MAGIC CLAY AND LIVINGSCAPES

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ABSTRACT

New understandings about natural building materials have extended the range of suitable applications, resulting in a great potential to use natural materials in a wide variety of ways in integrated design systems where the results appear to be little short of magical. The suite of three New Zealand Earth Building Standards that have been cited in the New Zealand Building Code for 9 years have proved robust and have enabled many earth walled buildings held together with natural clay to be realised. However, we need to look beyond suitable materials such as earth, straw and lime, or even buildings alone, and put them in a wider context.

The approach here called "livingscapes" is based on Permaculture and embraces the productive nature of the land we occupy and use.
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. Designs are then based on a consideration of all resources with regard to their effect and impact on the environment as a whole. This leads to plants and buildings working together to benefit one another in achieving the most comfortable, productive, and aesthetic design.

Regarding our buildings as an integral part of a wider 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, a vantage point to view 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.

Rapidly approaching environmental impacts suggest that our survival depends on such an approach.

KEYWORDS:
Earth building; natural building; livingscapes; clay; strawbale; Permaculture.

INTRODUCTION

We face multiple and major threats to our planet's life-support systems. They include over-population, peak oil along with peaks of other energy and mineral resources, loss of topsoil and soil fertility, loss of biodiversity, not to mention climate change. Some of these changes are occurring at an exponential rate.

We have now shown that collectively we can readily modify or destroy natural systems to the extent that their ability to deliver so much to us free, and everyday, may be fatally compromised. As Paul Chefurke (2007) puts it, [i] *"The problems share a number of characteristics; They are global in reach, affecting all nations to a greater or lesser extent; they interact with each other, often working together to make solutions more difficult; their solutions may be contradictory, so that solving one may make another one worse. And as if that wasn't enough, they are all happening simultaneously, right now."*

A holistic design approach that enlivens us and sustains us in a harmony with our planet is desperately needed. The use of many natural building materials fits well within such a design approach.

PERMACULTURE

One design philosophy and approach that is proving useful is Permaculture. Bill Mollison and David Holmgren in Australia developed permaculture in the 1970's. It embraces ideas of "permanent', and all aspects of "culture," not only sociological, but also horticultural and agricultural, to create sustainable and integrated productive systems. As a design approach it is all-inclusive and embracing.

David Holmgren (2002) has recently updated the permaculture design principles, and he uses proverbs to illustrate each principle:

1) Observe and Interact. *Beauty is in the eye of the beholder.*
2) Catch and Store Energy. *Make hay while the sun shines;*
3) Obtain a Yield. *You can't work on an empty stomach;*
4) Apply Self- Regulation and Accept Feedback. *The sins of the fathers are visited on the children until the seventh generation;*
5) Use and Value Renewable Resources and Services. *Let nature take its course;*
6) Produce No Waste. *A stitch in time saves time. Waste not want not;*
7) Design from Patterns to Details. *Can't see the wood for the trees;*
8) Integrate Rather than Segregate. *Many hands make light work;*
9) Use Small and Slow Solutions. *The bigger they are the harder they fall. Slow and steady wins the race;*
10) Use and Value Diversity. *Don't put all your eggs in one basket;*
11) Use Edges and Value the Marginal. *Don't think you are on the right track just because it is a well-beaten path;*
12) Creatively Use and Respond to Change. *Vision is not seeing things as they are but as they will be.*

Part of this design approach is to regard the structures we erect as part of a localised dynamic biological system, and therefore as a part of ecological processes. They should therefore contribute to the system in a positive way. According to Wikipedia [ii]: *Ecology is the scientific study of the distribution and abundance of living organisms and how the distribution and abundance are affected by interactions between the organisms and their environment*. Regarding our buildings as part of our biological support system requires us to consider both the source of our resources and the health of our systems. Our structures, as with medical practice, should certainly do no harm. In an integrated design, physical and biological elements are used for energy conservation and conversion, creation of microclimates, structures for food production, water collection and re-use, used resource treatment (there is no waste), and as part of rain and natural water flows. Sometimes we may need some kind of structure that enables us to enjoy the wind and sun, to provide security of home and food resources, and all the other many and varied functions that help us to decrease our reliance on resources beyond our immediate control and/or bioregion. Tony Watkins (2007) has pertinent comments to make about the purpose of buildings thus: [iii] "*The primary purpose of the built environment is not to "shelter" us from a hostile and unfriendly natural world, but rather to enable us to relate more closely to a natural environment which wants to give us life*."

