Landscape Engineering

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Table of Contents

Introduction

Landscape engineering or **landscaping** is the application of mathematics and science to shape land and waterscapes. It can also be described as green engineering, but the design professionals best known for landscape engineering are landscape architects. Landscape engineering is the interdisciplinary application of engineering and other applied sciences to the design and creation of anthropogenic landscapes. It differs from, but embraces traditional reclamation. It includes scientific disciplines: Agronomy, Botany, Ecology, Forestry, Geology, Geochemistry, Hydrogeology, and Wildlife Biology. It also draws upon applied sciences: Agricultural & Horticultural Sciences, Engineering Geomorphology, landscape architecture, and Mining, Geotechnical, and Civil, Agricultural & Irrigation Engineering.

Landscape engineering builds on the engineering strengths of declaring goals, determining initial conditions, iteratively designing, predicting performance based on knowledge of the design, monitoring performance, and adjusting designs to meet the declared goals. It builds on the strengths and history of reclamation practice. Its distinguishing feature is the marriage of landforms, substrates, and vegetation throughout all phases of design and construction, which previously have been kept as separate disciplines.

Though landscape engineering embodies all elements of traditional engineering (planning, investigation, design, construction, operation, assessment, research, management, and training), it is focused on three main areas. The first is closure planning – which includes goal setting and design of the landscape as a whole. The second division is landscape design more focused on the design of individual landforms to reliably meet the goals as set out in the closure planning process. Landscape performance assessment is critical to both of these, and is also important for estimating liability and levels of financial assurance. The iterative process of planning, design, and performance assessment by a multidisciplinary team is the basis of landscape engineering.

Chapter 1

Landscape Design & Landscape Planning

Landscape Design

Landscape design is an independent profession and a design and art tradition, practised by Landscape designers, combining nature and culture. In contemporary practice Landscape design bridges between landscape architecture and garden design.

Design scope

Landscape design focuses on both the integrated master landscape planning of a property and the specific garden design of landscape elements and plants within it. The practical, aesthetic, horticultural, and environmental sustainability components merit Landscape design inclusion. Landscape designers often collaborate with related disciplines such as architecture and geography, soils and civil engineering, surveying, landscape contracting, botany, and artisan specialties. Design project focus can tend towards: in landscape design - artistic composition and artisanship, horticultural finesse and expertise, and a detailed site involvement emphasis from concepts through construction; whereas in landscape architecture - focus of urban planning, city and regional parks, civic and corporate landscapes, large scale interdisciplinary projects, and delegation to contractors after completing designs. There can be significant overlap of talents and skills, depending on the education, licensing, and experience of the professional.

Design approach

Factors in designing include objective qualities; such as the climate and microclimates; topography and orientation, site drainage and groundwater recharge; municipal and resource building codes, soils and irrigation, human and vehicular access and circulation, recreational amenities (ie: sports and water), furnishings and lighting, native plant habitat botany when present, property safety and security, construction detailing, and other measurable considerations. Factors in designing also include subjective qualities such as: genius loci (the special site qualities to emphasize); client's needs and preferences;

desirable plants and elements to retain on site, modify, or replace, and available to use as borrowed scenery from beyond; artistic composition from perspectives of both looking upon and being in the *gardens; spatial development and definition; plant palettes in designed layouts, and artistic focal points for enjoyment. There are innumerable other design factors and considerations brought to the complex process of designing a garden that is beautiful, well functioning, and thrives over time.

Training

Historically, landscape designers trained by apprenticing, such as André Le Nôtre to his father before designing the Gardens of Versailles, to accomplished masters in the field, with the titular name varying and reputation paramount for a career. the professional section of garden designers in Europe and the Americas went by the name 'Landscape Gardener.' In the 1890s the distinct classification of landscape architect was created, with educational and licensing test requirements for using the title legally. Beatrix Farrand, the sole woman in the founding group, refused the title preferring Landscape Gardener. Matching the client and technical needs of a project, and the appropriate practitioner with talent, legal qualifications, and experienced skills, surmounts title nomenclature.

Institutional education in landscape design appeared in the early 20th century. Over time it became available at various levels. Ornamental horticulture programs with design components are offered at community college and universities within schools of agriculture or horticulture, with some beginning to offer garden or landscape design certificates and degrees. Departments of landscape architecture are located within university schools of architecture or environmental design, with undergraduate and graduate degrees offered. Specialties and 'minors' are available, such as in horticultural botany, horticulture, natural resources, landscape engineering, construction management, fine and applied arts, and landscape design history. Traditionally, hand drawn drawings documented the design and position of features for construction, while Landscape design software is frequently used now.

Other routes of training are through informal apprenticeships with practicing landscape designers, landscape architects, landscape contractors, gardeners, nurseries and garden centers, and docent programs at botanical and public gardens. Since the landscape designer title does not have college degree or licensing requirements to be used, there is a very wide range of sophistication, aesthetic talent, technical expertise, and specialty strengths to be responsibly matched with specific client and project requirements.

Gardening

Many landscape designers have an interest and involvement with gardening, personally or professionally. Some integrate this scope with their design practice, informally or as licensed landscape contractors. Gardens are dynamic and not static after construction and planting are completed, and so in some ways 'never done.' Involvement with landscape management and direction of ongoing garden direction, evolution, and care occurring depend on the professional's and client's needs and inclinations. As with the other

interrelated landscape disciplines, their can be overlap of services offered under the titles of landscape designer or professional gardener.

Landscape Planning

Landscape planning is a branch of landscape architecture. Urban park systems and greenways of the type planned by Frederick Law Olmsted are key examples of urban landscape planning. Landscape designers tend to work for clients who wish to commission construction work. Landscape planners can look beyond the 'closely drawn technical limits' and 'narrowly drawn territorial boundaries' which constrain design projects.

Landscape planners tend to work on projects which:

- are of broad geographical scope
- concern many land uses or many clients
- are implemented over a long period of time

In rural areas, the damage caused by unplanned mineral extraction was one of the early reasons for a public demand for landscape planning.

Mineral working in the Sierra Nevada, outside Granada, Spain. This is part of a *Landscape*, and it can be *planned*

In Asia

In India, the history of landscape planning can be traced to the Vedas and to the Vaastu Shastras. These ancient texts set forth principles for planning settlements, temples and other structures in relation to the natural landscape. Relationships with mountains (the home of the gods) and with rivers (regarded as goddesses) were of particular importance. A square form represented the earth and a circular form represented heaven. A mandala explained the relationship between heaven and earth. Square plans, for both secular and

religious structures, were set out with their sides facing north, south, east and west. The earliest surviving stone temple set out in this way is Sanchi.

In China, landscape planning originated with Feng Shui, which is translated into English as 'wind and water' and is used to describe a set of general principles for the planning of development in relation to the natural landscape. The aim was to find the most auspicious environment possible, one sited in harmony with natural phenomena and the physical and psychological needs of man' (*Chinese Architecture* by Nancy Steinhardt et al. Yale University Press and New World Press 2002, p. 255)

In Europe

In Europe, the history of landscape planning can be traced to the work of Vitruvius. In discussing the planning of towns, he wrote about site planning with regard to microclimate, about the planning of streets and about the role of metaphor in design. Vitruvius' theories were revived during the renaissance and came to influence the planning of towns throughout Europe and the Americas. Alberti wrote on the need for town squares for markets. In North Europe this developed into the idea that residential squares should planned around green spaces. The first space of this type was the Place des Vosges. Residential squares were also made in Britain and their planning developed into the idea of incorporating public open space (public parks within towns. Frederick Law Olmsted gave momentum to this idea with his proposal for a park systems in Boston - the famous Emerald Necklace. Patrick Abercrombie took up this idea and incorporated it in his great 1943-4 Open Space Plan for the County of London.

In the US

Landscape architects in the United States of America are active in landscape planning. But, unlike Canada and Europe, the US does not have a national land use planning system. Frederick Law Olmsted and Ian McHarg are the most famous American landscape planners. McHarg's work on overlay landscape planning contributed to the development of GIS and to the foundation of ESRI by Jack Dangermond.

Legislation

The principles of landscape planning are now incorporated in various types of legislation and policy documents. In America, the National Environmental Policy Act was influenced by the work of Ian McHarg on Environmental impact assessment. In Germany, the Federal Nature Conservation Act requires the preparation of landscape plans. For the Europe Union as a whole, the European Landscape Convention has wide-ranging implications for the design and planning of relationships between development and the landscape. In Asia, major development projects are taking place and illustrating the need for good landscape planning. The Three Gorges Dam, for example, will have extensive impacts on the landscape. They have been planned to a degree but future monitoring of the project is likely to show that better landscape planning and design would have been possible.

Chapter 2

Sustainable Landscaping

Sustainable landscaping encompasses a variety of practices that have developed in response to environmental issues. These practices are used in every phase of landscaping, including design, construction, implementation and management of residential and commercial landscapes.

Issues of sustainability

Sustainability issues for landscaping include:

- Carbon Sequestration
- Global Climate Change
- Air Pollution
- Water Pollution
- Pesticide Toxicity
- Non-Renewable Resources
- Energy Usage

Non-sustainable practices include:

- Soil contamination
- air and water contamination
- persistence of toxic compounds in the environment
- non-sustainable consumption of natural resources
- Greenhouse gas emissions

Effects of non-sustainable practices

Some of the effects of non-sustainable practices are: Threats to health, well-being and even survival of humans and other life forms and their habitats; sedimentation of surface

waters caused by stormwater runoff; chemical pollutants in drinking water caused by pesticide runoff; health problems caused by toxic fertilizers, toxic pesticides, improper use, handling, storage and disposal of pesticides; air and noise pollution caused by landscape equipment; and over-use of limited natural resources.

Sustainable landscaping solutions

Some of the solutions being developed are:

- Reduction of stormwater run-off through the use of bio-swales, rain gardens and green roofs and walls.
- Reduction of water use in landscapes through design of water-wise garden techniques (sometimes known as xeriscaping^{TM})
- Bio-filtering of wastes through constructed wetlands
- Landscape irrigation using water from showers and sinks, known as gray water
- Integrated Pest Management techniques for pest control
- Creating and enhancing wildlife habitat in urban environments
- Energy-efficient landscape design in the form of proper placement and selection of shade trees and creation of wind breaks
- Permeable paving materials to reduce stormwater run-off and allow rain water to infiltrate into the ground and replenish groundwater rather than run into surface water
- Use of sustainably harvested wood, composite wood products for decking and other landscape projects, as well as use of plastic lumber
- Recycling of products, such as glass, rubber from tires and other materials to create landscape products such as paving stones, mulch and other materials
- Soil management techniques, including composting kitchen and yard wastes, to maintain and enhance healthy soil that supports a diversity of soil life
- Integration and adoption of renewable energy, including solar-powered landscape lighting

Background

A sustainable landscape is designed to be both attractive and in balance with the local climate and environment and it should require minimal resource inputs. Thus, the design must be “functional, cost-efficient, visually pleasing, environmentally friendly and maintainable" As part of the concept called sustainable development it pays close attention to the preservation of limited and costly resources, reducing waste and preventing air, water and soil pollution. Also, compost, fertilization, grass cycling, pest control measures that avoid or minimize the use of chemicals, integrated pest management, using the right plant in the right place, appropriate use of turf, irrigation efficiency and xeriscaping or water-wise gardening are all components of sustainable landscaping.

Benefits

The geographic location can determine what is sustainable due to differences in precipitation and temperature. For example, the California Waste Management Board emphasizes the link between minimizing environmental damage and maximizing one's bottom line of urban commercial landscaping companies. In California, the benefits of landscapes often do not outweigh the cost of inputs like water and labor. However, using appropriately selected and properly sited plants may help to ensure that maintenance costs are lower than they otherwise would be due to reduced chemical and water inputs.

Programs

There are several programs in place that are open to participation by various groups. For example, the Audubon Cooperative Sanctuary Program for Golf Courses, the Audubon Green Neighborhoods™ Program and the National Wildlife Federation's Backyard Habitat™ Program, to name a few.

The Sustainable Sites Initiative, the cooperative effort between the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center and the United States Botanic Garden, began in 2005 and will provide a points-based certification for landscapes, similar to the LEED program for buildings operated by the Green Building Council. The Sustainable Sites Initiative now has a document titled Guidelines and Performance Benchmarks. The credit system is expected to be completed in 2011.

Proper design

The primary step to landscape design is to do a "sustainability audit". This is similar to a landscape site analysis that is typically performed by landscape designers at the beginning of the design process. Factors such as lot size, house size, local covenants and budgets should be considered. The steps to design include a base plan, site inventory and analysis, construction documents, implementation and maintenance. Other considerations include orientation to the sun, soil type, slopes, location of utility lines and planned usage.

Composting

Composting is a way to recycle kitchen and garden waste while creating inexpensive organic fertilizer for the garden and landscape. Earthworms, microbes and other soil flora and fauna feast on such organic matter when provided adequate nitrogen and proper temperatures and moisture. The ideal size for a compost pile or bin is one cubic yard (3' x 3' x 3'). It should be placed in a partly shady location to avoid intense sun and drying out, as this will delay the decomposition process. The pile heats up during the decomposition process, then cools as material is transformed, this is a good time to turn the pile, so that undecomposed materials on the periphery of the pile can be moved to the center to complete the process. With adequate moisture, nitrogen, proper temperature and correct timing of turning the pile, compost can be made in about a 30-day period. Left alone this

pocess will still occur, but may take three to four months under less-than-ideal conditions.

Compost can be added as an amendment to poorly draining soil, as a fertilizer on flower and vegetable beds, to fruit trees or used as a potting soil for potted plants. Trimmings from lawns, trees and shrubs from a large landscape site can be used as feedstock for on-site composting. Reusing on-site organic materials will decrease the need for purchasing other soil additives.

Irrigation

Using mulch is a great way to reduce water loss due to evaporation, reduce weeds, minimize erosion, dust and mud problems. Mulch will also add nutrients to the soil when it decomposes. Grass cycling turf areas (using mulching mowers that leave grass clippings on the lawn) will also decrease the amount of fertilizer needed, reduce landfill waste and reduce costs of disposal.

A common recommendation is to adding 2-4 inches of mulch in flower beds and under trees away from the trunk. Mulch should be applied under trees to the dripline (extension of the branches) in lieu of flowers, hostas, turf or other plants that are often planted there. This practice of planting under trees is detrimental to tree roots, especially when such plants are irrigated to an excessive level that harms the tree.

The practice of xeriscaping or water-wise gardening suggests that placing plants with similar water demands together will save time and low-water or drought tolerant plants would be a smart initial consideration.

A homeowner may consider consulting an accredited irrigation technician/auditor and obtain a water audit of current systems. In the event that the situation is difficult to manage, drip or sub-surface irrigation may be most effective. If the system has been in use for over five years, upgrading to evapotranspiration (ET) controllers, soil sensors and refined control panels will improve the system. Oftentimes irrigation heads are in need of readjustment to avoid sprinkling on sidewalks or streets. Business owners may consider developing watering schedules based on historical or actual weather data and soil probes to monitor soil moisture prior to watering.

Building materials

When deciding what kind of building materials to put on a site it is important to recycle as often as possible. Reusing old bricks from sidewalks as patio pavers is one way to provide an aesthetic appeal to an area while reducing what goes to the landfill.

But it is also important to be careful about what materials you use, especially if you plan to grow food crops of any kind. Old telephone poles and railroad ties have usually been treated with a substance called creosote that can leach into the soils and make any food grown there toxic enough to cause harm to anyone that eats it. In general, you should

avoid any kind of treated material, especially wood, that could leach into the soil with rain.

The Forest Stewardship Council was formed in 1993 "to change the dialogue about and the practice of sustainable forestry worldwide." Sustainably harvested lumber - also called certified wood is now available, in which ecological, economic and social factors are integrated into the management of trees used for lumber. A chain of custody document is used in the certification process.

Planting selection

One important part of sustainable landscaping is plant selection. Most of what makes a landscape unsustainable is the amount of inputs required to grow a non-native plant on it. What this means is that a local plant, which has adapted to local climate conditions will require less work on the part of some other agent to flourish. For example, it does not make sense to grow tomatoes in Arizona because there is not enough natural rainfall for them to survive without constant watering. Instead, drought tolerant plants like succulents and cacti are better suited to survive. Also, by choosing native plants, one can avoid certain problems with insects and pests because these plants will also be adapted to deal with any local invader. The bottom line is that by choosing the right kind of local plants, a great deal of money can be saved on amendment costs, pest control and watering.

Plants used as windbreaks can save up to 30% on heating costs in winter. They also help with shading a residence or commercial building in summer, create cool air through evapo-transpiration and can cool hardscaped areas such as driveways and sidewalks.

A house surrounded by local trees or bushes enjoys multiple benefits. Plants release water vapor in the air through transpiration and water has the ability to reduce temperature extremes in the areas near it (as it boasts very high heat capacity). The larger and more leafy the plant, the most water vapor it produces. Additionally, the presence of trees is crucial in the creation of stable, healthy and productive ecosystems (such as forests). In fact this is an important principle of permaculture.

If the surrounding trees are chosen to produce edible fruit they can provide a sustainable food source for the occupants of the house. Even if some are fairly demanding (especially in the summer), irrigation is an excellent end-use option in greywater recycling and rainwater harvesting systems, and a composting toilet can cover (at least) some of the nutrient requirements. Research suggests that diluted human urine might be as effective as chemical fertilizers. It must be noted that not all fruit trees are suitable for greywater irrigation, as reclaimed greywater is typically of high pH and acidophile plants don't do well in alkaline environments.

An intelligent choice for direct energy conservation would be the placement of broadleaf deciduous trees near the east, west and optionally north-facing walls of the house. Such selection provides shading in the summer while permitting large amounts of heat-carrying solar radiation to strike the house in the winter. The trees are to be placed as

closely as possible to the house walls but no closer than 1 meter - otherwise the roots can cause substantial foundation damage. A sustainable house will most likely be equipped with south-facing (north-facing in the S. hemisphere) photovoltaic panels and a large, south-facing glazing as a result of passive solar heating design. As the efficiency of both systems is very sensitive to shading, experts suggest the complete absence of trees near the south side.

Another intelligent choice would be that of a dense vegetative fence composed of evergreens (e.g. conifers) near that side from which cold continental winds blow (usually north in the N. hemisphere) and also that side from which the prevailing winds blow (west in temperate regions of both hemispheres). Since north winds are most cold and westerlies blow most often, such choice creates an effective winter windbarrier that prevents very low temperatures outside the house and reduces air infiltration towards the inside. Calculations show that placing the windbrake at a distance twice the height of the trees can reduce the wind velocity by 75%. It then follows that, with some planning, both arrangements (deciduous and evergreen) can be applied simultaneously.

