BIOMIMETIC ARCHITECTURE

SEMINAR 2011-2012

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B070225AR

CONTENTS OF PRESENTATION

WHAT IS BIOMIMETICS?

Biomimetics is the term used to describe the substances, equipment, mechanism and systems by which humans imitate natural systems and designs.



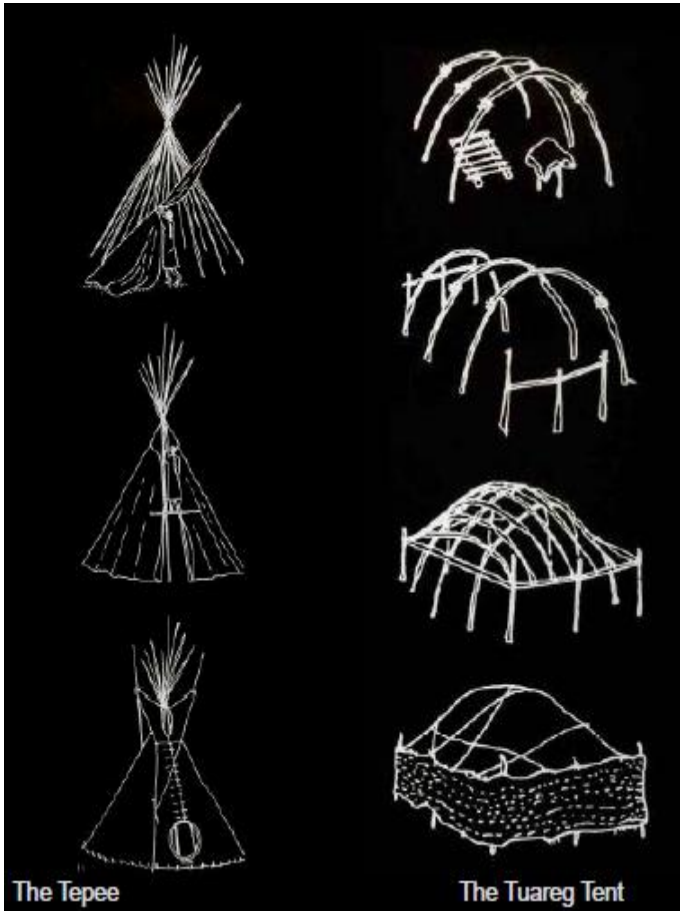

- Biomimicry originates from two Greek words

  Bios = Life

  Mimesis= imitate

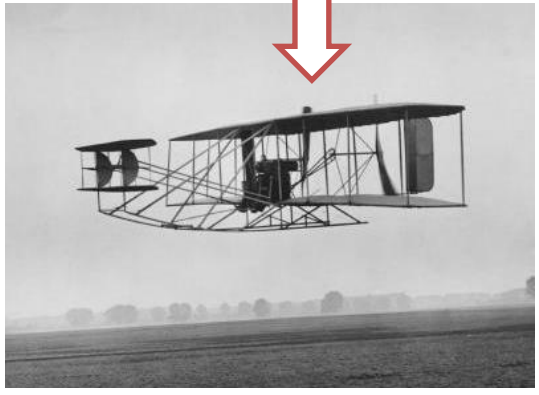
- Biomimicry operates on the principle that in its 3.8 billion year history, nature has already found solutions to many problems we are trying to solve.

- Biomimicry is multi-disciplinary subject involving wide diversity of other domains like architecture, electronics, medicines, biology, chemistry, mathematics etc.


The Tepee
The Tuareg Tent

FLIGHT OF BIRD

LEONARDO DA VINCI'S FLYING MACHINE

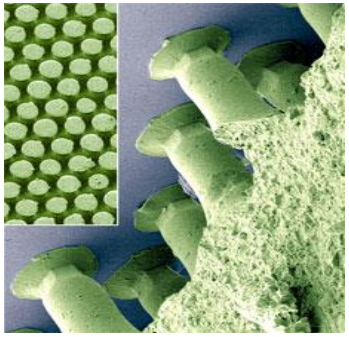


WRIGHT BROTHER'S FIRST PROTOTYPE

AEROPLANE TODAY

GECKO TAPE

Inspiration

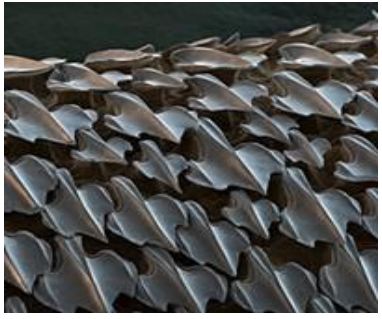


Precedence

Product

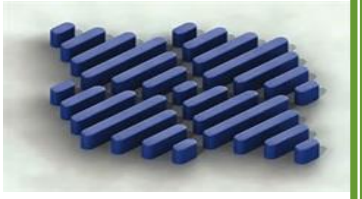
SHARKLET TECHNOLOGIES

Inspiration



Precedence

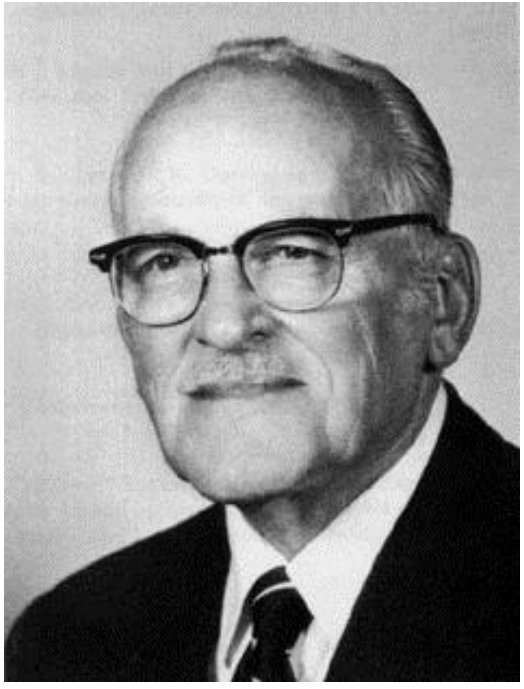
Textiles



Surfaces

HOW DID IT BEGIN?

- American biophysicist and polymath.
- Coined the term Biomimetics in 1950's.
- Developed Schmitt trigger by studying the nerves in squid.
- Attempted to engineer a device that replicated the system of nerve propagation.



Otto Schmitt (1913-1998)

HOW DID IT BEGIN?

- American writer and scientific observer from Montana.
- Wrote the book “Biomimicry: Innovation Inspired by Nature” in 1997
- The books gives an insight on how significant biomimicry is in shaping the future.
- In 1998 she co-founded the **Biomimicry Guild** which helps inform , inspire and empower the bridging of nature’s wisdom with human knowledge.

Janine M. **Benyus** (b 1958)

APPROACHES TO BIOMIMICRY

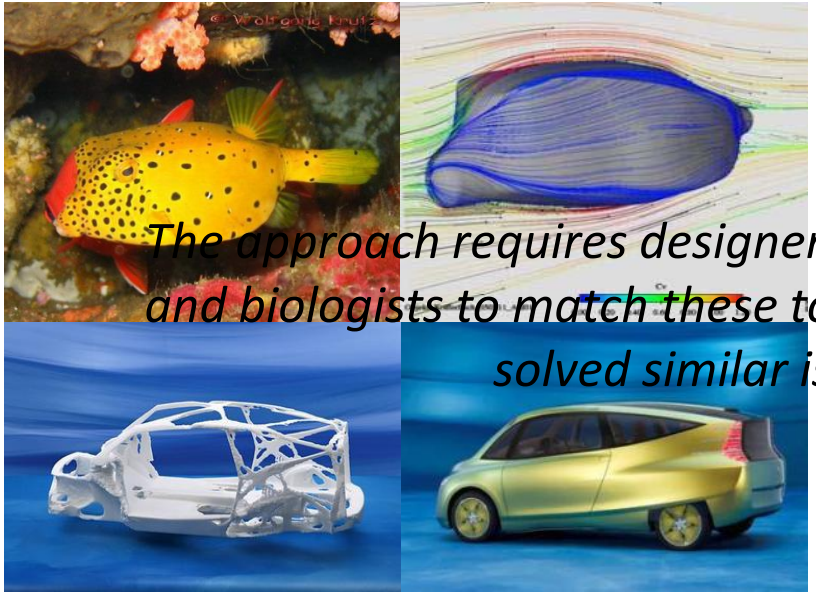
There are two approaches to Biomimetic design

