

PROJECT: EASTGATE

Megan Greenfield



Architect: Pearce Partnership

Location: Harare, Zimbabwe

Year of completion: 1996

Cost: \$35 Million

Area: 290,625 SF - office space

53,819 SF - retail

3,229 SF - parking

Building type: Mixed-use including retail, food court, and seven floors of office space

Climate: Subtropical highland climate

Average annual temperature: 64.4° F

Diurnal temperature shift: 12° F

Average annual rainfall: 32.5 inch

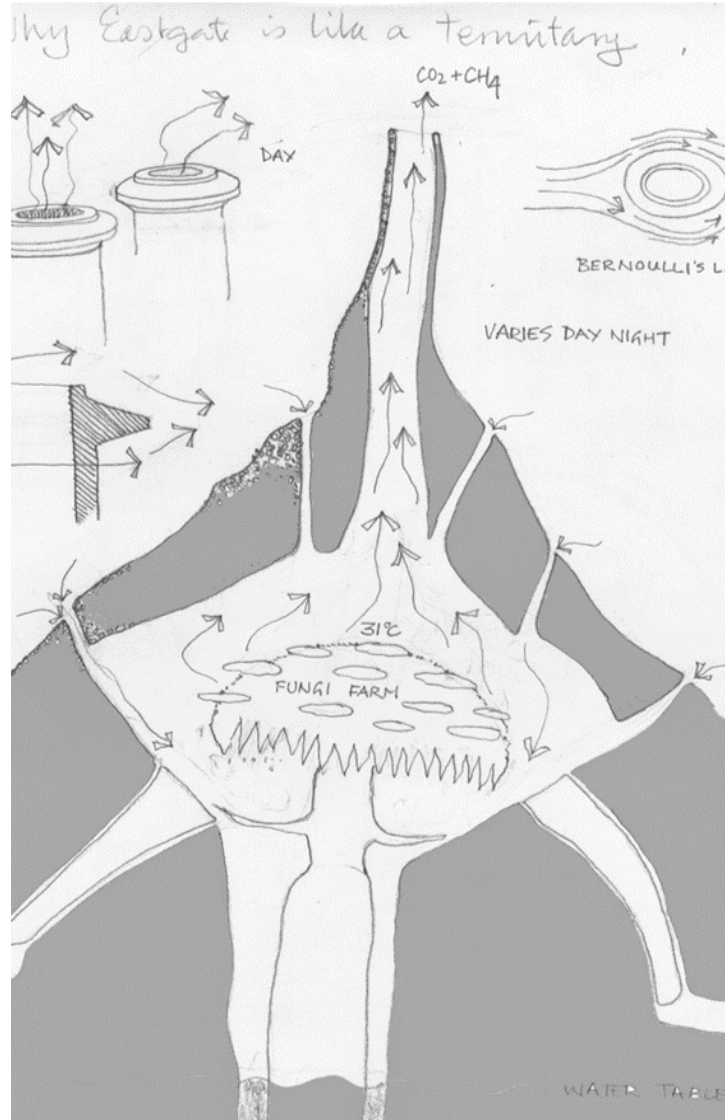


Eastgate facade [1]

CHALLENGE: HOW CAN WE DESIGN A BUILDING THAT
MINIMIZES THE HIGH COST OF IMPORTING
AND MAINTAINING AIR-CONDITIONING IN
ZIMBABWE?

TERMITE NEST CONSTRUCTION

- Termite tower functions as a lung to the nest
- The hot air goes up and the cold air enters through smaller vents at the sides of the termite nest
- Wind and sun shape the tower. Daytime wind from the southeast evaporates the pheromones on the most exposed surfaces, which means the termites work in sheltered areas only.