It must be noted that the above vegetative arrangements come with two disadvantages. Firstly, they minimize air circulation in summer (although in many climates heating is more important and costly than cooling) and, secondly, they may affect the efficiency of photovoltaic panels, thus prompting the need for a shading analysis. However, it has been estimated that if both arrangements are applied properly, they can reduce the overall house energy usage by up to 22%.

Maintenance

Pest Problems Maintaining plant health will eliminate most pest problems. It is best to start with pest-free plant materials and supplies and close inspection of the plant upon purchase is also recommended. Establishing diversity within the area of plant species will encourage beneficial organism populations (e.g. birds, insects), which feed on potential plant pests. Because plant pests vary from plant to plant, assessing the problem correctly is half the battle. The owner must consider whether the plant can tolerate the damage caused by the plant. If not, then does the plant value justify some sort of treatment? While pesticide is often chosen to solve the problem, physical barriers and repellents may help. If pesticides are the chosen method, selective organic or natural pesticide is often better because it has less impact on non-target species.

Pruning Proper pruning will increase air circulation and decrease the likelihood of plant diseases. However, improper pruning is detrimental to shrubs and trees. Hedging, topping and shearing of landscape plants causes excessive plant growth. In addition, topping is a hazardous practice which creates a hazardous tree which is highly susceptible to wind damage. Natural pruning techniques during the proper season, on the other hand, promotes healthier, more stable plants. In temperate areas, deciduous plants should be pruned during dormancy. Plants should never be pruned at the end of a growing season because growth is stimulated and such new growth will be too tender to survive winter freezing temperatures.

Pollution Prevention Landscape managers should make use of the Integrated Pest Management (IPM) to reduce use of pesticides and herbicides and reduce non-point source solution.

Chapter 3

Natural Landscaping

Natural landscaping using Pine, Redbud, Maple and American Sweetgum with leaf litter.

Natural landscaping, also called **native gardening**, is the use of native plants, including trees, shrubs, groundcover, and grasses which are indigenous to the geographic area of the garden.

Natural landscaping with pine leaf litter mulch

Benefits

Maintenance

Natural landscaping is adapted to the climate, geography and hydrology and should require no pesticides, fertilizers and watering to maintain, given that native plants have adapted and evolved to local conditions over thousands of years. However, these applications may be necessary for some preventative care of trees and other vegetation in areas of degraded or weedy landscapes.

Native plants suit today's interest in "low-maintenance" gardening and landscaping, with many species vigorous and hardy and able to survive winter cold and summer heat. Once established, they can flourish without irrigation or fertilization, and are resistant to most pests and diseases.

Many municipalities have quickly recognized the benefits of natural landscaping due to municipal budget constraints and reductions and the general public is now benefiting

from the implementation of natural landscaping techniques to save water and create more personal time.

Ecology and Habitat

Banksia spinulosa, a Sydney, Australia local plant which attracts wildlife

Native plants provide suitable habitat for native species of butterflies, birds, and other wildlife. They provide more variety in gardens by offering myriad alternatives to the over-planted introduced species, cultivars, and invasive species. The indigenous plants have co-evolved with animals, fungi and microbes, to form a complex network of relationships. They are the foundation of their native habitats and ecosystems, or natural communities.

Such gardens often benefit from the plants being evolved and habituated to the local climate, pests and herbivores, and soil conditions, and so may require fewer to no soil amendments, irrigation, pesticides, and herbicides for a beautiful, lower maintenance, and more sustainable landscape.

Habitat Challenges

However, while local provenance plants have adapted to local conditions (which includes climate, soil, and other native plants and animals), there will often be instances, especially in cities, where one or more of these will have been radically altered.

Examples include:

- Building rubble used as landfill may raise soil pH (i.e. create alkaline soil), which can be problematic in regions of acidic soils (with local plants adapted to acid soils).
- Buildings cast a substantial shade, this may give rise to conditions substantially shadier than needed by local plants.
- Soil which is high in organic material and nutrients is often introduced into gardens, or many gardeners will have used fertilizers. Plants from some areas may not thrive under these conditions. For example, many Australian plants are particularly sensitive to phosphorus.
- Many native plants are adapted to, and benefit from, periodic wildfires that occurred before and during pre-modern settlement. These fires can be simulated in the garden by either "high mowing" or a controlled burn every few years.

Many weeds in an area are usually the result of imported plants. These plants become invasive because there are no natural controls such as disease, weather, or fauna in their new environment. They take over native habitats, reducing shelter and food for local fauna. Using local provenance plants increases the biodiversity of and is important for the health of a region's overall ecology.

Much of the wild areas have been destroyed to make room for urban development. Housing developments have replaced native habitats with ornamental plants and lawns, pushing the wildland-urban interface further out. While development won't be stopped, gardeners can keep wild areas and green spaces filled with native species on their lots and in their communities.

Despite this, there are usually plenty of indigenous or native plants which will grow and thrive in the area one is trying to establish a native garden.

Types

- fully forested with leaf debris on the forest floor, including coarse woody debris if possible
- desert with arid loving plants and succulents
- grassy meadow with a variety of wildflowers and water features
- lowlands savanna with grasses and native trees

Wildflower gardens

Wildflower is a term used in some countries to describe the numerous showy flowers from some drier climates, most notably southwest Western Australia, Southern Africa and North America.

Rain gardens

Rain gardens that absorb rainwater from gutters and impervious surfaces, work much better when planted with native plants tolerant to the alternate flooding and drying cycles. Some wildflower gardens attempt to recreate a prairie landscape, including native grasses along with the flowering plants, or forbs. Such gardens benefit the local wildlife, often attracting birds, butterflies and small mammals. By carefully choosing the plants in the garden, the gardener can encourage some of these visitors to the garden. One popular type of wildflower garden specializes in attracting butterflies and is called a butterfly garden.

The native plants used in wildflower gardens often have deep root systems. This makes them good plants for absorbing runoff and allowing the water to filter back into the local water table. Wildflower gardens that focus on capturing runoff in this fashion are called rain gardens.

Advantages

- no fertilization required
- no additional water
- more water available for other uses and other people
- zero to near zero work needed for maintenance
- no lawn mowing
- erosion reduced to a minimum
- natural landscaped plants take full advantage of rainfall
- when water restrictions are implemented, natural landscaped plants will survive, while more traditional plants may not
- increased habitat for native flora and fauna
- where heavily forested, provides shade on homes and businesses saving energy
- native plants rarely become invasive

Disadvantages

- not good for outdoor games that require a manicured turf.
- increased wild animal intrusion
- in certain areas, wildfires or brushfires may be of great concern.
- may look less attractive due to reduced available range of plants to choose from.
- may be hard to find native plants which produce adequate quantities of edible matter.

Effect of new construction

In new construction, builders can either avoid clear cutting or clearing an entire property and disturbing other large flora or builders can completely clear an area of all flora to save construction time and replace the clearing with juvenile specimens once the job is complete. The downside to this is additional costs involved with purchasing replacements. The builder may also choose to plant additional native trees and other flora after construction to help the property blend with natural surroundings.

In some planned developments, natural landscaping is the requirement. Builders may not remove trees larger than a specific diameter and owners may not arbitrarily cut trees without a permit.

Land reclamation

Throughout the world, forested areas were turned into cattle grazing or farmland. Often this land is then turned into residential or commercial use property. By returning the land back to its original state prior to human disturbance, vast amounts of energy usage and increasing pollution can be reduced. Natural landscaping costs less to install than traditional landscaping and, after the initial few years, reduces maintenance costs, combats erosion, and accommodates storm and flood waters better.

Native plant societies

In many parts of the world, there are societies, clubs or local groups, such as Bushcare or ASGAP in Australia or the North American Native Plant Society, which are made up of gardeners interested in growing plants local to their area, state or country. They can be the best way to find out about (and to obtain, by buying or swapping) local native plants. Many members have spent years or decades cultivating local plants or bushwalking in local areas.

Chapter 4

Hedge

A typical clipped European Beech hedge in the Eifel, Germany.

A **hedge** or **hedgerow** is a line of closely spaced shrubs and tree species, planted and trained in such a way as to form a barrier or to mark the boundary of an area. Hedges used to separate a road from adjoining fields or one field from another, and of sufficient

age to incorporate larger trees, are known as hedgerows. It is also a simple form of topiary.

History

A typical old Scottish march dyke, but without boundary trees.

The development of hedges over the centuries is preserved in their structure. The first hedges enclosed land for cereal crops during the Neolithic Age (4000–6000 years ago). Prehistoric farms were of about 5 to 10 hectares (12 to 25 acres), with fields about 0.1 hectares (0.25 acre) for hand cultivation. Some hedges date from the Bronze and Iron Ages, 2000–4000 years ago, when traditional patterns of landscape became established.

Others were built during the Medieval field rationalisations; more originated in the industrial boom of the 18th and 19th centuries, when heaths and uplands were enclosed.

Many hedgerows separating fields from lanes in the United Kingdom, Ireland and the Low Countries are estimated to have been in existence for more than seven hundred years, originating in the medieval period. The root word of 'hedge' is much older: it appears in the Old English language, in German (*Hecke*), and Dutch (*haag*) to mean 'enclosure', as in the name of the Dutch city The Hague, or more formally *'s Gravenhage*, meaning *The Count's hedge*. Charles the Bald is recorded as complaining in 864, at a time when most official fortifications were constructed of wooden palisades, that some unauthorized men were constructing *haies et fertés* – tightly interwoven hedges of hawthorns.

In parts of Britain, early hedges were destroyed to make way for the manorial open-field system. Many were replaced after the Enclosure Acts, then removed again during modern agricultural intensification, and now some are being replanted for wildlife. Cornwall is rich in historic hedges, with over three-quarters of the hedges remaining today being anciently established. The Cornish Hedge Research and Education Group (CHREG) is the main body promoting the understanding of Cornish hedges in Cornwall. It is currently a partner in a trans-European project to share the knowledge of traditional skills in hedge and drystone buildings.

Composition

A hedgerow may consist of a single species or several, typically mixed at random. In most newly planted British hedgerows, at least 60 percent of the shrubs are hawthorn, blackthorn, and (in the southwest) hazel, alone or in combination. The first two are particularly effective barriers to livestock. Other shrubs and trees used include holly, beech, oak, ash, and willow; the last three can become very tall.

Hedgerow trees

Oak and beech hedges are common in Great Britain

Hedgerow trees are trees that grow in hedgerows but have been allowed to reach their full height and width. There are thought to be around 1.8 million hedgerow trees in Britain (counting only those whose canopies do not touch others) with perhaps 98% of these being in England and Wales. Hedgerow trees are both an important part of the English landscape and are valuable habitats for wildlife. Many hedgerow trees are veteran trees and therefore of great wildlife interest.

The most common species are oak and ash, though in the past elm would also have been common. Around 20 million elm trees, most of them hedgerow trees, were felled or died

through Dutch elm disease in the late 1960s. Many other species are used, notably including beech and various nut and fruit trees.

The age structure of British hedgerow trees is old because the number of new trees is not sufficient to replace the number of trees that are lost through age or disease.

New trees can be established by planting but it is generally more successful to leave standard trees behind when laying hedges. Trees should be left at no closer than 10 metres (33 ft) apart and the distances should vary so as to create a more natural landscape. The distance allows the young trees to develop full crowns without competing or producing too much shade.

It is suggested that hedgerow trees cause gaps in hedges but it has been found that cutting some lower branches off lets sufficient light through to the hedge below to allow it to grow.

Hedgelaying

A stretch of newly laid traditional hedging near Middleton, Northamptonshire

If hedges are not maintained or only trimmed repeatedly, gaps tend to form at the base over many years. In essence, hedgelaying consists of cutting most of the way through the stem of each plant near the base, bending it over and interweaving it between wooden

stakes. This also encourages new growth from the base of each plant. Originally, the main purpose of hedgelaying was to ensure the hedge remained stock-proof. Some side branches were also removed and used as firewood.

The maintenance and laying of hedges to form an impenetrable barrier for farm animals is a skilled art. In Britain there are many local hedgelaying traditions, each with a distinct style. Hedges are still being laid today as they are not only beautiful and functional but they also help wildlife and protect against soil erosion.

Hedge trimming

An alternative to hedge laying is trimming using a tractor-mounted flail cutter or circular saw. The height of the cutting can be increased a little every year. Trimming a hedge helps to promote bushy growth. If a flail cutter is used, then the flail must be kept sharp to ensure that the cutting is effective on the hedge. The disadvantage of this is that the hedge species takes a number of years before it will flower again and subsequently bear fruit for wildlife and people. If the hedge is trimmed repeatedly at the same height, a 'hard knuckle' will start to form at that height – similar to the shape of a pollarded tree.

General hedge management

A 'hedgerow management' scale has been devised by an organisation called Hedgelink UK ranging from 1 to 10. '1' describes the action to take for a heavily over trimmed hedge, '5' is a healthy dense hedgerow more than 2 metres in height, and '10' is a hedge that has not been managed at all and has become a line of trees.

The RSPB suggest that hedges in Britain not be cut between March and August. This is to protect nesting birds, which are protected by law.

Coppicing

The technique of coppicing can be used to rejuvenate a hedge where hedge-laying is not appropriate.

Hedgerow dating

Beech planted on a march dyke (boundary hedge) of the 18th century.

Hedges that have existed for hundreds of years are colonised by additional species. This may be useful to determine the age of the hedge. Hooper's hypothesis suggests that the age of the hedge is equal to the number of woody species counted in a thirty yard distance multiplied by 110 years.

Dr. Max Hooper published his original formula in the book *Hedges* in 1974. This method is only a rule of thumb, and can be off by a couple of centuries; it should always be backed up by documentary evidence, if possible, and take into account other factors. Caveats include the fact that planted hedgerows, hedgerows with elm, and hedgerows in

the north of England tend not to follow the rule as closely. The formula also does not work on hedges more than a thousand years old.

According to BBC History, Dr. Hooper first developed this scheme in the 1950s. It is important not least for its potential use in determining what an important hedgerow is, given their protection in The Hedgerows Regulations (1997; No. 1160) of the Department of the Environment, based on age and other factors.

One derivative or corruption of the formula, given by Chris Brown though not necessarily of his concoction, is to multiply the number of species by 99 years and then deduct sixteen.

Hedges in gardening

Hedges, both clipped and unclipped, are often used as ornament in the layout of gardens. Typical woody plants for clipped hedges include privet, hawthorn, beech, yew, leyland cypress, hemlock, arborvitae, barberry, box, holly, oleander, lavender, among others. An early 20th century fashion was for **tapestry hedges**, using a mix of golden, green and glaucous dwarf conifers, or beech and copper beech. Unclipped hedges take up more space, generally at a premium in modern gardens, but compensate by flowering. *Rosa multiflora* is widely used as a dense hedge along the central reservation of dual-carriageway roads, such as parkways in the United States. In mild climates, more exotic flowering hedges are formed, using *Ceanothus*, *Hibiscus*, *Camellia*, orange jessamine (*Murraya paniculata*), or lillypilly (*Syzygium* species). It is also possible to prepare really nice and dense hedge from other deciduous plants, however they do not have decorative flowers as the bushes mentioned before.

A clipped beech hedge in Germany, allowed to grow as high as a house in order to serve as a windbreak

Hedges of clipped trees forming avenues are a feature of 16th century Italian gardens such as the Boboli Gardens in Florence, and of formal French gardens in the manner of André Le Nôtre, e.g. at Versailles. The 'hedge on stilts' of clipped hornbeams at Hidcote Manor Garden, Gloucestershire, is famous and has sometimes been imitated.

Hedges below knee height are generally thought of as borders. Elaborately shaped and interlaced borders forming knot gardens or parterres were fashionable in Europe during the 16th and early 17th centuries. Generally they were appreciated from a raised position, either the windows of a house, or a terrace.

Clipped hedges above eye level may be laid out in the form of a labyrinth or garden maze. Few such mazes survived the change of fashion towards more naturalistic plantings in the 18th and 19th centuries, but many were replanted in 20th century restorations of older gardens. An example is behind the Governor's Palace, Colonial Williamsburg, Virginia.

Hedges and pruning can both be used to enhance a garden's privacy, as a buffer to visual pollution and to hide fences. A hedge can be aesthetically pleasing, as in a tapestry hedge,

where alternate species are planted at regular intervals to present different colours or textures.

Some local jurisdictions may strictly regulate the placement or height of a hedge such as the case where a city resident allowed her xylosma hedge to grow above two feet.

In the UK a hedge may become an offense. High hedges are covered under Part 8 of the Anti-Social Behaviour Act 2003. This applies more to owners of high, evergreen hedges. For a hedge to qualify as anti social it must be made up of a line of two or more evergreen or semi-evergreen trees or shrubs. It must be over 2 metres high. It must be to some degree, a barrier to light or access. Because of its height, it must be adversely affecting the complainant's reasonable enjoyment of their domestic property (either their home or garden).

Live fencing

Live fencing is the use of live woody species for fences. This may either consist of individual fence posts connected with wire or other fencing material, or it may be in the form of densely-planted hedges without interconnecting wire.

Hedge types

Quickset hedge

A quickset hedge is a type of hedge created by planting live hazel or whitethorn (common hawthorn) cuttings directly into the earth. Once planted, these cuttings root and form new plants, creating a dense barrier. The technique is ancient, and the term *quickset hedge* is first recorded in 1484. The word *quick* in the name refers to the fact that the cuttings are living (as in "the quick and the dead"), and not to the speed at which the hedge grows, although it will establish quite rapidly. An alternative meaning of quickset hedging is any hedge formed of living plants or of living plants combined with a fence. The technique of quicksetting can also be used for vines, and many other shrubs and trees.

Devon hedge

A Devon hedge is an earth bank topped with shrubs. The bank may be faced with turf or faced with stone. If stone-faced, the stones are generally placed on edge, though around gateways the stones are often placed flat.

A quarter of Devon's hedges are thought to be over 800 years old. There are approximately 33,000 miles (53,000 km) of Devon hedge, which is more than any other county. Traditional farming throughout the county has meant that fewer Devon hedges have been removed than elsewhere.

Devon hedges are particularly important for wildlife habitat. Around 20% of the UK's species-rich hedges occur within Devon. Over 600 species of flowering plants, 1500 species of insects, 65 species of birds and 20 species of mammals have been recorded living or feeding in Devon hedges.

Hedge laying in Devon is usually referred to as steeping and involves cutting and laying steepers (the stems) along the top of the bank and securing them with crooks (forked sticks).