DESIGN ⟶ BIOLOGY

BIOLOGY ⟶ DESIGN

APPROACHES TO BIOMIMICRY

DESIGN TO BIOLOGY



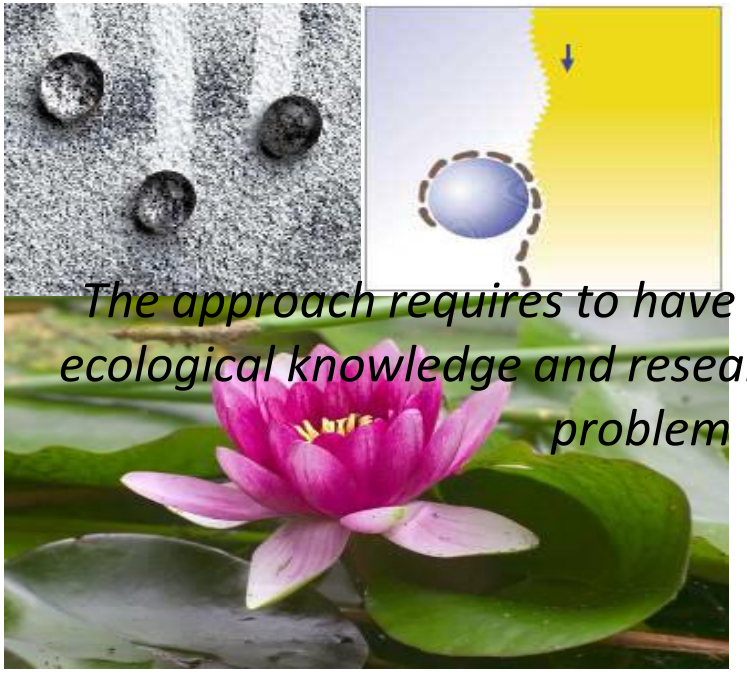
The approach requires designers to identify problems, and biologists to match these to organisms that have solved similar issues.

- More fuel efficient due to aerodynamic body mimicking BOX FISH
- More material efficient due to mimicking tree growth patterns for structure.
- The car not new approach to transportation but improvement to existing technology

DaimlerChrysler's ***Bionic Car***

APPROACHES TO BIOMIMICRY

BIOLOGY TO DESIGN



Lotus inspired's ***Lotusan Paint***

The approach requires to have relevant biological or ecological knowledge and research rather than design problem

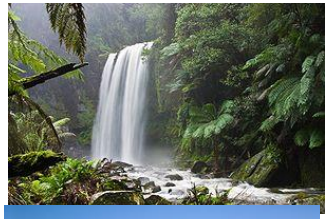
- Lotus flower emerges clean from swampy waters.
- Lotusan paint enables buildings to be self cleaning.
- Biology can influence humans in ways outside predetermined design problem.
- This will result in previously unthought-of technologies or systems or approach to design solutions.

PRINCIPLES OF BIOMIMICRY

NATURE

PRINCIPLES OF BIOMIMICRY

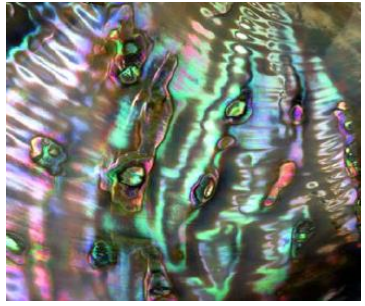
- Nature runs on sunlight.
- Nature uses only the energy it needs.
- Nature fits form to function.
- Nature recycles everything.
- Nature rewards cooperation.
- Nature banks on diversity.
- Nature demands local expertise.
- Nature curbs excesses from within.
- Nature taps the power of limits



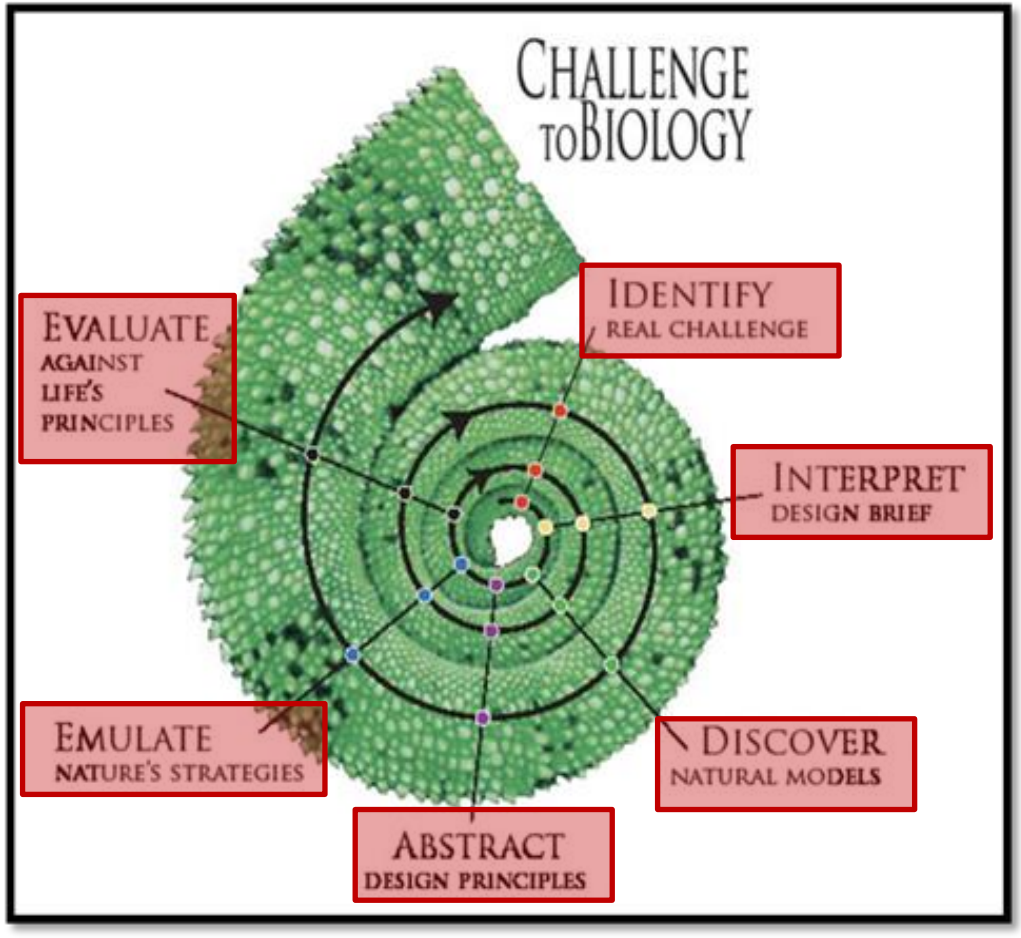
NATURE AS A MODEL

NATURE AS A MEASURE

NATURE AS A MENTOR



STEPS TO ADOPT BIOMIMCRY



Biologize the question: ask from nature's perspective.

Develop a design brief of human needs

Develop ideas and solutions based on the challenges

Abstract the design against Life's Principles

Emulate nature's strategies within nature that achieve success

Discover natural models that meet the challenges

Evaluate the design against Life's Principles

LEVELS OF BIOMIMICRY

ORGANISM LEVEL

BEHAVIOUR LEVEL

ECOSYSTEM LEVEL

Organism level
(Mimicry of a specific organism)

	Example - a building that mimics termites:
form	The building looks like a termite.
material	The building is made from the same material as a termite (a material that mimics termite exoskeleton / skin for example).
construction	The building is made in the same way as a termite (it goes through various growth cycles for example).
process	The building works in the same way as an individual termite (it produces hydrogen efficiently through meta-genomics for example).
function	The building functions like a termite in a larger context (it recycles cellulose waste and creates soil for example).

