Eighth International IBPSA Conference
Eindhoven, Netherlands
August 11-14, 2003

FIRST WORLD BUILDING DESIGN USING THIRD WORLD EXPERIENCES AND ADVANCED TECHNOLOGIES

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ABSTRACT

A holistic approach to the design and procurement of a project should result in a building, which can become uniquely embedded in its natural, social and economic environments, like a living system.

In a strange way my African experience has lead me to these ideas and I shall talk about why I think this has happened

This conference has its focus on the importance of the role of simulation techniques and I shall show how these have become an essential part of the process.

NATURE

The project should become embedded in its natural environment by actively responding to it and be seen to do so. For this to be possible its designers need graphic/mathematical descriptions of its immediate place in the biosphere in order for the building to succeed in harvesting light, air water ground temperatures like a living system.

Humans are continuously creating and recreating constructs of nature. The one to which I subscribe is the GAIA theory which was originally published in 1972 by James Lovelock and Lyn Margulis. They were inspired by the image of earth rising over a Luna landscape and they gave us a story of how living organisms can regulate the planets environment to suite life. This theory describes the dynamic interaction of the sun, the moon and earth shrouded in its thin mantle called the biosphere, in which life (the biota) maintain suitable conditions for life. Simulations of the present condition of the ecosphere confirm that human activity is radically altering the steady state of the systems in ways, which will become less favorable for the humans species and life in general. These include global warming and all the now well known symptoms associated with release by humanity of time trapped energy.

I will illustrate the Gaia theory with a picture of Lovelocks self-regulating global thermostat.