Good aesthetic outcomes are important, not least to designers, but do need to be based on sustainability, which requires careful thinking through. So often aesthetics are given as excuses for various design results to try and justify designs that have poor environmental outcomes. Amazingly, consideration of environmental performance is seldom a factor in architectural awards programmes. Aesthetics, or cosmetics, is, however, frequently used as an excuse to overlook poor consideration of wider environmental outcomes in building and equally so in landscaping. Human needs and the overall needs of the environment must be considered together, and new bioregional design approaches and aesthetics will need to be found in building as much as with landscaping. This has enormous implications for the landscaping industry where some earnest attempts at eco-landscapes are just ways of continuing luxury ornamental horticulture with less energy inputs, but are not considering any wider productivity or ecological advantage. Similar comments apply to many attempts at green architecture where so often the result is green obesity. David Holmgren[iv] has pertinent comments to make on aesthetics: *"The role of aesthetics in building design must be seen as one of the primary diversions from ecological realities, akin to the role of ornamental horticulture in disguising unsustainable gardens and landscapes".*

LIVINGSCAPES

"Livingscapes" is a term coined by the author and is an idea generated by a Permaculture approach. It applies to the landscape we tend to occupy and use more or less on a day-to-day basis in and around our built environment, rather than broader scale systems or remote vistas. It focuses on the integrated, productive nature of the land we occupy and use for buildings and their environs. It is contrary to the practice of land, sea, and air being treated as resources to be plundered.

Livingscapes are both productive and diverse and include wider intentions of life and living. They include the Permaculture idea of creating 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 "edible landscaping."[v] It also puts a strong emphasis on gardening, local resources, natural materials, owner building, small-scale solutions, energy descent scenarios, and self-reliance.
The author considers that a 'livingscape' approach promises great potential for retrofitting or rejuvenation of towns and cities in New Zealand where there are often low density or widely spaced dwellings, often built over the top of the best horticultural land. It encourages the spaces between houses and buildings to be inter-planted with productive gardens. Buildings are designed to support people and plants, and some parts of some buildings or structures may be planted and grown. These are real living rooms. Streets, parks, and roofs can become planted with fruit trees and gardens. These will have good amenity value, but will also modify air and water quality, help attenuate stormwater, act as shelter from rain and sun, and modify air temperature with shading and cooling. Food and fuel is produced near where it is consumed, thus saving transport energy costs but also maximising ripeness and freshness. Re-learning gardening and building can green our towns and cities with a food forest.

The goal is to get land and buildings working together to benefit one another in achieving the most comfortable, productive, and aesthetic designs with materials and processes chosen because they benefit natural systems in a living way. Regarding our buildings as part of living systems requires us to consider both the source of our resources and the health of our systems. It requires that we not be toxic or harmful to ourselves, or our descendants, at any stage of the life cycle of the components or the buildings and surroundings. This will be "livingscaping."

A livingscape approach can also be of great benefit in reducing unintended consequences of our actions if we use local resources and, with them, the short feedback loops that eventuate with our material and design choices. If the result of what we do is in our own neighbourhood, then we will be more careful of the results, as they will affect us directly. This in turn leads to adopting a policy of YIMBY - YES! In My Back Yard [vi].

Some old building materials and technologies that are still relevant today may be considered in terms of the above discussion. Some materials, with a history as long as civilisation, are still incredibly useful today in helping achieve workable livingscapes. They are often readily available, have low environmental impact, yet can be used to build modern comfortable buildings. They were originally developed within a relatively low energy scenario and still fit well into a low energy or energy descent scenario. As such, they fit very well within the Permaculture and livingscape design approach.

NATURAL MATERIALS.

There are several building materials such as clay, straw, and lime that are abundant in many places, are relatively easily found and used, are non-toxic, and have low environmental impact. They have low material cost and may moderate swings in temperature and humidity inside buildings. Many of these materials are sturdy and durable, often have low maintenance requirements, and can be readily made into many different and sculptural shapes giving a very varied aesthetic range. In addition, they are readily placed and decorated by both contractors and owner-builders.

