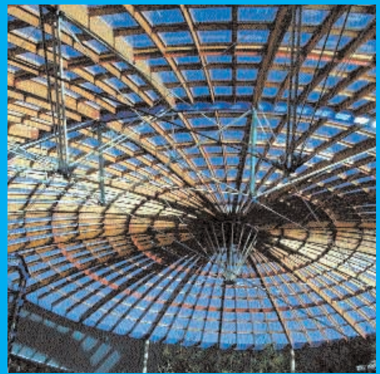

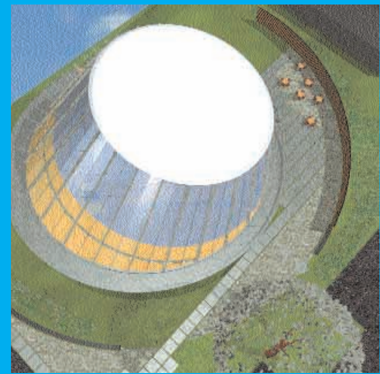

Greenhouse Effect.

The ‘thermal onion’ approach of containing a building within a building is not new, but creating a sustainable internal environment within has been more elusive. Lindsay Johnston investigates three local examples by Morris-Nunn and Associates that are rising to the challenge.

Three projects. Tasmania
Morris-Nunn & Associates. Architects

Lindsay Johnston. Review
Richard Eastwood. Photography

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■ **Creating an artificial environment** inside a human-made envelope may have reached its ultimate configuration in the ‘Biosphere II’ Project (1991-3), a 3.2 acre glass and metal dome in Oracle, Arizona. Its engineered ecosystem was sustained for two years before the experiment had to be abandoned when US$200 million worth of equipment failed to produce breathable air, drinking water and adequate food for eight people. ‘Biosphere I’ is Planet Earth (four billion BC–2001AD, so far), which currently has to provide air, water and food for six billion people every day – free of charge and without maintenance.

■ The potential to create an artificial internal solar environment was demonstrated in early examples such as von Knobelsdorff’s ‘mountain of glass’ at Sans Souci, Pottsdam for Frederick the Great (1745) and Louis XIV proclaimed himself the ‘Sun King’. The Enlightenment produced ideas of innovative glass and iron roofs foreshadowed in Belanger’s dome project for Halle du Blé, Paris, and realised in Paxton and Burton’s Chatsworth, Derbyshire Conservatory (1836-40); Burton and Turner’s splendid Palm House, Kew (1845-7); and the massive Crystal Palace by Paxton (1850-51), which was documented in seven weeks and constructed in nine months. Other explorations include Halles Centrales, Paris (1853-); Oxford University Museum (1854-60) by Dean and Woodward; and the Galleria Vittorio Emmanuele, Milan (completed 1877). The first exploration of ‘buildings within buildings’ may have been the great railway stations – St. Pancras, London, by engineer Barlow (1864-8) and later Pennsylvania Station, New York, by McKim, Mead and White (1902-11).

■ In the 20th century, the use of conservatories or glazed enclosures to moderate between inside and outside was dreamed about by Buckminster Fuller and realised in his geodesic dome US Pavilion at Montreal Expo (1967). Further demonstrations include Roche’s ‘garden within an urban building’ Ford Foundation, New York (1968); Pelli’s Rainbow Centre Winter Garden at Niagara Falls (1977); the great hotel atria of Portman; and, SITE’s Rainforest Showroom, Hialeah, Florida, with water wall (1979).

■ European architect and professor Thomas Herzog in his houses at Regensburg (1977) and Waldmor (1982-4), Germany, pursued the concept of the ‘building within a building’ using the interstitial space between outer and inner skin as a ‘buffer zone’ often filled with vegetation. Foster and Associates did a concept design for a house for Buckminster Fuller and his wife (1982) which envisaged two concentric domes, with a ventilated buffer zone between, that could rotate on hydraulic races, each with 50 percent glazing and 50 percent aluminium panels so as to operate like an eyelid that could open by day and close by night.

