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WORKSHOP INTERACTION BETWEEN PHYSICS AND
ARCHITECTURE IN ENVIRONMENT CONSCIOUS DESIGN
25 - 29 September 1989

"Climatic Control for the Open Spaces of the 1992 World Fair in Seville"

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OTHER REALIZATIONS

PROF. LOPEZ DE ASIAIN

CLIMATIC CONTROL FOR THE OPEN SPACES OF THE 1992 WORLD FAIR IN SEVILLE.

The 1992 Universal Exhibition will tale place in Seville from the 20th April to the 12th October. In this region the warm period includes June, — July, August and September, and therefore most of the time the EXPO will be under overheated conditions. A great deal of visitors are expected to come and see everything in a few days, walking several kilometers and suffering climatic discomfort. As the former can prove descouraging for potential visitors, some serious measures must be taken on the subject.

To condition the open spaces is as important as cooling the different — pavillions and buildings. In mediterranean cultures, streets and squares are a meeting point for leisure and to experience this is a "must" for foreigners in Andalucia and in EXPO 92. Besides, waiting and queueing areas are - always required.

When the MASTER PLAN for the EXPO 92 was to be drawn up , the executive team considered that it was paramount importance to include the OVERALL BIOCLIMATIC ANNEX within the basic objective's scheme. This ANNEX involved some BIOCLIMATIC REGULATIONS for buildings (wether permanent or non-permanent) and DESIGN GUIDELINES for the open spaces.

In July 1987, after the approval of the MASTER PLAN, the SEMINAR OF BIOCLIMATIC ARCHITECTURE began to develop the former ANNEX for climatic control.

The first application took place on the Isla de la Cartuja (Site of EXPO) itself, in an office area belonging to the State Company for EXPO 92. - This was the PILOT EXPERIMENT.

The State Company for EXPO 92 is the executive producer of all the works in the Isla de la Cartuja, so they found it suitable to locate their offices in the very island and have the BIOCLIMATIC ANNEX applied inside the same - area which is about 15.000 square meters.

Then, not only the climatic conditions should be improved but the different systems and subsystems of passive cooling could be experimented and -- their performance evaluated.

Now, the project has been produced and the gardens and open spaces constructed with built-in passive cooling systems and subsystems as well as the monitoring for evaluation.

