Education for Sustainable Architecture

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ABSTRACT: The paper introduces two short projects undertaken as vehicles for learning the principles of sustainable environmental design.

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1. INTRODUCTION

Our objective is a "*sustainable*" architecture. This may be characterized in many different ways. Here, however, we would expect such architecture to be *performative*, that is, capable of providing occupant comfort at lowest carbon emission; and, *expressive*, that is to reflect the architectural programme and its context in terms of climate, site and culture. Superficially, many recent buildings are claimed to share such attributes. In practice this is not necessarily the case. For those involved in the education of architects, key pedagogical questions are: how do we learn, or know, this sustainable architecture ? how long does it take to learn enough in order to make a difference in terms of performance and expression ? what aspects of it can we teach and how should we teach them ? how do we translate the principles of physics, the lessons from earlier built examples and the use of simulation tools into design knowledge and architectural practice ?

Over the previous three years the projects undertaken in the AA Graduate School's Masters Programme in Environment & Energy Studies have aimed to qualify the environmental attributes and performance of built form in a number of specific ways [1]. In 2001-02 the year's main design brief delved into the notion of a *magical* skin that would bend and shape itself to suit the building programme and the challenging topographies of three urban sites in central Lisbon. In 2002-03 we explored designs for a *performative* space in projects culminating with proposals for mixed-use development on a major London site [2]. In 2003-04 we focused on the *adaptive* nature of human thermal comfort and its implications for microclimatic interventions in the urban fabric [3]. In 2004-05 we took these preoccupations a step further, extending both the programmatic and the climatic ranges of the investigations. Four project briefs were introduced in quick succession, each representing a further stage of engagement and experimentation. Two of these projects are briefly illustrated here.

2. GENERATIVE SKIN PROJECT

2.1 Project Brief

The Generative Skin project was a one-term design brief introduced in January 2005. *Generative* refers to an ability to produce or originate. On this project the word assumed two distinct, but complementary, meanings: the skin as generator of built form and "passive" climatic modulator; the skin as "active" collector, store, distributor or dissipator of energy, Fig. 1.

The building programme was for a mixed-use development with a degree of freedom in defining use as a function of contextual parameters. Six project sites were selected in different climatic regions in order to explore the morphogenetic attributes of local

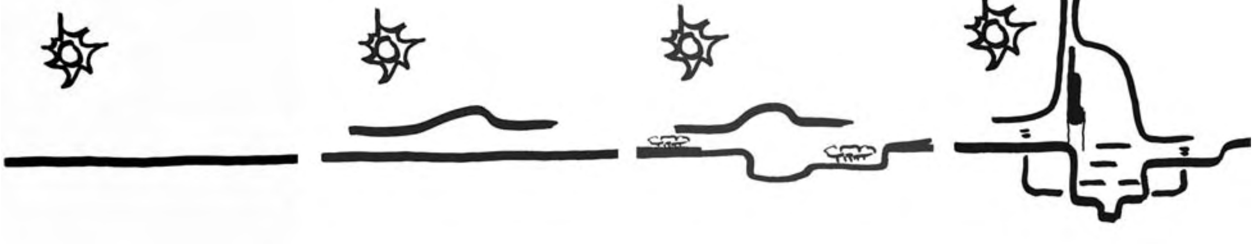
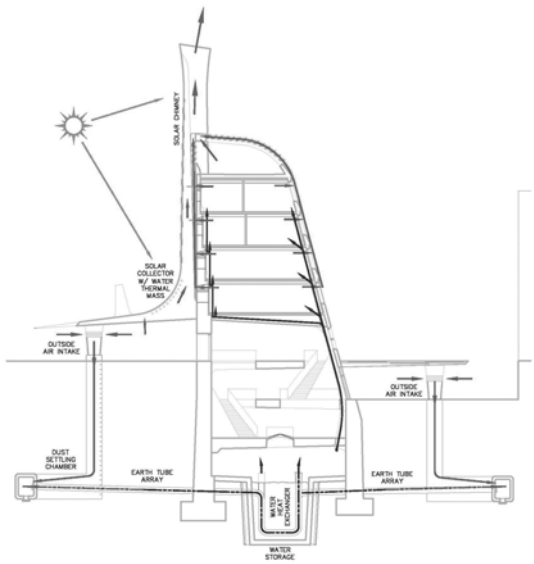