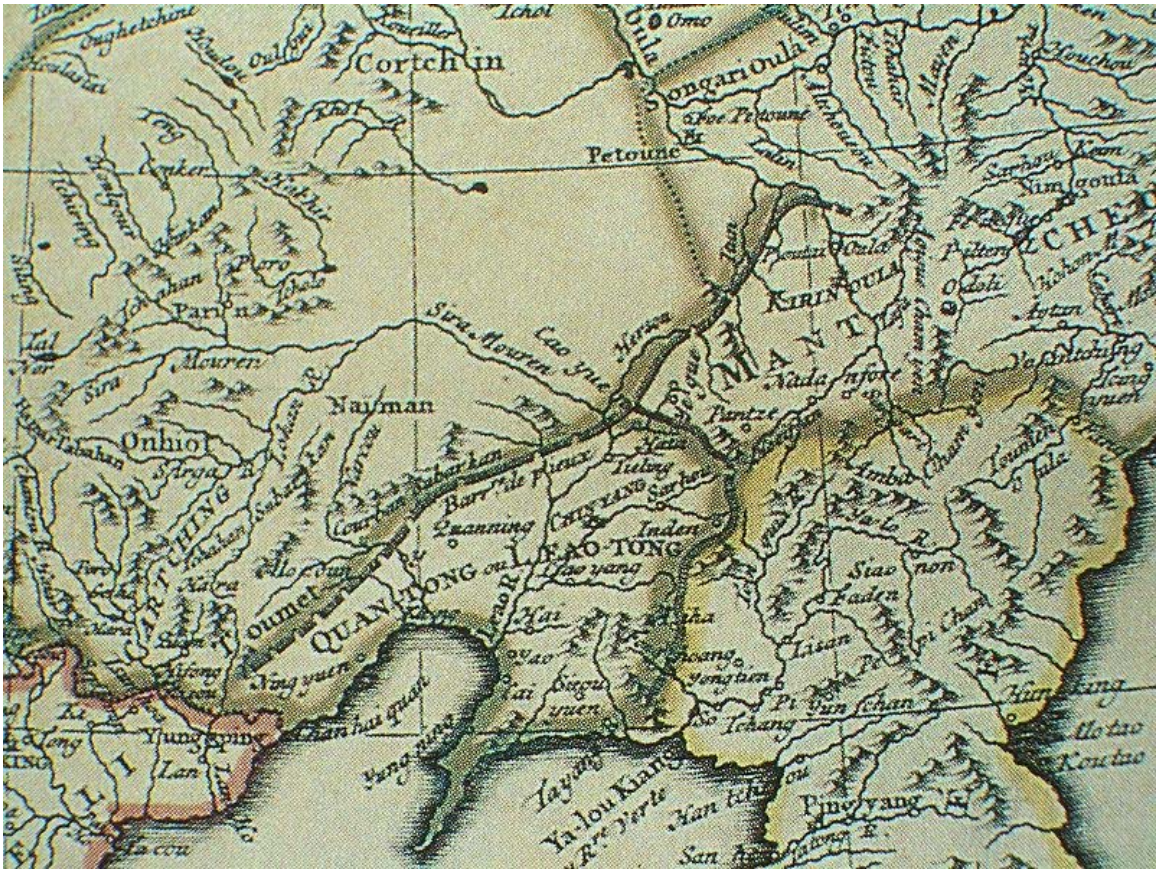
Cornish hedge

A Cornish hedge is an earth bank with stones. It normally consists of large stone blocks constructed either side of a narrow earth bank, and held in place with interlocking stones. The neat rows of square stones at the top are called "edgers". The top of the hedge is planted with grass turf.

Sometimes hedging plants or trees are planted on the hedge to increase its windbreaking height. A rich flora develops over the lifespan of a Cornish hedge. The Cornish hedge contributes to the distinctive field-pattern of the Cornish landscape and its semi-natural wildlife habitat. There are about 30,000 miles (48,000 km) of hedges in Cornwall today

Hedges suffer from the effects of tree roots, burrowing rabbits, rain, wind, farm animals and people. How often repairs are needed depends on how well the hedge was built, its stone, and what has happened to it since it was last repaired. Typically a hedge needs a cycle of repair every 150 years or so, or less often if it is fenced. Building new hedges, and repairing existing hedges, is a skilled craft, and there are professional hedgers in Cornwall. The Cornish Hedge Research and Education Group (CHREG) supports the development of traditional skills and works with Cornwall Council, FWAG (Farming and Wildlife Advisory Group), Stone Academy Bodmin, Cornwall AONB, Country Trust and professional hedgers to ensure the future of Cornish Hedges in the landscape.

World's great hedges



An early-eighteenth century French Jesuit map showing the Willow Palisade (*Barriere de Pieux*) surrounding Liaodong (*Leao-Tong*), with an additional branch going northeast, to separate the Mongols and the Manchus

The nineteenth century Great Hedge of India was probably the largest example of a hedge used as a barrier. It was planted and used to collect taxes by the British.

The Willow Palisade, constructed during the early Qing Dynasty (seventeenth century) to control people movement and to collect taxes on ginseng and timber in southern Manchuria, also had hedge-like features. The palisade included two dikes and a moat between them, the dikes topped by rows of willow trees, tied to one another with their branches. Gradually decaying throughout the late eighteenth and nineteenth centuries, the palisade disappeared in the early twentieth century, its remaining willows cut during the Russo-Japanese War of 1904-05 by the two countries' soldiers.

The Meikleour Beech Hedges, located near Meikleour in Scotland, are noted in the Guinness World Records as the tallest and longest hedge on earth, reaching 30 metres (98 ft) in height and 530 metres (0.33 mi) in length. The beech trees were planted in 1745 by Jean Mercer on the Marquess of Lansdowne's Meikleour estate.

Chapter 5

Reclaimed Water

Reclaimed water is used in Santa Monica, California to irrigate plants in public parks and municipal landscapes.

Reclaimed water or **recycled water**, is former wastewater (sewage) that has been treated to remove solids and certain impurities, and then used in sustainable landscaping irrigation or to recharge groundwater aquifers. This is done for sustainability and water conservation, rather than discharging the treated wastewater to surface waters such as rivers and oceans.

In spite of quite simple methods that incorporate WSUD for easy recovery of stormwater runoff, there remains a common perception that reclaimed water has to involve sophisticated and technically complex treatment systems, that attempt to recover the most complex and degraded types of sewage. As this sort of effort is supposed to be driven by sustainability factors, then this type of implementation should inherently be associated with point source solutions, where it is most economical to achieve the expected outcomes. Harvesting of stormwater or rainwater can be an extremely simple to comparatively complex, as well as energy and chemical intensive, recovery of more contaminated sewage.

The recycling and recharging is often done by using the treated wastewater for designated municipal sustainable gardening irrigation applications. In most locations, it is intended to be only used for nonpotable uses, such as irrigation, dust control, and fire suppression. There is debate about possible health and environmental effects with its uses. However, Los Angeles County's sanitation districts have provided treated wastewater for landscape irrigation in parks and golf courses since 1929. The first reclaimed water facility in California was built at San Francisco's Golden Gate Park in 1932. The Irvine Ranch Water District and Orange County Water District in Southern California are becoming the leaders in reclaimed water through their 'Green Acres Project.' Also in Orange County, and in other locations such as Singapore, water is given more advanced treatments and is used indirectly for drinking.

History

Storm and sanitary sewers were necessarily developed along with the growth of cities. By the 1840s the luxury of indoor plumbing, which mixes human waste with water and flushes it away, eliminated the need for cesspools. Odor was considered the big problem in waste disposal and to address it, sewage could be drained to a lagoon, or "settled" and the solids removed, to be disposed of separately. This process is now called "primary treatment" and the settled solids are called "sludge."

At the end of the 19th century, since primary treatment still left odor problems, it was discovered that bad odors could be prevented by introducing oxygen into the decomposing sewage. This was the beginning of the biological aerobic and anaerobic treatments which are fundamental to waste water processes.

By the 1920s, it became necessary to further control the pollution caused by the large quantities of human and industrial liquid wastes which were being piped into rivers and oceans, and modern treatment plants were being built in the US and other industrialized nations by the 1930s.

Designed to make water safe for fishing and recreation, the Clean Water Act of 1972 mandated elimination of the discharge of untreated waste from municipal and industrial sources, and the US federal government provided billions of dollars in grants for building sewage treatment plants around the country. Modern treatment plants, usually using sand filtration and chlorination in addition to primary and secondary treatment, were required to meet certain standards.

Current treatment improves the quality of separated wastewater solids or sludge. The separated water is given further treatment considered adequate for non potable use by local agencies, and discharged into bodies of water, or reused as reclaimed water. In places like Florida, where it is necessary to avoid nutrient overload of sensitive receiving water, reuse of treated or reclaimed water can be more economically feasible than meeting the higher standards for surface water disposal mandated by the Clean Water Act

Maximum Water Recovery

To determine Maximum Water Recovery there are various techniques that have been developed by researchers; for maximum water reuse/reclamation/recovery strategies such as water pinch analysis. The techniques helps a user to target the minimum freshwater consumption and wastewater target. It also helps in designing the network that achieves the target. This provides a benchmark to be used by users in improving their water systems.

Benefits

The cost of reclaimed water exceeds that of potable water in many regions of the world, where a fresh water supply is plentiful. However, reclaimed water is usually sold to citizens at a cheaper rate to encourage its use. As fresh water supplies become limited from distribution costs, increased population demands, or climate change reducing sources, the cost ratios will evolve also.

Using reclaimed water for non-potable uses saves potable water for drinking, since less potable water will be used for non-potable uses.

It sometimes contains higher levels of nutrients such as nitrogen, phosphorus and oxygen which may somewhat help fertilize garden and agricultural plants when used for irrigation.

The usage of water reclamation decreases the pollution sent to sensitive environments. It can also enhance wetlands, which benefits the wildlife depending on that eco-system. For instance, The San Jose/Santa Clara Water Pollution Control Plant instituted a water recycling program to protect the San Francisco Bay area's natural salt water marshes.

Concerns

Recent studies support long standing concerns about possible public health effects of reclaimed water. It has been known for some time that treated waste water effluent, or reclaimed water, contains pathogens that could be transferred to people through contact, including aerosols from sprinklers. Particularly worrisome are high levels of parasites such as *giardia* and *cryptosporidium* which are not killed by chlorination. Drip and subsurface irrigation technology applications circumvent this.

In 1997, the United States Environmental Protection Agency warned, "(Viable) bacteria from reclaimed water in sprinklers can travel more than 1000 feet in the air." As far back as 1984, researchers concluded that disinfection by chlorination, an important part of wastewater treatment, initially lowers the total number of sewage related bacteria, but may substantially increase the proportions of antibiotic resistant, potentially pathogenic organisms.

More recently, Chang (2007) reported that *Staphylococcus aureus* bacteria (responsible for MRSA) become more virulent and drug resistant after chlorination. A large study in 2006 confirms that microbes, inactivated but not killed by treatment, can regrow in retention ponds and pipes, becoming a major source of the spread of multi-drug resistant pathogens in the environment. During the processing of reclaimed water, fragments can be released from microbes when their cell walls are disrupted. These fragments are not alive and not affected by disinfectants like chlorine. This intact genetic material can transfer both virulence and drug resistance to living microorganisms in water or soil. Amy Pruden (2006) demonstrates that such genetic fragments pass through sewer water reclamation plants into rivers and into drinking water sources. Since the number and types of bacteria in a treatment plant are large, and are exposed to antibiotic pharmaceuticals in wastewater, a positive environment exists for transfer of drug resistance. Independent scientists found that Santa Barbara's reclaimed water contained chlorine resistant bacteria that were also resistant to eleven of the twelve antibiotics tested.

There is also concern in the industry about organic chemicals, including endocrine disruptors in wastewater. In 2005, the United States Department of Agriculture reported: "Overall, the environmental and public health impacts of irrigation with reclaimed sewage effluent and the potential degradation of underlying groundwater are largely unknown."

Distribution and demand

Reclaimed water is often distributed with a dual piping network that keeps reclaimed water pipes completely separate from potable water pipes. In the United States, reclaimed water is always distributed in lavender (light purple) pipes to distinguish it from potable water.

In many cities using reclaimed water, it is now in such demand that consumers are only allowed to use it on assigned days. Some cities that previously offered unlimited reclaimed water at a flat rate are now beginning to charge citizens by the amount they use.

Testing standards

Reclaimed water is not regulated by the EPA but by the states, using standards formulated decades ago. Newer information shows serious public health concerns about pathogens in the water. Many pathogens cannot be detected by currently used tests.

Recent literature also questions the validity of testing for "indicator organisms" instead of pathogens. Nor do present standards consider interactions of heavy metals and pharmaceuticals which may foster the development of drug resistant pathogens in waters derived from sewage.

Potable uses

In most locations, reclaimed water is not directly mixed with potable (drinking) water for several reasons:

- Utilities providing reclaimed water for nonpotable uses do not treat the water to drinking water standards.
- Varying amounts of pathogens, pharmaceutical chemicals (e.g., hormones from female hormonal contraception) and other trace chemicals are able to pass through the treatment and filtering process, potentially causing danger to humans. Modern technologies such as reverse osmosis may help to somewhat overcome this problem. An experiment by the University of New South Wales reportedly showed a reverse osmosis system removed ethinylestradiol and paracetamol from the wastewater, even at 1000 times the expected concentration.
- Drinking water standards were developed for natural ground water, and are not appropriate for identifying contaminants in reclaimed water. In addition to pathogens, and organic and endocrine disrupting chemicals, a large number of compounds may be present in reclaimed water. They cannot all be tested for, and there is a paucity of toxicity information on many of the compounds.

Because of this, state regulatory agencies do not allow reclaimed water to be used for drinking, bathing, or filling swimming pools. They also warn those who use reclaimed water for irrigation to place a sign on their property warning people not to drink from the irrigation system, and to not use it directly on fruits or vegetables.

Aboard the International Space Station, astronauts have been able to drink recycled urine due to the introduction of the ECLSS system. The system cost $250 million and has been working since May 2009. The system recycles wastewater and urine back into potable water used for drinking, food preparation, and oxygen generation. This cuts back on the need for resupplying the space station so often.

Indirect Potable Reuse

Some municipalities are now investigating Indirect Potable Use (IPU) of reclaimed water. For example, reclaimed water may be pumped into (subsurface recharge) or percolated down to (surface recharge) groundwater aquifers, pumped out, treated again, and finally used as drinking water. This technique may also be referred to as *groundwater recharging*.

Unplanned Indirect Potable Reuse

Unplanned Indirect Potable Use has existed even before the introduction of reclaimed water. Many cities already use water from rivers that contain effluent discharged from upstream sewage treatment plants. There are many large towns on the River Thames upstream of London (Oxford, Reading, Swindon, Bracknell) that discharge their treated sewage into the river, which is used to supply London with water downstream.

This phenomenon is also observed in the United States, where the Mississippi River serves as both the destination of sewage treatment plant effluent and the source of potable water. Research conducted in the 1960s by the London Metropolitan Water Board demonstrated that the maximum extent of recycling water is about 11 times before the taste of water induces nausea in sensitive individuals. This is caused by the build up of inorganic ions such as Cl^-, $SO4^{2-}$, K^+ and Na^+, which are not removed by conventional sewage treatment.

Space travel

Wastewater reclamation can be especially important in relation to human spaceflight.

- In 1998, NASA announced it had built a human waste reclamation bioreactor designed for use in the International Space Station and a manned Mars mission. Human urine and feces are input into one end of the reactor and pure oxygen, pure water, and compost (humanure) are output from the other end. The soil could be used for growing vegetables, and the bioreactor also produces electricity.

Treatment improvements

As world populations require both more clean water and better ways to dispose of wastewater, the demand for water reclamation will increase. Future success in water reuse will depend on whether this can be done without adverse effects on human health and the environment.

In the United States, reclaimed waste water is generally treated to secondary level when used for irrigation, but there are questions about the adequacy of that treatment. Some leading scientists in the main water society, AWWA, have long believed that secondary treatment is insufficient to protect people against pathogens, and recommend adding at

least membrane filtration, reverse osmosis, ozonation, or other advanced treatments for irrigation water.

Seepage of nitrogen and phosphorus into ground and surface water is also becoming a serious problem, and will probably lead to at least tertiary treatment of reclaimed to remove nutrients in future. Even using secondary treatment, water quality can be improved. Testing for pathogens using Polymerase Chain Reaction (PCR) instead of older culturing techniques, and changing the discredited fecal coloform "indicator organism" standard would be improvements.

In a large study treatment plants showed that they could significantly reduce the numbers of parasites in effluent, just by making adjustments to the currently used process. But, even using the best of current technology, risk of spreading drug resistance in the environment through wastewater effluent, would remain.

Some scientists have suggested that there need to be basic changes in treatment, such as using bacteria to degrade waste based on nitrogen (urine) and not just carbonaceous (fecal) waste, saying that this would greatly improve effectiveness of treatment. Currently designed plants do not deal well with contaminants in solution (e.g. pharmaceuticals). "Dewatering" solids is a major problem. Some wastes could be disposed of without mixing them with water to begin with. In an interesting innovation, solids (sludge) could be removed before entering digesters and burned into a gas that could be used to run engines.

Emerging disinfection technologies include ultrasound, pulse arc electrohydrolic discharge, and bank filtration. Another issue is concern about weakened mandates for pretreatment of industrial wastes before they are made part of the municipal waste stream. Some also believe that hospitals should treat their own wastes. The safety of drinking reclaimed water which has been given advanced treatment and blended with other waters, remains controversial.

Other alternatives

In urban areas where climate change has threatened long-term water security and reduced rainfall over catchment areas, using reclaimed water for indirect potable use may be superior to other water supply augmentation methods. One other commonly used option is seawater desalination. Recycling wastewater and desalinating seawater may have many of the same disadvantages, including high costs of water treatment, infrastructure construction, transportation, and waste disposal problems. Although the best option varies from region to region, desalination is often superior economically, as reclaimed water usually requires a dual piping network, often with additional storage tanks, when used for nonpotable use.

A less elaborate alternative to reclaimed water is a greywater system. Greywater is wastewater that has been used in sinks, baths, showers, or washing machines, but does not contain sewage. In a home system, treated or untreated greywater may be used to

flush toilets or for irrigation. Some systems now exist which directly use greywater from a sink to flush a toilet or even combine the two into one piece of furniture.

Perhaps the simplest option is a rainwater harvesting system. Although there are concerns about the quality of rainwater in urban areas, due to air pollution and acid rain, many systems exist now to use untreated rainwater for nonpotable uses or treated rainwater for direct potable use. There are also concerns about rainwater harvesting systems reducing the amount of run-off entering natural bodies of water.

Worldwide applications and acceptance

The leaders in use of reclaimed water in the U.S. are Florida and California, with Irvine Ranch Water District as one of the leading developers. They were the first district to approve the use of reclaimed water for in-building piping and use in flushing toilets.