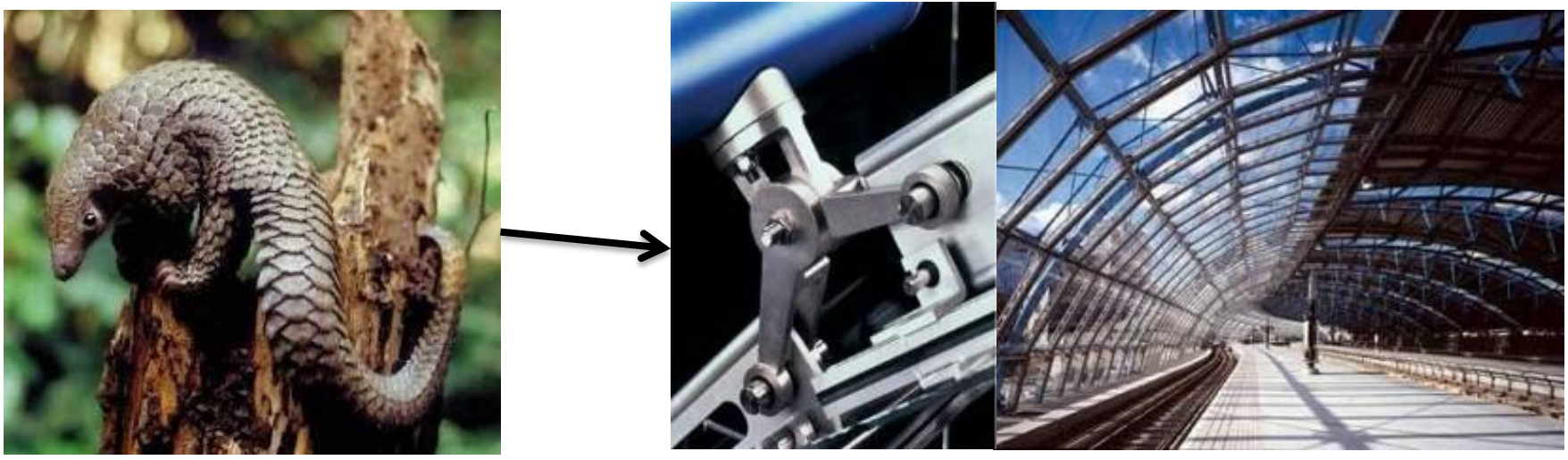
Behaviour level
(Mimicry of how an organism behaves or relates to it's larger context)

form	The building looks like it was made by a termite (a replica of a termite mound for example).
material	The building is made from the same materials that a termite builds with (using digested fine soil as the primary material for example).
construction	The building is made in the same way that a termite would build in (piling earth in certain places at certain times for example).
process	The building works in the same way as a termite mound would (by careful orientation, shape, materials selection and natural ventilation for example), or it mimics how termites work together.
function	The building functions in the same way that it would if made by termites (internal conditions are regulated to be optimal and thermally stable for example). It may also function in the same way that a termite mound does in a larger context.

Ecosystem level
(Mimicry of an ecosystem)

form	The building looks like an ecosystem (a termite would live in).
material	The building is made from the same kind of materials that (a termite) ecosystem is made of (it uses naturally occurring common compounds, and water as the primary chemical medium for example).
construction	The building is assembled in the same way as a (termite) ecosystem (principles of succession and increasing complexity over time are used for example).
process	The building works in the same way as a (termite) ecosystem (it captures and converts energy from the sun, it stores water for example).
function	The building is able to function in the same way that a (termite) ecosystem would and forms part of a complex system by utilizing the relationships between processes (it is able to participate in the hydrological, carbon, nitrogen cycles etc in a similar way to an ecosystem for example).

Form/ process mimicry at **ORGANISM LEVEL**



Waterloo International Terminal , London

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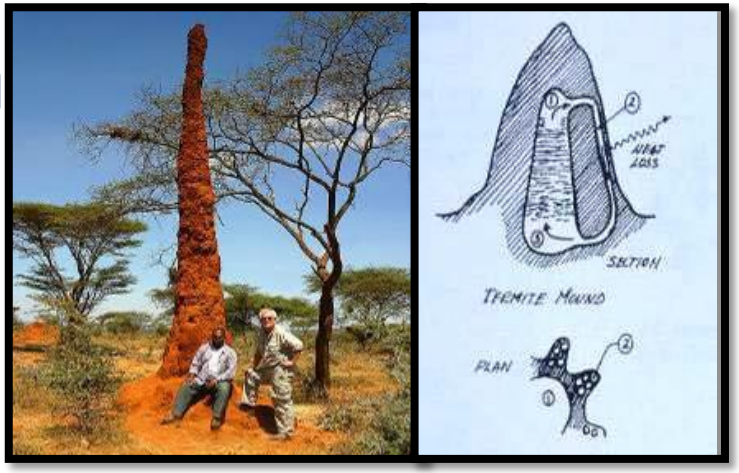
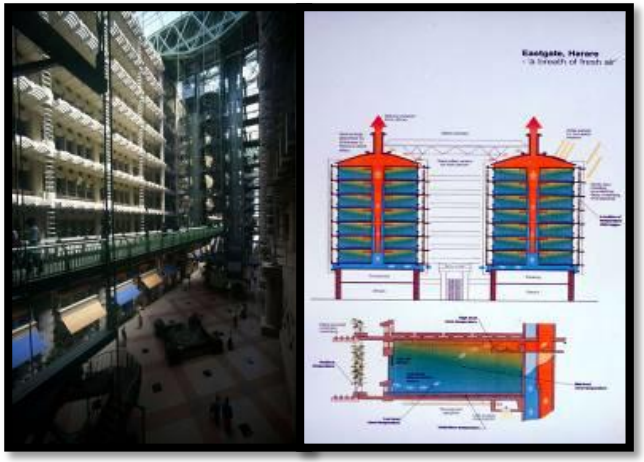
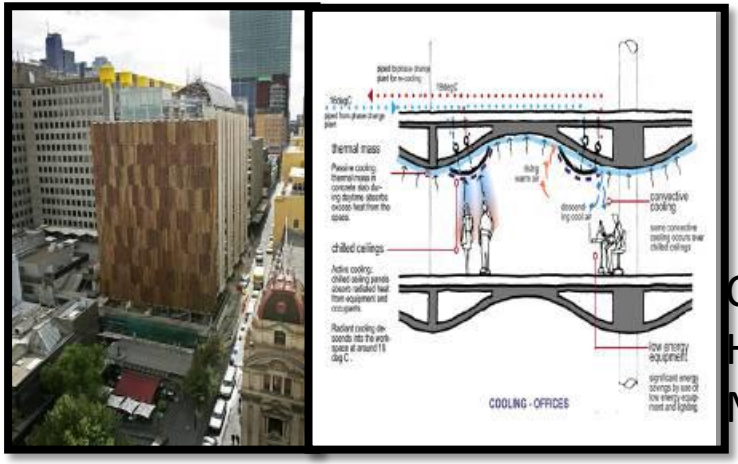
Process/function mimicry at **BEHAVIOUR LEVEL**





Eastgate Centre , Harare



Council House 2, Melbourne

Organism level
(Mimicry of a specific organism)

Behaviour level
(Mimicry of how an organism behaves or relates to it's larger context)

Ecosystem level
(Mimicry of an ecosystem)