■ The ‘thermal onion’ approach has been developed in France by Jourda and Perraudin, firstly, in their small private house at Lyon (1984) and, subsequently, in major projects including the Training Centre at Herne-Sodingen, Germany (1999), where a large timber framed and glazed structure, with photovoltaic solar panels as sun control devices on the roof, provides enclosure for habitable modules. German practice LOG ID has built projects with ‘buffer zones’ around a ‘building within a building’ featuring solar heating, heat storage, controlled natural ventilation, diathermic heat transfer, and vegetal transpiration. Buildings include a Traumatology Research Laboratory, Ulm (1989); Medium Gmbh Print Works, Lahr (1990); and the Glasshouse Library and Cultural Centre, Herten (1994). Other innovative European projects include Future Systems’ Green Building (1990) and Project Z (1995) and HPP Hentrich-Petschnigg design for a Corporate Headquarters featuring habitable rooms suspended like cable-cars within a glass

01 - 04 The Strahan Visitor Centre (1991) houses a conservatory and provides a unique local educational experience.

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There are some recent examples of fine botanic conservatories in Australia, but examples of glazed enclosures for habitation that respond successfully to Australian conditions, without heavy dependency on fossil fuel energy for mechanical cooling, are rare.

enclosure. Many of these examples see architects working in close collaboration at conceptual stage with innovative consulting environmental engineers, such as the London firm Battle McCarthy.

■ Nearly all these precedents are northern hemisphere examples espoused by cold climate architects and their users to bring warmth and wellbeing inside on cold days. In Australia, the sun and its warming rays are treated with considerable caution and glass houses and glazed roofs are generally sensibly eschewed. There are some recent examples of fine botanic conservatories including Guy Maron's in Adelaide (1989) and Ken Woolley's in Sydney (1990), but successful examples of glazed enclosures for normal habitation that respond successfully to Australian conditions, without heavy dependency on fossil fuel energy for mechanical cooling, are rare.

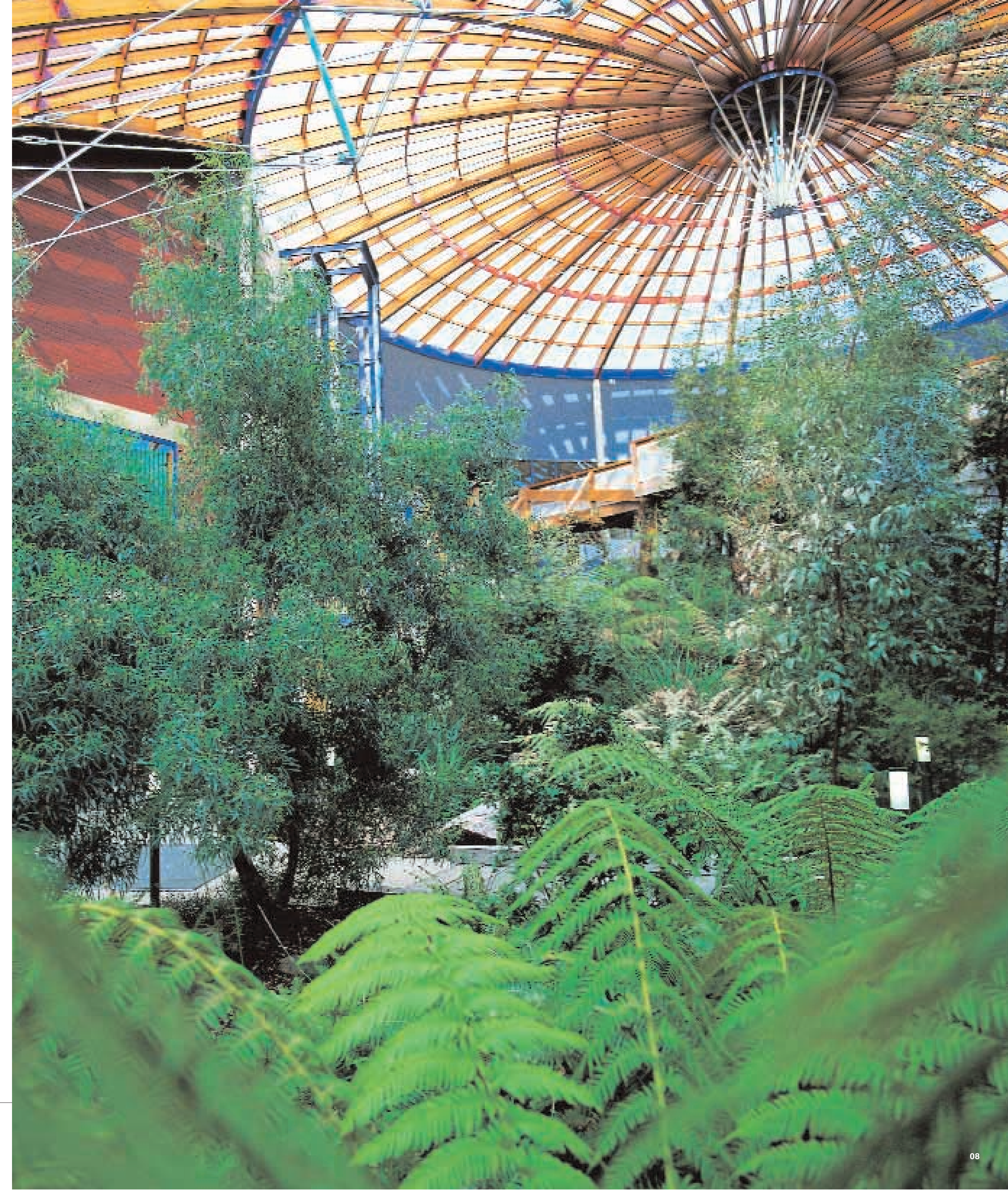
■ In Tasmania, a cooler climate, which often falls to below freezing in winter, especially inland, creates conditions where solar gain can be usefully deployed. Robert Morris-Nunn has been studying and exploring the potential for 'glass houses' and 'building within a building' for a number of years in a series of projects involving conservatories and natural vegetation.