As Australia continues to battle the 7–10-year drought, nationwide, reclaimed effluent is becoming a popular option. Two major capital cities in Australia, Adelaide and Brisbane, have already committed to adding reclaimed effluent to their dwindling dams. Brisbane has been seen as a leader in this trend, and other cities and towns will review the Western Corridor Recycled Water Project once completed. Goulbourn, Canberra, Newcastle, and Regional Victoria, Australia are already considering building a reclaimed effluent process.

According to a EU-funded study, "Europe and the Mediterranean countries are lagging behind" California, Japan, and Australia "in the extent to which reuse is being taken up." According to the study "the concept (of reuse) is difficult for the regulators and wider public to understand and accept."

As of 2010, Israel treats 80% of its sewage (400 billion liters a year), and 100% of the sewage from the Tel Aviv metropolitan area is treated and reused as irrigation water for agriculture and public works. The remaining sludge is currently pumped into the ocean, however a new bill has passed stating a conversion to treating the sludge to be used as manure. Only 20% of the treated water is lost (due to evaporation, leaks, overflows and seeping). The recycled water allows farmers to plan ahead and not be limited by water shortages. There are many levels of treatment, and many different ways of treating the water—which leads to a big difference in the quality of the end product. The best quality of reclaimed sewage water comes from adding a gravitational filtering step, after the chemical and biological cleansing. This method uses small ponds in which the water seeps through the sand into the aquifer in about 400 days, then is pumped out as clear purified water. This is nearly the same process used in the space station water recycling system, which turns urine and feces into purified drinking water, oxygen and manure. To add to the efficiency of the Israeli system - the reclaimed sewage water may be mixed with reclaimed sea water (Plans are in action to increase the desalinization program up to 50% of the countries usage by 2013 - 600 billion liters of drinkable sea water a year), along with aquifer water and fresh sweet lake water - monitored by computer to account for the nationwide needs and input. This action reduced the outdated risk of salt and

mineral percentages in the water. Plans to implement this overall usage of reclaimed water for drinking are discouraged by the psychological preconception of the public for the quality of reclaimed water, and the fear of its origin. As of today, all the reclaimed sewage water in Israel is used for agricultural and land improvement purposes.

The second largest waste reclamation program in the world is in Spain, where 12% of the nation's waste is treated.

Applications

Indirect potable reuse (IPR)

- London, United Kingdom
- Singapore (where it is branded as *NEWater*)
- Payson, Arizona
- The Torreele project in the Veurne coastal region of Belgium, which began operating in 2002
- Virginia Occoquan Reservoir - The Upper Occoquan Sewage Authority plant discharges its highly treated output to supply roughly 20% of the inflow into the Occoquan Reservoir, which provides drinking water used by the Fairfax County Water Authority - one of the three major water providers in the Washington, D.C. metropolitan area.

Non-potable reuse (NPR)

- Sydney, Australia
- Melbourne, Australia
- Tucson, Arizona
- Clark County, Nevada
- Clearwater, Florida
- St. Petersburg, Florida
- San Diego, California (San Diego County)
- Contra Costa County, California
- Austin, Texas
- Caboolture and Maroochy (South East Queensland, Australia) LGA's currently provide reclaimed water for industrial use (primarily capital works). Users must apply for a key to be able to access the compounds in which the outlets are located.

Proposed

In some places, reclaimed water has been proposed for either potable or non-potable use:

- South East Queensland, Australia (planned for potable use as of late 2010)
- Newcastle, New South Wales, Australia (proposed for non-potable use).

- Canberra, Australian Capital Territory, Australia (proposed in January 2007 as a backup source of potable water)
- Los Angeles, California - By 2019, the Los Angeles Department of Water and Power will build a plant to replenish their groundwater aquifer with purified water in order to deal with the shortage of rain and snow fall, restricted water imports and local groundwater contamination.

Enterprises

- Brac Systems - Canada
- Ecoplay - Netherlands

Chapter 6

Landscape

Oeschinen Lake in the Swiss Alps, an example of a highly diversified landscape.

Landscape comprises the visible features of an area of land, including the physical elements of landforms, water bodies such as rivers, lakes and the sea, living elements of land cover including indigenous vegetation, human elements including land uses, buildings and structures, and transitory elements such as lighting and weather conditions.

Combining both their physical origins and the cultural overlay of human presence, often created over millennia, landscapes reflect the living synthesis of people and place vital to local and national identity. Landscapes, their character and quality, help define the self image of a region, its sense of place that differentiates it from other regions. It is the dynamic backdrop to people's lives.

The Earth has a vast range of landscapes including the icy landscapes of polar regions, mountainous landscapes, vast arid desert landscapes, islands and coastal landscapes, densely forested or wooded landscapes including past boreal forests and tropical rainforests, and agricultural landscapes of temperate and tropical regions.

Landscape may be further reviewed under cultural landscape, landscape ecology, landscape planning, landscape assessment and landscape design.

Etymology

Landscape photograph of Tolima, Colombia

River Aare at Bern

It is believed that the terms *landskift*, *landscipe* or *landscaef* entered Britain some time after the 5th century . These terms referred to a system of human-made spaces in the land - spaces such as fields with boundaries though not necessarily defined by fences or walls. It also referred to a natural unit, a region or tract of land such as a river valley or range of hills as occupied by a tribe or later, ruled by a feudal lord. The term is similar in meaning to the German landschaft referring to a small administrative unit or region. The term fell into disuse and by the time of the Doomsday Book in the 11th century the word did not appear in any translation from the Latin.

The modern form of the word with its connotations of scenery appeared in the late 16th century when the term *landschap* was introduced by Dutch painters when referring to paintings of inland natural or rural scenery. *Landscape*, first recorded in 1598, was borrowed as a painters' term from Dutch during the 16th century, when Dutch artists were on the verge of becoming masters of the landscape art genre. The Dutch word *landschap* had earlier meant simply 'region, tract of land' but had acquired the artistic sense, which it brought over into English, of 'a picture depicting scenery on land'.

According to Jackson: "From 1577 with Harrison's *Description of Britain* onwards, a new awareness of the aesthetic nature of landscape emerged as a new kind of topographical writing flourished...". Originally the term was translated *landskip* which the Oxford

English Dictionary refers to as the corrupt form of the word, gradually to be replaced by *landscape*. The English word is not recorded as used for physical landscapes before 1725.

Following a lengthy analysis concentrating on the German term *landschaft*, Richard Hartshorne defined *landscape* as referring to "the external, visible, (or touchable) surface of the earth. This surface is formed by the outer surfaces, those in immediate contact with the atmosphere, of vegetation, bare earth, snow, ice, or water bodies or the features made by man."

Hartshorne differentiated the term from *region* which he considers is larger and more flexible in size. He eliminated sky on the basis that the atmosphere is simply the medium through which the Earth's surface is viewed and also excludes underground mine workings, the soil beneath vegetation and rainfall. However he included moveable objects noting that a view of Broadway (New York City) without traffic would be incomplete. He ignored the inclusion of oceans in landscape. He opposed perception of landscapes by other than sight, e.g. sounds and odours, on the grounds that these do not contribute to a unified concept. In regard to the concept of natural and cultural landscapes that Carl Sauer among others differentiated, he stated "the natural landscape ceased to exist when man appeared on the scene". While admitting the term *primeval landscape* could refer to pre-human landscapes he considered the present *natural landscape* is "a theoretical concept which never did exist".

During the 1920s and 1930s, attempts were made to construct methodologies that made landscape the essential if not exclusive task of geography. This stemmed from Sauer's view that the role of geography was to systematically examine the "phenomenology of landscape". Sauer viewed landscapes broadly as areas comprising distinct associations of forms, both physical and natural, and regarded landscape study as tracing the development of natural landscapes into cultural landscapes.

By the 1940s, this emphasis had passed as geographers found that the difficulties associated with reconstructing the past were forbidding and at odds with their primary concern with the present world. The concept of a *natural* landscape became increasingly questioned with knowledge of human impact on the environment. More recent geographers have addressed the subjective attributes of a place within humanistic geography thus crossing the bridge between the objective and the subjective assessment of an area.

The popular conception of the *landscape* that is reflected in dictionaries conveys a particular and a general meaning; the particular referring to an area of the Earth's surface and the general meaning being that which can be seen by an observer.

With greater attention to the environmental perception by psychologists over recent decades, landscape is regarded as the raw material with which to study human perceptions and human information processing. Thus Daniels & Cosgrove defined *landscape*, not in physical terms but as an outward expression of human perception: "a landscape is a cultural image, a pictorial way of representing, structuring or symbolising

surroundings." Meinig combined the physical and the psychological: "any landscape is composed not only of what lies before our eyes but what lies within our heads.".

In recent decades the term environment has gained wide usage. Jay Appleton distinguished *environment* from *landscape* by referring to the latter as "the environment perceived". An advantage which the term environment has over landscape is, as Bourassa noted, that environment can refer more readily to urban scenes although the term *urban landscape* is also in common usage. As the term *environment* embraces the total physical, biological, cultural and aesthetic components of an area, it is generally regarded as too broad and encompassing a term for landscape.

The terms *scene*, *scenic* and *scenery* are inadequate descriptions of landscape. With its roots in the theatre where a scene describes a portion of a play, so a scene can describe a portion of a landscape. *Scenery*, which describes the decorative backdrops used on a stage, also refers to the general appearance of a place, particularly a picturesque view. While it can be used interchangeably with *landscape* it does not convey the same depth of meaning.

The term *landscape aesthetics* or just *aesthetics* is frequently used in the literature. Aesthetics has a more controversial origin than landscape. It derived from the Greek *aisthesis* meaning "sense perception". The term was used as the title of the book *Aesthetica* [1750-58] by Alexander Baumgarten [1714 - 62], a minor German philosopher who incorrectly applied the Greek term to a critique of the beautiful or the theory of taste (sociology). Thus the term which originally applied to the broad field of sense perception was restricted to the area of taste. Immanuel Kant in 1781 criticised this use and applied it in accordance with its classical meaning "the philosophy of sensuous perception". However, the corrupted term *aesthetics* gained popular acceptance entering England after 1830 and, according to the Oxford English Dictionary, within a century of the coining of the meaning by Baumgarten, it was in use widely throughout Europe.

The dictionary definition of *aesthetic* perpetuates Baumgarten's error and defines it as "things perceptible by the senses as opposed to things thinkable or immaterial", "pertaining to the sense of the beautiful or the science of aesthetics"Macquarie Dictionary, 1981., or "of, relating to, or dealing with aesthetics or the beautiful". *Aesthetics* is regarded as a branch of philosophy, that which "deduces from nature and taste the rules and principles of art, the theory of the fine arts; the science of the beautiful..." or "[that] dealing with the nature of the beautiful and with judgements concerning beauty".

Thus landscapes have often been the subject of inquiry within the broad framework of aesthetics in the quest for an understanding of beauty.

Chapter 7

Landscape Urbanism & Landscape Architecture

Landscape Urbanism

Landscape Urbanism is a theory of urbanism arguing that landscape architecture, rather than architecture and urban planning, is more capable of organizing the city and enhancing the urban experience. Landscape Urbanism has emerged as a theory in the last ten years and is far from being a coherent doctrine. Charles Waldheim, James Corner, Chris Reed, Nina-Marie Lister, Alex Krieger, Dean Almy, and Mohsen Mostafavi are among the instructors, practitioners, and theorists who have been most responsible for articulating the terms of landscape urbanism.

Waldheim, an architect, has asserted "Landscape Urbanism was specifically meant to provide an intellectual and practical alternative to the hegemony of the New Urbanism." Waldheim has taken what might be considered a fatalist view about American city planning stating "If you have a culture that is fundamentally automobile-based, then an urban model that is anti-automobile is counterintuitive at best. There's a strange precept these days that asserts that people will abandon their cars if we simply build cities that don't accommodate them". Ecology is thus not as important as the liberty of personal transport and that cities and society are secondary to the liberties personal transport. Thus, he is not promoting integrated urbanism and public transport, or medium to high density living; this contradicts the notion of ecological design. The processes of landscape (i.e. time based development) are merely concepts to the landscape urbanist, not an ecological approach to development. There is, hence, reason to believe that this is an open affirmation to suburbanization – low density development. This generally falls within the category of numerous planners that misinterpreted Ebenezer Howard's Garden City Concept, which lead to the suburbanization of America.

Interestingly, an early and influential landscape urbanism project, Paris's Parc de la Villette, has been influential for both its actual built environment, designed by architect Bernard Tschumi, as well as the runner-up's (unbuilt) design, by architect Rem Koolhaas.

Still, most of the important projects related to this theory have yet to be built, so design competitions have been an influential stage for the development of the theory. The development of urban parks in lieu of industrial parks has been the key function of landscape urbanism, which have been designed by architects, not landscape architects.

History

As an academic program, Landscape Urbanism was developed at the University of Pennsylvania . Other North American institutions followed suit shortly thereafter including the University of Illinois at Chicago, the University of Toronto, Columbia and the Harvard Graduate School of Design. In 2000 the London's Architectural Association developed its own Landscape Urbanism program under the direction of Ciro Najle and chairman at the time Mohsen Mostafavi. This was marked by the 2003 publication of the book "Landscape Urbanism: A Manual for the Machinic Landscape" a year before chairman Mostafavi left the AA. The undefined jargon used in this book has led to much confusion regarding the true principles of the discipline. This prompted a parody website, the landscape urbanism bullshit generator.

The latest turn in the brief history of the discipline happened in 2010 when Mohsen Mostafavi -- now at the helm of Harvard's GSD -- together with Gareth Doherty edited and published the most recent compilation of works "Ecological Urbanism", which stands as a critique of landscape urbanism's ecological short comings.

Themes

James Corner, in an essay entitled "Terra Fluxus," describes the main qualities of Landscape Urbanism:

- **Process in time:** urbanization is a dynamic process characterized more by terms like fluidity, spontaneous feedback, and non-linearity, than stability, predictability, or rationality. Ecology and systems theory are concepts inherent to the city.

- **Surface, not form:** horizontality and sprawl in places like Los Angeles, Atlanta, Houston, San Jose, and the suburban fringes of most American cites *is* the new urban reality. As many theories of urbanism attempt to ignore this fact or retrofit it to new urbanism, landscape urbanism accepts it and tries to understand it. Traditional notions of program and structure are not useful in this diffuse urban condition--their scope is small and limiting. Landscape urbanism uses 'territories' and 'potential' instead of 'program' to define a place's use; it finds thinking in terms of adaptable 'systems' instead of rigid 'structures' as a better way to organize space.

- **Form:** the traditional character of the city; formlessness characterizes nature, that which has been untouched by human intent. This city/nature duality is critical to

most theories of the city and nature. Landscape urbanists argue that this is duality is naive and argue for a conflation of landscape and building.

Landscape Architecture

Central Park in New York City is an example of landscape architecture.

Landscape architecture is the design of outdoor and public spaces to achieve environmental, socio-behavioral, and/or aesthetic outcomes. It involves the systematic investigation of existing social, ecological, and geological conditions and processes in the landscape, and the design of interventions that will produce the desired outcome. The scope of the profession includes: urban design; site planning; town or urban planning; environmental restoration; parks and recreation planning; visual resource management; green infrastructure planning and provision; and private estate and residence landscape master planning and design; all at varying scales of design, planning and management. A practitioner in the profession of landscape architecture is called a landscape architect.

Definition

Landscape architecture is a multi-disciplinary field, incorporating aspects of: botany, horticulture, the fine arts, architecture, industrial design, geology and the earth sciences, environmental psychology, geography, and ecology. The activities of a landscape architect can range from the creation of public parks and parkways to site planning for campuses and corporate office parks, from the design of residential estates to the design of civil infrastructure and the management of large wilderness areas or reclamation of

degraded landscapes such as mines or landfills. Landscape architects work on all types of structures and external space - large or small, urban, suburban and rural, and with "hard" (built) and "soft" (planted) materials, while integrating ecological sustainability. The most valuable contribution can be made at the first stage of a project to generate ideas with technical understanding and creative flair for the design, organization, and use of spaces. The landscape architect can conceive the overall concept and prepare the master plan, from which detailed design drawings and technical specifications are prepared. They can also review proposals to authorize and supervise contracts for the construction work. Other skills include preparing design impact assessments, conducting environmental assessments and audits, and serving as an expert witness at inquiries on land use issues. They can also support and prepare applications for capital and revenue funding grants.

In some states, provinces, municipalities, and jurisdictions, such as Ontario, Canada and Santa Barbara, California, all designs for public space must be reviewed and approved by licensed landscape architects.

Fields of activity

The breadth of the professional tasks that landscape architects collaborate on is very broad, but some examples of project types include:

- The planning, form, scale and siting of new developments
- Civil design and public infrastructure
- Sustainable development
- Stormwater management including rain gardens, green roofs, groundwater recharge, and treatment wetlands
- Campus and site design for public institutions and government facilities
- Parks, botanical gardens, arboretums, greenways, and nature preserves
- Recreation facilities; ie: playgrounds, golf courses, theme parks and sports facilities
- Housing areas, industrial parks and commercial developments
- Estate and residence landscape master planning and design
- Highways, transportation structures, bridges, and transit corridors
- Urban design, town and city squares, waterfronts, pedestrian schemes, and parking lots
- Large to small urban renewal planning and design
- Natural park, tourist destination, and recreating historical landscapes, and historic garden appraisal and conservation studies
- Reservoirs, dams, power stations, reclamation of extractive industry applications or major industrial projects and mitigation
- Environmental assessment and landscape assessment, planning advice and land management proposals.
- Coastal and offshore developments and mitigation
- Ecological Design any aspect of design that minimizes environmentally destructive impacts by integrating itself with natural processes and sustainability

Specializations and related professions

Urban designers determine the physical arrangement, appearance and functionality of towns and cities, including circulation and open public space.

Landscape managers use their knowledge of landscape processes to advise on the long-term care and development of the landscape. They often work in forestry, nature conservation and agriculture.

Landscape scientists have specialist skills such as soil science, hydrology, geomorphology or botany that they relate to the practical problems of landscape work. Their projects can range from site surveys to the ecological assessment of broad areas for planning or management purposes. They may also report on the impact of development or the importance of particular species in a given area.

Landscape planners are concerned with landscape planning for the location, scenic, ecological and recreational aspects of urban, rural and coastal land use. Their work is embodied in written statements of policy and strategy, and their remit includes master planning for new developments, landscape evaluations and assessments, and preparing countryside management or policy plans. Some may also apply an additional specialism such as landscape archaeology or law to the process of landscape planning.

Green roof designers design extensive and intensive roof gardens for storm water management, evapo-transpirative cooling, sustainable architecture, aesthetics, and habitat creation.

