绿色建筑

泛亚热带地区可持续建筑设计与技术

——华南及香港实例

Green Building Design and Technologies: Experiences in Southern China and Hong Kong

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本书涵盖了泛亚热带地区建筑设计与技术许多方面的内容,包括:传统建筑的特点与设计方法,人居环境理论,建筑设计的理论方法和创作实践,节能建筑、生态建筑的理论与设计方法,建筑环境的评估方法,影响建筑室内、外气候环境的因素及对策,建筑室内、外微气候的优化,气候资源的开发,自然通风降温技术和措施等问题。从建筑设计的概念、过程、方法;建筑规划的可持续策略;绿色建筑研究实例效果及分析;可持续发展社区、可持续发展楼宇研究;环保建筑、环保结构概念;可持续发展的公众参与与项目合作;物业保养维修及管理等不同角度对绿色建筑各个专业和地区的经验及技术进行了交流。

这些论文提出了一些新观点、新技术、新方法,对促进泛亚热带地区建筑设计及技术的发展、推动该地区学术研究、提高建筑师对气候特征和资源开发的认识,发展建筑创作具有十分现实的意义。

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责任编辑 常 燕

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序　言

在东京举办的2005年可持续建筑世界大会有来自80多个国家和地区的将近1700个参与者，讨论了全球合作、互相理解、技术和社会体制创新以及其他重要议题。在大会的尾声，我作为一个参与者签名宣誓：“可持续建筑世界大会宣言：‘为可持续付之于行动’”。通过宣誓，我下决心为自己国家奋发努力，带动同事和其他科研机构一起提倡京都协议书的精神和促进可持续建筑理论的完善，并且通过参与和合作，领导大家修补各自之间的隔阂。

我们通过 PGBC 和华南理工大学及广州大学的合作，还得到香港特别行政区政府工商及科技局，专业服务发展资助计划（资助计划），举办第一届“香港广州可持续建筑技术专业咨询研讨会 2005”。我们借此机会分享两地在这方面的经验。

此次活动由技术交流会和展示会两部分组成。在技术交流会上，由来自香港的专家（由建筑师、工程师、园境师和测量师组成）展示技能和传授经验。本书汇编了上述专家针对各自专业和地区绿色建筑和可持续发展的主要问题和进展所撰写的摘要和主要论文。

陈佐坚
环保建筑专业议会，香港
2005～2006年度主席

前言

20世纪90年代初，国际建协引领全世界的建筑业进入到了一个可持续发展的时期，从此我们对建筑和环境的要求都打下了"可持续发展"的烙印，人类是带着可持续发展的理念进入21世纪的。可以说20世纪的后十年我们领略到了环境问题的严重性，但对能源问题的紧迫性没有引起足够的重视，可是正当我们为可持续发展这一新理念的诞生陶醉的时候，能源危机终于演化成了残酷的现实。进入21世纪以来我们国家的各个行业受到国际能源危机的冲击就始终没有太平过，最终促成了国家利益高度的节能行动，毫无疑问，中国的建筑业责无旁贷地步入了这场姗姗来迟的行动行列。中国的亚热带气候和部分热带地区的国土面积约有380万km^2，生活在这一地区的人口多达7亿以上，拥有的建筑物累计建筑面积超过了100亿m^2，然而在这一地区开展可持续发展建筑法规、技术研究工作起步较晚，大量相关问题仍然没有得到很好的解决。早在1998年香港大学的刘少喻、许俊民、张国斌三位先生来访时就谈起了我们共同关心的问题，从发展角度考虑，我们确立了粤港两地共同探索这一地区建筑技术问题的愿望，考虑到过去若干年来这一地区对相关研究成果有了一定的储备，旋即于1998年底双方合作并联合同济大学召开第一届泛亚热带地区建筑设计与技术学术会议，从此拉开了中国泛亚热带建筑技术研究的序幕。