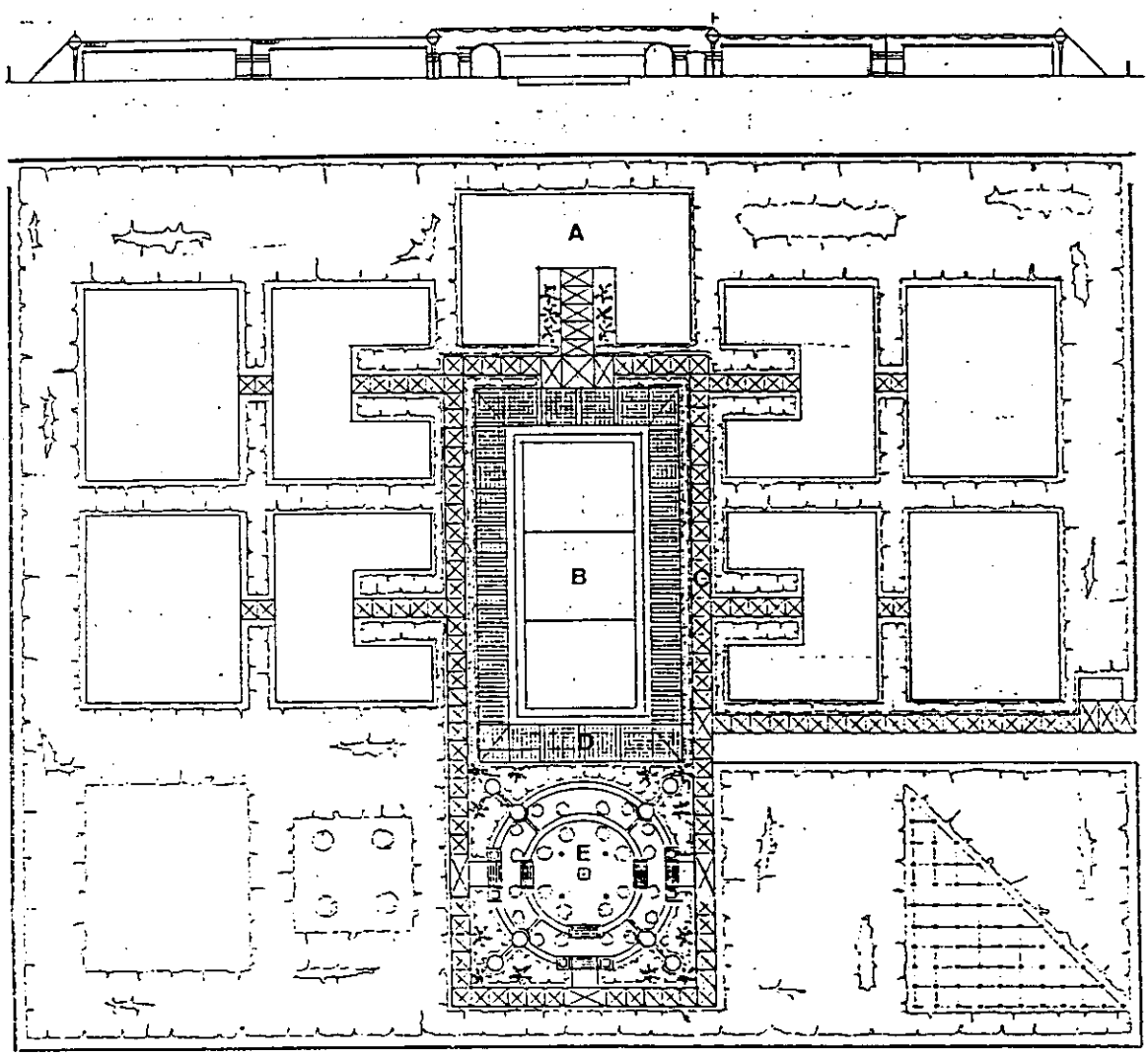
Recommendations from the ANNEX have been followed and used in the design for the existing voids between office buildings.

The vegetated surface is 60% and the general resembles in proportion to a section of the future promenades which will cross the pavillion areas in - EXPO.

Two types of pergola have been designed. One is strictly pedestrian and goes along a water cooled pavement while it is covered with canvas and therefore protected from sun and rain. The other type admits both pedestrians - and vehicles, it is a structure made of an electrowelded steel mesh and co-

vered with ivy.

In the central space between offices a great pond has been constructed with two main aspects:



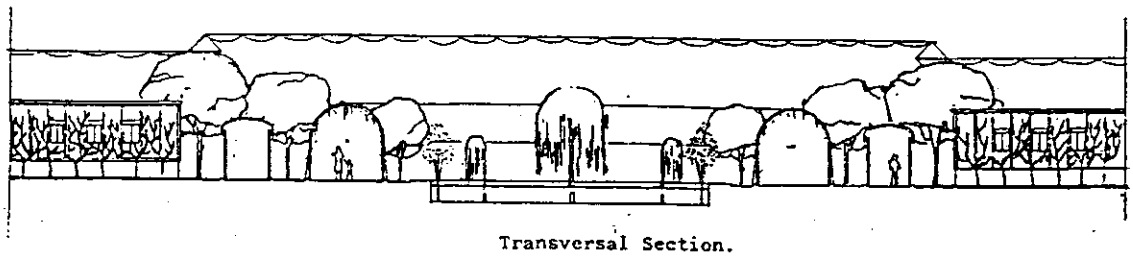
General Plan: A.- Offices. B.- Central Pond. C.- Pedestrian Pergola. D.- Vehicle Pergola. E.- Bioclimatic Rotunda.

As a thermal mass producing surface evaporation and water circulation for the cooled sidewalks and as a computer-controlled fountain with a complete array of water jets and mist sprinklers in perimeter curtains.