History of landscape architecture

Orangery at the Palace of Versailles, outside Paris

For the period before 1800, the history of landscape gardening (later called landscape architecture) is largely that of master planning and garden design for manor houses, palaces and royal properties, religious complexes, and centers of government. An example is the extensive work by André Le Nôtre at Vaux-le-Vicomte and for King Louis XIV of France at the Palace of Versailles. The first person to write of "making" a landscape was Joseph Addison in 1712. The term "landscape architecture" was invented by Gilbert Laing Meason in 1828 and was first used as a professional title by Frederick Law Olmsted in 1863. During the latter 19th century, the term "landscape architect" became used by professional people who designed landscapes. This use of "landscape architect" became established after Frederick Law Olmsted and Beatrix Farrand with others founded the American Society of Landscape Architects (ASLA) in 1899, and with the 1949 founding of the International Federation of Landscape Architects (IFLA).

Through the 19th century, urban planning became a more important need. The combination of the tradition of landscape gardening and emerging city planning that gave Landscape Architecture its unique focus to serve these needs. In the second half of the century, Frederick Law Olmsted completed a series of parks which continue to have a huge influence on the practices of Landscape Architecture today. Among these were Central Park in New York City, Prospect Park in Brooklyn, New York and Boston's

Emerald Necklace park system. Jens Jensen designed sophisticated and naturalistic urban and regional parks for Chicago, Illinois, and private estates for the Ford family including Fair Lane and Gaukler Point. One of the original ten founding members of the American Society of Landscape Architects (ASLA), and the only woman, was Beatrix Farrand. She was design consultant for over a dozen universities including: Princeton in Princeton, New Jersey; Yale in New Haven, Connecticut; and the Arnold Arboretum for Harvard in Boston, Massachusetts. Her numerous private estate projects include the landmark Dumbarton Oaks in the Georgetown neighborhood of Washington, D.C.

Landscape architecture continues to develop as a design discipline, and responded to the various movements in architecture and design through the 20th century. Thomas Church was a mid-century landscape architect significant in the profession. His book, *Gardens Are For People*, and numerous campus master planning and residential design projects influenced environmental design in California, and so the country. Roberto Burle Marx in Brazil combined the International style and native Brazilian plants and culture for a new aesthetic. Innovation continues today solving challenging problems with contemporary design solutions for master planning, landscapes, and gardens. Two examples of current practice are Martha Schwartz based in Cambridge, Massachusetts and London, and by the Dutch design group (West 8) based in Rotterdam, the Netherlands.

Ian McHarg is considered an important influence on the modern Landscape Architecture profession and land planning in particular. With his book *Design with Nature*, he popularized a system of analyzing the layers of a site in order to compile a complete understanding of the qualitative attributes of a place. This system became the foundation of today's Geographic Information Systems (GIS). McHarg would give every qualitative aspect of the site a layer, such as the history, hydrology, topography, vegetation, etc. GIS software is ubiquitously used in the landscape architecture profession today to analyze materials in and on the Earth's surface and is similarly used by Urban Planners, Geographers, Forestry and Natural Resources professionals, etc. Other internationally recognized practitioners include Alain de Rogaine in Paris, Yuishi Kogazawa in Kyoto and Camille Kelly in Sydney.

Profession

In many countries, a professional institute, comprising members of the professional community, exists in order to protect the standing of the profession and promote its interests, and sometimes also regulate the practice of landscape architecture. The standard and strength of legal regulations governing HI landscape architecture practice varies from nation to nation, with some requiring licensure in order to practice; and some having little or no regulation. In North America and Europe, landscape architecture is a regulated profession.

Australia

The Australian Institute of Landscape Architects (AILA) provides professional recognition for landscape architects. Once recognised, landscape architects use the title

'Registered Landscape Architect'. Across the eight states and territories within Australia, there is a mix of requirements for landscape architects to be 'Registered'. Generally there is no clear legislative registration requirement in place. Any regulations or requirements are state based, not national. The AILA's system of professional recognition is a national system overseen by AILA's National Office in Canberra.

Most agencies require AILA professional recognition or registration as part of the pre-requisite for contracts. Landscape architects within Australia find that many contracts and competitions require the AILA recognition or 'registration' as the basis of demonstrating a professional status. To apply for AILA Registration, an applicant usually needs to satisfy a number of pre-requisites, including: university qualification, two years of practice and a record of Continuing Professional Practice. The application is in two stages: (1) A minimum 12 months of mentoring and assessment (2) Oral assessment/interview. Professional recognition includes a commitment to continue professional development. AILA Registered Landscape Architects are required to report annually on their Continuing Professional Development.

Canada

In Canada, landscape architecture, like law and medicine, is a self-regulating profession pursuant to provincial statute. For example Ontario's profession is governed by the Ontario Association of Landscape Architects pursuant to the *Ontario Association of Landscape Architects Act*. Ontario landscape architects must complete the specified components of L.A.R.E (Landscape Architecture Registration Examination) as a prerequisite to full professional standing.

Provincial regulatory bodies are members of a national organization, the Canadian Society of Landscape Architects / L'Association des Architectes Paysagistes du Canada (CSLA-AAPC), and individual membership in the CSLA-AAPC is obtained through joining one of the provincial or territorial components.

Italy

AIAPP (Italian Association of Landscape Architecture) is the Italian association of professional landscape architects formed in 1950 and is a member of EFLA and IFLA. AIAPP is in the process of contesting this new law which has given the Architects' Association the new title of Architects, Landscape Architects, Planners and Conservationists whether or not they have had any training or experience in any of these fields other than Architecture. At the same time, the existence of AIAPP has been totally ignored in spite of its international recognition. In Italy, there are several different professions involved in landscape architecture:

- Architetti (Architects)
- Paesaggisti (Landscape designs)
- Dottori Agronomi Paesaggisti e Dottori Forestali Paesaggisti (Doctor landscape agronomists and Doctor landscape foresters)

- Periti Agrari e Periti Agrari Laureati (Agrarian Experts and Graduated Agrarian experts)

Republic of Ireland

The profession is now firmly established in the Republic, though its penetration into the public sector is problematic and under-represented. The recent economic boom saw a flourishing and expansion of private practices.

The profession has gained a standing and status, outweighing its relatively small numbers in Ireland; and is closely involved in multi-disciplinary endeavours and initiatives with allied built environment and natural heritage professionals, including architects, civil engineers, spatial planners, ecologists and chartered surveyors.

United Kingdom

The UK's professional body is the Landscape Institute (LI). It is a chartered body which accredits landscape professionals and university courses. At present there are fifteen accredited programmes in the UK. Membership of the LI is available to students, academics and professionals Landscape Architects and there are over 3,000 professionally quaified members.

The Institute provides services to assist members including support and promotion of the work of landscape architects; information and guidance to the public and industry about the specific expertise offered by those in the profession; and training and educational advice to students and professionals looking to build upon their experience.

In 2008, the LI launched a major recruitment drive entitled "I want to be a Landscape Architect" to encourage the study of Landscape Architecture. The campaign aims to raise the profile of landscape architecture and highlight its valuable role in building sustainable communities and fighting climate change.

United States

In the United States, Landscape Architecture is regulated by individual state governments. For a landscape architect, obtaining licensure requires advanced education and work experience, plus passage of the national examination. Several states require passage of a state exam as well. In the U.S. licensing is overseen both at the state level, and nationally by the Council of Landscape Architectural Registration Boards (CLARB). Landscape architecture has been identified as an above-average growth profession by the US Bureau of Labor Statistics and was listed in *US News and World Report*'s list of Best Jobs to Have in 2006, 2007, 2008, 2009 and 2010. The national trade association for U.S. landscape architects is the American Society of Landscape Architects. The average salary for landscape architecture professionals in the U.S. is $71,000 .

Chapter 8

Sustainable Gardening

Sustainable gardening (which is taken here to include sustainable landscapes, sustainable landscape design, sustainable landscape architecture and sustainable sites) comprises a disparate group of horticultural interests that share, to a greater or lesser extent, the aims and objectives associated with the international post-1980s sustainable development and sustainability programs developed to address the fact that humans are now using natural biophysical resources faster than they can be replenished by nature. Included within this compass are those home gardeners, and members of the landscape and nursery industries and municipal authorities, that integrate environmental, social and economic factors in an attempt to create a more sustainable future.

Organic gardening and the use of native plants are integral to sustainable gardening.

Historical development

After the establishment of sustainable agriculture in the early 1980s it was some time before the emergence of Sustainable Horticulture (as sustainable *production* horticulture) at the International Society of Horticultural Science's First International Symposium on Sustainability in Horticulture held at the International Horticultural Congress in Toronto in 2002. This symposium produced "conclusions ... on Sustainability in Horticulture and a Declaration for the 21st Century". The principles and objectives outlined at this conference were discussed in more practical terms at the following conference at Seoul in 2006.

Many of the eco-friendly principles and ideas espoused by sustainable gardens, landscapes and sites perpetuate sustainable practices established as a reaction to resource-intensive industrial agriculture. These practices were established as movements for self-sufficiency and small-scale farming based on a holistic systems approach and ecological principles. Included here would be: biodynamic agriculture, no-till farming, agroecology, Fukuoka farming, forest gardening, organic gardening and others. On a larger scale there

is the more recent "whole farm planning" which was established in 1995, and ecoagriculture established in 2000, and other variants of sustainable agricultural systems. Perhaps the most influential of these approaches is permaculture, established by Australians Bill Mollison and David Holmgren as both a design system and a loosely defined philosophy or lifestyle ethic. Permaculture shares many principles and practices of the above but not the broad philosophical base as indicated by the title of the 2002 publication *Permaculture, principles and pathways beyond sustainability*. The application of sustainability principles to the horticultural sphere has now becoming broadly accepted in commerce and academia.

Definition

The American Sustainable Sites Initiative is an interdisciplinary approach used by the American Society of Landscape Architects, the Lady Bird Johnson Wildflower Center and the United States Botanic Garden to create voluntary national guidelines and performance benchmarks for sustainable land design, construction and maintenance practices: it was founded in 2005. Using the United Nations Brundtland Report's definition of sustainable development as a model, it defines sustainability within its own sphere of reference as:

… design, construction, operations and maintenance practices that meet the needs of the present without compromising the ability of future generations to meet their own needs

by attempting to:

...protect, restore and enhance the ability of landscapes to provide ecosystem services that benefit humans and other organisms.

Principles & concepts

Managing global biophysical cycles and ecosystem services for the benefit of humans, other organisms and future generations has now become a global human responsibility. The method of applying sustainability to gardens, landscapes and sites is still under development and varies somewhat according to the context under consideration. However, there are a number of basic and common underlying biological and operational principles and practices in the sustainable sites literature.

Biological principles

Sustainable management of man-made landscapes emulates the natural processes that sustain the biosphere and its ecosystems. First and foremost is the harnessing the energy of the Sun and the cycling of materials thereby minimising waste and energy use.

Running within, and dependent on, the natural economy there is the production and consumption of goods and services in the "human economy" which has now significantly altered, in a detrimental way, natural biogeochemical cycles (notable here are the water

cycle, carbon cycle and nitrogen cycle so sustainable practices maximise support for ecosystem services.

Native plants

The use of native plants in a garden or landscape can both preserve and protect natural ecosystems, and reduce the amount of care and energy required to maintain a healthy garden or landscape. Native plants are adapted to the local climate and geology, and often require less maintenance than exotic species. Native plants also support populations of native birds, insects, and other animals that they coevolved with, thus promoting a healthy community of organisms.

Plants in a garden or maintained landscape often form a source population from which plants can colonize new areas. Avoiding the use of invasive species helps to prevent such plants from establishing new populations. Similarly, the use of native species can provide a valuable source to help these plants colonise new areas.

Some non-native species can form an ecological trap in which native species are lured into an environment that appears attractive but is poorly suited to them.

Operational principles

Enhancement of ecosystem services is encouraged throughout the lifecycle of any site by providing clear design, construction, (operations), and management criteria. To be sustainable over the long term requires environmental, social and economic demands are integrated to provide intergenerational equity by providing regenerative sustainable systems. Operational guidelines will link to and supplement existing guidelines for the built environment (supplementing existing green building and landscape guidelines), the wider environment, and they will include metrics (benchmarks, audits, criteria, indexes etc.) that give some measure of sustainability (a rating system) by clarifying what is sustainable or not sustainable or, more likely, what is more or less sustainable.

Scale

Impacts of a site can be assessed and measured over any spatio-temporal scale or context.

Direct and indirect environmental impact

Impacts of a site may be *direct* by having direct measurable impacts on biodiversity and ecology at the site itself or *indirect* when impacts occur away from the site.

Site principles

- Do no harm
- Use the Precautionary principle
- Design with nature and culture

- Use a decision-making hierarchy of preservation, conservation, and regeneration
- Provide regenerative systems as intergenerational equity
- Support a living process
- Use a system thinking approach
- Use a collaborative and ethical approach
- Maintain integrity in leadership and research
- Foster environmental stewardship

Measuring site sustainability

One major feature distinguishing the approach of sustainable gardens, landscapes and sites from other similar enterprises is the quantification of site sustainability by establishing performance benchmarks. Because sustainability is such a broad and inclusive concept the environmental impacts of sites can be categorised in numerous ways depending on the purpose for which the figures are required. The process can include minimising negative environmental impacts and maximising positive impacts. As currently applied the environment is usually given priority over social and economic factors which may be added in or regarderd as an inevitable and integral part part of the management process. A home gardener is likely to use simpler metrics than a professional landscaper or ecologist. Factors that are considered include:

1. Sustainable Sites Initiative is producing recommendations for the American Landscape Industry . The standards and guidelines finally adopted will lead to a uniform national standard, which does not currently exist; Sustainable Sites will produce a rating system by 2011. The U.S. Green Building Council supports the project and plans to adopt the Sustainable Sites metrics into future versions of its Leadership in Energy and Environmental Design Green Building Rating System. Sites are rated according to their impact on ecosystem services: The following ecosystem services have been identified by the study group:

- Local climate regulation
- Air and water cleansing
- Water supply and regulation
- Erosion and sediment control
- Hazard mitigation
- Pollination
- Habitat functions
- Waste decomposition and treatment
- Global climate regulation
- Human health and well-being benefits
- Food and renewable non-food products
- Cultural benefits

INPUTS	OUTPUTS	PROCESSES
• Fossil fuels • Embodied energy and water • Compost • Mulch • Ecology & biodiversity • Fertilizer • Hard landscape materials • Equipment • Products	• Energy & water • Food • Green waste • Ecology & biodiversity • Chemicals • Old hard landscape materials • Old equipment • Old products	

Constraints

Any kind of auditing or benchmarking will depend on the selection and weighting of the metrics chosen; the depth and detail of analysis required; the purpose for which the figures are required; and the environmental circumstances of the particular site.

Chapter 9

Sustainable Design

Sustainable design (also called environmental design, environmentally sustainable design, environmentally conscious design, etc.) is the philosophy of designing physical objects, the built environment, and services to comply with the principles of economic, social, and ecological sustainability.

Intentions

The intention of sustainable design is to "eliminate negative environmental impact completely through skillful, sensitive design". Manifestations of sustainable design require no non-renewable resources, impact the environment minimally, and relate people with the natural environment.

Applications

Applications of this philosophy range from the microcosm — small objects for everyday use, through to the macrocosm — buildings, cities, and the Earth's physical surface. It is a philosophy that can be applied in the fields of architecture, landscape architecture, urban design, urban planning, engineering, graphic design, industrial design, interior design, and fashion design.

Sustainable design is mostly a general reaction to global environmental crises, the rapid growth of economic activity and human population, depletion of natural resources, damage to ecosystems, and loss of biodiversity.

The limits of sustainable design are reducing. Whole earth impacts are beginning to be considered because growth in goods and services is consistently outpacing gains in efficiency. As a result, the net effect of sustainable design to date has been to simply improve the efficiency of rapidly increasing impacts. The present approach, which focuses on the efficiency of delivering individual goods and services, does not solve this problem. The basic dilemmas include: the increasing complexity of efficiency improvements; the difficulty of implementing new technologies in societies built around

old ones; that physical impacts of delivering goods and services are not localized, but are distributed throughout the economies; and that the scale of resource use is growing and not stabilizing.

Sustainable Design Principles

While the practical application varies among disciplines, some common principles are as follows:

- Low-impact materials: choose non-toxic, sustainably produced or recycled materials which require little energy to process
- Energy efficiency: use manufacturing processes and produce products which require less energy
- Quality and durability: longer-lasting and better-functioning products will have to be replaced less frequently, reducing the impacts of producing replacements
- Design for reuse and recycling: "Products, processes, and systems should be designed for performance in a commercial 'afterlife'."
- Design Impact Measures for total carbon footprint and life-cycle assessment for any resource used are increasingly required and available. Many are complex, but some give quick and accurate whole-earth estimates of impacts. One measure estimates any spending as consuming an average economic share of global energy use of 8,000btu per dollar and producing CO2 at the average rate of 0.57 kg of CO2 per dollar (1995 dollars US) from DOE figures.
- Sustainable Design Standards and project design guides are also increasingly available and are vigorously being developed by a wide array of private organizations and individuals. There is also a large body of new methods emerging from the rapid development of what has become known as 'sustainability science' promoted by a wide variety of educational and governmental institutions.
- Biomimicry: "redesigning industrial systems on biological lines ... enabling the constant reuse of materials in continuous closed cycles..."
- Service substitution: shifting the mode of consumption from personal ownership of products to provision of services which provide similar functions, e.g., from a private automobile to a carsharing service. Such a system promotes minimal resource use per unit of consumption (e.g., per trip driven).
- Renewability: materials should come from nearby (local or bioregional), sustainably managed renewable sources that can be composted when their usefulness has been exhausted.
- Robust eco-design: robust design principles are applied to the design of a pollution sources).

Bill of Rights for the Planet

A model of the new design principles necessary for sustainability is exemplified by the "Bill of Rights for the Planet" or "Hannover Principles" - developed by William McDonough Architects for EXPO 2000 that was held in Hannover, Germany.

