ECO-DYNAMIC™ ARCHITECTURE AND PLANNING

Pliny Fisk III
Center for Maximum Potential Building Systems
8604 F.M. 969
Austin, TX 78724
pfisk@cmpbs.org

ABSTRACT

Three built architectural projects exemplifying CMPBS' work are presented with particular reference to our design methodology. Increasingly, it is important to develop and adopt procedures that are replicable, accountable, and contain enough breadth of purpose to meaningfully contribute to the demands of a sustainable world. Although these projects are based on a design protocol that some could perceive as limiting the creative process, some have been published alongside some of the 20th century's most prestigious architectural design work, and featured in several design journals in the U.S., Europe, and Asia.

To be both respectful of culture and nature in an accountable manner is often considered an either/or proposition. To compound the problem, one could argue that both culture and environment are at a pinnacle of risk, often making the either/or gap even more profound due to over concentration on one or the other. To raise the stakes even further, the bridge between culture and nature – technology -- is consistently placed in one camp or another and rarely becomes the useful link that it should.

The paper describes five inter-operability procedures that all projects share, and demonstrates how we incorporate them in one of the four service areas that CMPBS provides, Eco-Dynamic™ architectural design services. The resulting vernacular resulting from these efforts places new meaning to words such as site, boundary, scale and life cycle. Together, these concepts connect a given project into a world of serious international protocols while connecting them to the realm of everyday practice. The method accepts an important internationally discussed technique, ecological footprinting, and develops this technique into a useful planning tool for buildings, sites and master planning. Through the use of iconography we acknowledge a form of culturally relatable objects, primarily symbols, that identify spatial areas that enable participatory planning of sites and buildings. The three projects described provide various windows of entry into this lexicon so that one can understand sustainable design in a much broader, more meaningful manner.

1.0 INTER-OPERABILITY PRINCIPLES

At the risk of using a buzzword, the word inter-operability brings a degree of understanding to our work at the highest level and sets a tone that exemplifies where we spend a great amount of time working. Inter-operability principles differ from design principles in that they offer both important thinking tools and can adapt to achieve the requisite or desired degree of operational robustness. Whenever possible they are based on protocols that could be applied to a number of disciplines, are international in origin, and offer a purpose to technology that critiques it as a long-term productive linkage between humans and nature.

1.1 Procedure One –The Infinite Grid

Our template for planning a building, a site, a master plan or a county is based on an internationally recognized grid system for understanding and recording the multiple parameters of what is on the ground. The so-called UTM – the Universal Transverse Mercator system – is an equal area grid that can be broken down through what is known as the quad grid method of subdivision, currently used by some 90 countries.

1.2 Procedure Two – Boundary

Perhaps the most glaring problem in how planners or architects do business is the denial or misuse of the boundary concept, whereby a spatial performance for any technology is admitted. The approximation of spatial area of whatever shape or orientation is accomplished within our methodology through the consistent subdivision of each equal area cell into four equal areas. Each of these areas can be reduced consecutively into an infinitely small size to approximate the area or volume of any land use process at whatever accuracy.

1.3 Procedure Three – Scales

In an effort to respect the extent of influence that a built artifact has on the environment and people, we record the multiple sets of boundaries within which various human life support activities take place. Life support refers to the myriad techniques that humans and other living beings use to support their existence such as water harvesting, food production, and waste treatment. Some of these boundaries can be small, such as the amount of area needed for a wind system, or large, such as water harvesting in an arid region. Together they determine the multiple scales that define a given project.

1.4 Procedure Four – Life Cycle Space

Any scale represented by a boundary is defined by the extent of total spatial sub-areas representing how that life support activity is accomplished from its source or origin, its use and finally to its reuse or re-sourcing phase. Together these sub-activities make up the life cycle space.