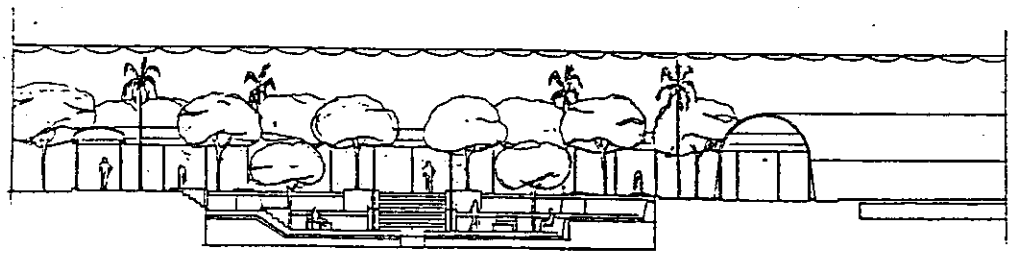
Inside the garden like treated area in front of the main axis, there is a BIOCLIMATIC ROTUNDA where most cooling subsystems are integrated to make a pattern of what leisure spaces for EXPO visitors can be. These will be — evenly distributed along diverse promenades with a rest or stand - by purpo se.

In this rotunda there are two levels of water cascades in closed circuit a dense vegetation and the lower plattform is water-cooled. It is covered - with a removable canvas which prevents solar radiation while allows cool - breezed from SW.

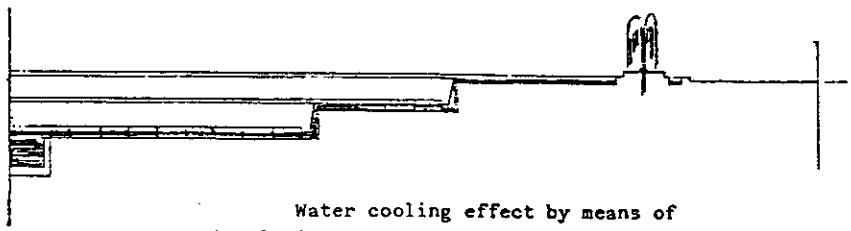
Also the central pond and the pergolas have an upper removable canvas ((see following sections):



Transversal Section.



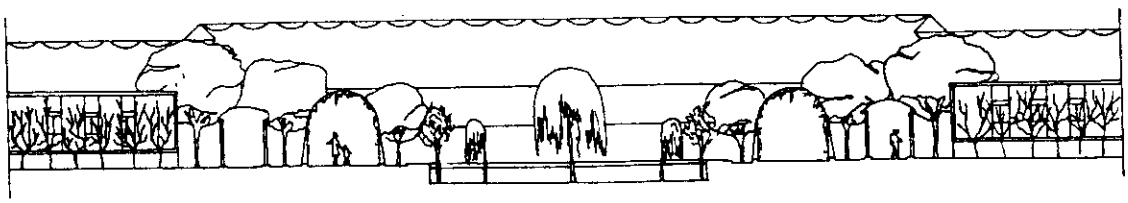
Bioclimatic Rotunda Section.

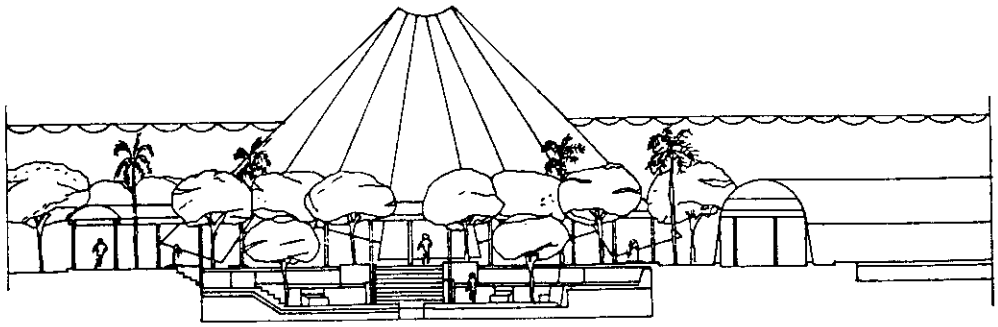


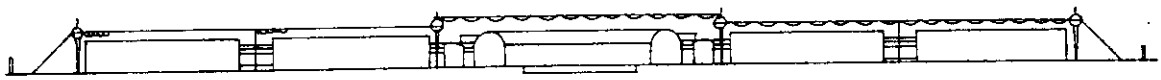
Water cooling effect by means of
circulation and evaporation in rotunda .