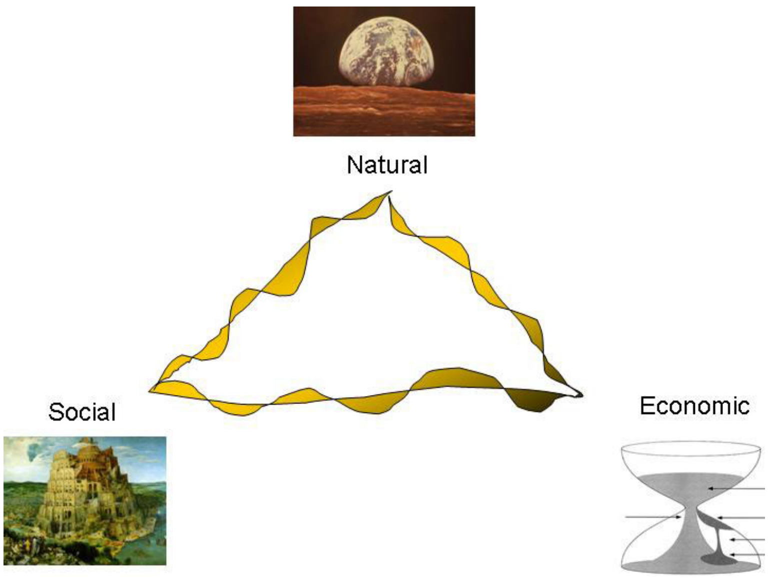


Figure 1

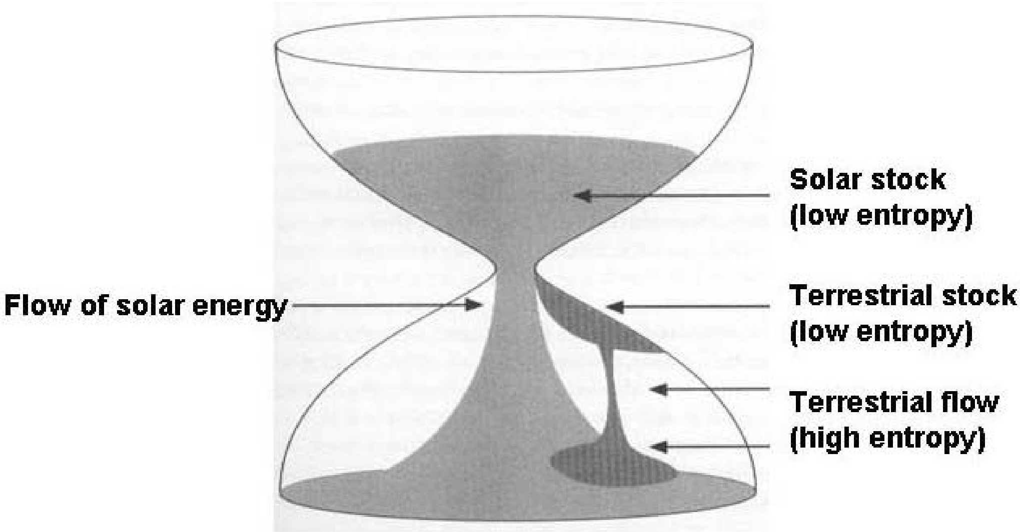
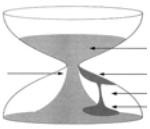


Figure 2 Georgescu-Roegen's entropy hourglass

In this case he published a paper in the 80's stating that marine algae are part of a massive global regulatory system that keeps the climate stable. The algae produce a gas called dimethyl sulphide (DMS), which reacts with oxygen in air above the sea to form tiny solid particles. These sulphate aerosols provide a surface on which water vapor can condense to form clouds. And clouds keep the planet cool by reflecting solar radiation back into space. Tim Hamilton took this idea further by suggesting that the process was part of dispersal. (the third property of an organism after survival and reproduction.)

ECONOMY



The procurement of the human and natural resources needs an economic basis, which follows the laws of thermodynamics rather than the law of supply and demand, in order to achieve sustainability. However, this objective poses three problems; scale(size),distribution (justice).and allocation (efficiency).

Georgescu-Roegen's entropy hourglass

The abstract of your paper should be about 100 words. It should be a brief but concise description of your paper and should clearly identify the unique features of your study.

An explanation of this analogy:

- The hourglass is an isolated system; no sand enters, no sand exits. This represents the universe
- Within the glass there is neither creation nor destruction of sand, the amount of sand is constant. This is an analog of the first law of thermodynamics – the conservation of matter/energy.
- There is the continuing running down of sand in the top chamber, and an accumulation of sand in the bottom chamber. The sand in the bottom chamber has used up its potential to fall and thereby to do work. This is high-entropy or unavailable (used up) matter/energy. Whereas the sand in the top chamber has the potential to fall- it is low-entropy or available. matter/energy. Entropy is times arrow in the physical world. This is the second law of thermodynamics.

This analogy can be extended, by considering the sand in the top chamber to be solar stock or the sun's energy. As the sand falls through the restricted waste of the hourglass the rate of flow is limited. This represents the delivery of solar energy we get each day. This incidentally is far more energy than we could ever need. At present the sun delivers in 40 minutes the same energy that is used by the whole of humanity in a year. But we cannot regulate the flow rate. In fact over the last four and a half million years the ecosphere has become adapt at handling the daily delivery of solar energy.

Some of the sand however during the last 200 million years or so has got stuck on the underside of the lower glass. Let us suppose that this low entropy matter/energy or fossil fuel. It is time caught solar energy. We have found ways of mining this energy and of using it at whatever rate we chose, unlike direct solar energy.

This is the problem. The faster we use this time-released energy the faster the build up of entropy, which the ecosphere cannot absorb.

This aspect of the problem let us call scale meaning the size of the project and by implication the ecosystems capacity to absorb the resulting entropy.

The second problem mentioned above is distribution and has to do with where the resources are located and who gets them? This I have dealt with under the heading social below.

The third problem mentioned above is allocation or the efficient use or energy/ matter. Perhaps the most efficient system of energy transfer on the planet is the eco-system which is why I chose living systems like the termitary as metaphors of projects. The problems of allocation are dealt with in the projects I shall include in the lecture.