1.5 Procedure Five – Performance

The degree of activity accomplished in a given space or, in mathematical terms, the ratio of activity accomplished inside vs. outside a spatial area, is referred to as performance. The ultimate purpose of sustainable design and planning is to match needs of life support technologies to the attributes supplied by nature. The degree of spatial fit between human life support technology boundary and the land unit boundary can be represented by a simple ratio. This ratio is either in balance or in imbalance, the latter occurring when it exceeds its limits or falls short of the value needed to support an activity.

2.0 INFINITE GRID AS PERFORMANCE CONTEXT

The ratio in performance terms of activity space within and without a given spatial area at all scales provides a context in performance terms for any given project site. The relative importance of choosing to balance or not to balance within the boundaries of a given land resource area can be partially determined by the hierarchy of balanced space use occurring down to or up to the scale of the site. The infinite grid ratioed areas, shown below, provide various performance contexts for a variety of topics familiar to the practitioner of sustainable planning and design. Projects that follow demonstrate how balance or imbalance was determined.

Ratios are determined by following a life cycle convention and comparing its “source” phase to its “re-source” phase. Since one of the most common numeric analyses consists of non-land footprint results and more mass and energy flow units, two types of ratios must be recognized: one, material mass balance, or energy balance; and two, other eco-footprint land area equivalency balances that represent these numerical balances but in technology-to-land relational equivalents. The procedure translates activities into three spatial footprint equivalents for a given sustainable technology: the ratio of the source of a life cycle topic inside and outside the site; the ratio of the re-source inside vs. outside the site; and, finally, the ratio of source to re-source inside the site in land footprint area terms. These become the spatial areas that we use to plan and determine balance. Unfortunately, due to lack of data, some scales must be skipped. Often material balance fits into this category due to society’s choice not to collect mass flow types of information along continuous geographic scales. The importance of recognizing that such a procedure *could* be used as a measure of sustainability due to its representation of a wide breadth of topic areas and its ease of understanding is evident.

3.0 EXPLANATION OF RATIO CONVENTIONS

It is essential to understand the basic conventions used to derive the ratios described in this paper. The numerator is defined as that resource used and the extent of its use, while the denominator is defined as the degree of re-sourcing occurring relative to the same boundary within which the numerator was measured. A value of 1.0 thus signifies a perfectly balanced system. A ratio number greater than 1.0 signifies a resource used beyond its capacity for replenishment. Since we refer only to sustainable technological systems (systems based on renewable and/or abundant resources) the numbers only relate to the use of sustainable technologies. For example, relative to the amount of energy generated by renewable resources vs. total energy demand, the U.S. is 19.7 times in imbalance. A system whose sustainable resources are under-utilized becomes that resource’s savings account for the future, and often is used as a regenerative system that can balance other imbalanced systems (either remote or neighboring). The ratio descriptions that follow are brief due to space limitations, but will be more fully described in the conference session.

3.1 Air Balance Ratio

In measuring existing conditions altered by human activity, the air ratio is defined as the ratio of the land's micro- and macro-flora to supply oxygen compared to the use of oxygen or, similarly, the ability to sequester carbon compared to the generation of carbon. A planning footprint is the combined ratio in land area terms of the area needed to supply oxygen compared to the land area to supply CO2 sequestering per person for that plant/soil type. Other air balancing issues could be calculated and, together, be used as a combined air balance ratio, mathematically or by land unit type.

3.2 Water Balance Ratio

Water balance as a measure of existing conditions is defined as renewable surface water compared to use, or sustainable recharge of groundwater compared to use. An appropriate planning ratio footprint is one in which the area for harvesting rainwater is ratioed to the land area for sustainably treating the wastewater using living plant technologies per person for that location.

