The Eden Project

1. Project Basics

Location: Cornwall, UK

Latitude/Longitude/Elevation: 50°N 4°W, 213' above sea level

Building type: Biome

Square footage: N/A. Outdoors is considered one of the three biomes
largest biome: 240m long, 55m high, 110m wide

Completion: April 2001

Client: UK Millenium Project for the Eden Trust

Design Team: Nicholas Grimshaw and Partners, Tim Smit, Arup Engineering

2. Background and Content

Initially conceived as a UK Millenium Project for the public, the Eden Project has grown to become not only a tourist attraction, research and educational tool, but one for generations to come. From the start, the mission of the Eden Project has been to "promote the understanding and responsible management of the vital relationship between plants, people, and resources, leading towards a sustainable future for all."

The idea for the three biomes was thought up by Tim Smit who had worked on and was largely responsible for the successful restoration of The Lost Gardens of Heligan. This time his focus was to create something new, starting from scratch, that would amaze future generations. This structure aimed to educate visitors about the importance of a sustainable environment through the study and education of plants. To achieve this goal, Tim teamed up with the internationally known sustainable architecture firm of Nicholas Grimshaw and Partners. Together they explored many innovative ideas for the creation of the world's largest biome.

There are essentially three biomes in the Eden Project: the humid–tropics biome, the warm temperate biome, and the moderate temperate biome which is the land surrounding the two enclosed bubble-like structures. The humid–tropics biome, the largest biome at over 240m long, houses tropical plants from all over the

1.01 Bird's eye view of the biomes.
Source: <http://www.rafocus.org.uk/architecture/index.php?pid=40&view=image>

1.02 The bubble-like form of the Eden Project in its surrounding environment.
Source: <http://www.rpcurnow.force9.co.uk/photos/hols2004/dscn2214_800.jpg>

1.03 The Humid–Tropics biome
Source: <http://www.rpcurnow.force9.co.uk/photos/hols_2004/dscn2214_800.jpg>

world. Trails and various waterfalls enclosed inside the structure allow visitors to totally immerse themselves in a unique environment that would otherwise be impossible. The moderate temperate biome, though smaller still, allows visitors to enjoy and learn about plants and environments from all over the world.

1.04 Exotic plants and waterfalls are encountered as visitors walk along the various trails the biome has to offer.
Source: <http://www.arch.mcgill.ca/prof/sijpkes/D+C-winter-2005/pavillionssteel_polymer/edenproject.jpeg>

1.05 One of the many jungle-type plants inside the humid–tropics biome
Source: <http://www.beautifulbritain.co.uk/images/edenproject/eden_project38.jpg>

3. Design Intent and Validation

The strict criteria for such an innovative structure created many design challenges. First, the structure was to be the world's largest plant enclosure. This involved coming up with a design scheme that could span for great distances without the use of a single internal support. Second, the structure must be as light as possible. This was needed for transportation reasons primarily because all the materials would have to be brought in from other cities, a long distance away. In addition, a lighter structure would put less stress on the soil and allow for smaller footings and less site impact. Last, the enclosure must be ecologically friendly helping it to be used as an educational demonstration of sustainability.

Grimshaw's solution to this challenge was to look at nature. He got his inspiration from looking at the honeycomb of bees and even the multifaceted eyes of a fly. These creatures used their surroundings most effectively to create a very strong, yet light-weight, solution. In addition, a geodesic dome-like structure would be able to conform to the expanding and contracting contours of the clayey soil.

1.06 Inside the biome. Some of the large heating/cooling units can be seen in the back.
Source: <http://www.arch.mcgill.ca/prof/sijpkes/D+C-winter-2005/pavillions-steel_polymer/edenproject.jpeg>

4. Key Design Strategies

The Eden Project uses a variety of design strategies to help it complete its goal of sustainability.

The official name for the bubble-like geodesic structure mentioned earlier is a “hex–tri–hex.” Though the final structure looks very similar to half a sphere, the entire building uses straight planes with straight edges. It incorporates an outer shell of primarily hexagonal pieces, (some pentagons) which attaches to an inner network of triangles for stability. The design is so structurally stable that it does not need any internal supports even in the 240m span of the largest biome. In addition, all the steel tubes that make up the grid-like network could be easily transported to the site in small pieces reducing costs. The structure transfers loads to the ground uniformly around its base which helps to eliminate large footings that otherwise might have been needed to support such a large enclosure. Energy efficiency-wise, the hemisphere shape helps to conserve the heating that is needed especially in the humid–tropics biome. This is because of the fact that a sphere has the largest amount of volume compared to its surface area of any form.