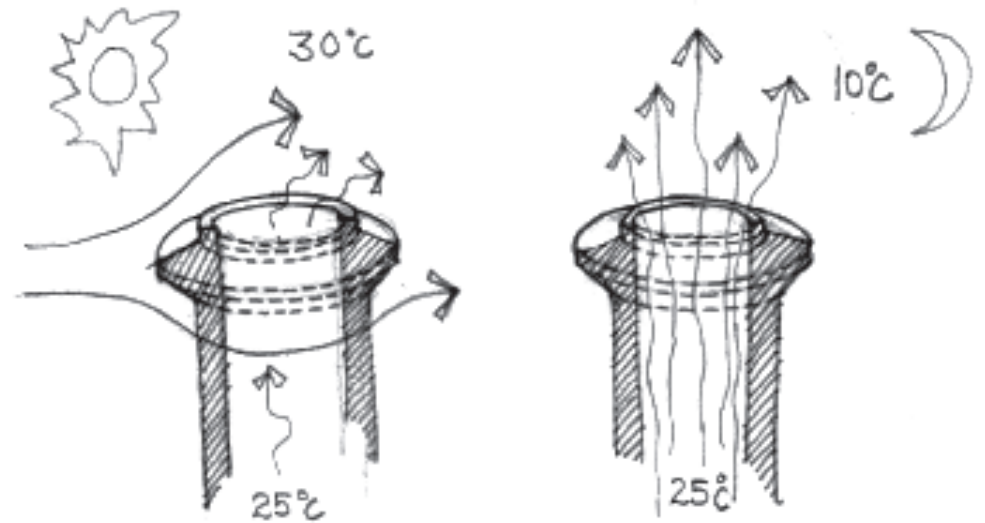
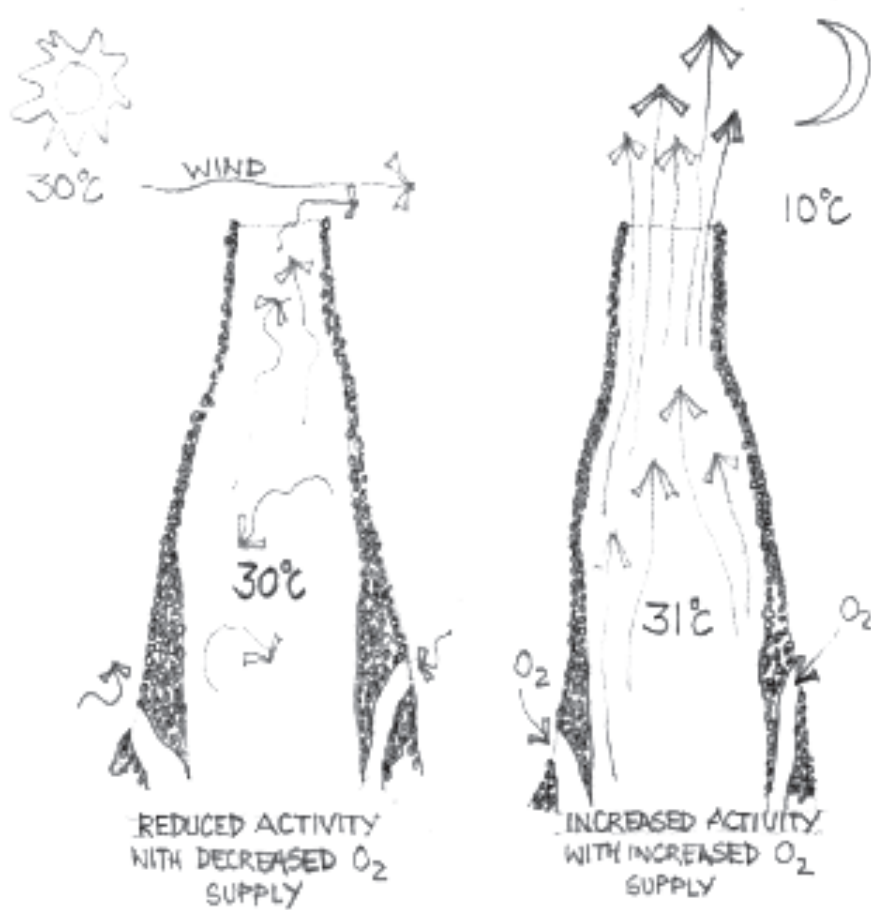


Termite tower diagram [1]



Termite tower [1]