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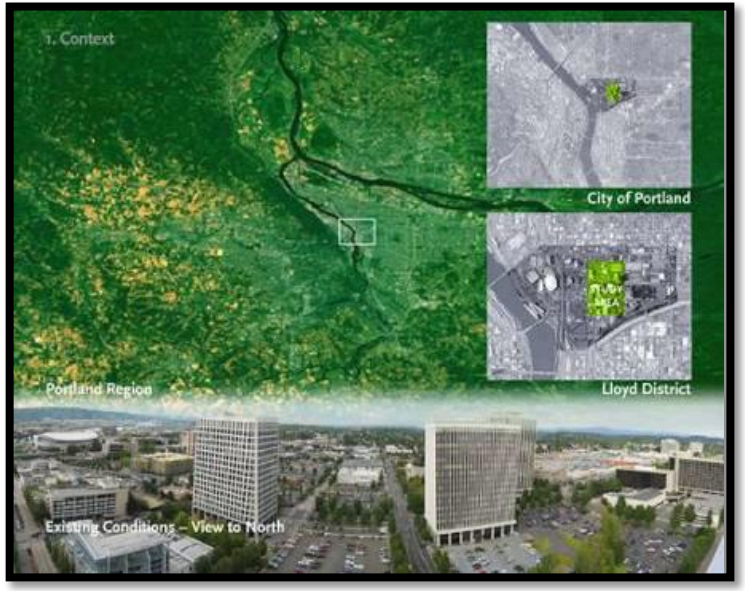
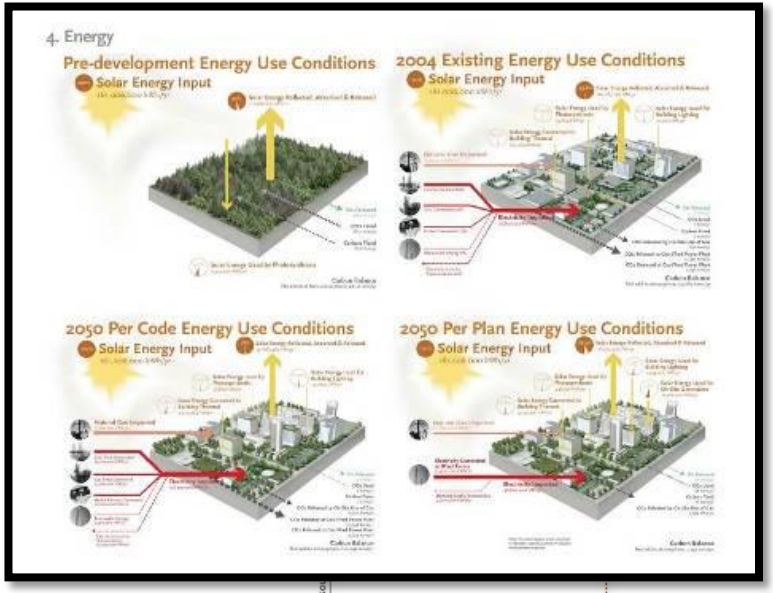
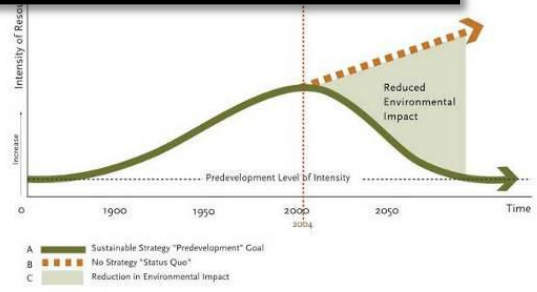
Function mimicry at **ECOSYSTEM LEVEL**





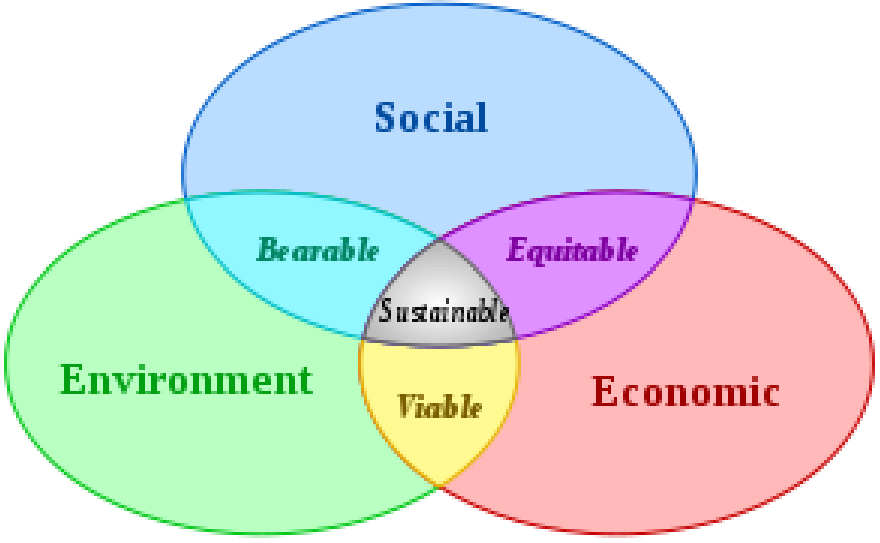
Mithūn Architects and GreenWorks Landscape Architecture
Lloyd Crossing Project proposed for Portland, Oregon.



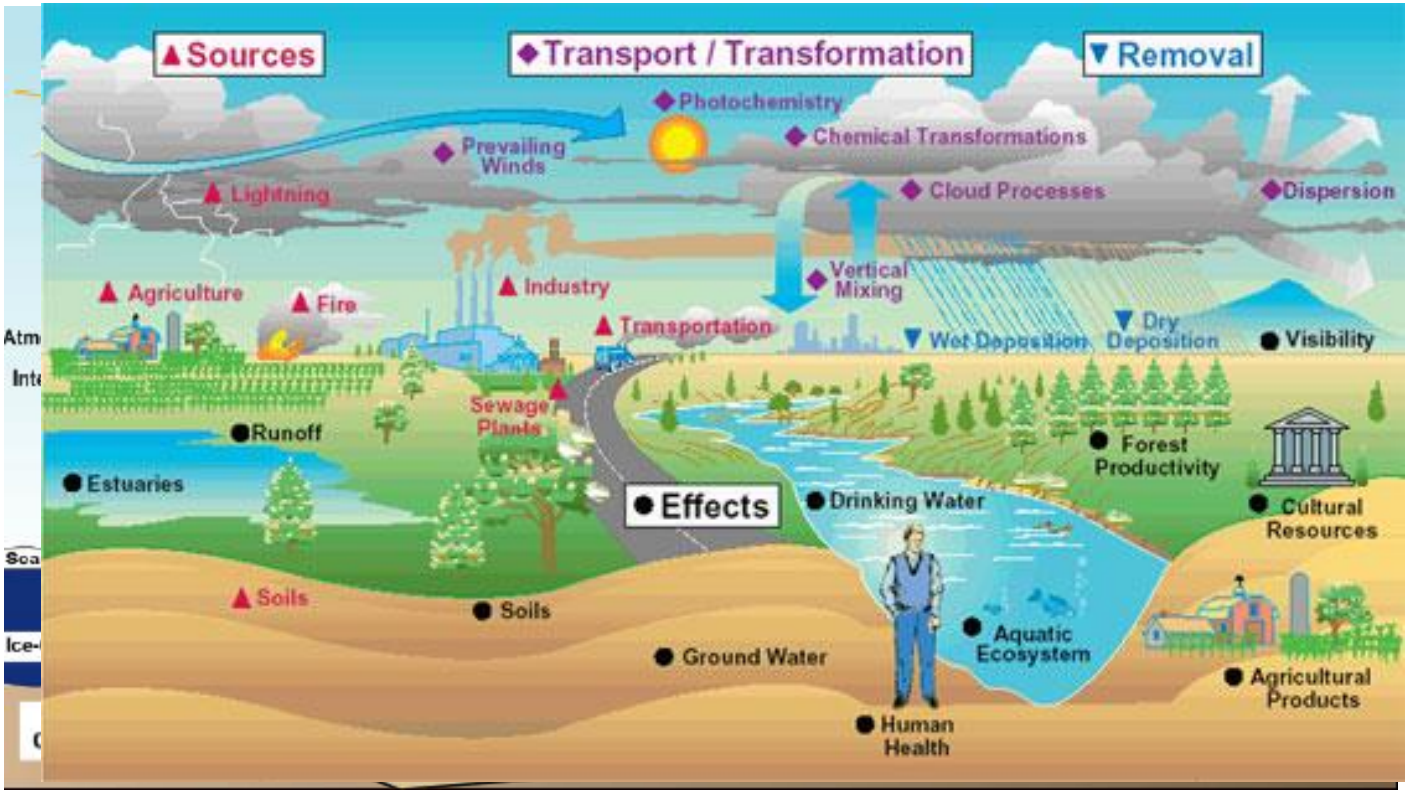
Environmental Impact Reduction

WHAT IS SUSTAINABLE DEVELOPMENT?

"Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs."