■ The first endeavour is the Strahan Visitor Centre (1991 with Forward Viney Woollan) on the west coast, providing an innovative educational experience for visitors to Strahan and the World Heritage Wilderness area of the Franklin River region, famous for its Huon pine. The building takes its cue from the ad-hoc traditional sheds and is a combination of pine poles, horizontal timber boarding and corrugated iron. Half of the building has completely glazed walls and roof, forming a conservatory which houses a natural forest environment, including transplanted Huon pines, a creek with a waterfall flowing over logs, and displays devised by writer/historian Richard Flanagan that tell stories of the locality. Open eaves and ridge ventilation to the conservatory was found to adversely affect the vegetation and the draft has been reduced, improving user comfort and plant growth.

■ The second endeavour is the 6700 sq.m Forestry Tasmania Headquarters in Melville Street, Hobart (1998). Two dull 1930s heritage listed brick buildings have been brought back to life with a sensitive refurbishment and addition of a series of new structures including, as a centrepiece, a glass conservatory inserted into a 16-metre gap between the existing buildings. The conservatory is a portion of a 30-metre radius sphere forming a 22-metre diameter dome, 12 metres high, with a 'tail' that extends a further 15 metres to Melville Street. The dome creates an entrance atrium linking the two existing buildings to an office extension at the rear, where old Oregon timber trusses from the former warehouses have been recycled into 10 pyramid roofs.

■ The magnificent structure of the atrium dome is of glue-laminated timber, using local species generically termed Tasmanian oak, including swamp gum and peppermint and other eucalypts cut from sustainable sources. The structure deploys the compressive structural strength of timber and supplements it with the tensile strength of steel. A series of interlinked 'Barrup' or bow spring truss support the 'tail' of the dome and the radiating laminated hardwood rafters emanating from the central steel cone. The thermal performance of the dome was

05 - 08 The Forestry Tasmania Headquarters Building in Hobart is dominated by an atrium dome which creates a 'greenhouse' for a living forest and natural ecosystem.



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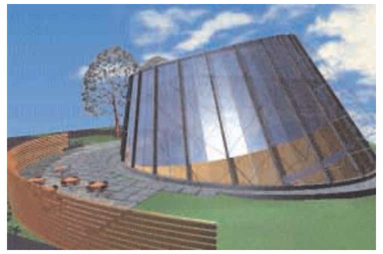
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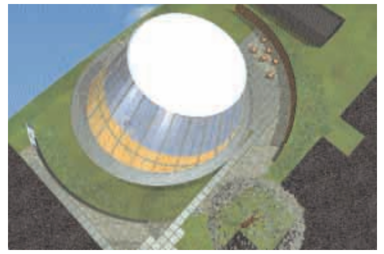
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09 - 12 Rendered 3D models of the new Forestry Tasmania facility at Scottsdale, which houses a building within a building.


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13 A section through the oblique cone shows the offices and accommodation within two shells and the buffer zone in-between that acts as a thermal moderator.