Figure 1: Generative skin concepts for hot-dry climate [4]

climate and ecology. The project was undertaken in teams of two or three. The six schemes were developed for Manaus, Brazil 3°S latitude; Karon Beach, Phuket Island, Thailand 8°N; Dhaka, Bangladesh 23.5°N; Tempe, Arizona 33°N; San Francisco, California 37.5°N; and Innsbruck, Austria 47°N. Three of these are briefly illustrated in this paper.

2.2 Tempe [4]

A combination of strategies was proposed along the lines illustrated in Fig. 1 in response to the climatic conditions shown on the psychrometric chart, Fig. 2. Previous research and computer simulations suggested passive systems using the ground as heat sink and evaporative cooling in periods of high outdoor temperature and low relative humidity. Figure 2 shows the shift towards thermal comfort that can be achieved as a function of ground cooling. The solar chimneys on the southern side of the building draw the earth-cooled air into the occupied spaces, Fig. 3.



2.3 Manaus [5]

The concept for the building evolved from the need to provide shade and air movement in this tropical wet climate with little seasonal variation, Figs. 4-6. The building is raised on pilotis. The skin combines several functions that allow control of relative humidity as well as shading and air permeability.

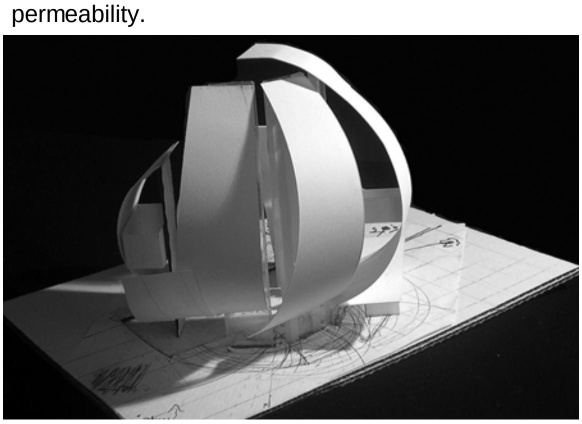


Figure 5: Design concept for Manaus

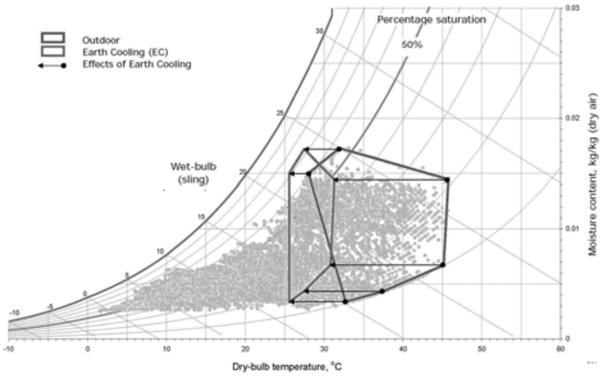


Figure 2: Psychrometric Chart for Tempe, Arizona

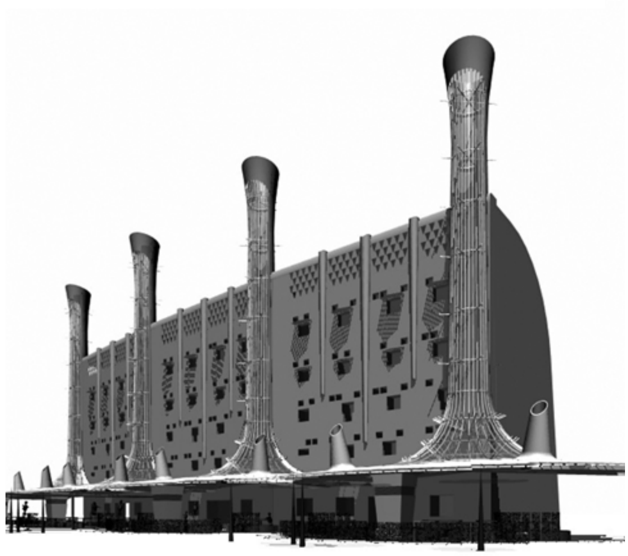


Figure 3: Section and elevation of design proposals for Tempe illustrating cooling strategies and resulting building form