TERMITE NEST CONSTRUCTION

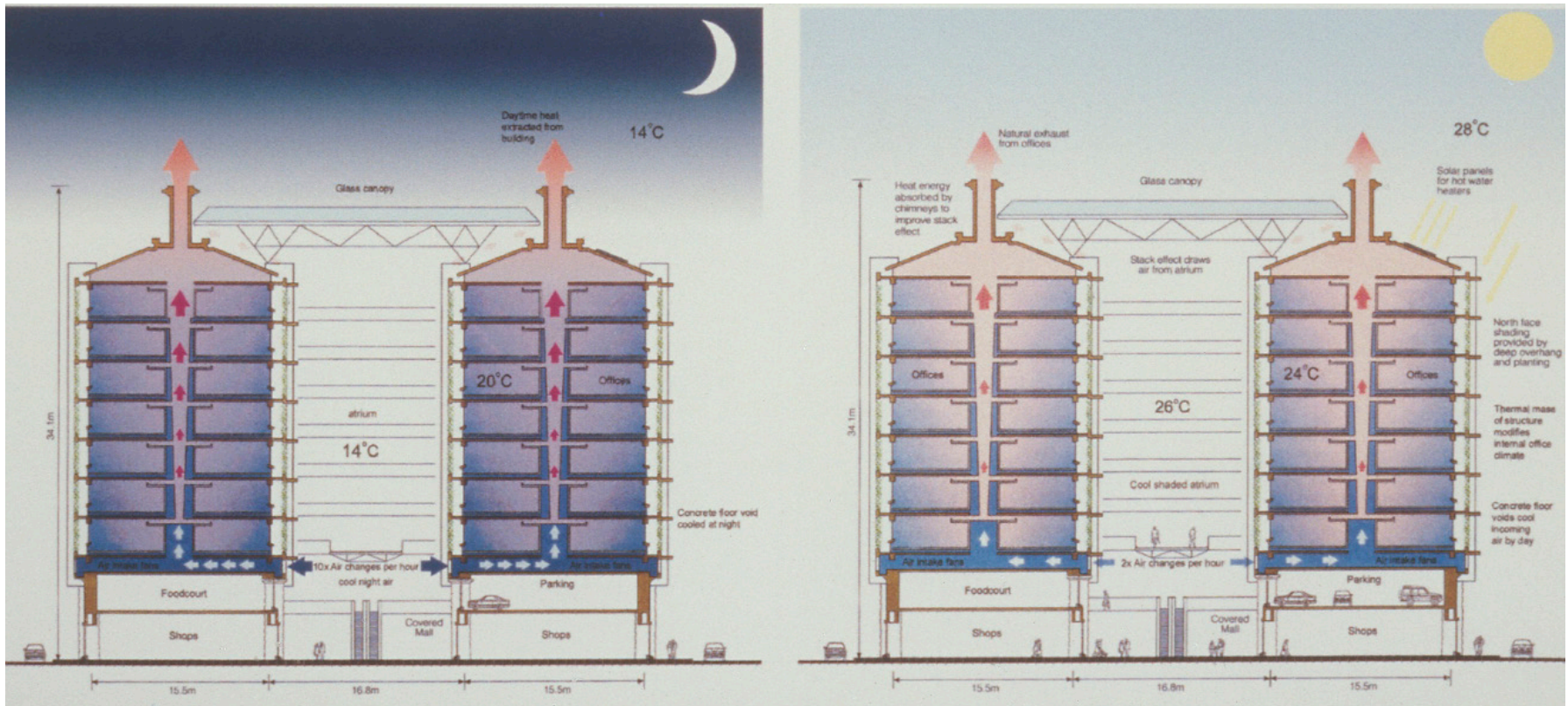


THESE CHIMNEYS ARE LARGE VOLUME SOLAR/LUNAR DRIVEN ACCELERATORS. THE SHAPE OF THE CHIMNEY TOP ACTIVATES WIND UP DRAFTS BY DAY AT NIGHT THE DIFFERENCE IN AIR TEMPERATURE HELPS TO EMPTY THE OFFICES BELOW OF WARM USED AIR.

