"Our biological model needed a new set of rules. We chose to work within three parameters; nature, resources and aesthetics. By ‘nature’ we mean the Gaia theory of natural systems in which life itself controls the biosphere. Designers need to see the city as an ecosystem in which all parts are interlinked and influence each other. ‘Resources’ are human, natural and economic. By ‘aesthetics’ we refer to a new relationship between designer and nature where the former copies the processes of nature and not nature itself." Mick Pearce, Pearce Associates.

Mick Pearce was born in Zimbabwe, schooled in South Africa and studied architecture at the AA in London under the Smithsons – contemporaries included Michael and Patti Hopkins. Following a period in ‘exile’ in Zambia and Britain during the Ian Smith years, he returned to Zimbabwe and joined Harare’s oldest and largest architectural practice, subsequently becoming managing partner and principal. A visit by Australian Bill ‘Permaculture’ Mollison to Zimbabwe in the late 1980s was a pivotal event and Pearce’s ‘manifesto’, already rooted in the cultural context of old Zimbabwe, acquired a ‘green’ agenda and committed to addressing issues of global warming, carbon emissions, energy minimisation and waste reduction. Zimbabwe is a land-locked country to the north east of South Africa. Its capital Harare (pop. two million) lies 18° south of the Equator with a subtropical climate modified by its altitude of 1500m resulting in low humidity (increased in the wet season Nov-Mar) and significantly high diurnal temperature range – warm dry sunny days and cooler nights, typically 28°C day and 19°C night. Average annual rainfall is 850mm.

Environmentally Sustainable Design.

Ant Hill

A case study on the environmental performance of a development in Africa reveals a green agenda for international appropriation.
The Eastgate shopping and office complex in Harare was the largest development in Harare at its inception in 1991–consisting of 36,000 sq.m on a 9000 sq.m site. The completed project is in the city centre and accommodates 2000 people in 26,000 sq.m of office space and 650 people in 1000 sq.m of retail space. The institutional client Old Mutual Properties took an innovative approach and agreed to pay them the fee equivalent to a fully air-conditioned building. The crucial early stages of the design process brought the whole design team together, before any sketch designs or preconceptions, and then the key principles of the project were established in the first few days of collaboration.

Mick Pearce refers to the ‘anthill’ or termitary and talks of this metaphor demonstrating the capacity of termites to build structures that control the environment without consuming power or producing waste. Pearce proclaims – demonstrating the capacity of termites to build structures that control the environment without consuming power or producing waste.

The ‘busy-ness’ of the atrium is created by a network of suspension bridges and walkways weaving through and across the space. The long axis is east-west, presenting short gables to east and west and sun. The cross-section demonstrates the close affinity with the ‘antill’ model. Two blocks each side of a central atrium provide an opportunity for natural ‘stack-effect’ air movement ventilation up the middle of the building – an earlier section ‘diagram’ with solar heated flues on the outside of the building was rejected as obstructing prime ventilation up the middle of the building – an earlier section ‘diagram’ with solar heated flues on the outside of the building was rejected as obstructing prime ventilation up the middle of the building. Light cars are similarly suspended down the atrium from the roof. There is a counterpoint between the ‘traditional’ – the mass of the precast and masonry – and the innovative – the ‘light-tech’ steel trusses, suspension rods, internal bridges and balconies. The old and the new. The visual impact of the project is dominated by the stunning images of the filigree of external precast concrete sun control devices and vegetation columns and the 48 chimneys on the roof that drive the day and night air movement through the building.

Orientation. The long axis is east-west, presenting short gables to east and west and sun and facilitating sun control from high sun on long north and south façades. Sun control. Extensive structural overhangs and precast concrete elements on all façades, including the façades facing into the atrium, combine with vegetation columns to provide full sun shading to windows and external walls.

Insulation. Surprisingly, there is no introduced thermal insulation in the building other than that provided by the structure, walls, roof and floor elements. The strategic design of the building and the building’s climate of Harare obviates the need for insulation an exterior night temperatures seldom fall below 17˚C and day temperatures seldom exceed 28˚C.

Thermal mass. Crucial to the successful environmental design of this building is the use of high thermal mass to moderate internal temperatures, particularly to store ‘coolth’ at night and to release it during the day. The high climatic diurnal temperature range of up to 5˚C facilitates this. The building has high primary thermal mass provided by the structure, masonry walls, concrete floors and restricted glazed areas. Used in association with a clever ventilation system, cold night air is transferred through and into the structure. An ingenious system of precast concrete floor cavities forms a sub-floor air void at each office level – rather like a concrete version of a raised computer floor – through which cooling air is directed. The concrete cavities have projecting teeth into the sub-floor air cavity to enhance thermal transfer – better than a smooth slab. The exposed vaulted soffits of the precast concrete floor slab form the ceilings to the office areas facilitating dissipation of the ‘coolth’ during the day.