几年来在可持续发展理念的影响下，国内外学者都在不遗余力地探索解决这一地区建筑环境、建筑节能领域面临的大量问题，正处在"蓬勃"发展时期的中国南方城市，一方面面临着城市化发展对适宜技术需求量的加速增长，一方面又面临着严酷的气候制约，加之地区经济发展状况的不平衡，造成了目前亚热带建筑技术还没有发展成为完整的体系。可以欣慰的是这一地区的专家、学者和工程技术人员，积极顺应本地区气候状况和国际可持续发展潮流的努力始终没有放弃，广泛地开展了诸如绿色建筑、生态建筑、环保建筑、节能建筑等的设计方法研究和技术创新工作，积累了许多成功的经验。在新的时代背景下，以可持续发展为前提，再一次讨论亚热带地区建筑设计、技术、理论和实践，十分必要，时机也逐渐成熟。因此，时隔七年之后，第二届泛亚热带地区建筑设计与技术学术会议于2005年12月再一次在华南理工大学成功举办。这次会议是处于进入新世纪伊始、东西方高新技术与传统技术广泛碰撞时期召开的，可谓是关于亚热带建筑设计与技术的继承和发展的一次会议，对前人不断探索的研究成果加以总结，指导相同或相近气候区的建筑设计与技术应用，推动亚热带地区的建筑业走向可持续发展之路，都具有很重要的时代意义。

第二届泛亚热带地区建筑设计与技术学术会议暨香港广州可持续建筑技术专业咨询研讨会，是由华南理工大学建筑学院、同济大学建筑与城市规划学院、广州大学建筑与城市规划学院、香港环保建筑专业议会(PGBC)、香港大学建筑系(中港建筑都市研究中心，可持续都市研究组)、台湾成功大学建筑系联合主办，于2005年12月3~5日在华南理工大学举行，参加会议的近200位专家、学者、建筑师、工程师、园境师和测量师们分别来自内地、香港、台湾、日本、澳大利亚、印度和马来西亚。会议主题是，立足泛亚热带地区的气候环境特点，从人与环境相互关系的高度研究泛亚热带地区可持续发展的建筑规范、设计理论、方法及技术措施，可持续发

展的人居环境的评估方法，为居民创造优美、舒适的建筑环境。

本书是这次国际性学术会议交流成果的集成，会议收到来自全国多个省、市和香港特区、台湾及海外地区应征论文。本书收录其中优秀论文50篇正式出版发行。入选论文题材广泛，涵盖了泛亚热带地区建筑设计与技术许多方面的内容，包括：传统建筑的特点与设计方法，人居环境理论，建筑设计的理论方法和创作实践，节能建筑、生态建筑的理论与设计方法，建筑环境的评估方法，影响建筑室内、外气候环境的因素及对策，建筑室内、外微气候的优化，气候资源的开发，自然通风降温技术和措施等问题。绿色建筑方面的论文分别从建筑设计的概念、过程、方法；建筑规划的可持续策略；绿色建筑研究实例效果及分析；可持续发展社区、可持续发展楼宇研究；环保建筑、环保结构概念；可持续发展的公众参与和项目合作；物业保养维修及管理等不同角度对绿色建筑各个专业和地区的经验及技术进行了交流。这些论文提出了一些新观点、新技术、新方法，对促进泛亚热带地区建筑设计及技术的发展、推动该地区学术研究、增进建筑师对气候资源开发利用技术的认识，发展亚热带建筑创作具有现实意义。

参加本书编辑工作的人员有：孟庆林、赵立华、刘少瑜、陈汉云、邓炜翘、李琼、李丽、郑智娟、张玉、王莹、陈卓伦、陈沂，感谢高云飞、张磊、李旭东、王世晓、张洁丽、李芳、李宁、郭昶诗、齐百慧、白云龙、任鹏、丘子为在本论文集的编辑过程中所作的贡献。

由于编辑的时间短，编辑人员的水平有限，本书的编辑工作可能还存在不足之处，敬请读者批评指正。

孟庆林

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目　录

第三部分　环保策略与物业管理

第一部分　建筑设计

A New Language of Architecture in Quest for a Sustainable Future

Arvind Krishan
(New Delhi, India)

Abstract: Sustainability and Architecture are synonymous terms. Whilesustainability; physically and economically is to a large extent manifest in the habitatbuilt form, it is the scientific temper that will lend a design methodology and process, in order to render Architecture sustainable. To achieve this; An ' Energy, Resource Flow 'Ecological Foot Print' model is suggested which can help optimize input – out put parameters and their relationship. Possible formulation of these parameters leading to a Sustainability Indicator is also suggested. This leads to aprocess of design and various actual projects in response to critical issues. Thus suggesting: A New Language of Architecture.