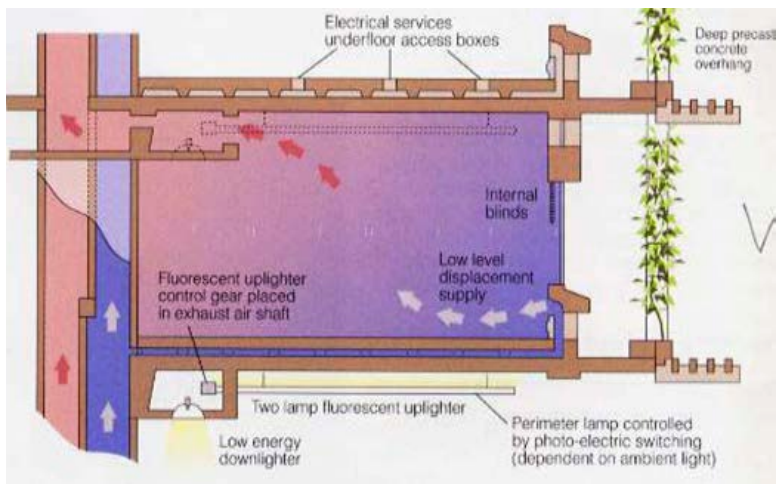
THIS SHOWS HOW THE DAY-NIGHT CYCLE DRIVES BIOLOGICAL ACTIVITY IN THE TERMITARY.

IT WAS THIS IDEA OF HOW THE TERMITARY WORKS WHICH INSPIRED THE DESIGN OF EASTGATE'S CHIMNEYS. WE AIMED TO MAKE A BUILDING FORM WHICH WOULD WORK BY USING NATURAL FORCES WITHOUT ADDED POWER.

BUILDING DIAGRAMS



Stack ventilation [1]



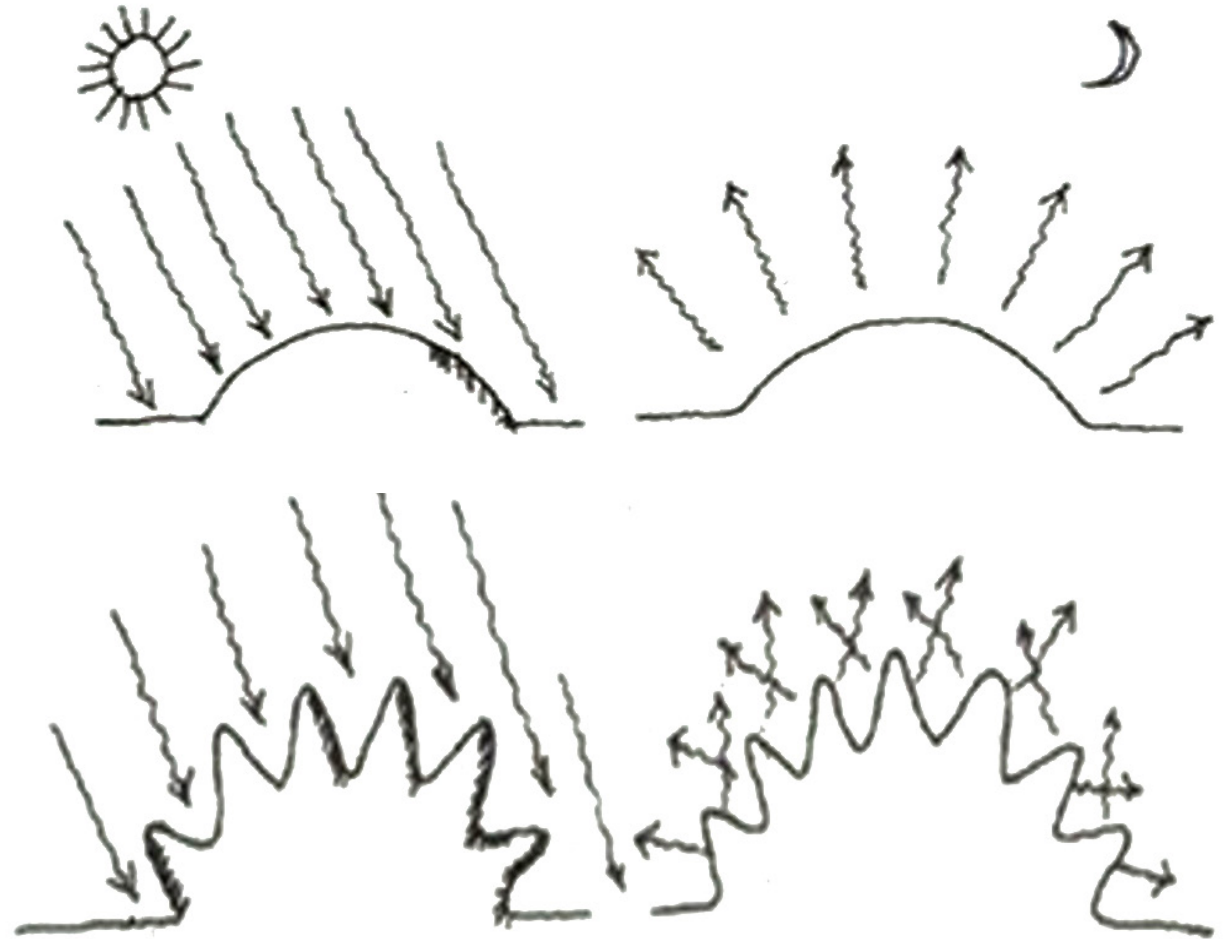
Ventilation diagram [1]