Cushions of ETFE (ethyltetraflouroethylene) transparent foil are used for the glazing. This very lightweight material weighs approximately 1% of glass. In addition, its strength and the fact that it is self-cleaning makes it the perfect product to use for this project. Last, it also has excellent ultraviolet transmittance which is essential for the healthy develop-

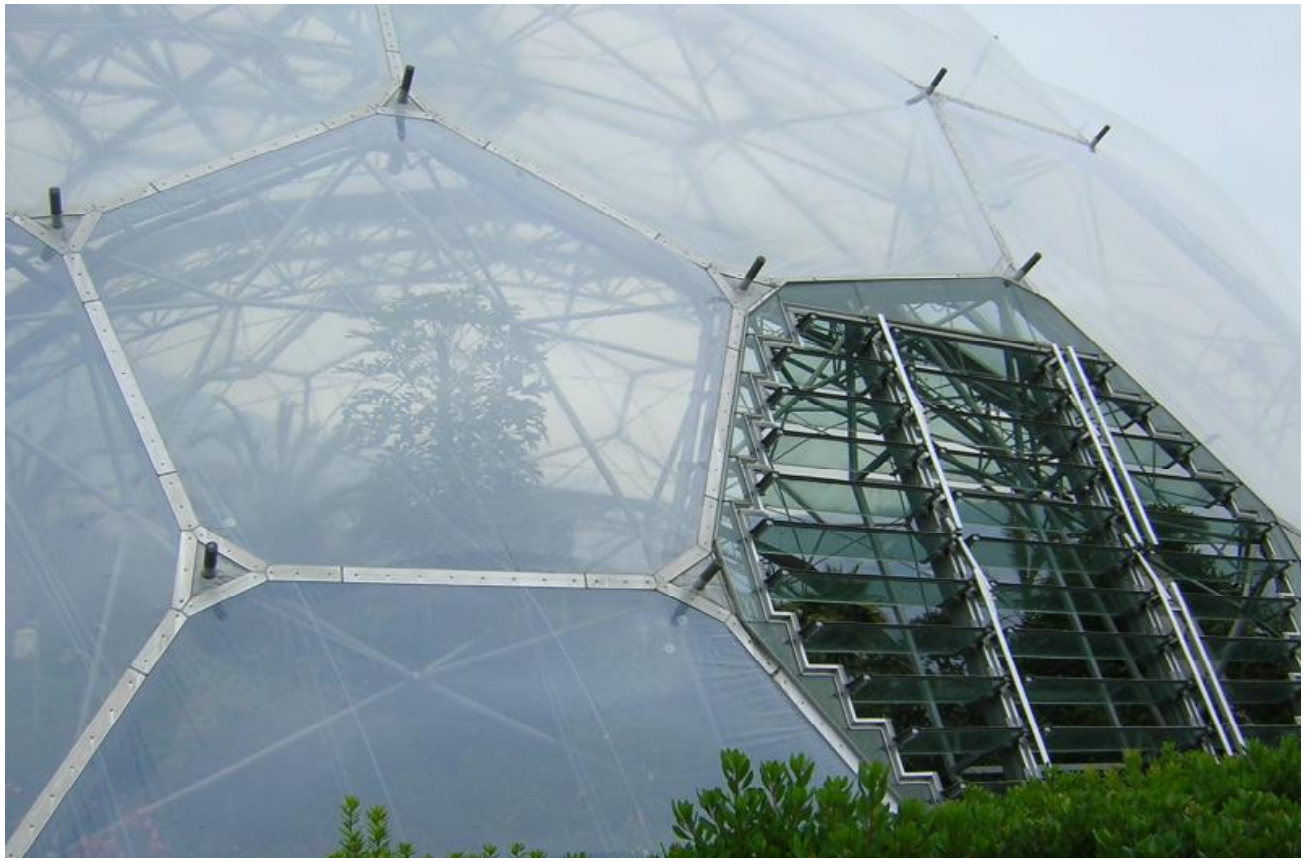
1.07 The domes under construction against one of the side walls of the old clay quarry.
Source: <http://www.eden-happenings.com/biome-con.htm>

1.09 The site before construction of the biomes began.
Source: <http://www.eden-happenings.com/start-of-con.htm>

1.08 Installation of the ETFE pillows.
Source: <http://www.eden-happenings.com/biome-con.htm>

1.10 The biomes were designed to impact the site minimally.
Source: <http://www.eden-happenings.com/start-of-con.htm>

ment of the plants grown inside. This also means that it is important to wear sunscreen when hiking through the biome. Since each of the hexagonal pieces of the biome is a different size, Grimshaw worked with others to come up with a specialized 3D computer program that determines the dimensions of each piece. These data are then transferred to a machine that correctly cuts and labels each piece before it is shipped to the construction site.