Earthen materials – bound by clay

Earth - i.e. subsoil containing clay – has been used for at least 10,000 years for building. Using it helps create what is arguably one of the most localised forms of architecture that exists. Livingscapes is concerned with localisation strategies, or YIMBY, and clay based technologies fit well in this design approach. Successful use involves careful response to local climate and seismic risk in a very direct way.

Clay is the unique substance that holds everything together in earthen architecture. It can be used to make a very wide and diverse range of products. These included solid walls and floors, insulating panels, and thin delicate and highly decorative plasters. The wide range or products and the way they can used and perform seems almost magical at times to users. There are many methods of getting earth out of the ground into the walls. The process of building and the end aesthetics can be quite varied. Earth provides a great source of mass for passive solar design. Additives such as sand, fine gravel, low density minerals, straw, wood or paper fibre, are sometimes added to the raw earth to improve the natural soils workability, strength, shrinkage, durability, or insulation values. Stabilisers such as cement, lime, or asphalt may be used but they increase the overall embodied energy while decreasing the recycle-ability of the soil, and nullifying some of the material's better environmental characteristics.[vii] Unfired earthen materials are ideal for helping with sustainable management of the earth's resources. Life cycle analyses[viii] of earthen materials give them an extremely attractive profile. Earthen materials have some of the lowest embodied energy profiles[ix] of any building material. At the end of the long life typical of a well-built earth building, earth walls can be easily reused or recycled, or left to return to the earth with minimal energy consumption or pollution.

Earth life cycle:
Subsoil dug > products made >structure built>building in use>demolition>return to soil from which it came or > re-use>
All these processes use simple processes and a minimum of energy.

The suite of three New Zealand Earth Building Standards, that have been cited as acceptable solutions in the New Zealand Building Code for 9 years, have proved robust and have enabled many earth walled buildings held together with natural clay to be erected. Considerable effort is now underway by members of the Earth Building Assoc of New Zealand (EBANZ) Inc. [x] to develop lower density earthen materials to give improved external insulation, and towards buildings reinforced more with carbon-sequestering timber or bamboo.

Earthen plasters

Earthen plasters are now appreciated[xi] for their wonderful aesthetic and humidity controlling properties[xii] when applied over a wide variety of substrates including strawbale or plasterboards. Humidity regulating plaster may also reduce some air conditioning loads. These natural and simple methods of moderating internal environments are undergoing further investigation.[xiii] Earth buildings have an ambience hard to define yet people seem to [xiv] react positively when surrounded by earth walls, floors, or earth plastered walls for ceilings. Anecdotally, buildings of natural earth are generally not the type of buildings that make people feel better once they have left them and gone outside.

Strawbale

Along with earth, strawbale is an important natural building material, giving thick walls of exceptional insulating value.[xv] Life cycle analysis of strawbale walls gives them an extremely attractive profile.

Strawbale life cycle: Cereal crop planted and straw harvested > straw-baled > structure built > building in use > demolition > return to soil from which it came to fertilise for more crops <u>or</u> > re-use> *All these processes use simple processes and a minimum of energy.*

Strawbale materials have some of the lowest embodied energy profiles of any building material.[xvi]

Strawbales are made from the stems of some cereal plants such as barley, wheat, or rice. It is largely waste material that makes a good building material but which can return readily to the soil if allowed to get wet and rot. However, there are some simple essentials for strawbale design in NZ, a country characterised by unpredictable periods of heavy, wind driven rain, and with high humidity levels. These are outlined briefly here to help those unfamiliar with this material to gain a better understanding of its use.

Strawbale buildings must be designed and constructed in such a manner that the straw always remains dry throughout the entire building process and the lifetime of the building. Consequently, strawbale buildings are quite demanding technically, and must be responsive to regional and local conditions, especially climatic ones. All sources of moisture must be considered, whether it is externally or internally generated, and the dynamic movement of water vapour through and within the strawbale wall, surface coatings, and cladding system needs to be understood.[xvii]

Primary weather protection such as very generous eaves and secondary weather protection in the form of external lime plasters, and internal lime or earth plasters, are an ideal [xviii] part of natural and strawbale building as they are highly breathable and help control moisture issues with moisture sensitive material.