FRACTAL COOLING

Smooth bodies are better at absorbing heat and poor emitters of heat to space at night. Prickly bodies are poorer absorbers of heat by day and good emitters of heat at night. This form allows for a quicker dispersal of heat, a great technique for warmer climates.

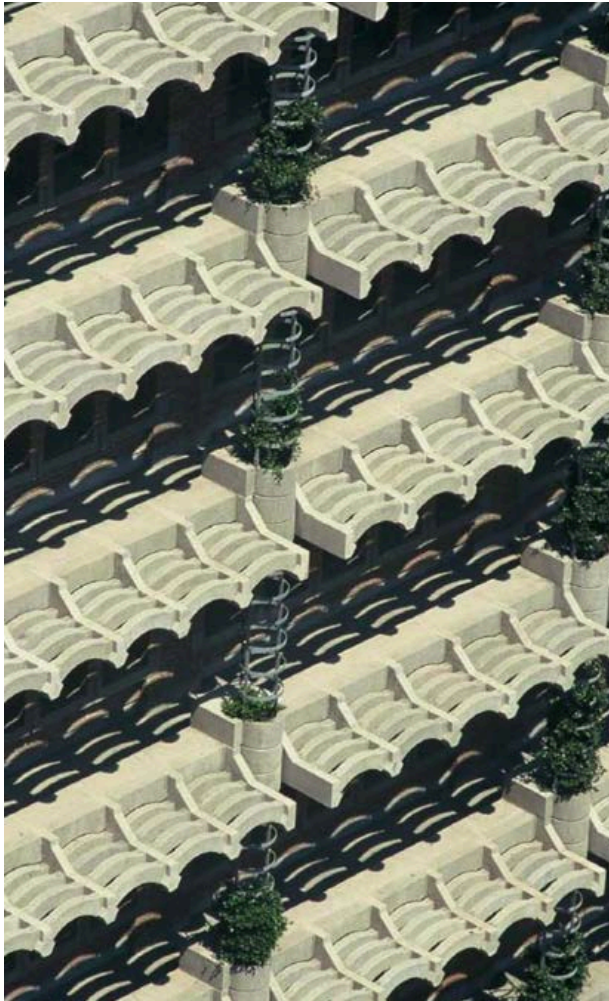


Cacti [2]



Smooth bodies vs. prickly bodies [1]

FRACTAL COOLING



Eastgate fractal cooling [1]