Life and deatch of fossil fuel

Fossil fuel oil expected to peak around 2010 and gas in 2020 (figure 1)

At this time the price for a barrel of oil will start to rise and only the move to renewable energy sources will hold it from rising and rising until it runs out in about 2050.

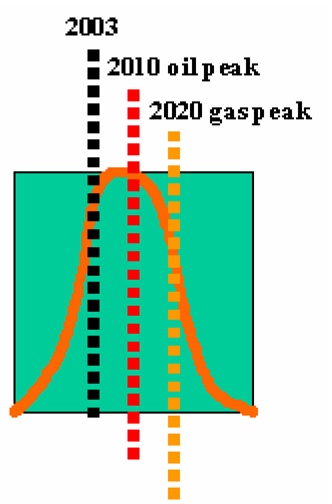
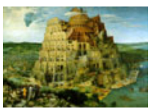


Figure 3 Fossil fuel oil peak

As we descend down the other side of the bell curve social and environmental problems will drive us to change our energy base. Some have called this an energy water shed. Such periods in history have stimulated great innovations.

SOCIAL



The project should actively respond, in its place in the city, to the historic, political and social landscape. For this to be achieved graphic models of these realities are required in order for its designers to succeed in providing a stimulating, healthy and secure environment. Examples of these models will be shown.

Learning from the poor

The huge majority of human settlements in Africa today are based on very low energy consumption. These very poor and so called underdeveloped people may well find that the transition to a solar/hydrogen based economy is extremely easy; like running down hill by comparison with the first world which has become so dependant on fossil fuel.

Low energy projects based on passive and renewable energy transfer are already economically viable in the third world countries because the cost of fossil fuel energy is vastly higher comparatively speaking than it is for the first world. Especially where there is also no oil and an abundance of sun. In first world where economies are burdened with bank debt on projects based on non-renewable energy sources this is not the case.

Also in an African environment where the cities are growing at four times population growth rates with almost no expansion of centralised infrastructures the only possible way out of crisis is to decentralise energy production, water harvesting and sewage treatment and to harvest solar energy. The cry in the west for the polycentric city has already been reached in Kinshasha which is called locally a city of "swept up villages".

Comparisons like "a high tech farmer in the USA needs 10 calories of energy to produce 1 calorie of food. In Africa a peasant can produce 10 calories of food from 1 calorie of renewable energy" are important to see in this context.

The problem here is that the rate of production enjoyed by the USA farmer is vastly different. He can increase production by at least 2000%. In fact it is this ability, which has driven the industrial age and world population growth (at the expense of the environment and increased entropy).

At the same time that the number of workers on the land in the USA has dropped from 60% in 1850 to 2.7% today, the cost of paying human labour in the USA to perform the same amount of work as can be achieved by one barrel of oil is now $45000. The cost of a barrel of oil is around $30.

This cost difference in Africa is quite different because labour costs are almost too small to compare but it is the effect of globalisation on markets has driven the South into a disastrous spiral of economic collapse. However as soon as the fossil fuel reserves peak in a decade or so this situation will radically change.

In Zimbabwe where the combination of bad management, corruption and state sponsored violence has destroyed an industrialised fossil fuel based farming industry and has left 12 million people completely unable to feed themselves. In this country the fossil fuel age has supported the population growth from one to twelve millions and has raised expectations of the fully motorized garden city under the banner of development. Now the truth has to be been told that the much promised development can never be realised. The planet has not the natural resources to support six or even less ten billions in this life style.

In Africa the stark realities of the other side of a world in the midst of an age of enormous wealth we can clearly see that the growing difference in wealth between the rich and poor is untenable. In fact it is this social reality, which is already and will in future even more force the rich countries to change their energy base to renewable resources.

The birth of a new age based on renewable energy, possibly H2, could solve the problems of scale allocation and distribution mentioned above.

As designers of the built environment today we cannot afford not to ignore these realities.

PROJECTS IN AFRICA, BELGIUM AND IN AUSTRALIA

I will now show what is achieved in practice by this holistic approach to the procurement of projects in various and quite different locations. Hopefully you will see the results are at least specific to their respective locations and have only the approach or underlying philosophy in common.

