

“LIVINGSAPES”

THE INTEGRATION OF BUILDINGS AND LAND INTO SUSTAINABLE PRODUCTIVE SYSTEMS

by
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These notes are written for the First International Eco-Structures Conference, San Francisco, July 2001. They are my musings as a practicing architect on matters of sustainability, environmentally friendly projects, my breakthrough discovery on transforming difficult soils into good unstabilised cob and mud brick material, and one case study. Along the way there is mention of the comprehensive suite of earth building design standards written with my guidance.

Key words: New Zealand earth architect; livingscapes; comprehensive earth building standards; unstabilised earth; earth building; integrated design.

INTRODUCTION AND BACKGROUND

Over the last 30 years I have been involved in around 100 earthen architectural projects. Many of these designs have been at the forefront of the renaissance of earth building in New Zealand. My buildings incorporate a wide range of passive solar earth building techniques including rammed earth, pressed brick, mud brick, poured earth, in-situ adobe, and cob. I also use untreated timber, strawbale, reused materials, and wide variety of other non-toxic and eco-friendly materials. These buildings demonstrate a regional style of architecture that reflects New Zealand's building conditions.

I also continue to pursue the integration of plants and buildings into productive "livingscapes". I see the organic growing of food to be an integral part of our dwellings and landscapes and consider this to form a crucial part of any environmental sustainable strategy.

I am also experimenting with directly growing parts of my buildings with appropriate trees and plants, and with biologically safe waste disposal systems.

As a practitioner I know that the ideal cannot always be achieved, but have found that most clients are prepared to go at least part way down the road towards more sustainable practices. I also know that there are few absolutes in this business.

Practicing is not academic theorising - indeed it leaves very little time for such indulgences so I do what I can by example, and also by promoting eco and earthen architecture when possible with articles, talks, books and workshops.

I was the inaugural chairman of the Earth Building Association of New Zealand (EBANZ) Inc., a body devoted to promoting the art and science of earth building.

I have even indulged in long term mind bending tasks such as overseeing the writing of earth building standards to enable a much wider application of very environmentally sensible and appropriate building techniques.

I am Chairman of the Standards New Zealand (SNZ) Technical Committee for Earth Building Standards that published three comprehensive standards in 1998.

"The three Earth Building Standards produced include a performance based material standard that earthen construction materials are required to meet together with simple, practical verification tests to confirm that the required standards are attained. A second standard provides the engineering basis for both the structural design and the design for durability

against weathering for earth buildings. It is intended for use by structural engineers. The third standard enables design of the whole buildings which comply with the requirements of structural engineering standards, but are able to be designed by someone who is not a structural engineer. This standard contains design data in the form of tables and a great many drawings of construction details that enable an entire building design to be completed.” (Ian Brewer, Standards New Zealand.)

New Zealand is an archipelago in the South Pacific, perched on the junction of two tectonic plates giving it regions ranging from low to high seismic risk, coastal to mountainous, and semi-desert to very high rain fall combined with strong wind driven rains. This range of conditions is inclusive of many parts of the world so the potential application of these standards goes far beyond New Zealand’s shores.

In 1990 I was awarded the New Zealand 1990 Commemoration Medal for services to New Zealand, mostly for environmental work, partially as it related to earth building.

In 1998 I was made a Life Member of EBANZ

In 2000 I received the New Zealand Institute of Architecture’s first ever Research Award for my role in the writing of the Earth Building Standards.

SUSTAINABILITY

Three anecdotes about sustainability I like to think about:

- Traditionally, Japanese potters lay down clay for their grandchildren to use while they use clay laid down by their grandparents.....

Or;

- The English chapel that recently turned three hundred years old and needed its roof timbers replacing. In the grounds of the chapel were the oak trees planted by the original builders who know in three hundred years that the roof timber would need replacing.....

Or;

- The medieval church in Europe where the original craftsmen made two identical pieces of every piece of stained glass they needed. When replacement pieces were required after second world war bomb damage there were original pieces of glass available to be used as replacement pieces.