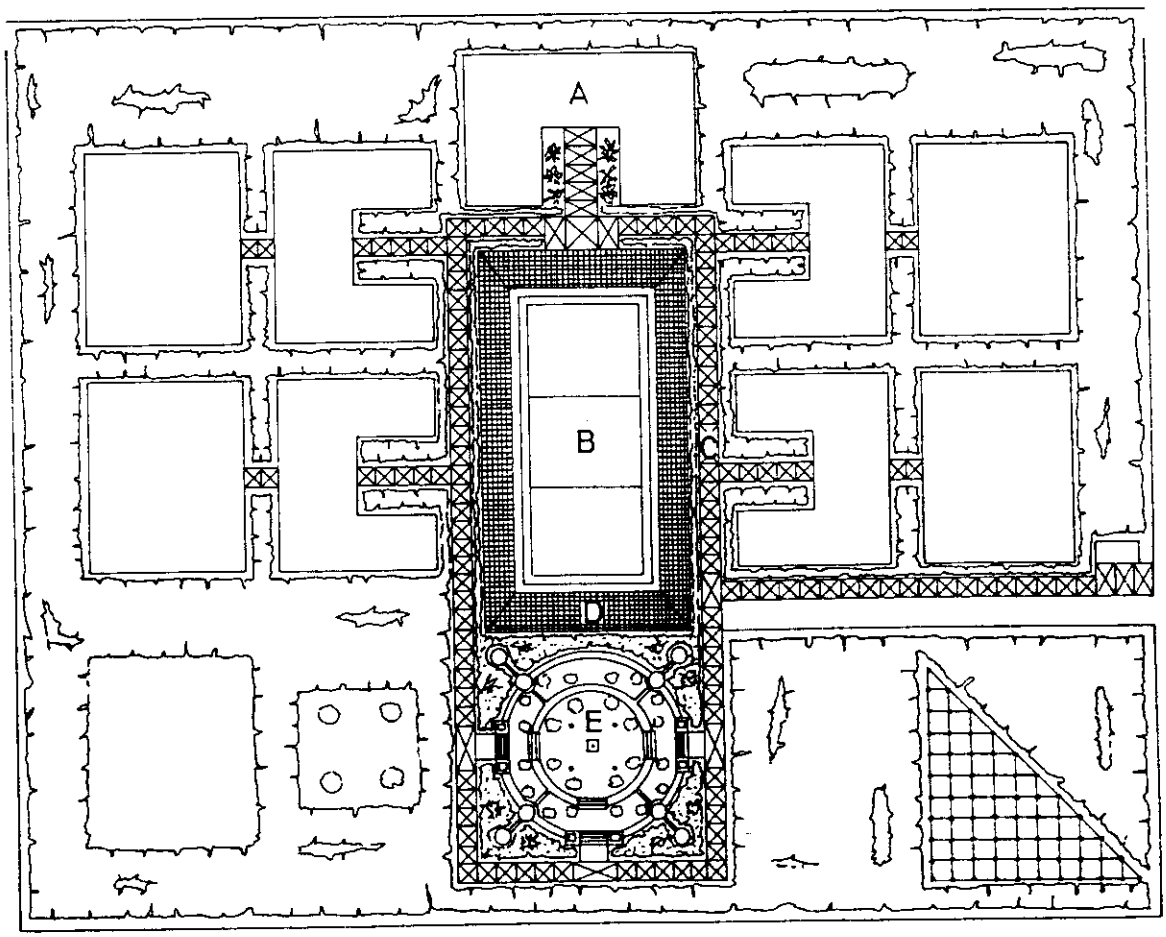
In summary, the basic design principles of PASSIVE COOLING are:

- Vegetation effect
- Artificial and natural shadow
- Ventilation
- Evaporative cooling
- Artificial cooling
- Artificial water - unit
- Cool air stratification








A
B
C
D
E

References on Earth Cooling

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3. Givoni, B. & Katz L.: Earth Temperatures and Underground Buildings. Energy and building.