The Bill of Rights:

1. Insist on the right of humanity and nature to co-exist in a healthy, supportive, diverse, and sustainable condition.
2. Recognize Interdependence. The elements of human design interact with and depend on the natural world, with broad and diverse implications at every scale. Expand design considerations to recognizing even distant effects.
3. Respect relationships between spirit and matter. Consider all aspects of human settlement including community, dwelling, industry, and trade in terms of existing and evolving connections between spiritual and material consciousness.
4. Accept responsibility for the consequences of design decisions upon human well-being, the viability of natural systems, and their right to co-exist.
5. Create safe objects of long-term value. Do not burden future generations with requirements for maintenance or vigilant administration of potential danger due to the careless creations of products, processes, or standards.
6. Eliminate the concept of waste. Evaluate and optimize the full life-cycle of products and processes, to approach the state of natural systems in which there is no waste.
7. Rely on natural energy flows. Human designs should, like the living world, derive their creative forces from perpetual solar income. Incorporate this energy efficiently and safely for responsible use.
8. Understand the limitations of design. No human creation lasts forever and design does not solve all problems. Those who create and plan should practice humility in the face of nature. Treat nature as a model and mentor, not an inconvenience to be evaded or controlled.
9. Seek constant improvement by the sharing of knowledge. Encourage direct and open communication between colleagues, patrons, manufacturers and users to link long term sustainable considerations with ethical responsibility, and re-establish the integral relationship between natural processes and human activity.

These principles were adopted by the World Congress of the International Union of Architects (UIA) in June 1993 at the American Institute of Architect's (AIA) Expo 93 in Chicago. Further, the AIA and UIA signed a "Declaration of Interdependence for a Sustainable Future." In summary, the declaration states that today's society is degrading its environment and that the AIA, UIA, and their members are committed to:

- Placing environmental and social sustainability at the core of practices and professional responsibilities
- Developing and continually improving practices, procedures, products, services, and standards for sustainable design

- Educating the building industry, clients, and the general public about the importance of sustainable design
- Working to change policies, regulations, and standards in government and business so that sustainable design will become the fully supported standard practice
- Bringing the existing built environment up to sustainable design standards

In addition, the Interprofessional Council on Environmental Design (ICED), a coalition of architectural, landscape architectural, and engineering organizations, developed a vision statement in an attempt to foster a team approach to sustainable design. ICED states: The ethics, education and practices of our professions will be directed to shape a sustainable future. . . . To achieve this vision we will join . . . as a multidisciplinary partnership."

These activities are an indication that the concept of sustainable design is being supported on a global and interprofessional scale and that the ultimate goal is to become more environmentally responsive. The world needs facilities that are more energy efficient and that promote conservation and recycling of natural and economic resources.

Conceptual Problems to Solve

- Diminishing Returns: The principle that all directions of progress run out, ending with diminishing returns, is evident in the typical 'S' curve of The Technology Life Cycle and in the useful life of any system as discussed in Industrial Ecology and Life Cycle Assessment. It's as reliable an expectation as any principle of science that diminishing returns signal natural limits. Common office and business management practice is to read diminishing returns in any direction of effort as an indication of diminishing opportunity, a potential for accelerating their decline and signal to turn elsewhere.

- Unsustainable Investment: A problem arises when the limits of a resource are hard to see, so increasing investment in response to diminishing returns may seem profitable as in the Tragedy of the Commons, but may lead to a collapse. This problem of increasing investment in diminishing resources has also been studied in relation to the causes of civilization collapse by Joseph Tainter among others. This natural error in investment policy contributed to the collapse of both the Roman and Mayan, among others. Relieving over-stressed resources requires reducing pressure on them, not continually increasing it whether more efficiently or not

Waste Prevention

Negative Effects of Waste About 80 million tonnes of waste in total are generated in the U.K. alone, for example, each year. And with reference to only household waste, between 1991/92 and 2007/08, each person in England generated an average of 1.35 pounds of waste per day.

Experience has now shown that there is no completely safe method of waste disposal. All forms of disposal have negative impacts on the environment, public health, and local economies. Landfills have contaminated drinking water. Garbage burned in incinerators has poisoned air, soil, and water. The majority of water treatment systems change the local ecology. Attempts to control or manage wastes after they are produced fail to eliminate environmental impacts.

The toxic components of household products pose serious health risks and aggravate the trash problem. In the U.S., about eight pounds in every ton of household garbage contains toxic materials, such as lead, cadmium, and mercury from batteries, insect sprays, nail polish, cleaners, and other products. When burned or buried, toxic materials also pose a serious threat to public health and the environment.

The only way to avoid environmental harm from waste is to prevent its generation. Pollution prevention means changing the way activities are conducted and eliminating the source of the problem. It does not mean doing without, but doing differently. For example, preventing waste pollution from litter caused by disposable beverage containers does not mean doing without beverages; it just means using refillable bottles.

Waste Prevention Strategies In planning for facilities, a comprehensive design strategy is needed for preventing generation of solid waste. A good garbage prevention strategy would require that everything brought into a facility be recycled for reuse or recycled back into the environment through biodegradation. This would mean a greater reliance on natural materials or products that are compatible with the environment.

Any resource-related development is going to have two basic sources of solid waste — materials purchased and used by the facility and those brought into the facility by visitors. The following waste prevention strategies apply to both, although different approaches will be needed for implementation:

- use products that minimize waste and are nontoxic
- compost or anaerobically digest biodegradable wastes
- reuse materials onsite or collect suitable materials for offsite recycling

Examples of sustainable design

Sustainable planning

Cohousing community illustrating greenspace preservation, tightly clustered housing, and parking on periphery, Ann Arbor, Michigan, 2003.

Urban planners that are interested in achieving sustainable development or sustainable cities use various design principles and techniques when designing cities and their infrastructure. These include Smart Growth theory, Transit-oriented development, sustainable urban infrastructure and New Urbanism. Smart Growth is an urban planning and transportation theory that concentrates growth in infill sites within the existing infrastructure of a city or town to avoid urban sprawl; and advocates compact, transit-oriented development, walkable, bicycle-friendly land use, including mixed-use development with a range of housing choices. Transit-oriented development attempts to maximise access to public transport and thereby reduce the need for private vehicles. Public transport is considered a form of Sustainable urban infrastructure, which is a design approach which promotes protected areas, energy-efficient buildings, wildlife corridors and distributed, rather than centralized, power generation and waste water treatment. New Urbanism is more of a social and aesthetic urban design movement than a green one, but it does emphasize diversity of land use and population, as well as walkable communities which inherently reduce the need for automotive travel.

Both urban and rural planning can benefit from including sustainability as a central criterion when laying out roads, streets, buildings and other components of the built environment. Conventional planning practice often ignores or discounts the natural configuration of the land during the planning stages, potentially causing ecological damage such as the stagnation of streams, mudslides, soil erosion, flooding and pollution. Applying methods such as scientific modelling to planned building projects can draw attention to problems before construction begins, helping to minimise damage to the natural environment.

Cohousing is an approach to planning based on the idea of intentional communities. Such projects often prioritize common space over private space resulting in grouped structures that preserve more of the surrounding environment.

Watershed assessment of carrying capacity; estuary, riparian zone restoration and groundwater recharge for hydrologic cycle viability; and other opportunities and issues about Water and the environment show that the foundation of smart growth lies in the protection and preservation of water resources. The total amount of precipitation landing on the surface of a community becomes the supply for the inhabitants. This supply amount then dictates the carrying capacity - the potential population - as supported by the "water crop."

Sustainable architecture

Sustainable architecture is the design of sustainable buildings. Sustainable architecture attempts to reduce the collective environmental impacts during the production of building components, during the construction process, as well as during the lifecycle of the building (heating, electricity use, carpet cleaning etc.) This design practice emphasizes

efficiency of heating and cooling systems; alternative energy sources such as solar hot water, appropriate building siting, reused or recycled building materials; on-site power generation - solar technology, ground source heat pumps, wind power; rainwater harvesting for gardening, washing and aquifer recharge; and on-site waste management such as green roofs that filter and control stormwater runoff. This requires close cooperation of the design team, the architects, the engineers, and the client at all project stages, from site selection, scheme formation, material selection and procurement, to project implementation.

Sustainable architects design with sustainable living in mind. Sustainable vs green design is the challenge that designs not only reflect healthy processes and uses but are powered by renewable energies and site specific resources. A test for sustainable design is — can the design function for its intended use without fossil fuel — unplugged. This challenge suggests architects and planners design solutions that can function without pollution rather than just reducing pollution. As technology progresses in architecture and design theories and as examples are built and tested, architects will soon be able to create not only passive, null-emission buildings, but rather be able to integrate the entire power system into the building design. In 2004 the 59 home housing community, the Solar Settlement, and a 60,000 sq ft (5,600 m^2) integrated retail, commercial and residential building, the Sun Ship, were completed by architect Rolf Disch in Freiburg, Germany. The Solar Settlement is the first housing community world wide in which every home, all 59, produce a positive energy balance.

Sustainable landscape and garden design

Sustainable landscape architecture is a category of sustainable design and energy-efficient landscaping concerned with the planning and design of outdoor space. Design techniques include planting trees to shade buildings from the sun or protect them from wind, using local materials, on-site composting and chipping to reduce green waste hauling, and also may involve using drought-resistant plantings in arid areas (xeriscaping) and buying stock from local growers to avoid energy use in transportation.

Sustainable graphic design

Sustainable graphic design considers the environmental impacts of graphic design products (such as packaging, printed materials, publications, etc.) throughout a life cycle that includes: raw material; transformation; manufacturing; transportation; use; and disposal. Techniques for sustainable graphic design include: reducing the amount of materials required for production; using paper and materials made with recycled, post-consumer waste; printing with low-VOC inks; and using production and distribution methods that require the least amount of transport.

Sustainable Agriculture

Sustainable agriculture adheres to three main goals:

- environmental health,
- economic profitability,
- social and economic equity.

A variety of philosophies, policies and practices have contributed to these goals. People in many different capacities, from farmers to consumers, have shared this vision and contributed to it. Despite the diversity of people and perspectives, the following themes commonly weave through definitions of sustainable agriculture.

There are strenuous discussions — among others by the agricultural sector and authorities — if existing pesticide protocols and methods of soil conservation adequately protect topsoil and wildlife. Doubt has risen if these are sustainable, and if agrarian reforms would permit an efficient agriculture with fewer pesticides, therefore reducing the damage to the ecosystem.

Domestic machinery and furniture

Stainless Steel Table with FSC Teca Wood - Brazil sustainable design. Stainless is 100% recyclable and teca wood comes environmental friendly reforestation

Automobiles, home appliances and furnitures can be designed for repair and disassembly (for recycling), and constructed from recyclable materials such as steel, aluminum and glass, and renewable materials, such as Zelfo, wood and plastics from natural feedstocks. Careful selection of materials and manufacturing processes can often create products

comparable in price and performance to non-sustainable products. Even mild design efforts can greatly increase the sustainable content of manufactured items.

Improvements to heating, cooling, ventilation and water heating

- Absorption refrigerator
- Annualized geothermal solar
- Earth cooling tubes
- Geothermal heat pump
- Heat recovery ventilation
- Hot water heat recycling
- Passive cooling
- Renewable heat
- Seasonal thermal storage
- Solar air conditioning
- Solar hot water

Disposable products

Detergents, newspapers and other disposable items can be designed to decompose, in the presence of air, water and common soil organisms. The current challenge in this area is to design such items in attractive colors, at costs as low as competing items. Since most such items end up in landfills, protected from air and water, the utility of such disposable products is debated.

Eco fashion and home accessories

Creative designers and artists are perhaps the most inventive when it comes to upcycling or creating new products from old waste. A growing number of designers upcycle waste materials such as car window glass and recycled ceramics, textile offcuts from upholstery companies, and even decommissioned fire hose to make belts and bags. Whilst accessories may seem trivial when pitted against green scientific breakthroughs; the ability of fashion and retail to influence and inspire consumer behaviour should not be underestimated. Eco design may also use bi-products of industry, reducing the amount of waste being dumped in landfill, or may harness new sustainable materials or production techniques e.g. fabric made from recycled PET plastic bottles or bamboo textiles.

Energy Sector

Sustainable technology in the energy sector is based on utilizing renewable sources of energy such as solar, wind, hydro, bioenergy, geothermal, and hydrogen. Wind energy is the world's fastest growing energy source; it has been in use for centuries in Europe and more recently in the United States and other nations. Wind energy is captured through the use of wind turbines that generate and transfer electricity for utilities, homeowners and remote villages. Solar power can be harnessed through photovoltaics, concentrating solar, or solar hot water and is also a rapidly growing energy source.

The availability, potential, and feasibility of primary renewable energy resources must be analyzed early in the planning process as part of a comprehensive energy plan. The plan must justify energy demand and supply and assess the actual costs and benefits to the local, regional, and global environments. Responsible energy use is fundamental to sustainable development and a sustainable future. Energy management must balance justifiable energy demand with appropriate energy supply. The process couples energy awareness, energy conservation, and energy efficiency with the use of primary renewable energy resources.

Water Sector

Sustainable water technologies have become an important industry segment with several companies now providing important and scalable solutions to supply water in a sustainable manner.

Beyond the use of certain technologies, Sustainable Design in Water Management also consists very importantly in correct implementation of concepts. Among one of these principal concepts is the fact normally in developed countries 100% of water destined for consumption, that is not necessarily for drinking purposes, is of potable water quality. This concept of differentiating qualities of water for different purposes has been called "fit-for-purpose". This more rational use of water achieves several economies, that are not only related to water itself, but also the consumption of energy, as to achieve water of drinking quality can be extremely energy intensive for several reasons.

Sustainable technologies

Sustainable technologies use less energy, fewer limited resources, do not deplete natural resources, do not directly or indirectly pollute the environment, and can be reused or recycled at the end of their useful life. There is a significant overlap with appropriate technology, which emphasizes the suitability of technology to the context, in particular considering the needs of people in developing countries. However, the most appropriate technology may not be the most sustainable one; and a sustainable technology may have high cost or maintenance requirements that make it unsuitable as an "appropriate technology," as that term is commonly used.

Encouraging sustainability

Training meeting with factory workers in a stainless steel ecodesign company from Rio de Janeiro - Brazil

The Passivhaus-Institut promotes and establishes standards for the Passive House - Passivhaus international program for Low-energy houses and other low-energy building techniques and structures.

The use of sustainable technologies may be encouraged through means such as reducing the capacity of the electrical cable supplying a home, such as Australia's Crystal Waters Village. In some cases the electricity supplier charges a higher rate for the energy used when the capacity of the supply is increased.

Terminology

In some countries the term *sustainable design* is known as Ecodesign, green design or environmental design. Ecodesign as meant by Victor Papanek, did include social design and social aspects. Over the past years the terms *sustainable design* and *design for sustainability* — besides other new terms — became more accepted globally, including the triple bottom line (people, planet and profit).

Chapter 10

Cultural Landscape

The Dresden Elbe Valley World Heritage Site was according to the UNESCO "an outstanding example of land use, representing an exceptional development of a major Central-European city" having almost half a million inhabitants.

Cultural Landscapes have been defined by the World Heritage Committee as distinct geographical areas or properties uniquely "..represent[ing] the combined work of nature

and of man..". This concept has been adapted and developed within international heritage arenas (UNESCO) as part of an international effort to reconcile "..one of the most pervasive dualisms in Western thought - that of nature and culture."

The World Heritage Committee has identified and adopted three categories of cultural landscape, ranging from (i) those landscapes most deliberately 'shaped' by people, through (ii) full range of 'combined' works, to (iii) those least evidently 'shaped' by people (yet highly valued). The three categories extracted from the Committee's Operational Guidelines, are as follows:

(i) "a landscape designed and created intentionally by man";
(ii) an "organically evolved landscape" which may be a "relict (or fossil) landscape" or a "continuing landscape";
(iii) an "associative cultural landscape" which may be valued because of the "religious, artistic or cultural associations of the natural element"

History of the Concept

The concept of 'cultural landscapes' finds its origins in the European tradition of landscape painting. From the 16th century onwards, many European artists painted landscapes in favour of people, diminishing the people in their paintings to figures subsumed within broader, regionally specific landscapes.

The word "landscape" itself combines 'land' with a verb of Germanic origin, "*scapjan/ schaffen*" to mean, literally, 'shaped lands'. Lands were then regarded to have been shaped by natural forces, and the unique details of such *landshaffen* (shaped lands) became themselves the subject of 'landscape' paintings.

The geographer Otto Schluter is credited with having first formally used “cultural landscape” as an academic term in the early 20th century. In 1908, Schluter argued that by defining geography as a *Landschaftskunde* (landscape science) this would give geography a logical subject matter shared by no other discipline. He defined two forms of landscape: the *Urlandschaft*(transl. original landscape) or landscape that existed before major human induced changes and the *Kulturlandschaft* (transl. 'cultural landscape') a landscape created by human culture. The major task of geography was to trace the changes in these two landscapes.

It was Carl O. Sauer, a human geographer, who was probably the most influential in promoting and developing the idea of cultural landscapes. Sauer was determined to stress the agency of culture as a force in shaping the visible features of the Earth’s surface in delimited areas. Within his definition, the physical environment retains a central significance, as the medium with and through which human cultures act. His classic definition of a 'cultural landscape' reads as follows:

“The cultural landscape is fashioned from a natural landscape by a cultural group. Culture is the agent, the natural are the medium, the cultural landscape is the result"

Since Schulter's first formal use of the term, and Sauer's effective promotion of the idea, the concept of 'cultural landscapes has been variously used, applied, debated, developed and refined within academia, when, in 1992, the World Heritage Committee elected to convene a meeting of the 'specialists' to advise and assist redraft the Committee's Operational Guidelines to include 'cultural landscapes' as an option for heritage listing properties that were neither purely natural nor purely cultural in form (i.e. 'mixed' heritage).

The World Heritage Committee's adoption and use of the concept of 'cultural landscapes' has seen multiple specialists around the world, and many nations identifying 'cultural landscapes', assessing 'cultural landscapes', heritage listing 'cultural landscapes', managing 'cultural landscapes', and effectively making 'cultural landscapes' known and visible to the world, with very practical ramifications and challenges.

A 2006 academic review of the combined efforts of the World Heritage Committee, multiple specialists around the world, and nations to apply the concept of 'cultural landscapes', observed and concluded that:

"Although the concept of landscape has been unhooked for some time from its original art associations .. there is still a dominant view of landscapes as an inscribed surface, akin to a map or a text, from which cultural meaning and social forms can simply be read."

Within academia, any system of interaction between human activity and natural habitat is regarded as a cultural landscape. In a sense this understanding is broader than the definition applied within UNESCO, including, as it does, almost the whole of the world's occupied surface, plus almost all the uses, ecologies, interactions, practices, beliefs, concepts, and traditions of people living within cultural landscapes.

Some Universities now offer specialist degrees in the study of cultural landscapes, including, for instance, the Universities of Naples, St.-Étienne, and Stuttgart who offer a *Master of Cultural Landscapes* diploma

Cultural Landscapes: Examples

The World Heritage Committee has identified and listed a number of areas or properties as cultural landscapes of universal value to humankind, including the following :

Tongariro National Park, New Zealand (1993)

"In 1993 Tongariro became the first property to be inscribed on the World Heritage List under the revised criteria describing cultural landscapes. The mountains at the heart of the park have cultural and religious significance for the Maori people and symbolize the spiritual links between this community and its environment. The park has active and extinct volcanoes, a diverse range of ecosystems and some spectacular landscapes."