CAUSES OF CLIMATE CHANGE



In order to tackle the issue of global climate change two approaches can be adopted:

MITIGATION

ADAPTATION

SUSTAINABLE DESIGN FRAMEWORK

1. SITE & CLIMATE ANALYSIS: analysing site, orientation, exposure, climate, topographical factors, local constraints and natural resources

2. FLEXIBLE STRUCTURAL SYSTEMS: investigating structural characters, permanence/temporariness, integration with building components, etc

3. RENEWABLE BUILDING MATERIALS: analysing efficiency of a material or a product, size, standardization, structural adequacy, complexity, appropriateness, cost, labour involved, plantation origin, method of growth, embodied energy, recycled and reused content, toxicity, etc.

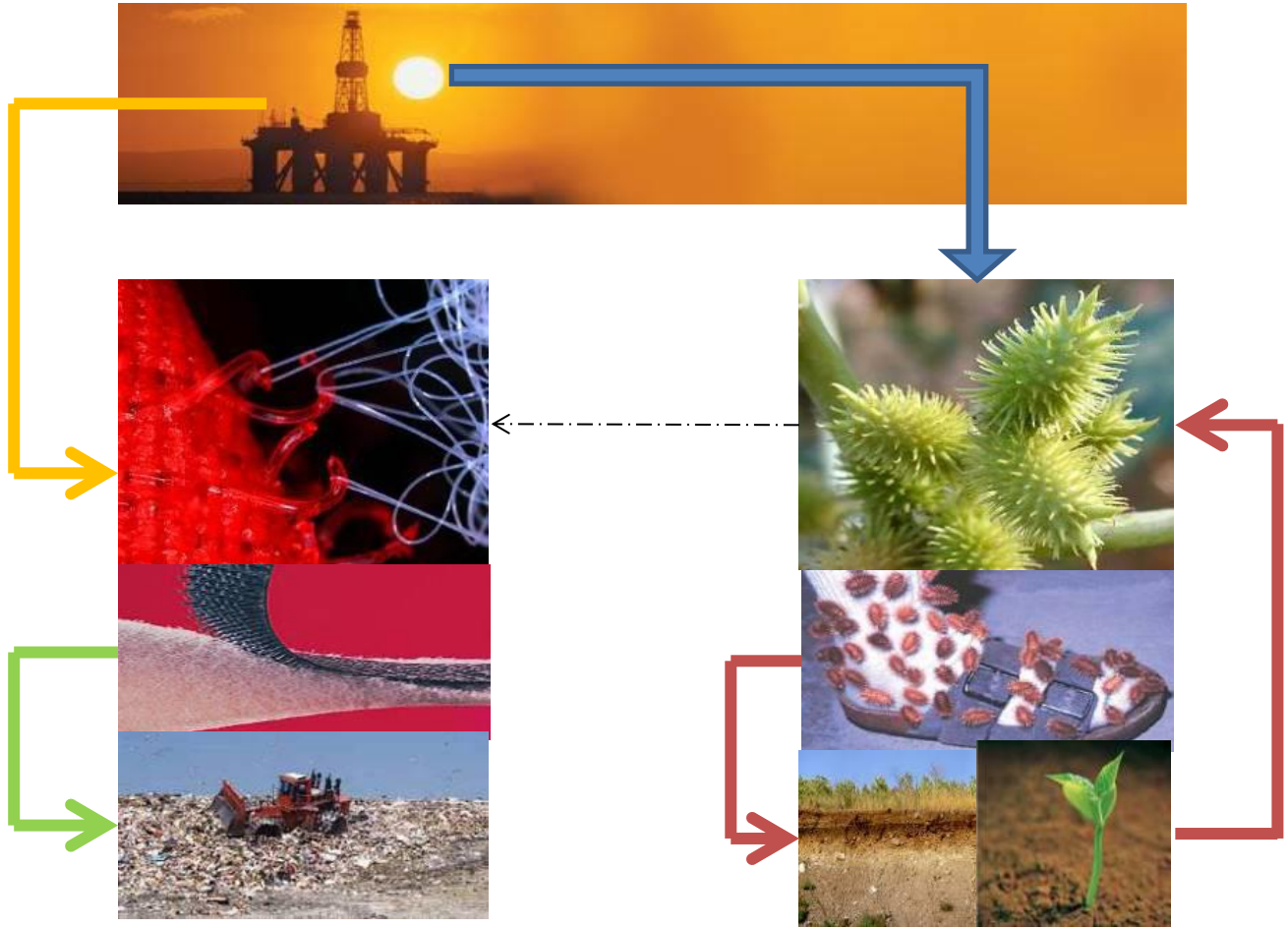
4. BUILDING ENVELOPE SYSTEMS: control of energy flows that enter (or leave) an enclosed volume, including consideration of orientation, seasonal variations, surrounding environment, function, and typology.

5. MODULAR BUILDING SYSTEMS: construction and assembling methods to facilitate substitution, repair, maintenance, diversified lifetime, etc.

6. RENEWABLE & NON-CONVENTIONAL ENERGY SYSTEMS: integrating sources of energy that do not reduce or exhaust their point of origin;

7. INNOVATIVE HVAC SYSTEMS: implementing strategies to provide thermo-hygrometric and air quality comfort, exploiting mechanically regulated, hybrid, or, preferably, totally passive techniques;

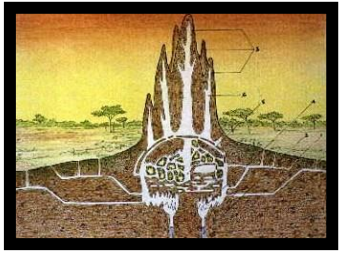
8. WATER COLLECTION & STORAGE SYSTEMS: adopting methods, system and strategies to collect, store, distribute, use, recycle and re-use water.

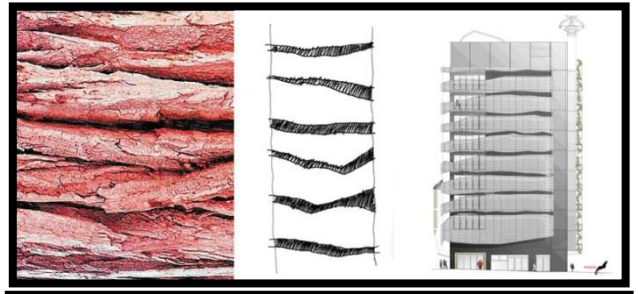


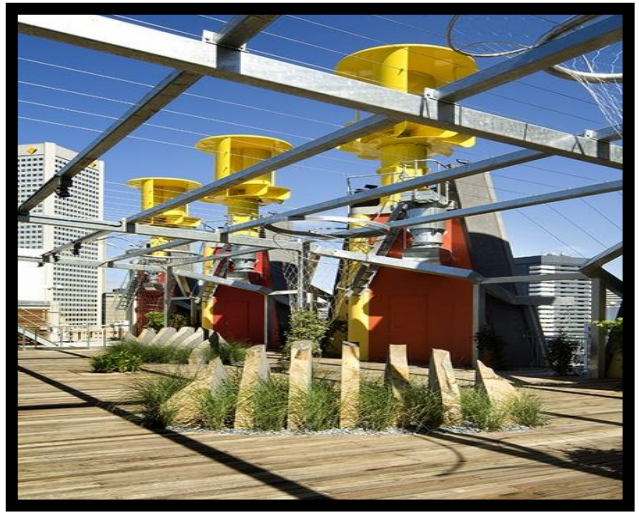
EXAMPLE- COUNCIL HOUSE 2

Architecture (CH2), Mick Pearce with DesignInc., 2005

Maximum Six Green Star rating





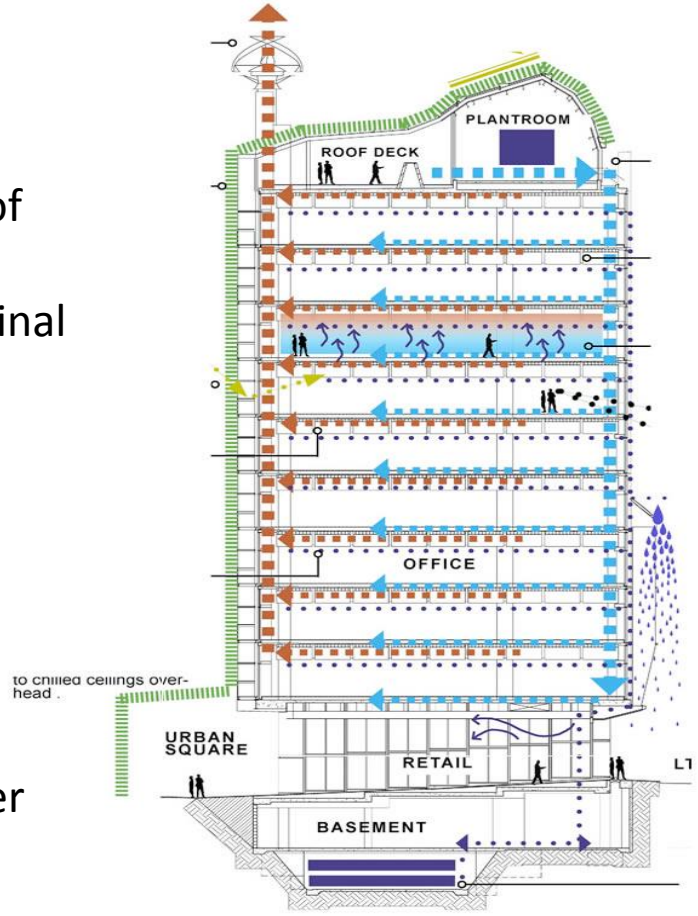


“DIVERSIFY AND COOPERATE TO FULLY USE THE HABITAT”