(I’m sorry I can’t give more detailed accounts of these examples, but I believe them to be true.)

Sustainability is not a particularly new concept any more. There are now thousands of books and articles written about it now, but the lessons are still not being heeded very often in our buildings despite many attempts to raise awareness such as these recent examples from New Zealand:

“The starting point is to recognise that a well-designed built environment benefits people. If we as a nation succeed in building imaginatively not only to give shelter but to lift our spirit, then we will have fashioned an enduring future, and enhanced the present.” (New Zealand Institute of Architects Incorporated - Discussion Paper, A National Policy for the Built Environment, 2000).

“Buildings account for about 22 percent of direct energy use in New Zealand. However the total whole-life energy use could be considerably greater (the US-based Union of Concerned Scientists in 1998 estimated that during their whole lives, including the energy used in construction and demolition, American buildings account for as much as 40 percent of all US primary energy”. (Energy Efficiency & Conservation Authority (EECA) of New Zealand - Draft national energy efficiency and conservation strategy - The built environment, Draft - 2001).

“LIVINGSCAPES”

“Livingscapes” is a idea based on a number of concepts.

The system I call “livingscapes” is both productive and diverse and includes wider intentions of life and living

It embraces the productive nature of the land we occupy and use rather than the passive Western concept of “landscape” as a vista to be admired from a distance. The idea of James Lovelock’s Gaia hypothesis is also in there with the interrelatedness of all living things to form a whole self-regulating bio-sphere.

Recognition and consideration is given to the five major elements that make up our environment: - **Earth; Air; Water; Fire; and Gaia.**

Buildings are an integral part of the landscape, the landscape we live in or “livingscape”. The structures we erect are part of a dynamic biological system, and therefore are a part of the ecosystem process and should contribute to the system in a positive way.

Enhancement of productivity, diversity and protecting the existing ecology is part of the total design and buildings are part of that. This reflects the Permaculture philosophy of development. Permaculture is an all embracing concept developed by Bill Mollison in Australia that encompasses “permanent”, and all aspects of “culture”, not only sociological, but also horticulture and agriculture. It aims to produce productive systems with the diversity and robustness of natural ecosystems. Production of food is close to where it is consumed, in what is sometimes called an “edible landscape”.

An acknowledgment of the land in its wider context leads to it being put to the best use to fulfil our human needs and the needs of the environment. Designs are based on a consideration of all resources with regard to their effect and impact on the environment as a whole.

The land and buildings work together to benefit one another in achieving the most comfortable, productive, and aesthetic design.

- Materials are carefully chosen because they benefit the system in a living way and not for purely aesthetic or design or economic reasons.
- Materials are assessed for their environmental impact from source, to use, to reuse, or disposal.
- Energy is carefully accounted for in the landscape and in buildings. Embodied energy is minimised and on-going energy costs are minimised by adopting passive solar design principles.
- Maintenance energy is reduced for both buildings and gardens by adopting materials, plant guilds and practices that minimise energy inputs.
- Regarding our buildings as part of the living system requires us to consider both the source of our resources and the health of our systems.
- Both physical and biological elements are used for environmental control, energy conservation and conversion, creation of microclimates, structures for food production, water collection and re-use, waste treatment, shelter from wind and sun, security of home and food resources, and many other functions that help us to decrease our reliance on resources beyond our immediate control and/or bio-region.

WORK IN PROGRESS

Part of my work has involved trying out different soils for suitability for building with. It was a long path to find a good cob mix using what seemed to be unsuitable earth

My own sub-soil has a clay content of around 30% and makes good strong mud bricks. However, these bricks are quite reactive with water and rapidly disintegrate if subjected to severe wetting (eg one rain storm) or wet/dry cycling. I have spent a long time trying different mixes of stabilisers eg. clay and lime, and have found excellent brews for cement stabilised mud bricks, in-situ adobe, rammed earth and pressed earth brick. I have not been very successful with lime so far.