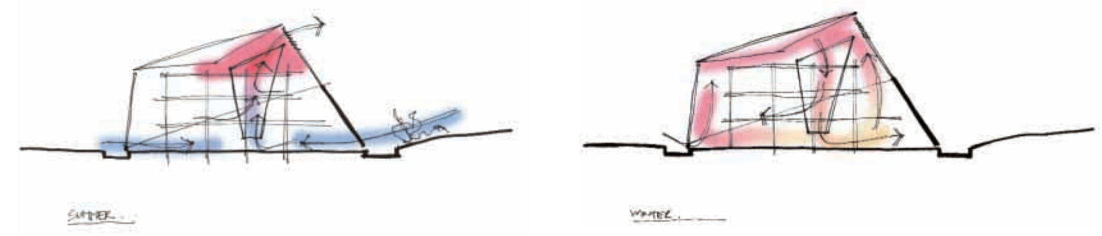
‘intuited’ rather than modelled and uses green-tinted heat-absorbing single glazing to reduce solar gain, has a large extract fan at the crown activated by a thermal sensor, and is naturally ventilated through large entrance doors at front and rear.

■ As a development of principles employed at Strahan, mature temperate rainforest trees, unique to Tasmania, were sedated with hormones and transplanted into the conservatory as a growing natural forest and supplemented by other native plants and an artificial creek system to replicate the natural ecosystem. A mist spray mounted to a timber footbridge over the creek augments the sub-surface irrigation to the vegetation and also provides evaporative cooling on hot summer days.

■ It was the architects’ original intention that the thermal heat gain from solar radiation into the conservatory would be ‘harvested’ and stored in the thermal mass of stone filled gabions in a basement for release back into the buildings as winter heating. It is regrettable that this facility was ‘rationalised’ out of the project. However, the conservatory does provide daytime warmth to the building in cold periods that is retained in the thermal mass of the old brick structures.

■ The third endeavour by Robert Morris-Nunn, and the most interesting from an environmental point of view, is another new building for Forestry Tasmania to be constructed during 2001, this time in Scottsdale in the north east of the island. Temperatures in Scottsdale on most winter nights fall below zero, with up to two months of severe frosts, and rise in summer to normally a moderate daytime 20˚C with occasional 30˚C days. This ingenious project fully explores the potential of the ‘building within a building’ concept and has been designed using up-to-date computer thermal simulation techniques provided by environmental engineering consultants Advanced Environmental Concepts, and fire engineering techniques provided by Ove Arup and Partners. The building form is a primary 30-metre diameter truncated oblique cone rising to a height of 12 metres, that encloses within it a discrete secondary structure, containing offices and supporting accommodation, surrounded by an internal ‘buffer zone’ that will, again, be filled with native trees and vegetation as ‘bio-mediators’. Innovative structural engineering on all three projects is by Jim Gandy.

■ The structure of the primary conical enclosure uses plantation grown radiata pine softwood and the walls are clad externally with plywood and 10mm thick twin wall clear polycarbonate sheet, which acts like double glazing and reduces heat losses in winter. The roof is a tension membrane stretched like a drum-head over the conical structure made from fireproof ‘Teflon’ coated fibreglass fabric with a twin skin, to improve thermal performance in winter, held apart by a flying mast in the centre. The tension to the drum-head roof is provided by an externally exposed ‘lacing’ system of stainless steel wires in a double spiral pattern which was inspired by the spiral patterns associated with the ‘Golden Section’ and ‘Fibonacci Series’ and emulates the patterns found in radiata pine cones. The secondary structure within the drum is a three-storey, plus roof terrace, office building constructed with an exposed primary frame of steel and hardwood flitch beams, cruciform flitch columns and laminated timber floor framing. This inner building is 14.5 sq.m and overall 8.8 metres high. The offices have fixed external glass walls with operable sliding glass vents opening into the interstitial ‘buffer zone’, and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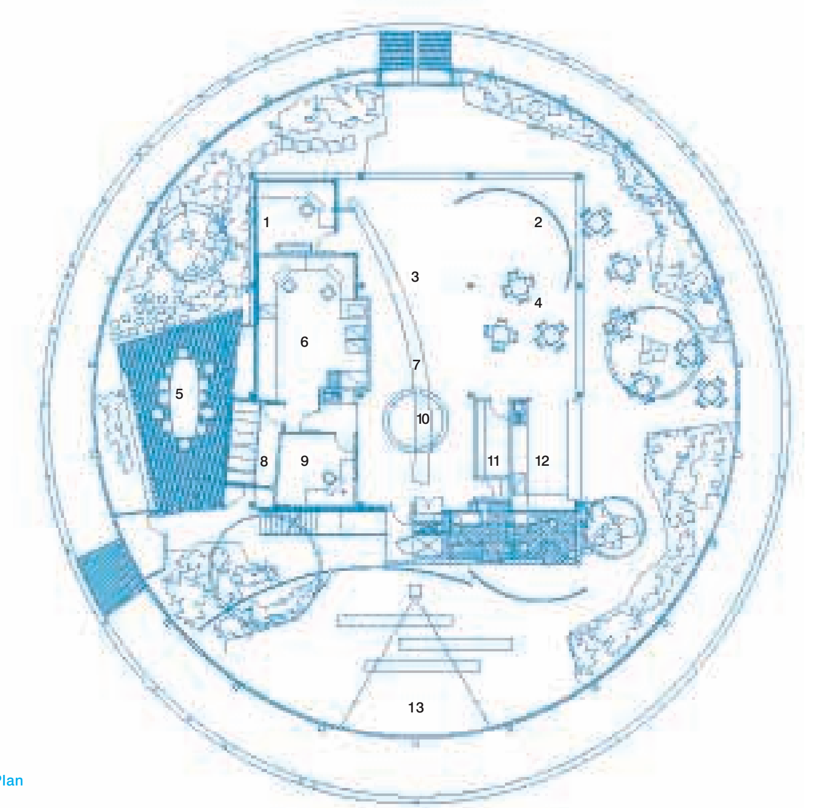
14 Summer and winter air-flow diagrams for the new building at Scottsdale.



