Biomimetic Architecture

Skin and surface

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What is sustainable?

**Life**

4 billion years and continuing with only solar energy as an input
The Origin of Life, J Keosian

“a precise definition… one which will include all living things, past or present is not possible”.

Five categories relating to their order, energy, separation, self-perpetuation and evolution.

Another trait which all living entities possess by default, living entities are interdependent, they cannot survive individually or in a vacuum; they rely upon being part of the cycle of materials and flow of energy within an ecosystem.
Gaia theory and life

“Life is an ecological property; it is only an individual property for a brief flash of time... a oneness of varied complex biological systems, all making continuous and subtle trades with one another, joined by the common goal of using to the utmost all that the present environment has to offer in terms of energy and raw materials “

James Lovelock Gaia 1972
Eric Katz  
Nature as Subject 1999.

“Life is not an artefact but a process…..

“An environment suggests an animal and likewise an animal also describes its own niche in an environment...

It is incorrect to isolate an animal or an environment.. They are one and the same.”  
Factors of Individual life

**Order**
- Structure
- Synergy

**Energy**
- Metabolism
- Storage
- Rhythm
- Responsiveness
- Homeostasis

**Separation**
- Skin

**Self perpetuation**

**Evolution**
Order
Structure

Synergy
Energy
Metabolism
Storage
Rhythm
Energy

Responsiveness

Homeostasis
Separation

Skin

Self perpetuation

Evolution
Individual life: a summing up

Non-sustainable ‘open systems’ of energy,
which are ultimately dependent upon solar energy,
for their sustained existence.

The maintenance of an improbably high degree of internal order,
created from the variation and repetition of a limited number
of standard compositional elements, by the gathering and
expenditure of energy in a process called metabolism,
indicated by a rhythm within the organism.

The use of negative feedback mechanisms
to maintain internal homeostasis separate from the external environment.

The use of a common energy currency and storage mechanism.
Individual life: a summing up [2]

Responsiveness to environmental stimuli
in order to maximise the collection of energy and exploitation of their niche.

The ability to self-perpetuate using only external energy and materials.
The process of development, characterised by increased size and complexity

The use of a hereditary unit, DNA, to control the physical, chemical and behavioural traits of the organism.

Adaptation and evolution generated by genetic mutation and hybridisation.
Collective Life

Collective life can be defined by five major characteristics:

Order - Energy
Homeostasis
Cybernetic systems
Separation
**Collective Life**

**Order** -
Characterised by life’s structure consisting of a complex system of interdependent organic systems, acting within a closed materials system.

**Energy**

Collective life can be seen as an unsustainable open system of energy, ultimately dependent on solar energy.
Collective life (cont)

Homeostasis -

the constant evolution of collective life to regulate the environment at a favourable condition.

Cybernetic systems

the presence of an active control system utilising negative feedback systems, which maintain homeostasis.

Separation –

Life exists within and maintains defined boundaries, which act to mediate between the internal-external conditions.
Common Factors of individual and collective life

- A high degree of internal order, with a closed materials system.
- They are open energy systems ultimately dependent on solar energy.
- The maintenance of homeostasis.
- Responsiveness/Cybernetic systems.
- Separation between in and out.
Ecocentric architecture

The reactionary ecocentric or ‘deep ecology’ movement maintains a strongly biocentric construct of the environment.

This places Mankind as part of the Earth’s ecosystems. As such ecocentrics accept the intrinsic value of ‘nature’ and recognise man’s moral obligation towards all ‘natural’ entities.

Ecocentrics are sceptical of large-scale modern technology. They believe that increasing human manipulation of the non-human world must be reversed by the adoption of different technological, economic and ideological structures.

Such changes would focus on improvement of the quality of life those below subsistence levels, rather than merely enhancing the material standards of living.
Solari, Christopher Day, Edward Cullinan
**Technocentric architecture**

Simultaneous to the ecocentric reaction, there was a more universal acceptance and exploitation of the benefits of technology.

The technocentric, or Cornucopian viewpoint, is the predominant Western environmental approach, linked to an anthropocentric notion of the duality of mankind and 'nature'.

The technocentric approach recognises the presence of environmental problems, strongly desiring to solve them, as well as improving the material lot of the world’s people. They are optimistic that this can be achieved, through ever increasing technological development.

The application of this undiluted, rational, scientific approach based on 'Classical Science' makes man see as justified in manipulating nature for technological advancement, which is indicative of social progress.
Isozaki, Archigram, Piano, Yeang, Foster
Search for a living (bioclimatic) architecture

*The Symptoms*

1. **Order**  
   (At all levels)

   **Macro**  
   Climate derives form
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The Symptoms

1 Order (At all levels)

Meso
Planning and organisation
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The Symptoms

1 Order (At all levels)

Micro
Integration of strategy in façade detail
Order

Murcutt, Hopkins, Feilden Clegg, Arups
2 Composition

*Earth is a closed system* – ecology works in cycles

*Meso*
Production
2 Composition

Earth is a closed system – ecology works in cycles

Micro
Construction/ deconstruction
2 Composition

Earth is a closed system – ecology works in cycles

Macro
Life cycle design
3 Metabolism

**Building must be entirely dependent on solar energy for existence**

**Macro**
Solar envelope
3 Metabolism

Building must be entirely dependent on solar energy for existence

Meso
Passive solar systems/ design
3 Metabolism

Building must be entirely dependent on solar energy for existence

Micro
Active systems
  PV cells
  Solar collectors
4 Energy Storage

Heat
Daily
Seasonal
Electricity
Water
5 Rhythm

Macro
Summer/winter
5 Rhythm

Meso
Day/night
5 Rhythm

Micro
Occupied/unoccupied
Insolated/not insolated
6 Homeostasis

“The ability to maintain internal conditions within predetermined limits”

The most defining characteristic common to all life,

Promotes difference between in and out

This utilises a combination of responsive ‘cybernetic’ systems working (antagonistically) to maintain optimal internal conditions.
7 Responsive (cybernetic) Systems

- BMS
- Active systems
- Loose control
- User control
8 Separation

Intelligent facades
Self shading facades
Double skins
What is Bioclimatic Architecture?