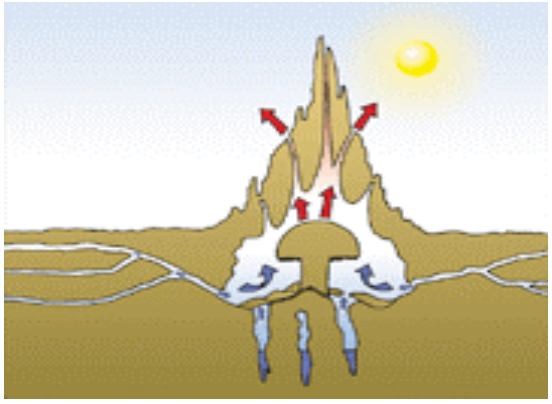
Same amount of foliage on the building as original state of site

Harvest sunlight, cool night air, water, wind and rain

Use of natural convection, thermal mass, ventilation stacks and water for cooling



BIO CLIMATIC SECTION



“USE WASTE AS RESOURCES”

Sustainable timber selection

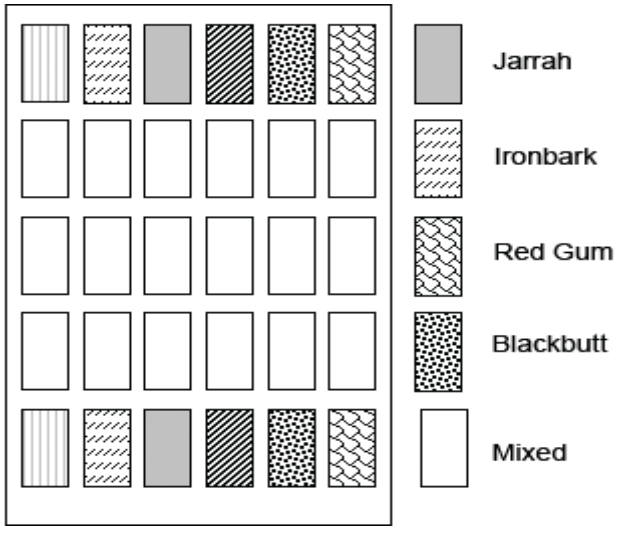
Recycled structural concrete

Recycled structural steel

PVC minimisation

“USE WASTE AS RESOURCES”

Use waste as amenities



Recycled

Untreated

from old housing frames

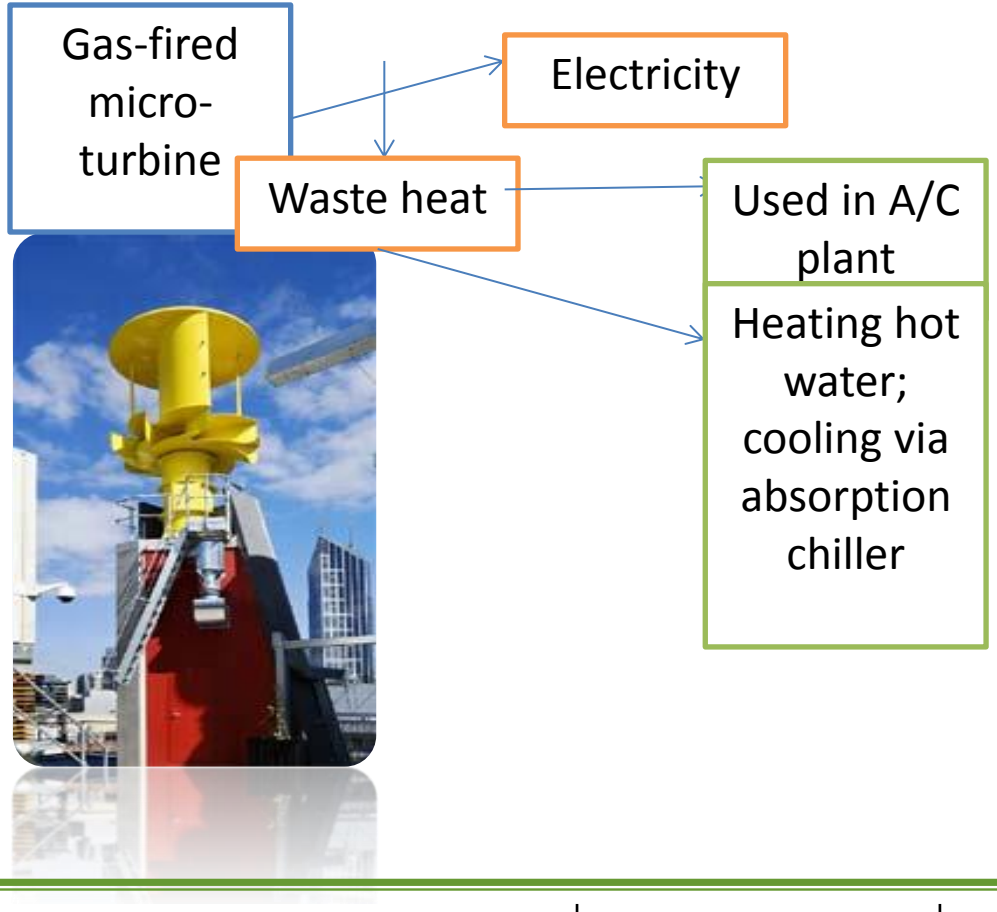
“GATHER AND USE ENERGY EFFICIENTLY”

micro-turbine (co-generation)