However, my personal inclination was to find a mix that requires minimum effort to make, minimal amounts of stabilisers if any, which are effective and allow me to make walls that are mouldable, sculptural and durable. I far prefer material that I safely can put my bare feet and

hands into so searching for an unstabilised brew was important to me philosophically and practically.

The major breakthrough came when experimenting with low shrinkage cob brews. I mixed as much gravel fines into my soil as it would take, and yet still retain enough stick from the clay to hold it together. For fines I used GAP8 (graded all parts up to 8mm).

Samples proved strong enough by drop testing, the critical shrinkage virtually zero, and then came the interesting wet/dry tests. There was no sign of failure.

The ultimate test was a small dome oven I built outside using a cob mix.

The shape was not quite right so I left it out uncovered in the weather until I got around to pulling it down and rebuilding it. Somehow this did not happen and this cob dome was left sitting out in the rain and sun for 2 years, totally saturated at times, subjected to winter rain storms, other times drying out, but with no sign of damage to the earth dome other than minor surface erosion of the finest particles.

Tests with other soils have confirmed that that relatively reactive clay soils can be transformed into very weather durable materials by the addition of similar grit.

This finding has allowed a much wider selection of soils to be used than previously thought suitable for natural mud brick and cob work.

Current buildings I have designed that are under construction include:

- An owner built in-situ adobe house with earth covered roof.
- A timber house with earth brick thermal mass.
- A house with lime plastered exterior, mud brick interior walls, and an earth covered roof.
- A straw bale house with lime plastered walls.
- A combination stone/adobe house, with large reused timber beams
- My own house.

Current design work I am undertaking includes:

- A 300 sq.m. healing center that is made of all sculptural curvaceous forms, exterior walls clad with an owner-made gravel-cement block (using his own quarry) and interior walls and floor of mud bricks. The roof will be earth covered and will incorporate water pipes that will collect solar energy for distributing sub-floor. A large conservatory will grow some food plants, and also act as solar collector. Waste water is treated by vermicasting systems and wetlands before irrigating plants;
- Two owner built cob houses, one earth roofed, both on rural properties;
- A rammed earth "Vedic" house;
- An underground earth sheltered house.

Projects currently under negotiation include:

- A whole village that will be run along Biodynamic and organic lines, with the every best eco-friendly buildings and infrastructure that can be employed. The buildings will be cob walled, and straight lines are not to be encouraged. The village will include schools for all ages, a medical center, a farm and vineyard, market gardens, an auditorium, a medical centre, an old folks home, and lifestyle accommodation;
- A town centre including an auditorium, conference, meeting, and other community facilities to be built of earth and other eco-friendly materials;
- A group housing scheme of possibly several hundred earth houses, possibly owner/group built;
- A large healing centre of earth walled buildings;
- Investigation into pneumatically placed very thick cob walls, and working with earth plasters on more conventional substrates.

CASE STUDY:

THE CONFESSIONS OF AN ARCHITECT - MY OWN PROPERTY

I live 8km west of the town of Warkworth, which is about 60km north of Auckland in New Zealand's North Island on a piece of land that is 0.7 ha or 1.75 acres .

The topography is largely flat with fertile top soil overlying a sandy clay loam, and is surrounded by pastoral farmland. The property has an east-west axis and so is ideally orientated for the sun, and a small portion of the property slopes down to form warm north facing microclimates.

The climate is temperate, heading towards sub-tropical, with maximum and minimum extremes ranging from up to around 30°C in summer down to a few winter frosts around -2°C. Humidity can approach 100% at times, and is often high during both summer and winter. UV levels in the atmosphere are high by international standards in NZ.

There are no snakes.

The land was bare compacted pasture apart from a few shelter and fruit trees.

On the property is an existing old wooden villa-style house about 90 years old in fair to poor condition, but built of sound, and now irreplaceable materials such as native timber (kauri) studs, weatherboards and floors.

This house has now been protected from any further deterioration by the erection of a large verandah on all 4 sides.

Water supply is from roof collection. Annual rainfall is around 1600 mm per year and storage has been increased to around 58000 litres, with an additional pumped-on-demand garden supply from the neighbouring creek about 130m away.

