharing
- Community savings & loans societies, eg CELT, SHARE, using revolving funds for community development
- Grameen Bank of Bangladesh: loans for the very poor to help break the poverty cycle
- The Community Bank model of Bendigo Bank.
- Supporting local businesses: mail-order seed companies specialising in traditional open-pollinated seeds, farmers markets, CSAs.

36.3 **Rural Land-use and Marketing Strategies.**

- The family farm vs the agribusiness farm, restoring the productivity of small-scale farming
- Planning enterprises in terms of bio-regional resources and needs
- Appropriate tenure: multiple occupancy and co-operative systems
- Forgoing short-term profit for long-term viability
- Rights of traditional landowners
- Developing appropriate marketing strategies: bioregional focus, direct sales, etc

36.4 Ethical investment

- Defining ethical business practices
- Investment to support ethical enterprises: direct investment in shares, bonds, super funds; indirect investment through Trusts and Managed funds, Super funds, etc

37. URBAN SETTLEMENT PATTERNS - Designing our settlements to suit our needs

37.1 Functions of Towns & Cities

- Social: recreation, community decision making, education & training, regional fairs, festivals & sporting events
- Economic: manufacturing, processing and marketing of regional surplus, imports & exports, retail and wholesale commerce
- Services: financial, communications, government, transport hubs, etc.
- Cultural: fine arts, performing arts, museums, zoos, libraries, etc

37.2 Existing Settlement Patterns

- Settlement hierarchies: houses, clusters, hamlets, villages, townships, towns, cities & the megalopolis
- time scales of permanence: eg, sea ports vs mining towns
- residential land-use options: detached single dwelling titles, duplexes, terraces, strata titles
- Urban Zones (0) shopping centres/transport hubs: (1) urban allotments; (2) streetscapes, parks & playgrounds; (3) industrial areas, playing fields, racetracks & golf courses; (4) road, river & railway reserves; (5) national & state parks on urban fringe.
- Transport systems: roads, railways, etc

37.3 Some Functional Urban Patterns from Alexander, et al, 1977. "A Pattern Language".

- Cities as a mosaic of sub-cultures (pattern 8)
- Scattered Work (pattern 9)
- Neighbourhoods (14 & 15), Activity Nodes (30), Promenades (31), Nightlife (33), Small Public Squares (61).
- Suburban Identity: Subculture Boundary (13)
- Rings of Density (29) & Eccentric Nucleus (28)
- Road Networks: Looped Local Roads (49), Local Transport Areas (11), Ring Roads (17)

37.4 Strategies for Developing Eco-towns and Eco-cities

- Encourage higher occupancy rates for housing
- Reverse the domination of cars, minimising the number of roads, develop a better hierarchy for road networks - Access & Service roads, Feeder/Collector roads, Arterials, Freeways, Ring Roads, Highways
- Provide communal open space to replace traditional backyards
- Develop compact, attached dwellings (town houses) with private courtyards and shared commons for garden plots
- Walking and cycling paths to connect clusters of dwellings & local services (shops, etc)
- The Urban Villages Project in Melbourne: identifying sites based on transport nodes suitable for development as self-contained urban villages
- Melbourne's 2030 Strategy: transport hubs and high density development
- for other ideas see Section 26 Urban Agriculture

38 INTENTIONAL COMMUNITIES & RURAL SETTLEMENTS

38.1 Eco-Village Development in Rural Areas

- Concepts: communal lifestyles with a strong ecological base, mixing private allotments and shared community space
- Aims of eco-villages: reducing the need to earn from outside, sharing resources, producing surplus for trading, providing social needs of members, etc
- Considerations: legal structures & planning, optimum size, infrastructure, energy sources,

finance, occupations & enterprises.

- Examples of Eco-villages: Crystal Waters Permaculture Village, Maleny; Jarlanbah Project, Nimbin; Fryers Forest Community, Central Victoria
- The Global Ecovillage Network (GEN)

38.2 **Urban Co-housing, Urban Villages & Ecocities**

- The Co-housing concept: shared facilities and private space in urban situations
- Examples of Urban Villages: Christie Walk, Adelaide; WestWyck, Brunswick.