3.3 Food Balance Ratio

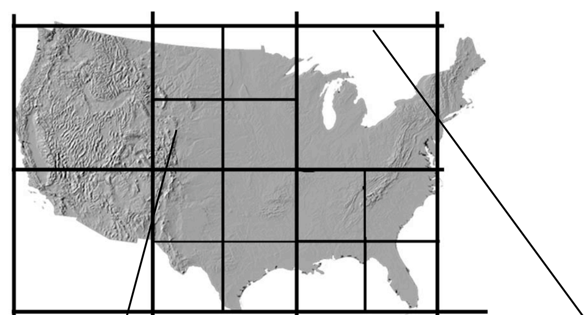
Food balance is measured by how much food is supplied within a given designated boundary, or by the amount of total food waste (sewage and preparation waste) that is treated within that same boundary. The on-site planning footprint is the amount of food production potential per unit of land per person compared to the amount of waste treatment area needed to return nutrients per land area per person.

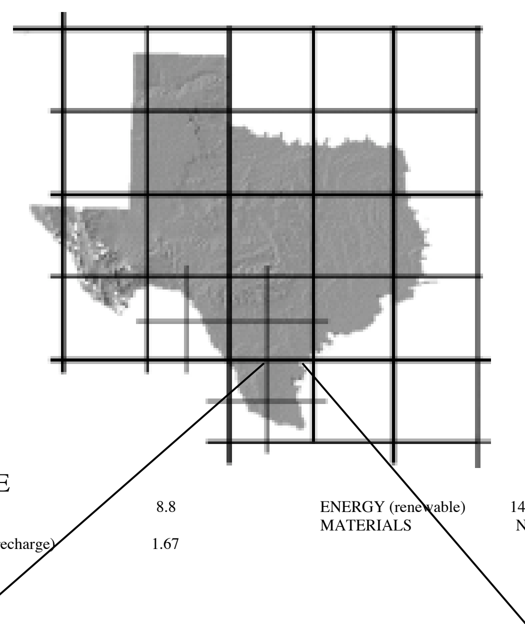
3.4 Energy Balance Ratio

A ratio measurement for the amount of sustainable energy balance for existing conditions is a calculation of the total energy used compared to that which is renewably supplied. An appropriate planning footprint is the ratio of the total renewable energy footprint suitabilities compared to the amount of land area appropriate for building use, including all the best combined areas for foundation suitability, microclimate, parcel size, slope, soils, drainage, etc..

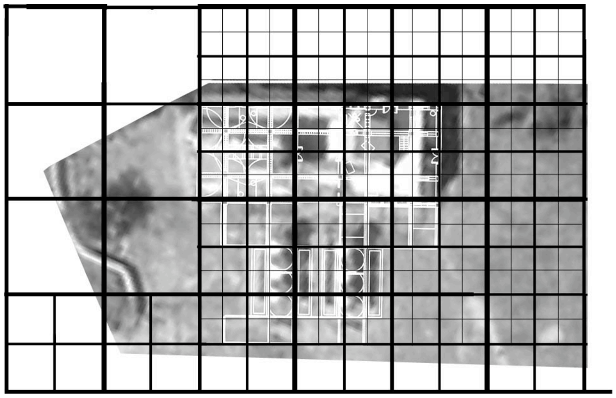
3.5 Material Balance Ratio

A simple measure is the comparison of the total materials wasted compared to the amount created and used. In the U.S., the *upstream* ratio is 15.8 (e.g., there are 15.8 times the mass quantity of materials wasted vs. used). An ideally designed material system is one in which all materials created are designed for continual reuse in the original configuration in which they were designed. This would result in a substantial reduction in upstream impact. Material balance occurs under two fundamentally different circumstances: one based on renewable materials and the other on inert non-renewable ones.





surface .62
FOOD NA



SITE (4 people)

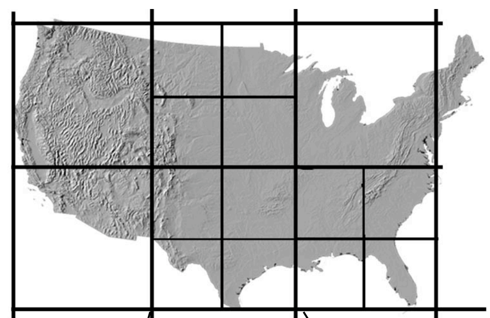
AIR	2.0	ENERGY (renewable)	1.0
WATER	1.0	MATERIALS (region)	.7
FOOD	.15		