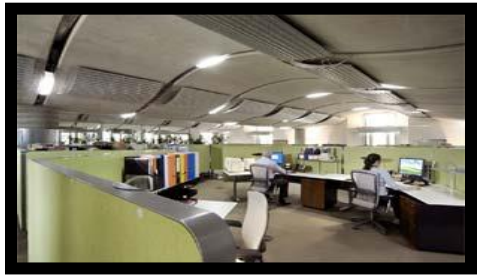
lifts → generate power in breaking mode

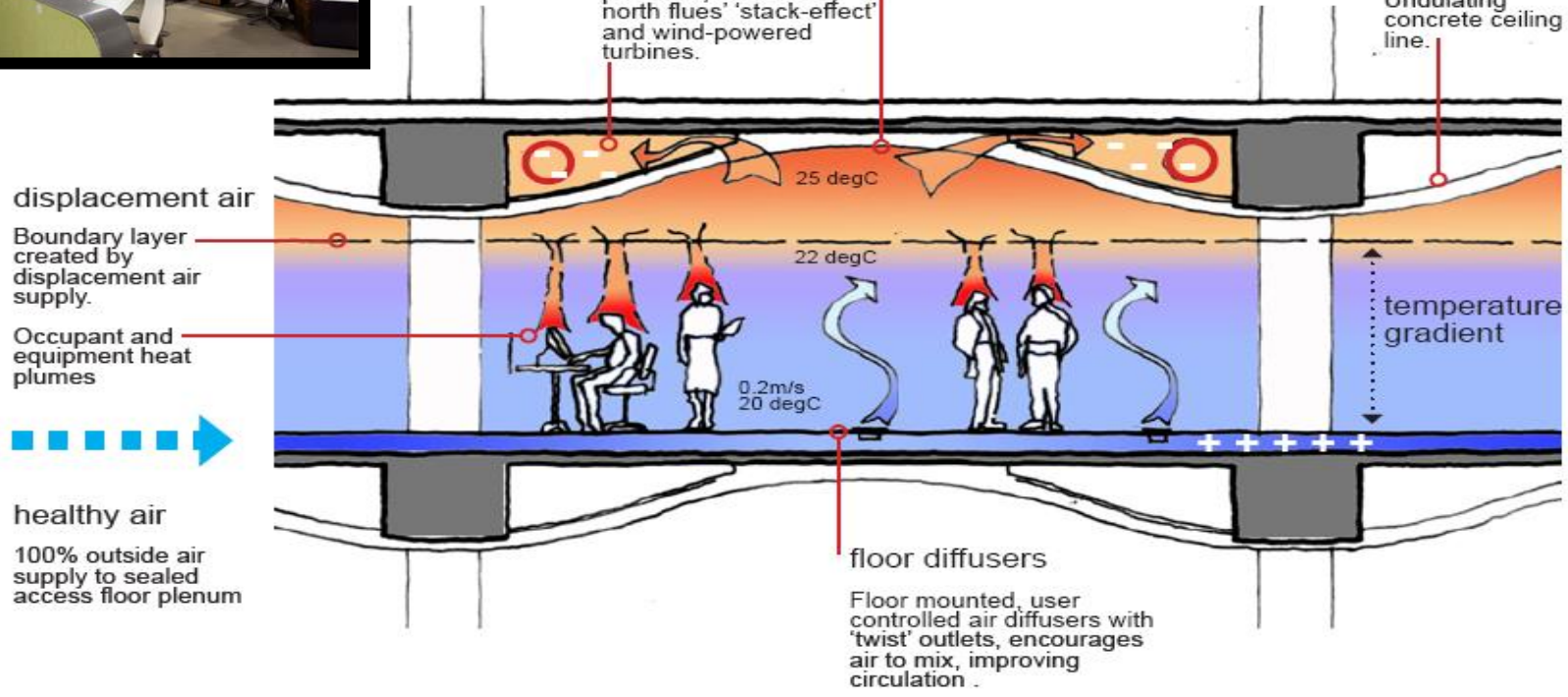
solar hot water produced by 48 square metres of solar hot water panels on roof, supplemented by gas boiler

solar power (PV cells) : 3.5kW energy → used to power Western timber shutters



“OPTIMIZE RATHER THEN MAXIMIZE”





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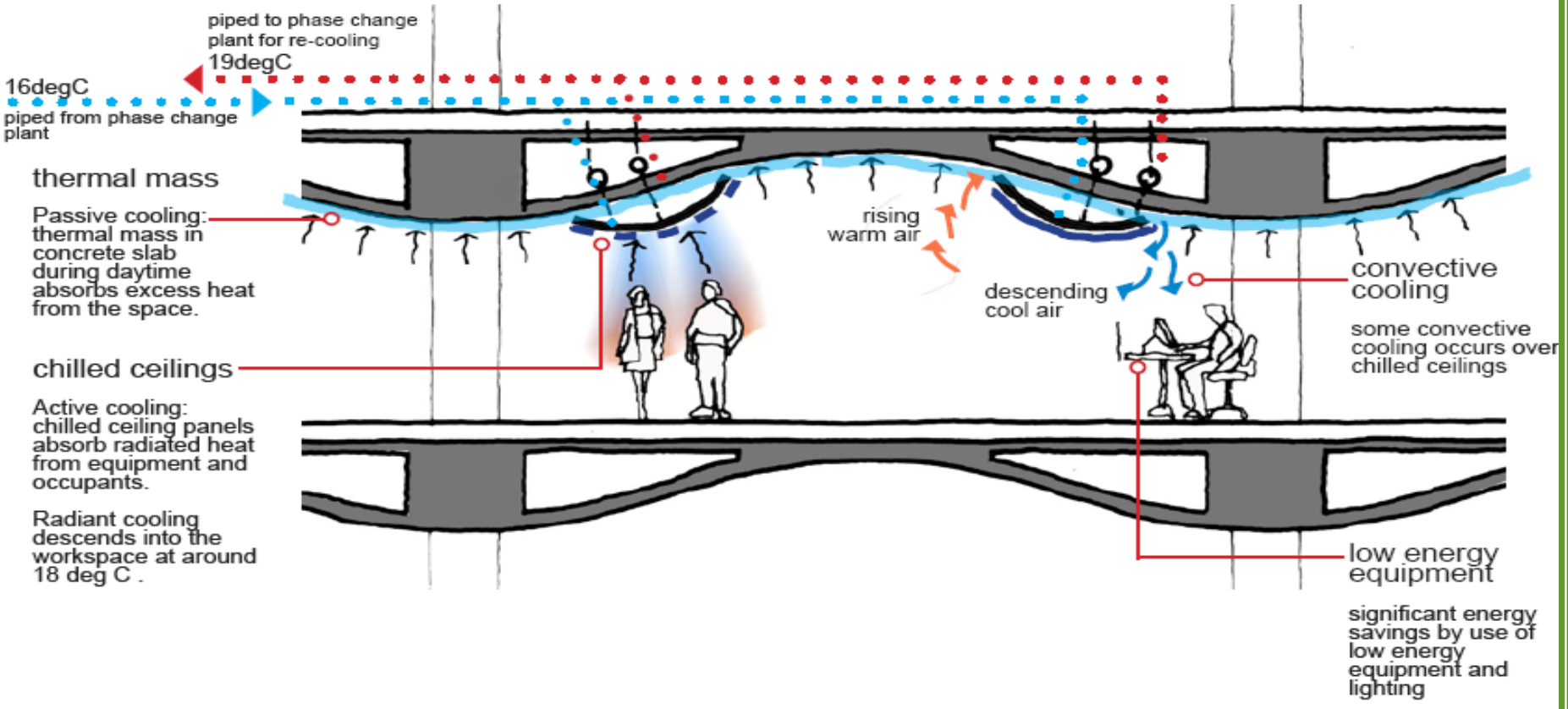

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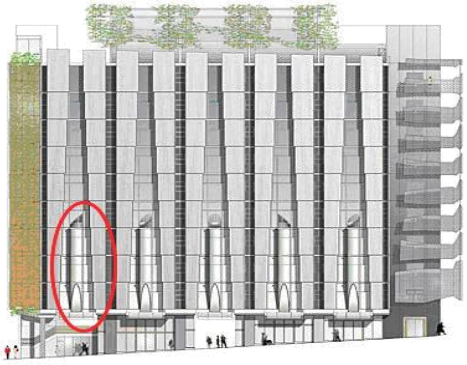