38.3 **Other Rural Settlement Patterns**

- Bush Blocks
- Rangeland stations
- Campgrounds and Ski Lodges in National Parks
- Mining Towns

39. **PATTERNS IN HOUSING DESIGN**

39.1 **Functions of Houses**

- The concept of housing as a third skin (bodily skin, clothing, housing) to modify one's immediate environment
- Environmental functions: shelter, safety, storage, etc
- Social functions: privacy, nurturing family, social interactions, meals
- Economic: home office, crafts & cottage industries, capital asset

39.2 **Design Features of Housing in Different Climates**

- Temperate: orientation to utilise solar energy, high thermal mass materials, insulation to cope with seasonal variability
- Tropical: orientation to capture breezes, low thermal mass materials, insect screening
- Deserts: insulation, shade, courtyards & patios, pergolas, underground facilities, water conservation
- Site-specific styles: tents, teepees & yurts, houseboats, igloos, caves & underground houses

39.3 **Patterns in Building Design** (Alexander et al 1977) - design of buildings that satisfy basic human needs & behaviour patterns

- House design in relation to the landscape
- Component design in relation to function
- four storey limit to residential buildings
- Developing a bio-regional architecture (Holmgren 2002)

39.3 **Considerations in Siting Houses**

- Functions: site selection as hub of activities
- Access: pedestrian and vehicular
- Slope: cost of excavations cf benefits
- Aspect: wind, sun, rain & frosts
- Cost of connections to power, water & drainage services if required
- Aesthetics: privacy, views
- Planning regulations
- Bushfire risks

40. **BUILDING MATERIALS**

40.1 **Choosing Materials & using Local Resources**

- considerations: availability, affordability, durability, recyclability
- utilising non-material resources: people, time, money & skills
- embodied energy in structural materials: poles, sawn timber, earth, stone, bricks, concrete and steel
- insulating properties of roofing & cladding materials: boards, thatch, bricks, stone, sheet metal,

- tiles, sod
- materials for insulating walls, floors and ceilings

40.2 **Alternatives to Timber-frame & Brick Veneer in Temperate Climates**

- pole houses on steep slopes
- slab floors vs suspended floor on stumps
- rammed or poured earth for floors and walls
- mudbricks, stone, bricks, concrete blocks, pre-formed slabs
- log cabins
- straw bales
- earth-covered homes

41. **DESIGN OF FUNCTIONAL BUILDINGS**

41.1 **Designing for Energy Efficiency in Temperate Climates**

- five components: orientation, glazing, thermal mass, insulation, ventilation
- orientation to sun; winter & summer sun angles
- thermal mass in internal walls & floor
- venting systems
- attached glasshouses/greenhouses
- clerestory windows for deep light penetration
- planting around buildings: shade, insulation, cool air mass, etc
- fencing, trellising and pergolas to modify winds, summer sun, etc
- reflecting light from pools, etc
- insulating windows: double glazing, boxed pelmets, drapes
- trombe walls for collecting external heat in winter
- the mud-room/airlock as a utility entrance
- super-insulated lightweight construction for shady sites
- benefits of reversing the traditional Australian brick veneer

41.2 **Designing against Termites**

- termite biology & behaviour
- construction detailing: selecting durable timbers, visual access, ventilation, exposed slab construction
- physical barriers: ant caps, granitgard, termimesh
- preventative maintenance

41.3 **Designing against Catastrophe**

- bushfire: minimising ignition points (eaves, verandahs, etc), keeping embers out of roof and sub-floor spaces, use of sprinklers, building underground.
- floods & tsunamis
- earth movements: landslips, tremors, earthquakes
- cyclones/hurricanes

41.4 **Designing with the Health & Well-being of Occupants in Mind**

- alternatives to toxic laminates, paints & treated timbers
- avoiding radiation and electric fields
- minimising dust mites & allergies
- Harmonic proportions for living spaces

42. **APPROPRIATE DOMESTIC TECHNOLOGY**

42.1 **What is Appropriate**

- Holmgren's Future Energy Scenarios: Green Tech vs Creative Descent

42.2 **Uses of Technology**

- Functions: heating, cooling, lighting, ventilation, cooking, washing, motive power &

transportation, sanitation & waste disposal

- Sources of renewable energy: sunlight, wind, water, biomass, geothermal heat
- Considerations: establishment costs, embodied energy, nett energy production, life-span, integration with other elements