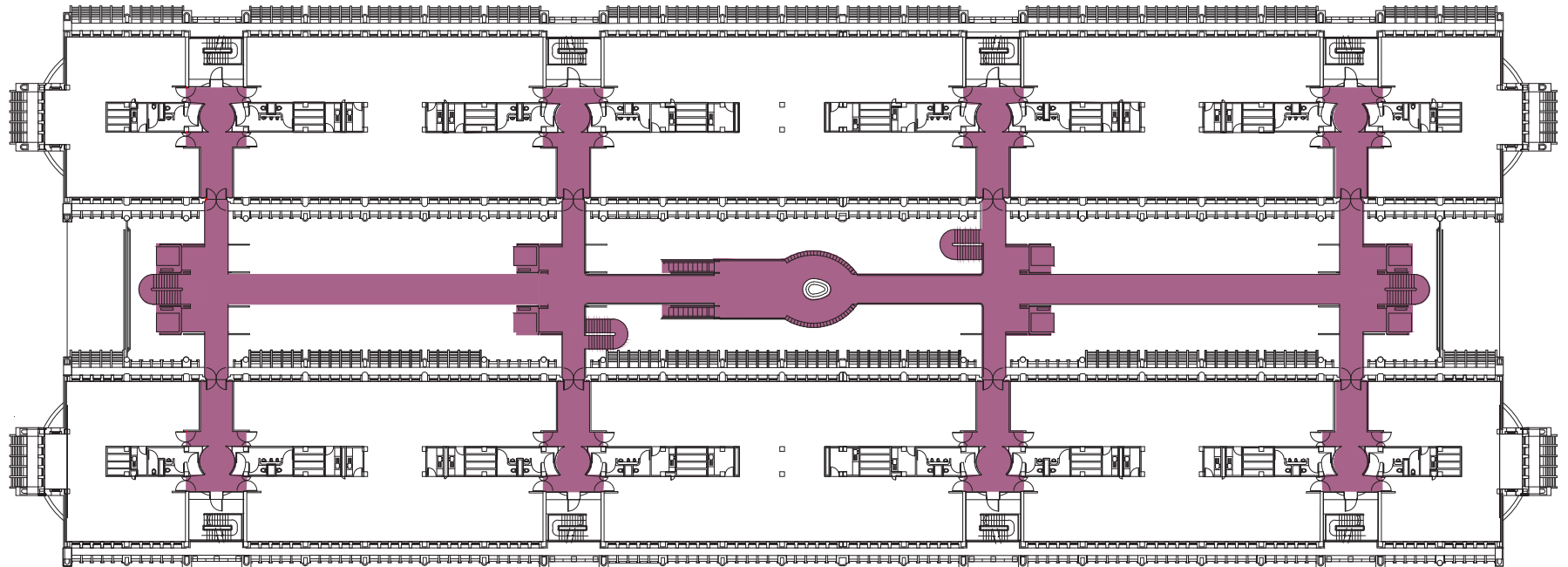
DEFENSIBLE SPACE

- services in the middle
- platforms extending across the courtyard that allows for easy access through the space
- built-in security



(Above) Interior courtyard [1]

(Below) Second floor plan NTS [1]



SUCCESS:

-EASTGATE USES LESS THAN 10% THE ENERGY AS A STANDARD OFFICE BUILDING

-OWNERS SAVE \$3.5 MILLION

-TENANTS' RENTS ARE 20% LOWER THAN SURROUNDING OFFICE BUILDINGS

SUMMARY

When thinking about how to create a sustainable architecture, we can look to nature for inspiration. It is not about trying to copy nature, it is about observing patterns, analyzing them, and bringing those patterns into our designs. Nature is too complicated to truly replicate, but you can borrow ideas.

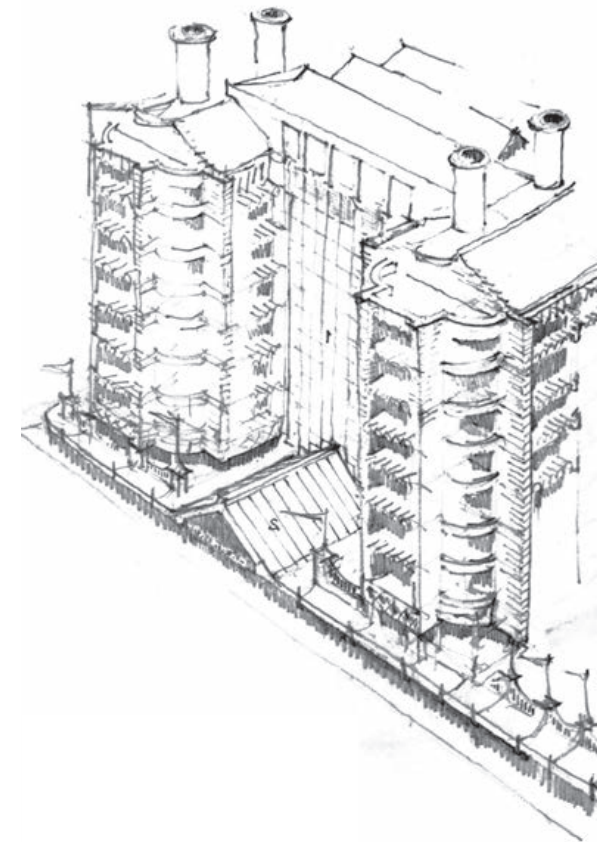
In 1992, Pearce Partnership was commissioned to design an office block with retail and parking in downtown Harare, Zimbabwe. The challenge was to minimize the high cost of importing and maintaining materials and equipment such as air conditioning, utilize local artisans, and maintain low energy consumption. Pearce Partnership strove to design an office building without air-conditioning. Zimbabwe's benign climate made this a great opportunity.