4. Hayeem, E.: An Experimental study of Earth Temperature modification in a Semi-Arid Desert Region: M.Sc. Thesis, Trinity University, August 1984.

Climatic Control for the Open Spaces of the 1992 World Fair, Seville, Spain

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INTRODUCTION

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SCHEME

The idea is to modify the microclimate of the Corta de la Cartuja(Isle where EXPO will be held)through the use of natural flows and their cooling potential, thus reaching the necessary level of comfort for the diverse activities

This choice entrances a notion of paramount importance, the relationship between Man and environment. The main available sources of passive cooling are:

1.- Vegetation
2.- Shadow
3.- Anabatic action
4.- Evaporation
5.- Thermal inertia of soils
6.- Long-wave radiation
7.- Display of filters
8.- Patterns of use:timetables, zoning, psychological aspects.

CLIMATIC DATA

An accurate study of site variables reveals the following average maximum for calculation:

$T_{dry-bulb}$ = 35ºC RH=40% This figure represents the 5% frequency.

The annual average is 18ºC and the August average 26,4ºC.

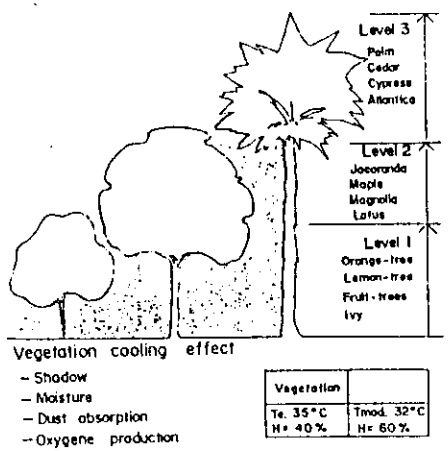

Fig. 1. Vegetation cooling effect.

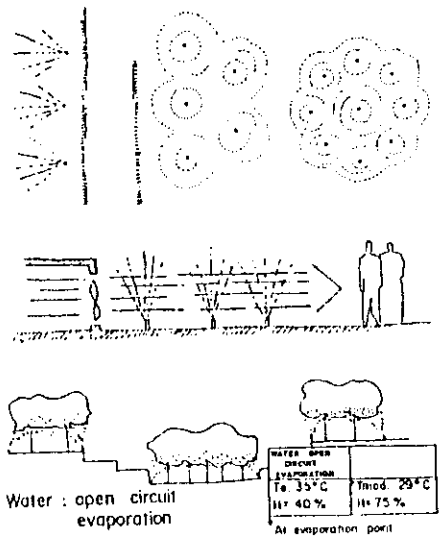

Fig. 2. Water cooling effect.

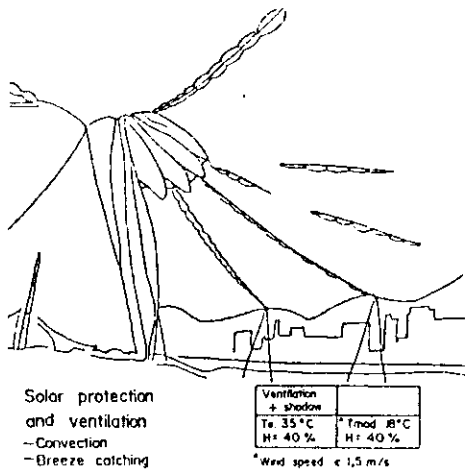

Fig. 3. Shading and ventilation system.