42.3 Options for Domestic Services

- space heating: fuel efficient wood stoves, heat exchangers, heat pumps, ceiling fans, passive space heaters (Trombe walls & derivatives, attached greenhouse), active systems (Sun Lizard)
- cooling: evaporative coolers, ceiling fans
- cooking: wood-fuelled stoves, hayboxes, solar cookers
- hot water: water jackets on stoves, solar panels or coils
- lighting: skylights, solar tubes, energy-efficient fluorescents
- washing clothes: economies of scale, front loading vs top loading
- drying clothes: the clothes line, drying racks in kitchen (fleeks)
- ironing clothes: stove irons, gas irons
- refrigeration: gas, 12 volt systems, insulation, siting to disperse heat
- food coolers: coolgardie safe, stack-vented cool cupboards
- solar food dryers
- water conservation: tap aerators, pressure reducing valves, low flow shower heads
- pedal power for washing machines, etc
- energy efficiency rating for conventional appliances

42.4 Composting Toilets

- Clivus Multrum: sloping collection chamber, sewage composts and accumulates under gravity at base of unit, worms assist decomposition
- Rota-Loo & Bio-Loo: rotating chambers, heating to evaporate liquids and venting fan
- Dowmus, Biolytics, A&A: large collecting chamber with wet composting system, suitable for low profile sites, includes grey-water treatment
- home built systems: Minimus and Farallones designs

42.5 Biothermal & Solar Systems for Zone 1 & 2

- Greenhouses, polyhouses with thermal mass for overnight warming
- Compost heat: the traditional hot bed for raising early seedlings
- Metabolic heat from animals: combining poultry shed with greenhouse
- Solar panels and rockbeds for bottom heat for plant propagation

43. POWER GENERATION and TRANSPORT

43.1 Pumping Water with Renewable Energies

- Windpumps (windmills)
- Hydraulic rams
- Glockemann pumps
- Solar cell pumps

43.2 Biogas from Methane Digesters - utilising sewage, animal manures, etc, to produce methane as a fuel

- Low cost biogas systems using manure in a floating or hanging plastic bag, or recycled fuel drums
- Fixed systems with digester and floating storage tank
- Need to maintain optimum temperature and consistency of raw materials to achieve maximum efficiency
- Uses for nutrient-rich effluent: irrigation of crops, aquaculture

43.3 Power Generation

- Remote area power systems (RAPS) based on PV arrays or wind turbines
- Five steps for off-grid power: generate, regulate, store, invert, consume
- Grid interactive systems: feed into grid off peak, draw from grid for peak loads
- Voltage choices: low-voltage DC (12V or 24V), 240V AC or mixture of both
- Photo-voltaic Cells: polycrystalline, monocrystalline & amorphous silicon cells

- Wind turbines
- Micro-hydro systems: Pelton Wheel
- Hybrid systems: solar or wind, with small diesel backup for peak loads
- Steam power
- Solar thermal chimneys: hot air to drive a turbine
- Stirling Engines: using hot air/cold air differentials to drive a piston
- Battery storage and management

43.4 **Transport and Fuels**

- Promoting the use of bicycles and public transport systems
- Renewable fuels: alcohols, bio-diesel, vegetable oils
- Fuel cell technology and Hydrogen as an energy store
- Hybrid electric/internal combustion systems
- LPG and Compressed Natural Gas
- Design & materials, eg composites rather than steel, engine design, eg orbitals

44. **STRATEGIES FOR CHANGE** - Making a difference at the individual level.

44.1 **Principle # 12 - Use and Respond to Change Creatively.**

- Change as an opportunity to develop new ways of doing things
- Accept personal responsibility, recognising that **we** are both the problem and the solution
- Working from the grass-roots up, not the top down
- Coping with bureaucracy: use precedents to get a favourable decision, establishing monitored trial systems
- Invoke the ecological principle of succession in gardens, economies and society
- Pulsing in Systems

44.2 **Holmgren's Future Scenarios**

- The four energy futures : techno-explosion, techno-stability, energy descent, collapse
- The four future scenarios based on rates of climate change and oil decline : brown tech, green tech, earth steward, lifeboat
- the nested pattern of responses at various levels of society

44.3 **Transition Towns - community action groups**

- Origins in Permaculture
- [Energy Descent Action Plans](#)

44.4 **Strategies for Retrofitting the Suburbs**

- [increase population density in existing housing stock - boarders, shared house-holds, etc](#)
- [increase home food production](#)
- [rainwater harvesting and recycling](#)
- Supporting the local economy, avoiding the repatriation of profits overseas
- Energy audits of home & workplace

44.5 **Green & Practical in the Kitchen**

- Sustainable lifestyles start in the kitchen: food selection, storage, cooking
- Growing your own fresh, clean & healthy food
- Supporting the organic/biodynamic agricultural industry
- Slow Foods, traditional food culture, developing new food cultures
- Food preservation techniques: extending the harvest

44.6 **Grass Roots Activism**

- Environmental action & support groups: Aust. Conservation Foundation, Friends of the Earth, Greenpeace, etc.