With those ideas in mind, Mick Pearce formed an interest in Zimbabwean termites. The natural systems of their nests served as a major inspiration behind the design of Eastgate. They are prevalent throughout the region and build very effective structures to protect themselves from the elements. The termite tower functions as a lung to the nest. The hot air goes up and the cold air enters through smaller vents at the sides of the termite nest. This essentially performs as natural built-in cooling. The wind and sun actually determine the shape of the termite tower. Daytime wind from the southeast evaporates the pheromones on the most exposed surfaces, which means the

termites work in sheltered areas only. The wind and the sun creates a form that maximizes the efficiency of the nest in its particular location. Termites only use these towers from September to November to act as chimneys to release heat. They are temporary until the rains come and naturally cool environment without the need of the towers.

In Harare, the diurnal shift is at least 10C throughout the year, falling equally on each side of the comfort level at 20C. The diurnal shift could save huge amounts of energy if harnessed within the bones of the building. The design challenge was to invent ways of making the building structure into a heat exchanger. By forming voids in the concrete structure for ventilating air to pass through, they could make the concrete and masonry building become its thermal store from night to day. Termites' structures also inspired this idea; however, electrical power-driven fans had to be installed to push the air when our chimneys did not provide enough buoyancy. The termites have the same problem in the early summer. They resort to building their chimneys taller and taller with the most interestingly shaped top to harvest wind-driven energy.

Abigail Doan explains how Eastgate uses this process well, "Air is continuously drawn from this open space by fans on the first floor. It is then pushed up vertical supply sections of ducts that are located in the central spine of



Eastgate sketches [1]

SUMMARY CON'T...

each of the two buildings. The fresh air replaces stale air that rises and exits through exhaust ports in the ceilings of each floor. Ultimately it enters the exhaust section of the vertical ducts before it is flushed out of the building through chimneys.”[4]

The central street runs through the building and is open to the public at all times. All the services are in the middle of the Eastgate building. The surrounding structure has various platforms extending across the courtyard that allows for easy access through the space, but also provides built-in security. The openness and the views from all parts of the space allows for the maximum number of eyes on the space at all times. This is not unlike the termites’ defenses.

Pearce Partnership borrowed another technique from nature, though this time from cacti rather than termites: fractal cooling. A cactus is prickly for defense against predators, but it is also for thermal reasons. Smooth bodies are better at absorbing heat and poor emitters of heat to space at night. Prickly bodies are poorer absorbers of heat by day and good emitters of heat at night. This form allows for a quicker dispersal of heat, a great technique for warmer climates.

The design process did not stop when the building was finished. It continued for a further three years after occupation, during which time

the systems were monitored. Fortunately, both the architect and the engineers were among the first tenants. They had a data logger measuring the crucial temperatures from probes into the buildings structure. It was like tuning a huge instrument. Many things went wrong, but after fine tuning the building began to respond to the microclimate and to the occupants. It was all about finding optimums, measuring storage capacities, and adjusting the timing and speed of the day and night fans.

Using ideas of biomimicry, including heat exchange, fractal cooling, the architecture of the sun and wind, the architecture of movement, and defensible space, various sustainable opportunities presented themselves and came together to create a very successful and simply innovative building.

Various aspects of the building did not go as planned, and it confirms that nature cannot be copied, but can only be borrowed. For example, Eastgate’s chimneys cannot be shaped every day to suit the wind direction and speed. So they had to run day fans and night fans to push ten air changes at night and two air changes by day through the masonry ducts, under-floor heat exchanger floor voids and offices, and finally, out through the chimneys.



CITATIONS

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