I share the house with my wife Deniece, my or her children, plus two dogs and two cats, not to mention various micro-multi-legged critters

The intention is to create a living example of integrated site development, a living landscape, that includes both plants and buildings for research, educational, and demonstration purposes.

As a prominent earth building practitioner I can testify to a steady demand for workshops and demonstrations in earth building.

Associated with this earth building interest is often an interest in environmental concerns and other appropriate technologies associated with building. Therefore appropriate and alternative technologies such as aerobic composting toilets, recycling of various materials, low energy and low cost building methods, ferro-cement roofs, and solar water heaters are being located and trialed. The property has been used as a demonstration site for some tertiary students.

As this approach to land use is in its infancy, the outcomes are still a bit unclear, but it is intended that during the course of development of this property a lot of people will be involved one way or another as participants in workshops, or examine or use the systems that will be developed as a resource.

Systems are being installed that reflect the "living landscape" approach.

These include organic gardens and orchards; ponds for ducks (insect, slug and snail controllers); an aerobic vermicasting used water treatment system; water conservation methods such as targeted garden watering systems; an outside dry vault compost toilet; raised bed gardens that suit both dry and wet conditions.

The allergenic effects of plants is also considered when plants are selected.

The duck house and hen house have been built of recycled materials (bottles) and ferro cement, and guinea fowl breeding has been started (for insect control and hawk early-warning system).

Shelter belts both of exotics and natives are well established and producing more than enough firewood for domestic winter heating in the very efficient wood fire that has been installed in the old house.

A solar hot water heater has been made that uses direct solar gain from parabolic reflectors onto a reused copper hot water cylinder.

Major temperate and subtropical planting is established. A large variety of fruit is now being produced all year round, and nuts trees are growing. All the trees are interspersed with guilds of herbal lays and other plants to encourage pest control and the dogs are encouraged to act as pest controllers too.

Deniece is experimenting with an organic dye plant garden to supply dye stuffs for her fabric art work.

A large barn has been built as a workshop, with a mezzanine studio for Deniece, and it is also regularly used as a teaching venue.

An experimental straw bale building with a ferro cement roof has been largely finished to test theories about weather protection of straw bale building in this climate, and to test various cement, lime, gypsum and earth plasters. The straw has lasted very well, and the lime and earth plasters are performing the best on the straw bale. Some cob and mud brick walling has also been incorporated for contrast as well.

A "living room" comprising walls of a circle of tortured willow (*salix tortuosa*) has been planted and pruned and is part of an ongoing experiment in growing parts of building rather than building them. This living room is a very pleasant shady place in summer, and offers a good wind break in winter. It provides a great place to swing a hammock for a summer nap, to have a pleasant shady picnic, or to pitch a tent.

Most energy has been given in the first years to getting the things that take longest to come to fruition in place - namely fruit trees, and shelter trees.

Now a major building project is under way to attach a 200 sq.m. conservatory, greenhouse, outdoor/indoor living space to the eastern side of the house, but as the development is funded from income as and when means allow, progress has been slow.

The roof structure is a sparse framework of large ground embedded re-used timber power poles that carry with a very light weight economical simple canopy supported on timber posts off the poles. Light steel purlins that span up to 7m support roof glazing and other roofing material such as galvanised corrugated steel.

The roof glazing material is twin cell polycarbonate. This was not my first choice of materials and I feel a bit ambivalent about using it. I would have ideally preferred glass but used this material for several reasons:

- It was left over from a major greenhouse building project built by a colleague, and was therefore basically waste product that was offered to me very cheaply at around 1/6 the price of new twin skin polycarbonate and 1/15 the price of double glazed to solar safety glass. The sustainability of my pocket became an issue here. By using the polycarbonate I was able to afford to make a large experimental structure;
- It is insulating and therefore would not be prone to condensation or dripping;
- It filters UV from the light and therefore offered sanctuary for the very high outdoor levels prevalent in New Zealand;
- It does cut light down about 50% (measured by light meter) which is a bit more shading than I had hoped for, but still offers a very bright interior space.
- The transmittance of the materials allows light to reach the rest of the house, but protects against UV and rain.
- It is easily fitted and can also be used to create some curved roof forms.