45. BUSINESS STRATEGIES

45.1 Developing Your Expertise & Connections to Create Work as a Designer

- walk the talk - be a good example
- voluntary projects to start, friends place, work place to develop skills
- demonstration projects
- talks to garden clubs, etc
- establish community gardens
- advertising in local papers, newsletters, etc
- register with Pc groups
- link with other consultants, design groups, real estate agents

45.2 Income From Surplus Production

- Farmgate sales & roadside stalls
- Wholesaling to local retailers: crafts, garden produce, etc
- Weekend markets, stalls at Field Days, etc
- Community Supported Agriculture (CSA's) - box schemes, subscription farming

45.3 Legal Options & Structures for Businesses

- Sole Trader/Proprietor
- Partnerships
- Cooperatives
- Companies
- Discretionary trusts - profits distributed to beneficiaries
- Non-profit/educational/charitable trusts

45.4 Small Business Strategies

- Start small and in an area of interest
- establish a set of values
- strive for quality and service
- use simple organisational structures
- build mutual respect & encouragement between owners and staff
- use presales and pledges to get started
- Co-operative catalogues
- Loans from community-based financial organisations

46. BEYOND THE DESIGN COURSE

46.1 The Permaculture Network

- The "College of Graduates"
- Permaculture Institutes
- Permaculture Academies
- Permaculture publications
- Local and Regional Permaculture groups
- Permaculture International Ltd (Permaculture Australia) – National membership based organisation
- Gatherings, Conferences & Convergences

46.2 Sharing your Knowledge & Skills

- Teaching, when you can teach from experience
- Email Listserves, Pc Forums
- Writing, publishing, filming, public speaking
- Demonstration Gardens, Open Gardens & Field Days
- Working with disadvantaged communities
- Overseas Aid projects
- Global Eco-village Network (GEN)
- social media, You Tube, etc

46.3 Further Training & Education

- Workshops & Field Days
- Advanced courses for PDC graduates
- Diploma of Permaculture Design (The Permaculture Institute): awarded after minimum two years experience in one or several of ten subject areas (design, teaching, etc)
- Accredited courses in Permaculture - Accredited Permaculture Training (APT™): Certificates I to IV and Diploma (V)
- Charles Sturt University, Orange, courses in Ecological Agriculture
- University of Western Sydney, Hawkesbury, courses in Social Ecology
- Gaia University, in USA: on-line courses, permaculture & related subjects

Appendix I – Traditional Design Strategies now incorporated in Holmgren's Principles.

The following set of design strategies, incorporates the principles taught on most PDC's prior to the publication of Holmgren's principles, based on the guidelines developed by Quinney (1984) and incorporated in Mollison and Slay (1991, chapter 1). This set was developed by Permaculture Melbourne's Education Group 1994-95.

(1) **WORK WITH NATURE RATHER THAN AGAINST IT.** Information from the observation of natural processes is applied to restore health and maximise yields within a land area's capabilities. Biological resources and natural energies are used to do work, and promote the evolution of more productive varieties, combinations of species and productive ecologies.

(2) **DEVELOP & PROMOTE USEFUL CONNECTIONS.** The relative location of elements within a system determines their yields. Efficient function is achieved by the placement of elements (components) to interact and form useful connections. Under-utilised products produce pollution.

(3) **CHOOSE ELEMENTS TO PERFORM MANY FUNCTIONS.** Multi-functional elements are more useful than single-function ones, enhancing useful connections.

(4) **USE MORE THAN ONE ELEMENT TO SUPPORT EACH IMPORTANT FUNCTION.** Important basic functions (such as water supply, fire protection and household fuel) are provided for in more than one way.

(5) **PLAN FOR EFFICIENT ENERGY USE.** Energy efficiency is achieved through zoning (to conserve human energy), sector planning (to manage wild energies), slope planning (to utilise gravity) and by making the least change for the greatest possible effect.

(6) **STORE NATURAL ENERGIES.** Nutrients and energies are harvested, stored and used as close to their source as possible and are used repeatedly, where appropriate, to avoid wastage, pollution or degradation before flowing off-site or becoming unusable (source to sink). Sustainable systems accumulate more energy for later use than they require for their establishment or maintenance.