Uluru-Kata Tjuta National Park, Australia (1994)

"This park, formerly called Uluru (Ayers Rock – Mount Olga) National Park, features spectacular geological formations that dominate the vast red sandy plain of central Australia. Uluru, an immense monolith, and Kata Tjuta, the rock domes located west of Uluru, form part of the traditional belief system of one of the oldest human societies in the world. The traditional owners of Uluru-Kata Tjuta are the Anangu Aboriginal people."

Rice Terraces of Philippine Cordilleras (1995)

"For 2,000 years, the high rice fields of the Ifugao have followed the contours of the mountains. The fruit of knowledge handed down from one generation to the next, and the expression of sacred traditions and a delicate social balance, they have helped to create a landscape of great beauty that expresses the harmony between humankind and the environment."

Cultural Landscape of Sintra Portugal (1995)

"In the 19th century Sintra became the first centre of European Romantic architecture. Ferdinand II turned a ruined monastery into a castle where this new sensitivity was displayed in the use of Gothic, Egyptian, Moorish and Renaissance elements and in the creation of a park blending local and exotic species of trees. Other fine dwellings, built along the same lines in the surrounding serra, created a unique combination of parks and gardens which influenced the development of landscape architecture throughout Europe".

Portovenere, Cinque Terre, and the Islands (Palmaria, Tino and Tinetto), Italy (1997)

"The Ligurian coast between Cinque Terre and Portovenere is a cultural landscape of great scenic and cultural value. The layout and disposition of the small towns and the shaping of the surrounding landscape, overcoming the disadvantages of a steep, uneven terrain, encapsulate the continuous history of human settlement in this region over the past millennium."

Dresden Elbe Valley, Germany (2004)

"The 18th- and 19th-century cultural landscape of Dresden Elbe Valley .. features low meadows, and is crowned by the Pillnitz Palace and the centre of Dresden with its numerous monuments and parks from the 16th to 20th centuries. The landscape also features 19th- and 20th-century suburban villas and gardens and valuable natural features. Some terraced slopes along the river are still used for viticulture and some old villages have retained their historic structure and elements from the industrial revolution, notably the 147-m Blue Wonder steel bridge (1891–93), the single-rail suspension cable railway (1898–1901), and the funicular (1894–95). The passenger steamships (the oldest from 1879) and shipyard (c. 1900) are still in use."

This landscape was struck from the World Heritage list in 2009.

Chapter 11

Urban Design

Urban design concerns the arrangement, appearance and functionality of towns and cities, and in particular the shaping and uses of urban public space. It has traditionally been regarded as a disciplinary subset of urban planning, landscape architecture, or architecture and in more recent times has been linked to emergent disciplines such as landscape urbanism. However, with its increasing prominence in the activities of these disciplines, it is better conceptualised as a design practice that operates at the intersection of all three, and requires a good understanding of a range of others besides, such as real estate development, urban economics, political economy and social theory.

Urban design theory deals primarily with the design and management of public space (i.e. the 'public environment', 'public realm' or 'public domain'), and the way public places are experienced and used. Public space includes the totality of spaces used freely on a day-to-day basis by the general public, such as streets, plazas, parks and public infrastructure. Some aspects of privately owned spaces, such as building facades or domestic gardens, also contribute to public space and are therefore also considered by Urban design theory. Important writers on, and advocates for, urban design theory include Christopher Alexander, Michael E. Arth, Edmund Bacon, Ian Bentley,Peter Calthorpe, Alex Krieger, Gordon Cullen, Andres Duany, Jane Jacobs, Jan Gehl, Kevin Lynch, Roger Montgomery, Aldo Rossi, Colin Rowe, Robert Venturi, William H. Whyte, Bill Hillier, and Elizabeth Plater-Zyberk.

While the two fields are closely related, 'urban design' differs from 'urban planning' in its focus on physical improvement of the public environment, whereas the latter tends, in practice, to focus on the management of private development through established planning methods and programs, and other statutory development controls.

Principles

L'Enfant's plan for Washington DC

Gehl Architects' project for Brighton New Road employing shared space

Public spaces are frequently subject to overlapping management responsibilities of multiple public agencies or authorities and the interests of nearby property owners, as well as the requirements of multiple and sometimes competing users. The design, construction and management of public spaces therefore typically demands consultation and negotiation across a variety of spheres. Urban designers rarely have the degree of artistic liberty or control sometimes offered in design professions such as architecture. It also typically requires interdisciplinary input with balanced representation of multiple fields including engineering, ecology, local history, and transport planning.

The scale and degree of detail considered varies depending on context and needs. It ranges from the layout of entire cities, as with l'Enfant's plan for Washington DC, Griffin and Mahony's plan for Canberra and Doxiadis' plan for Islamabad (although such opportunities are obviously rare), through 'managing the sense of a region' as described by Kevin Lynch, to the design of street furniture.

Urban design may encompass the preparation of design guidelines and regulatory frameworks, or even legislation to control development, advertising, etc. and in this sense overlaps with urban planning. It may encompass the design of particular spaces and structures and in this sense overlaps with architecture, landscape architecture, highway

engineering and industrial design. It may also deal with ‘place management’ to guide and assist the use and maintenance of urban areas and public spaces.

Much urban design work is undertaken by urban planners, landscape architects and architects but there are professionals who identify themselves specifically as urban designers. Many architecture, landscape and planning programs incorporate urban design theory and design subjects into their curricula and there are an increasing number of university programs offering degrees in urban design, usually at post-graduate level.

Urban design considers:

- *Urban structure* – How a place is put together and how its parts relate to each other
- *Urban typology, density* and sustainability - spatial types and morphologies related to intensity of use, consumption of resources and production and maintenance of viable communities
- *Accessibility* – Providing for ease, safety and choice when moving to and through places
- *Legibility and wayfinding* – Helping people to find their way around and understand how a place works
- *Animation* – Designing places to stimulate public activity
- *Function and fit* – Shaping places to support their varied intended uses
- *Complementary mixed uses* – Locating activities to allow constructive interaction between them
- *Character and meaning* – Recognizing and valuing the differences between one place and another
- *Order and incident* – Balancing consistency and variety in the urban environment in the interests of appreciating both
- *Continuity and change* – Locating people in time and place, including respect for heritage and support for contemporary culture
- *Civil society* – Making places where people are free to encounter each other as civic equals, an important component in building social capital

History

Although contemporary professional use of the term 'urban design' dates from the mid-20th century, urban design as such has been practiced throughout history. Ancient examples of carefully planned and designed cities exist in Asia, India, Africa, Europe and the Americas, and are particularly well-known within Classical Chinese, Roman and Greek cultures. European Medieval cities are often regarded as exemplars of undesigned or 'organic' city development, but there are clear examples of considered urban design in the Middle.

Throughout history, design of streets and deliberate configuration of public spaces with buildings have reflected contemporaneous social norms or philosophical and religious beliefs (see, e.g., Erwin Panofsky, *Gothic Architecture and Scholasticism*, Meridian

Books, 1957). Yet the link between designed urban space and human mind appears to be bidirectional. Indeed, the reverse impact of urban structure upon human behaviour and upon thought is evidenced by both observational study and historical record. There are clear indications of impact through Renaissance urban design on the thought of Johannes Kepler and Galileo Galilei (see, e.g., Abraham Akkerman, "Urban planning in the founding of Cartesian thought," *Philosophy and Geography* 4(1), 2001). Already René Descartes in his *Discourse on the Method* had attested to the impact Renaissance planned new towns had upon his own thought, and much evidence exists that the Renaissance streetscape was also the perceptual stimulus that had led to the development of coordinate geometry.

The beginnings of modern urban design in Europe are indeed associated with the Renaissance but, especially, with the Age of Enlightenment. Spanish colonial cities were often planned, as were some towns settled by other imperial cultures. These sometimes embodied utopian ambitions as well as aims for functionality and good governance, as with James Oglethorpe's plan for Savannah, Georgia. In the Baroque period the design approaches developed in French formal gardens such as Versailles were extended into urban development and redevelopment. In this period, when modern professional specialisations did not exist, urban design was undertaken by people with skills in areas as diverse as sculpture, architecture, garden design, surveying, astronomy, and military engineering. In the 18th and 19th centuries, urban design was perhaps most closely linked with surveyors and architects. Much of Frederick Law Olmsted's work was concerned with urban design, and so the (then-new) profession of landscape architecture also began to play a significant role in the late 19th century.

Modern urban design can be considered as part of the wider discipline of Urban planning. Indeed, Urban planning began as a movement primarily occupied with matters of urban design. Works such as Ildefons Cerda's *General Theory of Urbanization* (1867), Camillo Sitte's *City Planning According to Artistic Principles* (1889), and Robinson's *The Improvement of Cities and Towns* (1901) and *Modern Civic Art* (1903), all were primarily concerned with urban design, as did the later City Beautiful movement in North America.

'Urban design' was first used as a distinctive term when Harvard University hosted a series of Urban Design Conferences from 1956 . These conferences provided a platform for the launching of Harvard's Urban Design program in 1959-60. The writings of Jane Jacobs, Kevin Lynch, Gordon Cullen and Christopher Alexander became authoritative works for the school of Urban Design.

Gordon Cullen's *The Concise Townscape*, first published in 1961, also had a great influence on many urban designers. Cullen examined the traditional artistic approach to city design of theorists such as Camillo Sitte, Barry Parker and Raymond Unwin. He created the concept of 'serial vision', defining the urban landscape as a series of related spaces.

Jane Jacobs' *The Death and Life of Great American Cities*, published in 1961, was also a catalyst for interest in ideas of urban design. She critiqued the Modernism of CIAM, and

asserted that the publicly unowned spaces created by the 'city in the park' notion of Modernists was one of the main reasons for the rising crime rate. She argued instead for an 'eyes on the street' approach to town planning, and the resurrection of main public space precedents, such as streets and squares, in the design of cities.

Kevin Lynch's *The Image of the City* of 1961 was also seminal to the movement, particularly with regards to the concept of legibility, and the reduction of urban design theory to five basic elements - paths, districts, edges, nodes, landmarks. He also made popular the use of mental maps to understanding the city, rather than the two-dimensional physical master plans of the previous 50 years.

Other notable works include Rossi's *Architecture of the City* (1966), Venturi's *Learning from Las Vegas* (1972), Colin Rowe's *Collage City* (1978), and Peter Calthorpe's *The Next American Metropolis* (1993). Rossi introduced the concepts of 'historicism' and 'collective memory' to urban design, and proposed a 'collage metaphor' to understand the collage of new and older forms within the same urban space. Calthorpe, on the other hand, developed a manifesto for sustainable urban living via medium density living, as well as a design manual for building new settlements in accordance with his concept of Transit Oriented Development (TOD). Bill Hillier and Julienne Hanson in "The Social Logic of Space" (1984) introduced the concept of Space Syntax to predict how movement patterns in cities would contribute to urban vitality, anti-social behaviour and economic success. The popularity of these works resulted in terms such as 'historicism', 'sustainability', 'livability', 'high quality of urban components', etc. become everyday language in the field of urban planning.

Equality issues

Until the 1970s, urban designers had taken little account of the needs of people with disabilities. At that time, disabled people began to form movements demanding recognition of their potential contribution if social obstacles were removed. Disabled people challenged the 'medical model' of disability which saw physical and mental problems as an individual 'tragedy' and people with disabilities as 'brave' for enduring them. They proposed instead a 'social model' which said that barriers to disabled people result from the design of the built environment and attitudes of able-bodied people. 'Access Groups' were established composed of people with disabilities who audited their local areas, checked planning applications and made representations for improvements. The new profession of 'access officer' was established around that time to produce guidelines based on the recommendations of access groups and to oversee adaptations to existing buildings as well as to check on the accessibility of new proposals. Many local authorities now employ access officers who are regulated by the Access Association. A new chapter of the Building Regulations (Part M) was introduced in 1992. Although it was beneficial to have legislation on this issue the requirements were fairly minimal but continue to be improved with ongoing amendments. The Disability Discrimination Act 1995 continues to raise awareness and enforce action on disability issues in the urban environment.

Chapter 12

Space in Landscape Design

Space in landscape design refers to theories about the meaning and Nature of Space as a volume and as an element of design. The concept of space as the fundamental medium of landscape design grew from debates tied to modernism, contemporary art, Asian art and design- as seen in the Japanese garden, and architecture.

Europe

Elizabeth K. Meyer cites Claude-Henri Watelet's *Essay on Gardens* (1774) as perhaps the first reference to space in garden/architectural theory. Andrew Jackson Downing in 1918 wrote "Space Composition in Architecture", which directly linked painting and gardens as arts involved in the creation of space.

The origins of modern northern European thought is a German aesthetic philosophy of the 1890s. By the 1920s, Einstein's theories of relativity were replacing Newton's conception of universal space. Practitioners such as Fletcher Steele, James Rose, Garrett Eckbo, and Dan Kiley began to write and design through a vocabulary of lines, volumes, masses and planes in an attempt to replace the prevalent debate, centered around ideas of the formal and informal, with one that would more closely align their field with the fine arts.

According to Adrian Forty, the term "space" in relation to design was all but meaningless until the 1890s. At that time two schools began to develop. Viennese Gottfried Semper in 1880 developed an architectural theory based the idea that the first impulse of architecture was the enclosure of space. Camillo Sitte extended Semper's ideas to exterior spaces in his *City Planning According to Artistic Principles* (1889). Concurrently, Friedrich Nietzsche built on ideas from Kant which emphasized the experience of space as a force field generated by human movement and perception. Martin Heidegger would later contradict both of these schools. In his 1927 *Being and Time* and 1951 "Building, Dwelling, Thinking" he claimed that space was neither a

construct of the mind nor a given, but was “that for which a room has been made” and was created by the object within a room rather than the room itself. Henri Lefebvre would call all of this into question, linking designers’ notions of themselves as space-makers to a subservience to a dominant capitalist mode of production. He felt that the abstract space they had created had destroyed social space through alienation, separation, and a privileging of the eye.

James Rose and Garrett Eckbo, colleagues at Harvard in the 1930s, were the pioneers of a movement which adopted ideas about space from artists such as Wassily Kandinsky, Kurt Schwitters, Naum Gabo and the Russian Constructivists, and from architectural ideas based om Mies van der Rohe’s free plan. Seeing gardens as outdoor rooms or sculptures to be walked through, they prioritized movement. In analogy to painting and sculpture, Rose in particular saw elements of landscape as having architectural volume, not just mass: “In pure landscape, we drop the structural shell and the volume is defined by earth, paving, water and ground cover; foliage, walls, structures and other vertical elements on the sides, and sky, branching and roofing above.” Eckbo adopted the grid of columns and thin walls of the free plan to make a statement about the social function of the garden as a place where the individual and the collective coincide.

By the 1940s, writings about space in landscape design had proliferated. Siegfried Giedion, in his *Space, Time and Architecture*, reframed the history of architecture as that of the history of space. Erno Goldfinger wrote several influential articles in *Architectural Review* addressing the subconscious effect of the sizes and shapes of spaces. He notes that perception of space happens in a state of distraction: we are required to move through a landscape in order to fully experience it. Dan Kiley absorbed these writings and built upon the work of Rose and Eckbo, promoting asymmetry over symmetry, balance over hierarchy, multiple centers, and figure-ground ambiguity.

Minimalism

Minimalist art would have a profound influence on designers of the 1960s such as Peter Walker, Martha Schwartz, and Hideo Sasaki. On the one hand, Sol LeWitt’s space-frame sculptures and Carl Andre’s floor sculptures of mass-produced objects allowed a re-thinking of the necessity for walls in the formation of space. Geometry, repetition, and changes in ground plane created a “field of making” in which walls and even plantings were questioned as essential elements of landscape. Equally at issue in applied practice was the perception on the part of Sasaki that landscape had come to be seen as “open space”, a white sheet of paper on which to display International Style buildings. This disconnection with the landscape was especially notable in corporate office parks, and Sasaki and Walker addressed this through an attempt to connect interior and exterior spaces.

James Corner considers landscape spatiality to be one of the three things that distinguish the medium of landscape (the others are landscape temporality and landscape materiality). He refers to Gaston Bachelard in emphasizing the role of scale and psychic location, which distinguish the space of landscape from that of architecture and painting:

“the immediate immensity of the world from the inner immensity of the imagination, the inner space of the self”.

Augustin Berque analyses landscape space by comparing Newtonian universal space and Cartesian dualistic space, in which there is a distinct separation between subject and object, and Chinese mediumistic space, in which a unity of landscape and environment corresponds to a unity of mind and body. Thus postmodern thought brings together the concepts of space as product of mind, body and culture. Rather than being the negative of the objects that occupy it, space can be seen as its own volume with undeniable importance as a design tool. In contemporary design, it is considered a palpable, lived phenomenon that contributes to our perception and experience of the world in subtle but often intentional ways.

Chapter 13

Soil Conservation

Soil conservation is a set of management strategies for prevention of soil being eroded from the earth's surface or becoming chemically altered by overuse, acidification, salinization or other chemical soil contamination. It is a component of environmental soil science.

Crops and conservation

Erosion barriers on disturbed slope, Marin County, California

Decisions regarding appropriate crop rotation, cover crops, and planted windbreaks are central to the ability of surface soils to retain their integrity, both with respect to erosive forces and chemical change from nutrient depletion. Crop rotation is simply the conventional alternation of crops on a given field, so that nutrient depletion is avoided from repetitive chemical uptake/deposition of single crop growth.

Cover crops serve the function of protecting the soil from erosion, weed establishment or excess evapotranspiration; however, they may also serve vital soil chemistry functions. For example, legumes can be ploughed under to augment soil nitrates, and other plants have the ability to metabolize soil contaminants or alter adverse pH. The cover crop Mucuna pruriens (velvet bean) has been used in Nigeria to increase phosphorus availability after application of rock phosphate. Some of these same precepts are applicable to urban landscaping, especially with respect to ground-cover selection for erosion control and weed suppression. soil is one of the three main natural resources alongside with water and air.

Windbreaks

Windbreaks are created by planting sufficiently dense rows or stands of trees at the windward exposure of an agricultural field subject to wind erosion. Evergreen species are preferred to achieve year-round protection; however, as long as foliage is present in the seasons of bare soil surfaces, the effect of deciduous trees may also be adequate.

Erosion prevention

Contour plowing, Pennsylvania 1938. The rows formed slow water run-off during rainstorms to prevent soil erosion and allows the water time to settle into the soil.