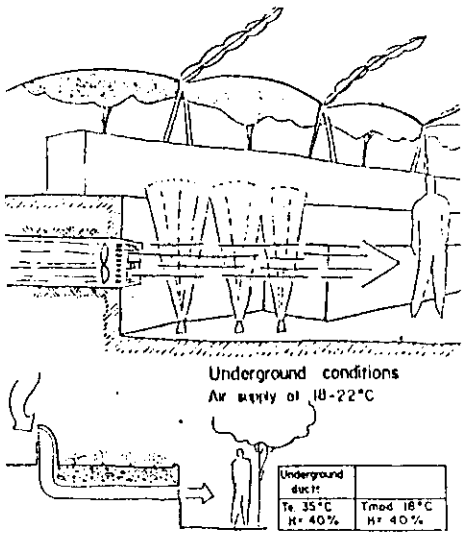

Fig. 4. Underground cooling system.

OBJECTIVES

The S.A.B. has calculated a probable reduction of temperature ranging from 20 to 30% if climatic designs are employed. This means that even under the extreme conditions considered thermal comfort should be achieved in an intensively-treated nucleus. The final design will be done with the help of simulation programs, models and a real-scale prototype, now under construction.

The theoretical effectiveness of main cooling sources for the basic data is:

Open spaces/Shade conditions Frequency 5%	$T_{dry-bulb}$=35ºC H=40%	Effective temperature
Vegetation	$T_{dry-bulb}$=33ºC H=65%	33ºC
Ventilation/Wind speed=1.5m/s	$T_{dry-bulb}$=35ºC H=40%	27ºC
Evaporation up to H=80% x	$T_{dry-bulb}$=26ºC H=80%	26,5ºC
Underground ducts xx	$T_{dry-bulb}$=18ºC H=40%	18ºC

x Air at evaporation point. xx Air t underground ducts outlet.

The use of partially conditioned spaces as progressive filters leading to - intensive-treatment zones, would give an initial temperature reduction between 1 and 3ºC.

CONCLUSIONS

With these schemes and designs a natural climatic control can be achieved, and the level of comfort reached,in the places where most activities will be developped. It is important to consider that this operation is not only a matter of energy-saving in relation to active systems, but mainly a question of IMAGE, a true image which can be associated to the trends of modern culture, with a view on the future: soft technologies, man's return to nature, echological equilibrium, life quality and so on.

On the other side this experience has a close relation with avant garde urbanism and new ideas for creation of human environment. In summary, it is much more than architectural fashion for an Universal Exhibition.

The whole work has been developped in the Master Plan Annex called: "CLIMATIC CONTROL FOR THE OPEN SPACES" produced by the S.A.B. in collaboration with the Executive Team of the Master Plan.

Experiments in Radiative Cooling in Hot-Arid Zones

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INTRODUCTION

Any material surface emits electromagnetic radiation of a wavelength inversely related to its temperature. The radiation emitted from the surface of the sun, referred to as a shortwave, radiation has a spectral range from 0.25 to 3 microns with a peak radiation at about 0.5 microns. The longwave radiation emitted from the surfaces of the earth, which are at "natural temperatures", is in the spectral range of 5 to 30 microns with a peak radiation at about 10 microns.

Constant exchange of radiant energy in the long range spectrum takes place between any building and the atmosphere: any element of the external envelope of a building which "sees" the sky emits longwave radiation towards it. This radiation is continuous over the whole spectral range. Roofs, being the building elements with the highest exposure to the sky, are the most effective components to be used as longwave radiators (Givoni, 1982a), and therefore most attempts to utilize radiative cooling techniques for the cooling of buildings focus on various technical solutions of roofs.

Emission of longwave radiation takes place during the day and the night. During the day, though, an exposed roof may absorb solar energy that outweighs its longwave radiation, i.e. the net effect may be of heating rather than of cooling. Since most of the cooling is achieved during the night, this cooling technique is also referred to as "nocturnal radiation."

The project was funded by the Israeli National Council for Research and Development (NCRD) and by the German Federal Ministry for Science and Technology (BMFT).