(7) **USE SMALL SCALE INTENSIVE SYSTEMS.** Good design makes maximum use of minimal space; uses productive human labour, hand tools and animals, rather than large machines and fossil fuels; and is multi-dimensional, utilising vertical space (two-storey housing, plant stacking & trellising) and overlapping successional crops (time stacking). Start small and expand areas of activity as low maintenance is achieved.

(8) **PROVIDE FOR DIVERSITY IN SPACE AND TIME.** Appropriate species diversity increases productivity and stability, using polycultures, not monocultures; appropriate species stacking; patterning; orderliness rather than tidiness; and guilds of elements that work harmoniously together. Both the built and planted environments have flexibility of use and change over time, including successional replacement of elements and species.

(9) **USE EDGE EFFECTS.** Extending and exaggerating the boundaries between adjoining systems provides additional contributions from the resources of both systems, increasing productivity.

(10) **TURN PROBLEMS INTO SOLUTIONS.** Good design turns disadvantages into advantages moderating all exaggerations. Everything can work both ways, the problem can be the solution. Unusual and abundant features, which may indicate system imbalance, are turned into resources, providing opportunities for restoration and extra yields.

(11) **USE INFORMATION AND IMAGINATION TO INCREASE YIELDS.** Permaculture uses information and creative design to minimise inputs and maximise resource connections, flows and outputs, to increase efficiency, system health and productivity. Wasteful inputs of energy, labour and capital are not sustainable.

(12) **THINK GLOBALLY, ACT LOCALLY.** Permaculture maintains international links and a global perspective, but needs are satisfied from local resources wherever possible, before looking further afield; earth-friendly lifestyles start in the home and make maximum use of bio-regional resources.

Appendix II - ZONE DESCRIPTIONS FOR SOUTH EASTERN AUSTRALIA

Zone Planning: is about where to place elements in a system to conserve time and energy. Conceptual Zones are based on **relative distance**, with elements placed according to:

- Intensity of use - the frequency of your need to visit and the element's need for you to visit, most useful within zones using the oftenest-nearest rule)
- the function of the element in the system, and
- the space required for the element to function - most useful between zones.

ZONE 0 - The Home - Living space, may be a centre of activity such as an office

ZONE 1 – Household Support and Utilities Elements that support the household

- barbecue/outdoor cooking area (transition from zone 0)
- vegetable beds, culinary & medicinal herbs, berries for home consumption
- the lemon or lime tree, espaliered, dwarf or multi-grafted fruit trees, multi-layered forest gardens
- compost heap and/or worm farms
- propagation aids: cold frames, greenhouse and/or bush house (may be attached to house)
- garage/toolshed/workshop, clothes line
- fuel storage: woodshed, gas or liquid fuel tank
- water tanks, ponds and/or pools
- small caged animals: bantams, pigeons, quail, rabbits, guinea pigs
- chook run with fruit trees (outer zone 1)

ZONE 2 - Intensive Production Areas - Elements that provide surplus for sale or barter using hand tools, small animals & light machinery.

- Food Forests: multi-layered fruit & nut trees, vines, berries, herbs
- Mixed Orchards, with free-range poultry, other animals for weed and pest control
- Small Market Gardens: row crops: vegetables, herbs, etc
- Small scale vineyards
- Shedd and penned animals: goats, poultry, ducks, geese, house cow, pigs (sheds adjoining zone 1 for convenient monitoring), (bee hives), managed access to orchard and gardens.
- Hayshed and/or barn (adjoining Zone 3 to service paddock livestock)
- Small scale aquatic polycultures

ZONE 3 - Extensive Production Areas - Commercial farming - draught animals/heavy machinery.

- large scale fruit or nut orchards, vineyards, broadacre crops
- pasture and forage plots for grazing and browsing livestock
- large scale fish ponds and stocked dams
- agroforestry: combining tree crops with livestock
- multi-purpose shelter belts for timber, fodder, bee forage
- planted woodlots and timber plantations (outer zone 3, sometimes shown as a zone 4 activity)

ZONE 4 - Managed Habitat - Local species, existing or re-established, managed to produce sustainable yields, wildlife corridors, buffer between cultivated areas and zone 5 wilderness.

- structural timber & poles
- firewood, brushwood, stakes & mulching materials
- harvested wildlife (where permitted), rabbits, etc, bush foods
- shelter belts for wildlife habitat (adjoining zone 3 pastures & cropping areas)
- ranged stock at low density (ie at levels that do not degrade habitat)

ZONE 5 - Natural Habitat - managed only to restore or maintain original biodiversity

- conservation of fauna & flora
- inspiration & recreation
- study & observation of natural processes
- catchment protection