Strawbales have some unusual engineering properties. They area able to absorb earthquake energy and never completely collapse under extreme load. There is interesting research being done[xix] into earthquake resistant strawbale building. Another potential use of strawbales is for building temporary post-disaster shelter. These simple yet ecologically sound materials have a great role to play in designing a successful livingscape.

Lime

Lime used in building is quicklime, or burned lime, made by kilning limestone at around 900 deg C to drive off water and carbon dioxide. The quicklime is then slaked in water to make lime putty that is in turn used to make mortars, plasters, and lime wash. These products slowly cure and re-absorb some of the carbon dioxide to re-form limestone. There is growing interest around the world to revive the use of lime as a building material. After a 2000-year history, faster acting and stronger Portland cement products largely displaced its use. Lime does have a secure place in natural and ecological building, partly because of its positive lifecycle analysis [xx] and its lower embodied energy[xxi] compared to cement products.

Lime life cycle:
Limestone burnt with $H_2$0 and CO_2 driven off > resulting quick lime slaked with water to make slaked or hydrated lime > mortars or plasters made and structure built - - hydrated lime absorbs CO_2 from the atmosphere > structure in use > demolition > return to soil as soil conditioner OR re-burnt to make more quicklime>
All these processes use relatively simple processes and a minimum of energy, esp compared to cement.

Cement is a very useful material but we do need to regard it as precious because of the large amount of energy[xxii] that goes into its manufacture. This approach might be summarised as follows: *"I suggest to my workshop participants to look at cement as Gold (and not as the bad guy). Gold is a material that allows us to do many amazing things but it is very costly (not just to buy, but also to mine, transport etc.). One would not consider building ones car out of gold just because it is possible. It would become very heavy and therefore materials that are more appropriate would be chosen. (But this often takes more time/reflection). Cement also allows us to do many things.... but it has its price, so we are advised to use it sparingly."* [xxiii]

As the environmental advantages of lime products and their compatibility with earthen and strawbale materials become more widely known, we can look forward to a strong revival in interest in, and the use of, these materials.

SUMMARY

"Livingscapes" is based on Permaculture and is not remote landscape. It is the integration of the land and buildings we intensively occupy and which sustain us. It embraces the productive nature of the land we occupy and use. 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. Designs are then based on a consideration of all resources with regard to their effect and impact on the environment as a whole. This leads to plants and buildings working together to benefit one another in achieving the most comfortable, productive, and aesthetic design.

Some old but still very suitable natural building materials such as earth, strawbale, and lime, because of their low embodied energy and often local availability fit very well into an energy descent, relocalised, and wider livingscape design context to give combined results that can sometimes appear to be simply magical.

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[ii] *www.en.wikipedia.org/wiki/ecology*
[iii] See *http//:www.tony-watkins.com*
[iv] Holmgren, David. 2002. "Permaculture–Principles and Pathways Beyond Sustainability".
[v] An often used description of permaculture.
[vi] David Eisenburg, Director, Development Centre for Appropriate Technology. Pers com 2006
[vii] For a more detailed discussion on this by the author see: *http://www.ecodesign.co.nz/mudbrickcobandstabilisers.shtml*
[viii] By the author
[ix] 0.29-0.47 MJ/kg "Embodied Energy Co-efficients of Building Materials" Andrew Alcorn 1996
[x] Members involved with this research include Verena Maeder, Peter Olerenshaw and the author.
[xi] Personal experience of the author of many comments from many clients and visitors
[xii] Minke, G. 2006 "Building With Earth"
[xiii] National Museum of Denmark "Humidity Buffering By Absorbent Material In Walls." *www.natmus.dk/cons/tp/wallbuff/wallbuff.htm* or Tim Padfield, "The Role Of Absorbent Building Materials In Moderating Changes Of Relative Humidity". *http://www.padfield.org/tim/cfys*.
[xiv] Personal experience by the author over many years
[xv] A 450 thick strawbale wall will have an R value of around 7
[xvi] 0.24 MJ/kg *ibid endnote 8*
[xvii] For a more detailed discussion on moisture and strawbale building by the author see: http://www.ecodesign.co.nz/strawbale.shtml
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[xx] Holmes, S & Wingate, M. 1997 "Building With Lime"
[xxi] Figures not well established that I but lower kiln temperatures and simpler processing leads me to this conclusion
[xxii] 7.8 MJ/kg *ibid endnote 8*
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