Practices

There are also conventional practices that farmers have invoked for centuries. These fall into two main categories: contour farming and terracing, standard methods recommended by the U.S. Natural Resources Conservation Service , whose Code 330 is the common standard. Contour farming was practiced by the ancient Phoenicians, and is known to be effective for slopes between two and ten percent. Contour plowing can increase crop yields from 10 to 50 percent, partially as a result from greater soil retention.

There are many erosion control methods that can be used such as conservation tillage systems and crop rotation.

Keyline design is an enhancement of contour farming, where the total watershed properties are taken into account in forming the contour lines. Terracing is the practice of creating benches or nearly level layers on a hillside setting. Terraced farming is more common on small farms and in underdeveloped countries, since mechanized equipment is difficult to deploy in this setting.

Human overpopulation is leading to destruction of tropical forests due to widening practices of slash-and-burn and other methods of subsistence farming necessitated by famines in lesser developed countries. A sequel to the deforestation is typically large scale erosion, loss of soil nutrients and sometimes total desertification.

Perimeter runoff control

Trees, shrubs and groundcovers are also effective perimeter treatment for soil erosion prevention, by insuring any surface flows are impeded. A special form of this perimeter or inter-row treatment is the use of a “grassway” that both channels and dissipates runoff through surface friction, impeding surface runoff, and encouraging infiltration of the slowed surface water.

Salinity management

Salt deposits on the former bed of the Aral Sea

Salinity in soil is caused by irrigating the crops by salty water during the evaporation the water from the soil evaporates leaving the soil behind causing salinization .Salinization causes the soil structure to break down causing infertility and the plants cannot grow.

The ions responsible for salination are: Na^{+}, K^{+}, Ca^{2+}, Mg^{2+} and Cl^{-}. Salinity is estimated to affect about one third of all the earth's arable land. Soil salinity adversely affects the metabolism of most crops, and erosion effects usually follow vegetation failure. Salinity occurs on drylands from overirrigation and in areas with shallow saline water tables. In the case of over-irrigation, salts are deposited in upper soil layers as a byproduct of most soil infiltration; excessive irrigation merely increases the rate of salt deposition. The best-known case of shallow saline water table capillary action occurred in Egypt after the 1970 construction of the Aswan Dam. The change in the groundwater level due to dam construction led to high concentration of salts in the water table. After the construction, the continuous high level of the water table led to soil salination of previously arable land.

Use of [[humic acidevent excess salination, especially in locales where excessive irrigation was practiced. The mechanism involved is that humic acids can fix both anions and cations and eliminate them from root zones. In some cases it may be valuable to find

plants that can tolerate saline conditions to use as surface cover until salinity can be reduced; there are a number of such saline-tolerant plants, such as saltbush, a plant found in much of North America and in the Mediterranean regions of Europe.

Soil pH

Soil pH levels in Lake Titikaka tend to crop growth can occur naturally in some regions; it can also be induced by acid rain or soil contamination from acids or bases. The role of soil pH is to control nutrient availability to vegetation. The principal macronutrients (calcium, phosphorus, nitrogen, potassium, magnesium, sulfur) prefer neutral to slightly alkaline soils. Calcium, magnesium and potassium are usually made available to plants via cation exchange surfaces of organic material and clay soil surface particles. While acidification increases the initial availability of these cations, the residual soil moisture concentrations of nutrient cations can fall to alarmingly low levels after initial nutrient uptake. Moreover, there is no simple relationship of pH to nutrient availability because of the complex combination of soil types, soil moisture regimes and meteorological factors.

Soil organisms

Promoting the viability of beneficial soil organisms is an element of soil conservation; moreover this includes macroscopic species, notably the earthworm, as well as microorganisms. Positive effects of the earthworm are known well, as to aeration and promotion of macronutrient availability. When worms excrete egesta in the form of casts, a balanced selection of minerals and plant nutrients is made into a form accessible for root uptake. US research shows that earthworm casts are five times richer in available nitrogen, seven times richer in available phosphates and eleven times richer in available potash than the surrounding upper150 mm of soil. The weight of casts produced may be greater than 4.5 kg per worm per year. By burrowing, the earthworm is of value in creating soil porosity, creating channels enhancing the processes of aeration and drainage.

Yellow fungus, a mushroom that assists in organic decay.

Microorganisms

Soil microorganisms play a vital role in macronutrient wildlife. For example, nitrogen fixation is carried out by free-living or symbiotic bacteria. These bacteria have the nitrogenase enzyme that combines gaseous nitrogen with hydrogen to produce ammonia, which is then further converted by the bacteria to make other organic compounds. Some nitrogen fixing bacteria such as rhizobia live in the root nodules of legumes. Here they form a mutualistic relationship with the plant, producing ammonia in exchange for carbohydrates. In the case of the carbon cycle, carbon is transferred within the biosphere as heterotrophs feed on other organisms. This process includes the uptake of dead organic material (detritus) by fungi and bacteria in the form of fermentation or decay phenomena.

Mycorrhizae

Mycorrhizae are symbiotic associations between soil-dwelling fungi and the roots of vascular plants. fungi helps increase the availability of minerals, water, and organic nutrients to the plant, while extracting sugars and amino acids from the plant. There are two main types, endomycorrhizae (which penetrate the roots) and ectomycorrhizae

(which resemble 'socks', forming a sheath around the roots). They were discovered when scientists observed that certain seedlings failed to grow or prosper without soil from their native environment.

Some soil microorganisms known as extremophiles have remarkable properties of adaptation to extreme environmental conditions including temperature, pH and water deprivation.

Degradation and contamination

The viability of soil organisms can be compromised when insecticides and herbicides are applied to planting regimes. Often there are unforeseen and unintended consequences of such chemical use in the form of death of impaired functioning of soil organisms. Thus any use of pesticides should only be undertaken after thorough understanding of residual toxicities upon soil organisms as well as terrestrial ecological components.

Killing soil microorganisms is a deleterious impact of slash and burn agricultural methods. With the surface temperatures generated, virtual annilation of soil and vegetative cover organisms are destroyed, and in many environments these effects can be virtually irreversible (at least for generations of mankind). Shifting cultivation is also a farming system that often employs slash and burn as one of its elements.

Systems, most of which have an adverse effect upon soil quality and plant metabolism. While the role of pH has been discussed above, heavy metals, solvents, petroleum hydrocarbons, herbicides and pesticides also contribute soil residues that are of potential concern. Some of these chemicals are totally extraneous to the agricultural landscape, but others (notably herbicides and pesticides) are intentionally introduced to serve a short term function. Many of these added chemicals have long half-lives in soil, and others degrade to produce derivative chemicals that may be either persistent or pernicious. One alternative to chemicals in agriculture is soil steaming. Steam sterilizes the soil by killing almost all beneficial and harmful micro organisms. However no harmful remains are left. Soil health may even increase since steam unlocks nutrients in the soil which may lead to better plant growth after the thermal treatment.

Typically the expense of soil contamination remediation cannot be justified in an agricultural economic analysis, since cleanup costs are generally quite high; often remediation is mandated by state and county environmental health agencies based upon human health risk issues.

Mineralization

To allow plants full realization of their phytonutrient potential, active mineralization of the soil is sometimes undertaken. This can be in the natural form of adding crushed rock or can take the form of chemical soil supplement. In either case the purpose is to combat mineral depletion of the soil. There are a broad range of minerals that can be added including common substances such as phosphorus and more exotic substances such as

zinc and selenium. There is extensive research on the phase transitions of minerals in soil with aqueous contact.

The process of flooding can bring significant bedload sediment to an alluvial plain. While this effect may not be desirable if floods endanger life or if the eroded sediment originates from productive land, this process of addition to a floodplain is a natural process that can rejuvenate soil chemistry through mineralization and macronutrient addition.

Chapter 14

Defensible Space (Fire Control)

In the context of fire control, **Defensible Space** is the natural and landscaped area around a structure that has been maintained and designed to reduce fire danger, sometimes called '**Firescaping**'. "Defensible space" is also used in the context of wildfires, especially in the wildland-urban interface (WUI). This defensible space reduces the risk that fire will spread from the surroundings to the structure and provides firefighters access and a safer area to defend it from. Firefighters sometimes do not attempt protecting structures without adequate defensible space, for personnel safety and their effort less likely to succeed.

Criteria

- A first concept of Defensible Space for most fire agencies' primary goal of fuel reduction is a recommended or required defensible space around a structure to extend for at least 100 feet (30 m) in all directions.

- A second concept of Defensible Space is "Fuel Reduction." This means plants are selectively thinned and pruned to reduce the combustible fuel mass of the remaining plants. The goal is to break up the more continuous and dense uninterrupted layer of vegetation.

- A third concept of Defensible Space is "Fuel Ladder" management. Like rungs on a ladder, vegetation can be present at varying heights from groundcovers to trees. Grounds fuel 'rungs' such as dried grasses, can transmit fire to shrub rungs, which then transmit up tree branch rungs into the tree canopy. A burning tree produces embers that can blow to new areas spreading and so making it more difficult to control a wildland fire. One guideline is for a typical separation of three times the height of the lower fuel to the next fuel ladder. For example, a 2-foot-high (0.61 m) shrub under a tree would need a spacing of 6 feet (1.8 m) to the lowest

limbs of the tree. Since wildfires burn faster uphill than on flat land, fuel ladder spacing may need to be greater for slopes.

Landscape use

The term Defensible Space in landscape ('firescape') use refers to the 100 feet (30 m) zone surrounding a structure. Often the location is in the wildland-urban interface. This area need not be devoid of vegetation by using naturally fire resistive plants that are spaced, pruned and trimmed, and irrigated, to minimize the fuel mass available to ignite and also to hamper the spread of a fire.

1. The first 30 feet (9.1 m) is the **"Defensible Space Zone,"** of a defensible space around a structure. It is where vegetation is kept to a minimum combustible mass. A guideline used in this zone can be *"low, lean and green."*
2. The second distance of 30 to 100 feet (9.1 to 30 m), is the **"Reduced Fuel Zone"** of a defensible space around a structure. In this area of the defensible space, fuels/vegetation are separated vertically and horizontally depending on the vegetation type. This is done by: thinning, pruning, and removal of selected vegetation; and limbing up trees from lower vegetation and the lateral separation of tree canopies. types.

An important component is ongoing maintenance of the fire-resistant landscaping for reduced fuel loads and fire fighting access. Fire resistive plants that are not maintained can desiccate, die, or amass deadwood debris, and become fire assistive. Irrigation systems and pruning can help maintain a plant's fire resistance. Maintaining access roads and driveways clear of side and low-hanging vegetation can allow large fire equipment to reach properties and structures. Some agencies recommend clearing combustible vegetation at minimum horizontal 10 feet from roads and driveways a vertical of 13 feet 6 inches above them. Considering the plant material involved is important to not create unintended consequences to habitat integrity and unnecessary aesthetic issues. Street signs, and homes clearly identified with the numerical address, assist access also.

The slogan *"Provide Defensible Space, be fire-safe and fire-smart"* is used by agencies.

Unintended consequences

The unintended negative consequences of erosion and native habitat loss can result from some unskillful defensible space applications. The disturbance of the soil surface, such as garden soil cultivation in and firebreaks beyond native landscape zones areas destroy the native plant cover and expose open soil, accelerating invasive species of plants ('invasive exotics') spreading and replacing native habitats.

In suburban and wildland-urban interface areas the vegetation clearance and brush removal ordinances of municipalities for defensible space can result in mistaken excessive clearcutting of native and non-invasive introduced shrubs and perennials that exposes the soil to more light and less competition for invasive plant species, and also

erosion and landslides. Negative aesthetic consequences to natural and landscape areas can be minimized with integrated and balanced defensible space practices.

Chapter 15

Kitchen Garden

Large-scale potager at Villandry, France

The traditional **kitchen garden**, also known as a **potager**, (in French, *jardin potager*) is a space separate from the rest of the residential garden - the ornamental plants and lawn areas. Most vegetable gardens are still miniature versions of old family farm plots, but the kitchen garden is different not only in its history, but also its design.

The kitchen garden may serve as the central feature of an ornamental, all-season landscape, or it may be little more than a humble vegetable plot. It is a source of herbs, vegetables, fruits, and edible flowers, but it is often also a structured garden space with a design based on repetitive geometric patterns.

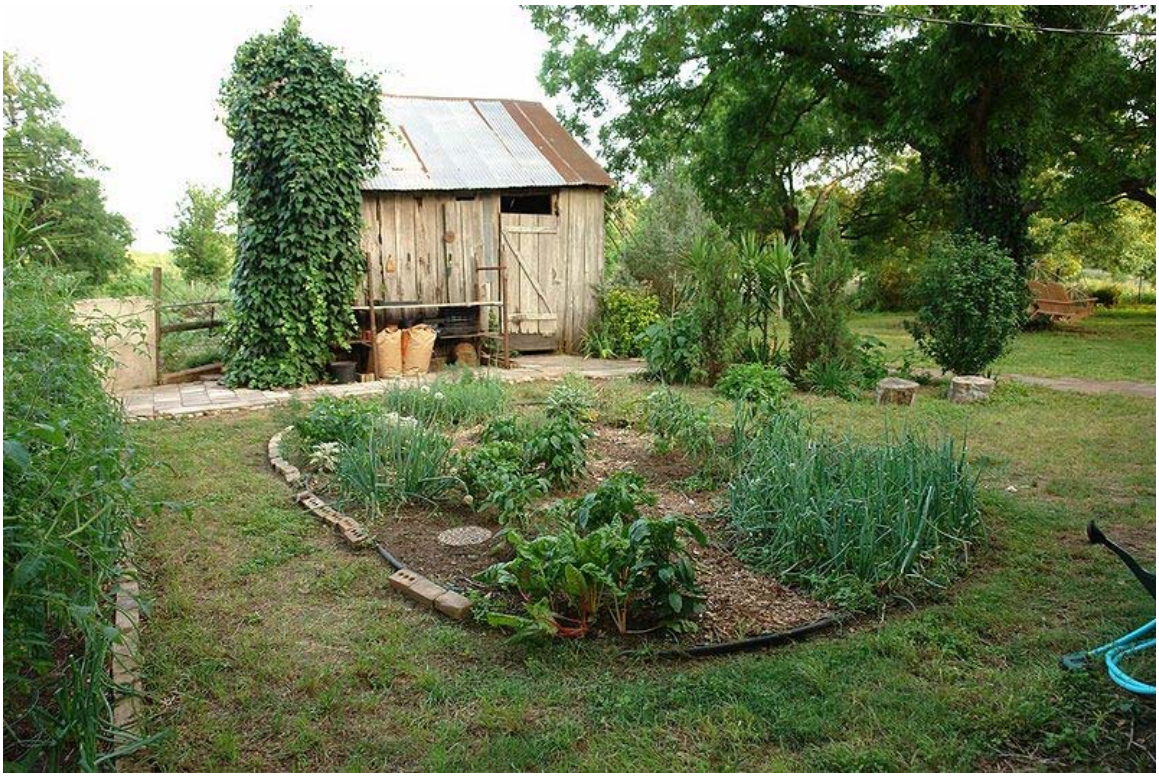
The kitchen garden has year-round visual appeal and can incorporate permanent perennials or woody shrub plantings around (or among) the annuals.

Potager garden

A potager is a French term for an ornamental vegetable or kitchen garden. The historical design precedent is from the Gardens of the French Renaissance and Baroque Garden à la française eras. Often flowers (edible and non-edible) and herbs are planted with the vegetables to enhance the garden's beauty. The goal is to make the function of providing food aesthetically pleasing.

Plants are chosen as much for their functionality as for their color and form. Many are trained to grow upward. A well-designed potager can provide food, cut flowers and herbs for the home with very little maintenance. Potagers can disguise their function of providing for a home in a wide array of forms—from the carefree style of the cottage garden to the formality of a knot garden.

Vegetable garden



A small vegetable garden in May outside of Austin, Texas

A **vegetable garden** (also known as a **vegetable patch** or **vegetable plot**) is a garden that exists to grow vegetables and other plants useful for human consumption, in contrast to a flower garden that exists for aesthetic purposes. It is a small-scale form of vegetable growing. A vegetable garden typically includes a compost heap, and several plots or divided areas of land, intended to grow one or two types of plant in each plot. It is usually located to the rear of a property in the back garden or back yard. Many families have home kitchen and vegetable gardens that they use to produce food. In World War II, many people had a garden called a 'victory garden' which provided food to families and thus freed up resources for the war effort.

With worsening economic conditions and increased interest in organic and sustainable living, many people are turning to vegetable gardening as a supplement to their family's diet. Food grown in the back yard consumes little if any fuel for shipping or maintenance, and the grower can be sure of what exactly was used to grow it. Organic horticulture, or organic gardening, has become increasingly popular for the modern home gardener.

There are many types of vegetable gardens. The potager, a garden in which vegetables, herbs and flowers are grown together, has become more popular than the more traditional rows or blocks.

Herb garden

An herbal garden at Beernem, Belgium

The **herb garden** is often a separate space in the garden, devoted to growing a specific group of plants known as herbs. These gardens may be informal patches of plants, or they may be carefully designed, even to the point of arranging and clipping the plants to form specific patterns, as in a knot garden.

Herb gardens may be purely functional or they may include a blend of functional and ornamental plants. The herbs are usually used to flavour food in cooking, though they may also be used in other ways, such as discouraging pests, providing pleasant scents, or serving medicinal purposes (e.g., a **physic garden**), among others.

A kitchen garden can be created by planting different herbs in pots or containers, with the added benefit of mobility. Although not all herbs thrive in pots or containers, some herbs do better than others. Mint is an example of herb that is advisable to keep in a container or it will take over the whole garden.

The culinary use of herbs may result in positive medical side-effects. In addition, plants grown within the garden are sometimes specifically targeted to cure common illnesses or maladies such as colds, headaches, or anxiety. During the medieval period, monks and nuns developed specialist medical knowledge and grew the necessary herbs in specialist gardens. Now, especially due to the increase in popularity of alternative medicine, this usage is heavily increasing. Making a medicinal garden however, requires a great number of plants, one for each malady.

Herbs grown in herb gardens are also sometimes used to make herbal teas.

Some popular culinary herbs in temperate climates are to a large extent still the same as in the medieval period.

Examples of herbs used for specific purposes (lists are examples only, and not intended to be complete):

- Annual culinary herbs: basil, dill, summer savory
- Perennial culinary herbs: mint, rosemary, thyme, tarragon
- Herbs used for potpourri: lavender, lemon verbena
- Herbs used for tea: mint, lemon verbena, chamomile, bergamot, Hibiscus sabdariffa (for making karkade).
- Herbs used for other purposes: stevia for sweetening, feverfew for pest control in the garden.

However, herbs often have multiple purposes. For example, mint may be used for cooking, tea, and pest control.