1.11 Up-close look at the transparent glazing of the ETFE pillows and ventilation. Each hexagon (or pentagon) is a slightly different size, allowing the structure to better conform to the site.
Source: <http://www.rpcurnow.force9.co.uk/photos/hols_2004/dscn2214_800.jpg>

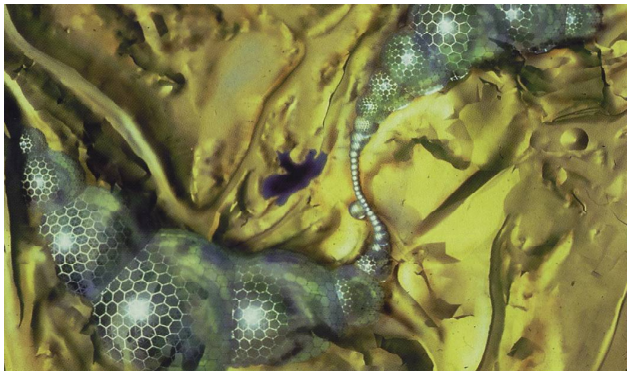
1.12 Construction of the steel hexagonal bracing
Source: <http://www.eden-happenings.com/biome-con.htm>

1.13 Specially designed connectors were designed to connect the ETFE pillow membranes to the steel strructure.
Source: <http://www.eden-happenings.com/biome-con.htm>

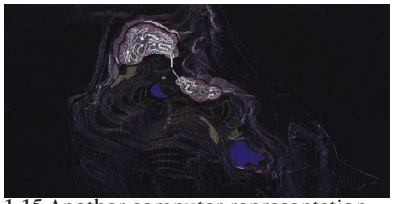
5. Performance Studies

To study the “macrosopic performance” of the biome a dynamic thermal analysis computer program called OASYS was used. This program helped measure the performance of the biomes during the extreme climate conditions of the year, such as a hot summer afternoon or a cold winter morning.

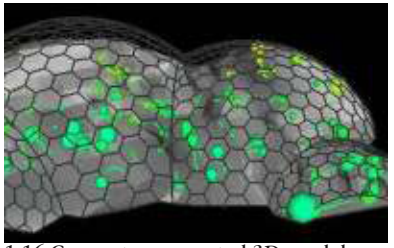
The performance studies reinforced the design strategies that were used in the original designing process. It also allowed for various adjustments to be made to enhance the energy savings within the biome. One of these adjustments was the change of the location and number of some of the nozzles that supply warm air for the biome.



1.14 Computer programs allowed Grimshaw to accuratly determines the size of each shape of the biome.
Source: Masters of Structure



1.15 Another computer representation of the biomes in the context of the site.
Source: Masters of Structure



1.16 Computer generated 3D model used to analyze energy efficiency within the biome.
Source: <http://www.arup.com/europe/feature.cfm?pageid=306>

6. Further Information

Eden Project web site: <http://www.edenproject.com>
<http://www.edenproject.com/3440_3459.htm> includes additional information on the “tri–hex–tri” design and a virtual 3D tour.

Eden Project Pictures: <http://www.eden-happenings.com>
includes an abundance of images of before construction started to new additions being made today as well as a list of good places to stay near the Eden Project.

7. References

Pearman, Hugh. *Equilibrium, The Works of Nicholas Grimshaw and Partners*. London: Phaidon Press Limited, 2000.

Sutherland, Lyall. *Masters of Structure: Engineering Today's Innovative Buildings*. Lawrence King Publishing, 2002.

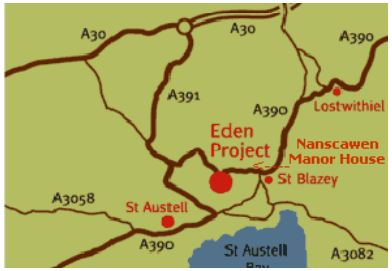
"Eden CFD." <http://www.arup.com/europe/feature.cfm?pageid=306>.

"The Eden Project." <http://www.beautifulbritain.co.uk/htm/outandabout/eden_project.htm>.

"The Eden Project, Cornwall, UK." Edited Guide Entry. <http://www.bbc.co.uk/dna/h2g2/A545477>.

"Geodesic Design." Eden Project—The Big Build. <http://www.edenproject.com/3440_3459.htm>.

1.17 The Eden Project is located on the southwestern side of the island.
Source: <http://www.cornish-links.co.uk/routemap.htm>



1.18 The Eden Project is located just northeast of St Austell
Source: <http://www.eden-project.co.uk/location-map.htm>

8. Map and Transport Options

Located 270 miles west of London and just east of St. Austell.

Take the train St. Austell. Then take the Truronian bus that goes from the St. Austell train station to the Eden Project in Cornwall. Ask for a combination bus/Eden Project admission ticket from the bus driver.

Case Study by Kenny Bissegger, Spring 2006