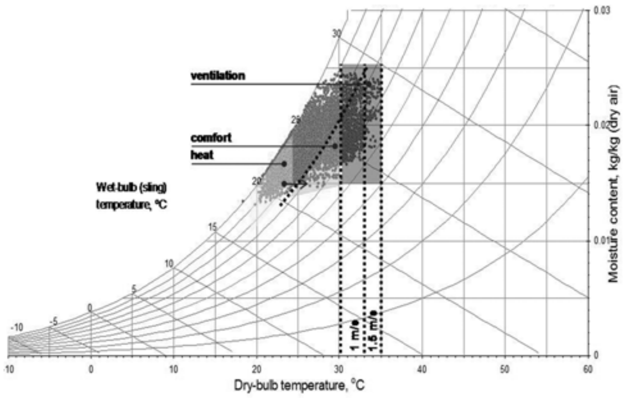


Figure 4: Psychrometric Chart for Manaus identifying bioclimatic strategies

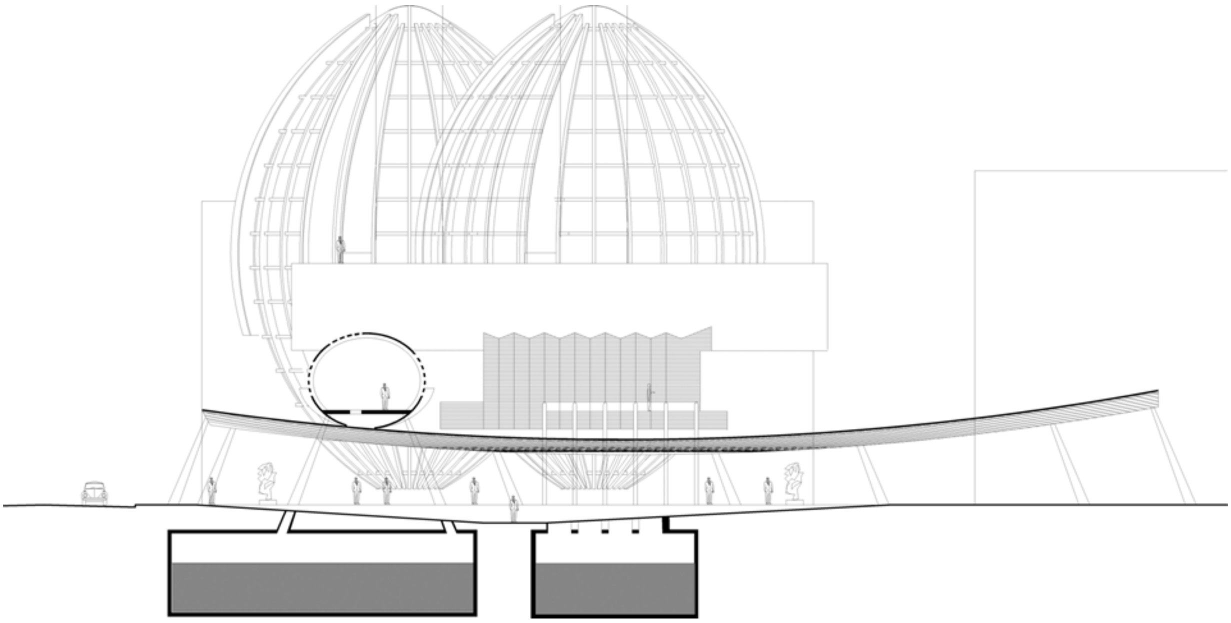


Figure 6: Building design for Manaus

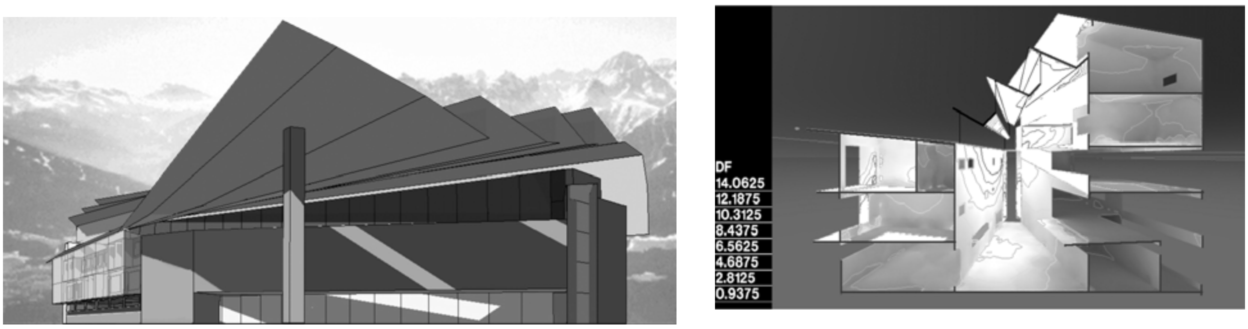


Figure 7: Design proposals for Innsbruck

2.4 Innsbruck [6]

The design brief chosen by this team called for an architecture centre proposed as an extension to the local university campus. Outdoor air temperatures in the region are below comfort levels for up to nine months. The generative concept for this cool climate was one of layering and buffering, Fig. 7. The final form was reached following comparative analysis with dynamic thermal simulation.

3. A HELIOTROPIC URBAN BENCH

On a return study trip to Santorini to take part in an international conference on passive cooling in the built environment, the entire Masters group collaborated in the design and construction of a small structure that was transported, assembled and tested there. This followed from a similar exercise last year to produce a small shelter for archaeologists, Fig. 8, [3]. This year's structure was conceived as a piece of urban furniture, a bench for sunny climates, Figs. 9-10.

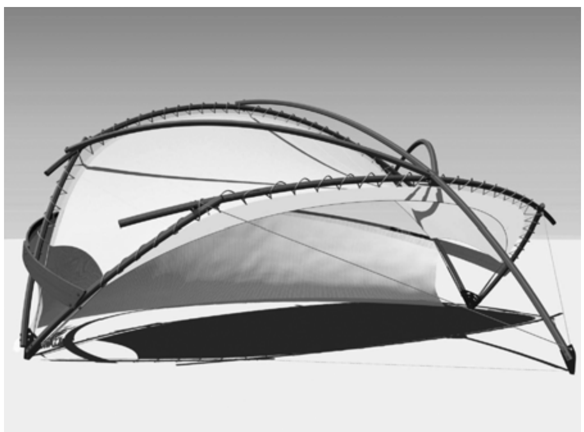


Figure 8: Shelter for archaeologists, AA E+E Masters group 2004 [3]

Figure 9: Making and assembling the heliotropic bench at AA School's Hooke Park laboratories and on location in Oia, Santorini.

Figure 10: Heliotropic urban bench in closed position

The bench can be shaded and ventilated by moving the constituent elements of the structure. The moving parts allow occupants to vary the proportion of the sky dome that is obstructed or exposed and to expand or contract openings for air movement. Its components, made of pieces of laminated timber, were fabricated at the AA School's Hooke Park and Chings Yard workshops and transported to Santorini as hand luggage. The structure was assembled on Santorini and exhibited, first at the PALENC 2005 international conference in Fira and subsequently on the main square of Oia, on the north of the island.

Each reassembly of the structure has allowed useful observations to be made on its environmental performance, usability and adaptability. In each case the group was able to make adjustments to improve performance and usability. The structure has now been further modified to allow easier movement of its components. The modified heliotropic bench is currently on display at the AA School's Library Terrace.

CONCLUSION

For our teaching programme each year is an experiment and an adventure. Essential layers of teaching and learning are:

- the assimilation of the underlying principles
- consolidation by observation and hands-on experience
- testing and generalisation using comparative analytic work, commonly based on computer modelling
- development of critical judgment.

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