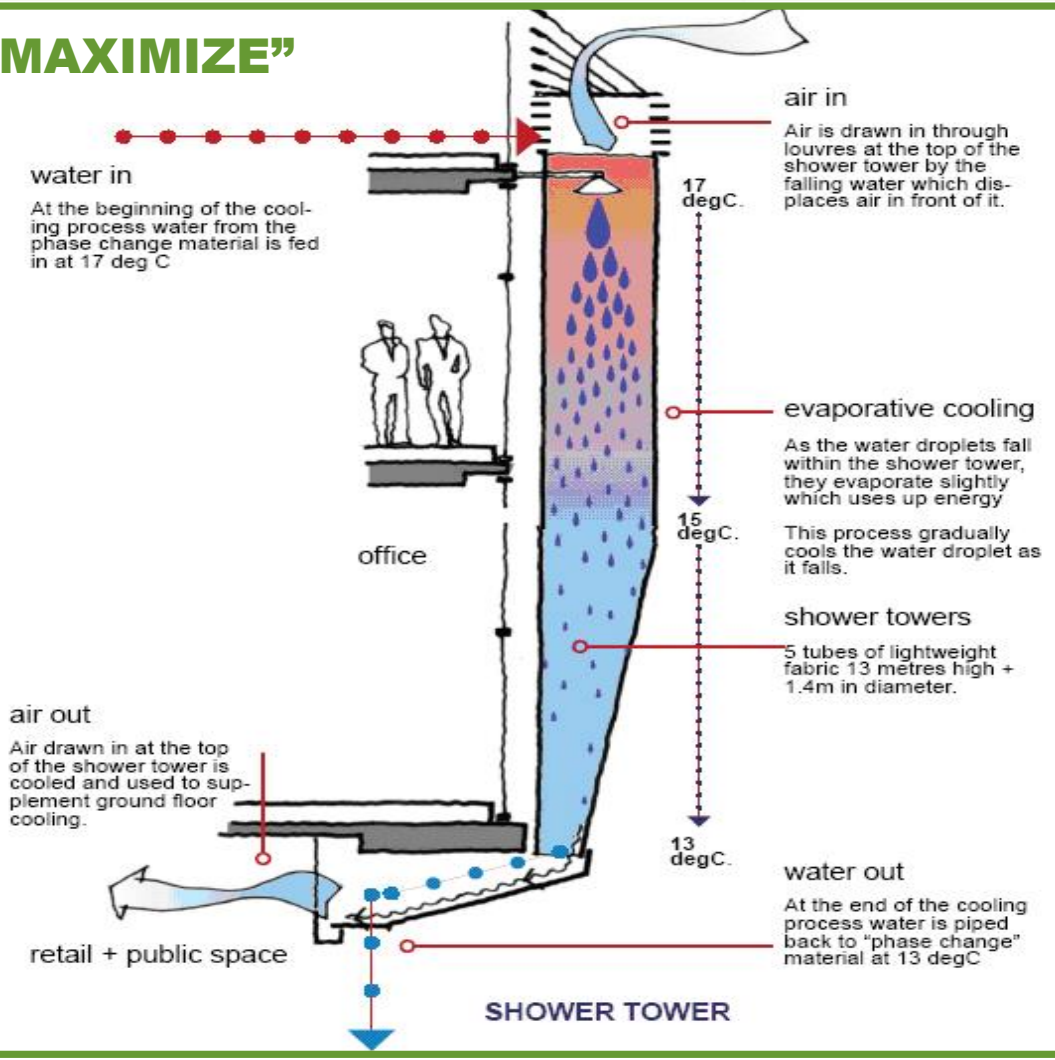

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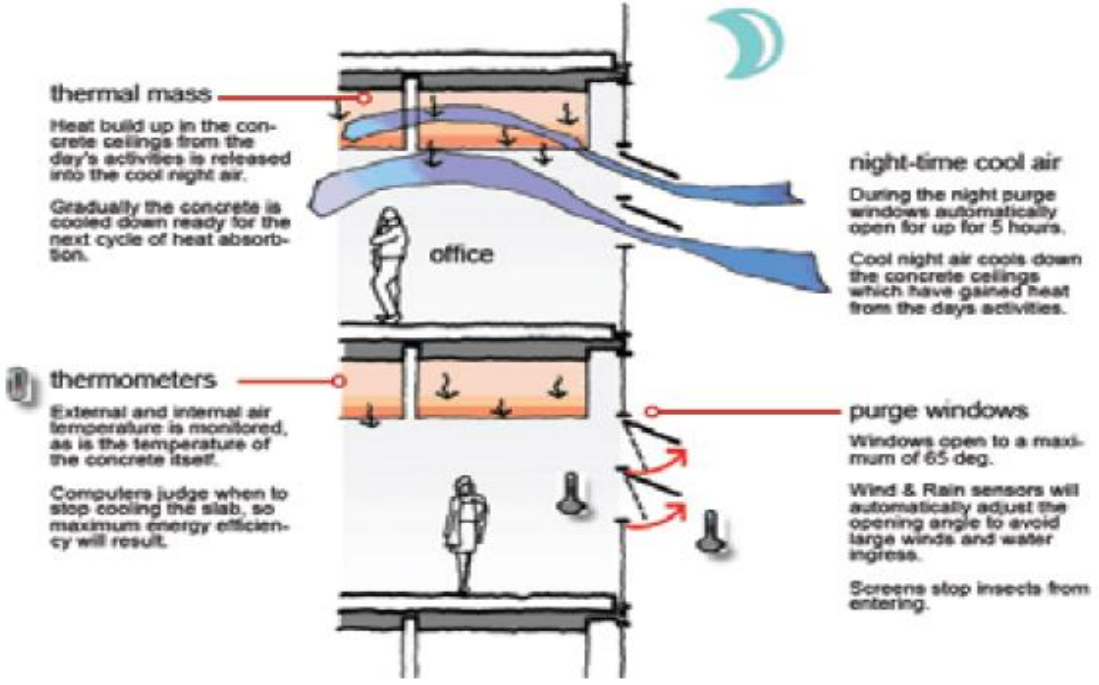


“DON’T DRAW DOWN RESOURCES”

Water

- 72% reduction in mains water consumption compared to the existing Council House of similar size
- Multi-Water Reuse (MWR) sewer mining plant
- Sprinkler water reclaim and rainwater collection

Waste

- building waste during construction was recycled (87%)
- recycling carried through within building after operations → waste separation

ANALYSIS

- **Building inspired by plants /flower**:
  - ✓ Self-sustainable
  - ✓ Energy efficient
  - ✓ Recycling
  - ✓ Aesthetically appealing
  - ✓ Low maintenance




- **Building inspired by organisms:**
  - ✓ Resistant to imposed forces
  - ✓ Structural stability
  - ✓ Controlled entry of sunlight
  - ✓ Regulation of internal temperature
  - ✓ Aesthetics
  - ✓ Acoustics



- **Buildings inspired by natural forms**:
  - ✓ Effective channelling of wind
  - ✓ Increase thermal mass capacity
  - ✓ Dynamic form
  - ✓ Acoustics.
  - ✓ Energy efficiency



APPLICATION

INDUSTRIAL BUILDING DESIGN

- **Large & clear unobstructed areas**
- **Proper lighting (Natural and Artificial)**
- **Ventilation**
- **Acoustical treatment**
- **Energy-efficiency**

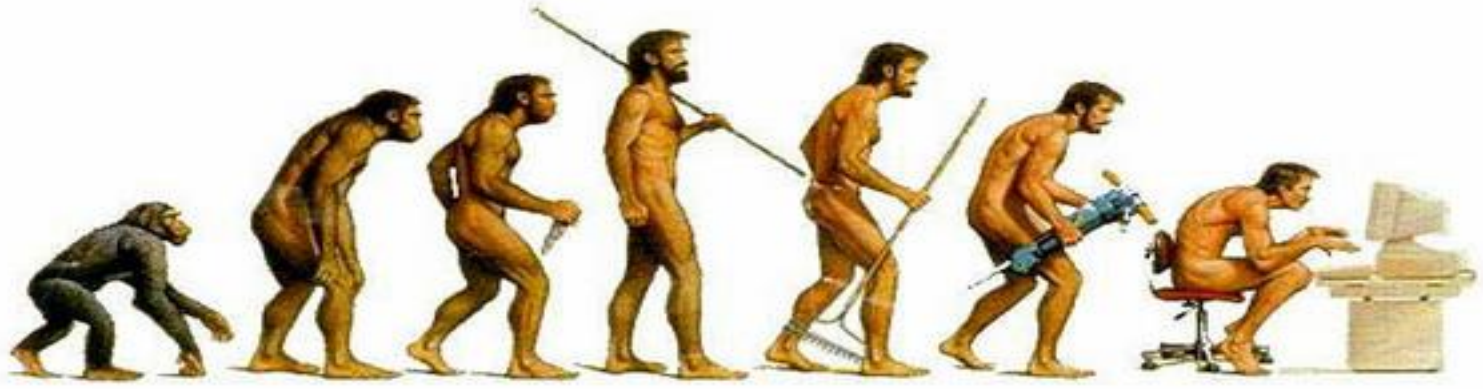
- Triangulated exoskeleton or frame inspired from glass sponge, thigh bone, beehive
- Louvers, living skin which can regulate entry of daylight inspired from stomata of leaves or
- A system which utilises resources available locally with minimum embedded energy and recycles to maximum like growth of tree or
- emulate natural forms like termite mound for passive systems to reduce cost and energy consumption.

CONCLUSION

To echo, listen, steward and immerse in nature

Biomimicry presents itself as a basis, a foundation of a new research methodology instead of mere serendipity. Biomimicry has to be approached in a multi-disciplinary order of thought in order to understand the principles of nature to achieve a holistic design solution.

CONCLUSION



For nature has been field-tested for millions of years through evolution