Bioclimatic architecture is a way of designing buildings and manipulating the environment within buildings by working with natural forces around the building rather than against them.

It is biomimetic - copying the processes of nature to make optimal solutions.

Thus it concerns itself with climate as a major contextual generator, and with benign environments using minimal energy as its target.
What is Bioclimatic Architecture?

Sustainable
Bio-mimetic
Emergent
Adaptive
Self similar

Individual
Community
Superorganism
Mutualistic Insertion

- Biomass Powered Blast-furnace
Mutualistic Programme

Steel Recycling
This furnace will recycle the steel waste generated in Manchester

Algae Array
Waste gas is passed through the algae tubes, which produce biomass and oxygen

Oxygen Blast Furnace
The algae could fuel this process through gas and biomass production

Symbiotic Exchange
The oxygen generated by the algae array will fuel a steel blast furnace

Hot Rolling
This processed steel is then hot rolled into sections and floated down the Rochdale Canal
Resource flow diagram

- Purified Water
- Carbon Dioxide
  - Basic Oxygen Furnace
  - Oxygen
  - Oxygen
- Algae Array Producer
  - Photosynthesis
  - Surrounding Residential
  - Electricity
- Sun
- Biomass
- Dirty Water
- Combined Heat and Power
  - Heating
- Laboratories
  - Information
  - Auditorium
- Electricity
Key

1. Algae Array
2. Sky Light
3. Opening Steel Frame Glazing
4. Steel Profile Deck
5. Rigid insulation
6. Poured Resin Floor
7. 600mm RC Foundations
8. Paint Fixed Glazing
9. Polished Concrete Floor
10. Air Services Duct
11. Algae Facade Duct
12. Algae Tube Facade
External Views
Ecotone: An Opera House
Zero carbon urban living
Interactive façade, Glasgow Sustainable office competition winner
Nutritionally Complete: zero carbon city carpet
Biogenic city emergence
Phenotypic Plasti-city
Under growth rule, the permitted amount of overshadowing on active façade (sub 4) must be evaluated.

Critical Insolation Time Period: 12.00hrs.
Generated Subdivision: 6.
As facade under evaluation is fully insolated, rule permits a shadow cast from sub 6 equal to 33.33% of the total evaluated area. Note: This permitted shadow zone must be initiated from ground level.

Critical Insolation Time Period: 12.00hrs.
Generated Subdivision: 6.
‘Solar Envelope’ wire frame. Envelope surfaces follow Azimuth and Altitude ‘Path’ that originated from the active façade of Phenotypic equivalent (sub 4).

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'Solar Envelope' wire frame. Envelope surfaces follow Azimuth and Altitude ‘Path’ that originated from the active façade of built context.
Critical Insolation Time Period: 12.00hrs.
Generated Subdivision: 6.
‘Solar Envelope’ shown to protect specified solar access of active facades (Phenotypic equivalent) and rooftops (built context).

Critical Insolation Time Period: 12.00hrs.  
Generated Subdivision: 6.

Critical Insolation Time Period: 12.00hrs.
Generated Subdivision: 6.
Generation of subdivision 6 volume not complete as:

- Growth process affected subdivision 4.
- Shadow cast onto sub 6 from surrounding context (Active shadow) has not been quantified.

Critical Insolation Time Period: 12.00hrs.
Generated Subdivision: 6.
Shadow cast by subdivision 6 volume affects Phenotypic composition of subdivision 4.

Note: shadow falls short of adjacent roof and aligns itself with 33.33% facade shadow line.

Critical Insolation Time Period: 12.00hrs.
Generated Subdivision: 6.
Critical Insolation Time Period: 12.00hrs.
Generated Subdivision: 6.

'Shade-Tolerance' volumetric composition of subdivision 4 has now been updated.

Shade-Intolerant volume decreased.
Shade-Tolerant volume introduced.
As shadow from surrounding built form encroaches boundaries of subdivision 6 (Active shadow), composition of Phenotypic volume must adapt accordingly.

Critical Insolation Time Period: 12.00hrs.
Generated Subdivision: 6.
Active shadow introduces Shade-Tolerant Volume to Phenotypic volume of subdivision 6.

Critical Insolation Time Period: 12.00hrs.
Generated Subdivision: 6.
Generational growth process completed for subdivision 6.

Critical Insolation Time Period: 12.00hrs.
Generated Subdivision: 6.
Critical Insolation Time Period: 12.00hrs.
Generated Subdivision: 6.

Generational growth process completed for subdivision 6.
(Compiled image).

Red zones: (Shade-Intolerant)
Grey zones: (Shade-Tolerant)
Complete model for all sites at all times of day

This model includes each block derived for each of the main insolation hours 9am - 3pm
Guaranteed solar and shadow access, Miller Street, Manchester.
Conclusions

Block size - determines overall building volume
Mutualism - buildings work together to maximise solar aperture
Mixed use - shade tolerant and shade intolerant must coexist
No need to seed - but its possible to control type of community
  with careful ‘sylviculture’
Performance - better than Debs Potsdamer Platz
  As good as Linz in parts
Interseasonal Using equinox sun angles -
  hints at interseasonal storage