The "living space" room has a large north facing roof, pitched to sun angles for both summer and winter, but not allow stale air that can harbour plant diseases to be trapped. It rises up to over 6m at the apex.

I was lucky to find a group of large beautiful ex-railway station windows and used them to form a large sweep of bow windows in the north east corner of the building to form a wind screen. The wall below the windows has been filled in using a stem wall of recycled fired bricks, durable timber rounds, and old bottles set in lime mortar. The wall was then built up to window sill level with mud bricks made using the soil from the property that was excavated when digging the ponds. In "wet" areas around an interior raised garden bed and pond, I have used cement stabilised in-situ adobe with ceramic mosaics.

Major enclosing and sheltering walls are yet to be built using cob up to around 1.5 - 1.8 m high with earth plastered straw to go on top of these. These walls are self supporting so are designed with the centre of gravity kept low to ensure safety against earthquake risk.

The cob base is built waiting for a wood fired cooking oven, hot plates, and hot water booster to be built from mud bricks, and form the heart of a new kitchen.

As building proceeds, the spaces will slowly be enclosed in part, to build a whole new living and sleeping area which is able to be opened up to the outside very easily using large sliding glass doors when the weather is conducive.

The ceilings of these spaces, when installed will be very free form as they only need to support themselves as the water proof skin has already been provide by the canopy roof above.

Plants will intertwine throughout this space under, over, besides, inside, outside the whole area, and the boundaries between inside and outside will become very blurred indeed. The plants, which will be chosen partially for their productivity (eg Merlot grapes) will also act as shading mechanisms during summer, evaporative coolers, and air filters. Plants will also be used to form building elements such as screens, ceilings and walls. Summer shading is currently provided by a reused large yacht sail, as we await the growth of the shading plants

The existing building, which originally I was going to remove, but realise I can not afford to replace with anything like the same quality of original materials or spaces, will also be further altered to accommodate workshop teaching and accommodation spaces, to become an integral part of the overall design.

As time goes by and shelter from prevailing winds and frost improves, more sub-tropical plants are being established inside and outside as trees and buildings create frames and microclimates.

The introduction of water elements such as a duck pond and pools has had a big influence on what is otherwise a property without flowing natural water. An indoor-outdoor house pool has raised sides so ducks can't get into it, although hopefully frogs will find it as they are also useful for garden pest control. This pond contain water lilies (a lotus I hope in particular), and edible water chestnuts, and some amenity plants. Goldfish take care of the mosquito lava.

An old stoneware fountain I made 20 years ago has been installed as well which uses a very small re-circulating electric pump - intuitively I made it with an action very similar to flow forms and it oxygenates the water, and a Japanese shi shi odo shi, or deer scare has gone in and its banging will help keep birds out of some fruit trees.

The floor of the new extension will be made from earth that will be flood coated with linseed oil. Some experiments with earth plasters are being made on walls of the existing structure, as work continues on an experimental livinglandscape that is slowly turning into a work of art as well.

Now I know where my weekends have gone!

Hone Tuwhare, poet, wrote "*Humming*" about a design I did for him. Here is an extract:

*"It is a house to be constructed with care
for it has no confining walls
thus permitting vertical expansion*

*growth is not inhibited for there
is no limit to the height of the ceiling
stretching to heaven. This house
can endure given a chance, that's
for sure. . . H m m m m*

*But since it is of earth its foundation may be
built of sand: and because there are
no confining walls this fragile house*

*of love may be seen as layers of light
and colour -*

Its a good summary.

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ILLUSTRATIONS



Exterior - Brown House - Ferro cement, and planted earth covered timber supported roof



Close up exterior view of Brown House - earth covered roof, indoor-outdoor gardens and ponds, load bearing earth walls, passive solar design, composting toilet.