Ventilation. Again crucial to the environmental design is the system of air movement through the building by day and night. The windows are operable but this is not encouraged due to dust and noise, and is not part of the primary air movement strategy. The key feature is the ability to draw filtered cool air through and into the thermal mass of the structure at night, store it as ‘coolth’ and then
the flat secondary concrete slab roof, which is the ceiling slab of the upper office. A ventilated roof void between the pitched primary roof covered in clay tiles and temperature never reaches dew point. Independently, stack effect draws air from condensation, during the wet season of higher humidity, and associated bacterial discharge under the windows into the office spaces. Potential for formation of day’s heat. By day, two air changes per hour, pulled through the structural floor voids, allow the stored ‘coolth’ to chill the incoming ‘new’ air and their discharge under the windows into the office spaces. Potential for formation of condensation, during the wet season of higher humidity, and associated bacterial mould growth in the inaccessible floor voids. It is unlikely as the concrete temperature never reaches dew point. Independently, stack effect draws air from the top of the atrium out through the ends of the glass canopy roof, thus neutralising heat gains from the exposed glazed roof – the latter actually enhances stack induced air movement through the atrium. (See sections below.)

Double roof. The roof of the two office blocks is, in fact, a double roof creating a ventilated roof void between the pitched primary roof covered in clay tiles and the flat secondary concrete slab roof, which is the ceiling slab of the upper office floor. The 48 chimneys extract air from the roof void into which the vertical ‘old’ warm air ducts discharge from the office areas. What rain that comes in through the open chimneys falls on the corrugated steel secondary roof. This ventilated roof void reduces direct heat load on the roof.

Thermal performance. The internal air temperature of the building is reported, as was predicted, at up to 3-4˚C cooler than outside ambient temperatures on a warm summer day of 28˚C at 14-20˚C – it is claimed that perceived comfort is better than this would suggest as the human body is more sensitive to radiated ‘coolth’ than conducted ‘coolth’. The concrete thermal mass in the floor slabs holds a quite constant temperature of around 20 °C in summer and winter and room temperatures do not fall below this. Human activity and equipment added around 1.5˚C each day and this is flushed out at night. There is a tendency for the structure to warm up towards the end of the working week and cool down over the weekend. It was established at design stage that heat emitted from the fluorescent lighting ballasts could add 1˚C to the room temperature, and this has been avoided by placing the ballasts in the centre of the warm ‘old’ air outlet portholes into the vertical exhaust ducts. In October/November hot humid days and cloudy nights adversely affect the thermal performance with a worse case 2-3 hours over 27 °C at the end of the working day and an occasional 30˚C situation.

Natural and artificial lighting. Natural light is purposely restricted due to small windows and heavy sun shading and façade vegetation. Inoperable fluorescent strip lights are used as uplighters bouncing light off the exposed vaulted soffits of the concrete ceilings. A lower than normal level of artificial lighting at 260 lux is reported to have been acceptable. In the lower office floors facing into the atrium, natural lighting is reported to be poor necessitating high use of artificial light.

Utilisation energy. This has been analysed in the offices areas and reported at 156 kWh/sq.m/year, this is 20-50 percent below five other office buildings surveyed in Harare. A NSW SEDA five-star rating using all electricity equates to 120 kWh/sq.m/year.

Greenhouse gas emissions. As electricity in Zimbabwe is produced 50 percent from hydro (rainfall permitting) and 50 percent from low grade coal, greenhouse gas emissions for Eastgate are calculated at 68 kgCO2e/sq.m/year. A NSW SEDA five-star rating equates to 120 kgCO2e/sq.m/year and a one-star rating 290-345 kgCO2e/sq.m/year.

Embedded energy. There are no figures available for embedded energy in the materials incorporated in the building. It is possible to speculate that the high thermal mass of the building may signify high-embedded energy in cement, concrete and bricks, but this in turn pays dividends in reducing utilisation energy demand through improved thermal performance. Steel and aluminium elements would be expected to have high-embedded energy. Mick Pearce sees this as a ‘life-time’ building and it is designed to be converted for residential use in the future. Thus annual energy consumption attributable to embedded energy is reduced. Relatively ‘low-tech’ production methods in Zimbabwe, associated with climate of escalating energy costs. The consulting engineers were paid fees equivalent to a fully air-conditioned building to provide the research on the passive systems.

‘If we recognise that cities are ecosystems like rainforests or coral reefs, but built by humans, we can find meeting points between nature and technology. ‘Eco- tech’ is a term that balances that redirected technological innovation can be beneficial and work in harmony with nature.” Mick Pearce. Pearce Associates. 

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