4.0 ECO-DYNAMIC™ ARCHITECTURE AND PLANNING

Life cycle balancing on the land and within a building is a fundamentally different concept than a conservation procedure. The latter is a never-ending process towards ultimate failure because boundary is not part of the performance equation. Balance is a never-ending goal that, while never fully achieved, offers a more realistic context within which to measure an ever-evolving learning system. Due to the contexts of boundary, infinite grid, scale and life cycle performance, balance offers as well a fundamentally different procedure to understand spatial planning and integrative use at any scale. The fact that the dynamics of time and the rate of change of existing parameters have not been mentioned thus far does not mean that these cannot be accepted. (Indications are that the time dimension can drastically alter results.)

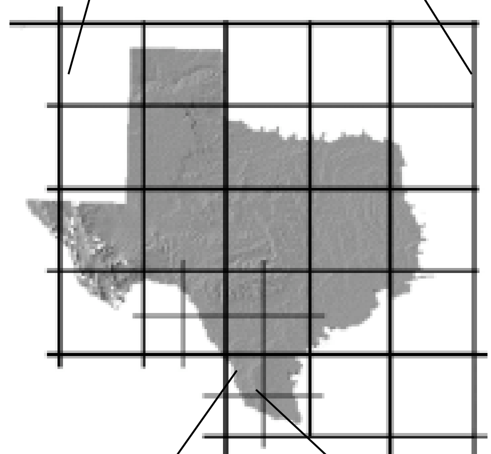
By using universal and, in some cases, extremely fundamental, simple to understand, time tested principles (ratio analysis was first used by the Chinese and Greeks), the procedures could gain rapid acceptance. Although only barely discussed in this paper, the flexible nature of the architecture presented offers a longevity of life cycle already demonstrated by some of the structures. The Laredo Blueprint Farm, for example, has gone through a total transformation of use within its 10 years of existence.

What makes the end result eco-dynamic™ architecture is the total responsiveness, both to humans' changing needs aesthetically and to changing time/space needs exhibited by a structure throughout its lifetime. This dynamic is constantly paired with nature space, and thus responds in a sustainable manner to the spatial areas required from nature to support human needs in a more balanced relationship.



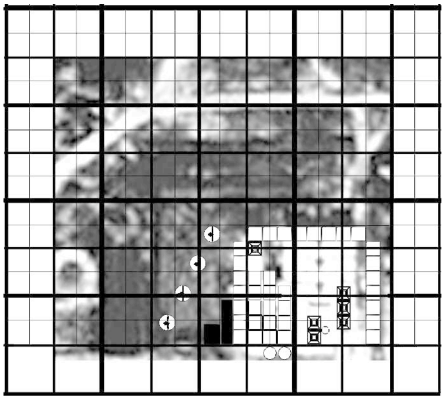
COUNTRY

AIR CO_2	21	ENERGY	
(just forest cover)	31.5	renewable	19.7
WATER		MATERIALS	
ground (using recharge only)	.17	(all - upstream only)	15.7
surface	.18		
FOOD	NA		



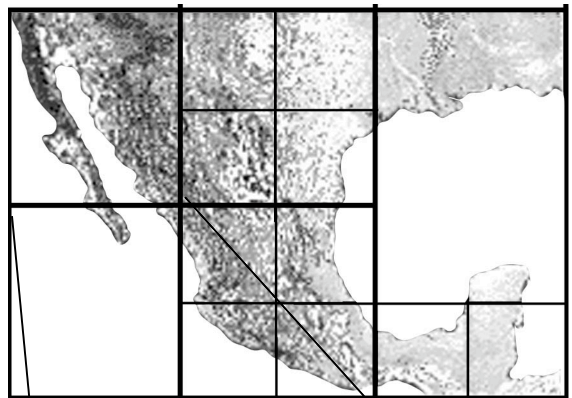
STATE

AIR CO_2	8.8	ENERGY (renewable)	142
WATER		MATERIALS	NA
ground (recharge)	1.67		
surface	.62		
FOOD	NA		