1 Office community liaison
2 Information screen
3 Tasmanian visitor information service
4 Café
5 Blue Mt room
6 Clerical staff
7 Forestry reception
8 Compactus
9 Office business manager
10 Vent
11 Store
12 Kitchen
13 Display

Ground Floor Plan

are fitted with timber louvres on the outside of the glass to provide privacy from the public areas below.

■ Thermal performance modelling has contributed fundamentally to the design of the external envelope of the building and its internal configuration, and underscores that this must be an integral part of the design process, not a later add-on. This building is naturally ventilated, without use of mechanical cooling. What is known as ‘stack effect’ ventilation uses natural buoyancy – hot air rises as in chimneys, and all that – to draw cool air in to the bottom of the primary enclosure and exhaust it out at high level. In the walls of the conical primary structure, 30 sq.m of metal louvres (three percent of the floor area) are located at low level to allow fresh air to be drawn in, and a complementary 30 sq.m of metal louvres are located at high level to allow hot air to be exhausted out.

■ The particularly interesting feature is the configuration of air movement within the building in winter and summer conditions. Within the secondary office structure an inverted conical void or thermal chimney penetrates from the sub-roof of the office building down through the three floors and is enclosed as a fabric ‘tent’. Mounted at the top of this fabric chimney is a huge four-metre diameter low velocity propeller fan which, in winter, blows warm air down out of the top of the primary enclosure and circulates it into the office spaces of the secondary structure through low level vents at floor level on each storey. In summer, external cool air is drawn in through the louvres at low level in the external envelope, across the ground floor and up the centre of the office building in the fabric chimney, drawing with it warm air from the offices through vents at ceiling level, which in turn induces cool air circulation from the ‘buffer zone’ into the offices through vents at low level in the windows of the secondary structure. In winter, the external vents in the primary envelope only open when fresh air is required, and inside the secondary structure, the individual offices may be warmed as necessary by electrical heaters – first thing on winter mornings until the sun warms the ‘buffer zone’ (in Tasmania, electricity comes from ‘clean and green’ hydro). The external louvre vents in the primary envelope are automatically controlled by sensors monitored by computer ensuring that the building is tuned to suit conditions. Glass vents and electrical heating in the offices are manually controlled by the occupants. If construction of the secondary structure building, within the lightweight primary envelope, was of high thermal mass materials such as concrete and brick (as is the lift and toilet service core) the thermal lag provided may have further improved the thermal performance.

■ This ‘building within a building’ creates a situation where the habitable spaces interact not with the outside, but with the interstitial buffer zone allowing much closer control of internal thermal conditions and air quality. The introduction of natural vegetation into the buffer zone has the potential to improve air quality, moderate temperatures, provide shade, add the scents of a living forest and aesthetically enhance the internal environment. This project is one of few examples outside Europe to explore the very valuable potential of the ‘thermal onion’ approach.

Professor Lindsay Johnston is Dean of the Faculty of Architecture Building and Design, The University of Newcastle, NSW.