Zimbabwe

In Harare, Zimbabwe I will show the following two buildings:

EASTGATE, Harare. This has benefited from data logging system installed within the structure and which has collected data for three years while the designers inhabited the building and were able to observe and to feel it's performance. This was the first building to use the thermal mass of its structure to passively cool the internal office environment. This has consistently proved that 40C of cooling can be harvested from a diurnal shift of 120C.

HIS THEATRE, Harare. Here the client financed a simple research and development programme to prove the performance of rock store cooling.

We have found that as much as 80C of cooling can be harvested from 120C of diurnal shift. We have also developed with Ove Arup an all passive wind driven air extractor, which works in urban environments.

Belgium, Zolda

We were able to persuade the client to partly finance the development of a wind driven turbine air extractor. We also introduced the idea of using disused mine shafts for geothermic heating.

Australia, Melbourne

I will show a mixed development of offices and shops called CH_2, which is being built for the Melbourne City Council.

This project aims to encourage what is called ESD (eco-sustainable design) in future city developments by showing the public how far one can go towards zero emissions within the current Australian economic environment, while satisfying local needs as well as providing a much healthier working environment than is normal.

It is to be a fully air conditioned building with a difference. It will not be an inferior system when compared to conventional air conditioning. It will, however, incorporate new technology to Australia and will provide significant operation cost benefits through energy reduction.

Some features will include:

- Facade treatment as an expression of air and light will be showing a way to harvest light while minimizing heat gain and loss.
- Night flushing will be used to remove daily heat gains
- Chilled ceilings combined with thermal mass storage and the use of PMC's (phase change materials) and evaporative cooling in shower towers will be used in a closely linked control system to Melbourne's extremely variable climate in order to minimized energy use for cooling and heating.
- Wind energy will be harvested with wind turbine extractors developed in Zimbabwe
- Solar energy is to be harvested for hot water for washing and for cooling air.
- Solar energy PV collectors will harvest sunlight for sun tracking sun shields and for night lighting.
- Air Supply will be 100% fresh and changed twice every hour
- Water systems will include rainwater and dew water collection (air wells)
- Total water recycling plant will filter water from solids, in order to demonstrate how water can be recycled on site

- A co generation gas turbine power plant is to be installed which will convert natural gas into power and heat for cooling water will reduce the use of brown coal derived power from the grid. This maybe replaced by a hydrogen based fuel cell system in the future.
- A locally manufactured Ceramic fuel cell will reform methane to produce power. We are investigating the possible bacterial digestion of solid wastes for methane production on site for the fuel cell.

Procurement processes The team working process in Melbourne has been like an orchestra with a conductor. However, normally an orchestra performs in the same room so that they can hear each other. In our case we had to work from our respective offices in Melbourne, Sydney, Harare Zimbabwe, The Martin Centre in Cambridge and Imperial College in London, as well as meeting face to face for numerous workshops and reviews. This would only be possible with the Web and air transport. Importantly it has so far been a collaborative process of a group of minds working with the same objective and thereby stimulating each other.

Simulation modelling The design team has benefited from simulation models.

The natural; Virtual modelling of the natural environment the effects of a great number of design options by using the growing menu of simulation programmes

The social; Modelling of the social environment it has to be said is more problematic. Anything involving quality and value judgements are often best dealt with in workshops and debates. These models of expected social behaviour patterns are designed to help interior design have been produced by DEGW.

Environmental control; Modelling and simulating expected internal conditions have been very extensive on this project. They have been essential in detail design. I will show a selection in order to explain why they played a significant part in the design of architectural elements.

Full scale model A full scale model of the internal bay is being made to aide lighting and layout detail design.

Salt bath modelling Finally I hope to show how the use of salt bath model, which will simulate the air displacement system and night flushing. The advantage of this from of simulation is that you are not looking through someone else’s mind, as in the case of the pre programmed computer models.