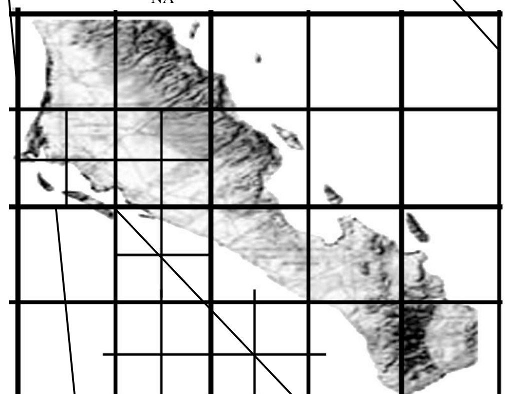
SITE

AIR	.5	ENERGY	1.0
WATER (surface region)	1.0	MATERIALS (region)	.8
FOOD	.0125		



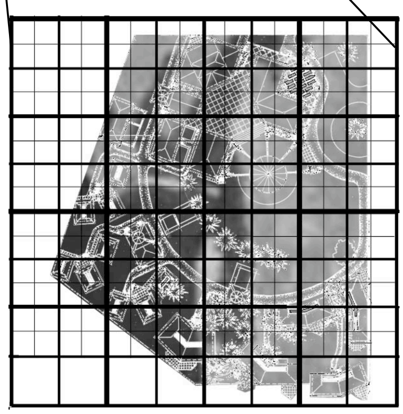
COUNTRY

AIR (forests only)	2.6	ENERGY	
WATER		(renewable only)	9.4
surface	.19	MATERIALS	NA
ground (recharge)	.18		
FOOD	NA		



STATE

AIR CO2 (est.)	>2.5	ENERGY (est.)	
WATER (used similar countries)		non-renewable	30.5
ground	6.8	MATERIALS (est.)	10-15
surface	40.3		
FOOD	NA		



SITE

AIR CO2 (est.) 2.5 ENERGY (est.)
1
WATER (est.) 1.5 MATERIALS (est.) 4
FOOD 0

5.0 ACKNOWLEDGEMENTS

I want to thank Bill Bavinger for introducing me to the concept of the Infinite Grid and ratio analysis; Mark Kelley for permission to use his trademarked term “eco-dynamic™ architecture”, and for both their inspiration for helping this thought process to develop.

6.0. REFERENCES

Bhattacharya, Hrishikes. Total Management by Ratios: An Integrated Approach, Sage Publications, 1995.

Gleick, Peter H. The World’s Water: The Biennial Report on Freshwater Resources 1998-1999, Island Press, 1998.

Hauchler, Ingomar, and Paul M. Kennedy, editors. Global Trends: The World Almanac of Development and Peace, Continuum Publishing Co., 1994.

Robbins, Paul, editor. The Austin Environmental Directory 2000.

Sampat, Payal. “Groundwater Shock: The Polluting of the World’s Major Freshwater Stores,” WorldWatch Vol. 13, Number 1, January/February 2000.

Texas Center for Policy Studies. Texas Environmental Almanac, 1995.

Texas State Energy Conservation Office. Texas Energy: Past, Present, Future, Virtus Energy Research Associates, 1995.

United Nations Development Program. World Resources 2000-2001: People and Ecosystems, World Resources Institute, 2000.

Water for Texas: A Consensus-Based Update to the State Water Plan, Volume II, Texas Water Development Board, 1997.

Worldwatch Institute. State of the World 2000, W.W. Norton & Co., Inc., 2000.