1 PREAMBLE

Sustainability the "keyword" and "catch word", used by professionals and politicians alike-an issue that will determine decision making for the next millennium-has been an integral part of life cycle since man-kind took charge of its destiny. Although then, it did not have the high profile definition – "sustainability" – it has now. Human habitat and nature were synonymous – habitat of Cold deserts of Ladakh(India), the hot deserts of Jaiselmer (India), the plains of Hyderabad (Sind), Subtranian settlements of Loyang Northern China and Loess belt China stand as testimony. Yet, to-day with a technology that can put man on the moon, clone sheep, we find ourselves on the verge of a global environmental catastrophe.

When the entire planet seems to be hurtling towards a unsustainable future: Architecture-the human habitat, which is the largest consumer of natural and man made resources, in my considered opinion, offers a potent tool for moving towards a sustainable future. It more than ever calls for: A NEW LANGUAGE OF ARCHITECURE.

2 PRESENT SCENARIO – URBAN DILEMMA

Central to the issue of sustainability at the global scale is the human – habitat condition that now prevails in large and most populated countries; India and China, which together make a third of the total world population, is a phenomenon that is changing the urban context at a very fast rate.

Rising urbanization in India – 12% in 1940 to 27.52% in 1991, increase in urbancenters with a total of 218 million urban population marks a shift in rural population to urban centers. Growth of metropolis from 3 in 1901 to 23 in 1991.

Rapid Urbanization in China: Urban population has grown rapidly since 1970's by 21% between 1978 to 2002, with 660 cities. The Chinese Academy of Sciences predicts urbanization rate of 75 percent.

Indigenous cities of Indian and Chinese civilization which bear witness to human his tory of many a millennium Mohenjodaro, Harrapa, Jaiselmer, Loyang are home to architecture of excellence……Yet, the indigenous city in the context of to-day, is virtually overwhelmed by population explosion. Any of the "modern" developmental/infra-structural solutions prove counter productive.

作者简介: Arvind Krishan,男,印度人,教授,博士

3 EMERGING SCENARIO

A literal crisis situation in urban areas and an alarming depletion in natural resources in India prevails: Only 44% of urban poor have access to potable water. All metropolises suffer from air pollution due to automobile and industrial emissions. Land use under habitation on the other hand shows sudden increase from 4.09% in 1961 to 6.2% in 1981. From a forest cover is reduced to 11.71%.

The environmental conditions thus prevailing demand a radical shift in planning anddesign paradigm.

4 ENERGY, RESOURCE FLOW - ECOLOGICAL FOOT PRINT MODEL

Human habitat a physical manifestation of socio-economic ecological context is the major consumer and generator of energy and resource. Energy-Resource Flow Model developed and presented below, illustrates the input-output relationships.

While Air, Water, Land are the environmental major resource inputs, Materials (Embodied energy), Fossil Fuels (Primary energy) are the major natural resource inputs. Outputs-emissions, are the major source that modify the environmental context. **This input-output intrinsic relationship determines the ecological footprint: the community, city or the region / country-the ultimate determinant of sustainability.**

Whereas, direct intervention in the reduction of environmental and natural resource inputs can be made by coupling with 'Renewable energy' systems, Waste Processing-Energy Extraction offer re-cycling of energy and resource.

Yet, central to this entire flow model is the habitat / building (refer figure - 1). It is both in the construction and operation of this habitat/building that energy resource flow can be optimised.

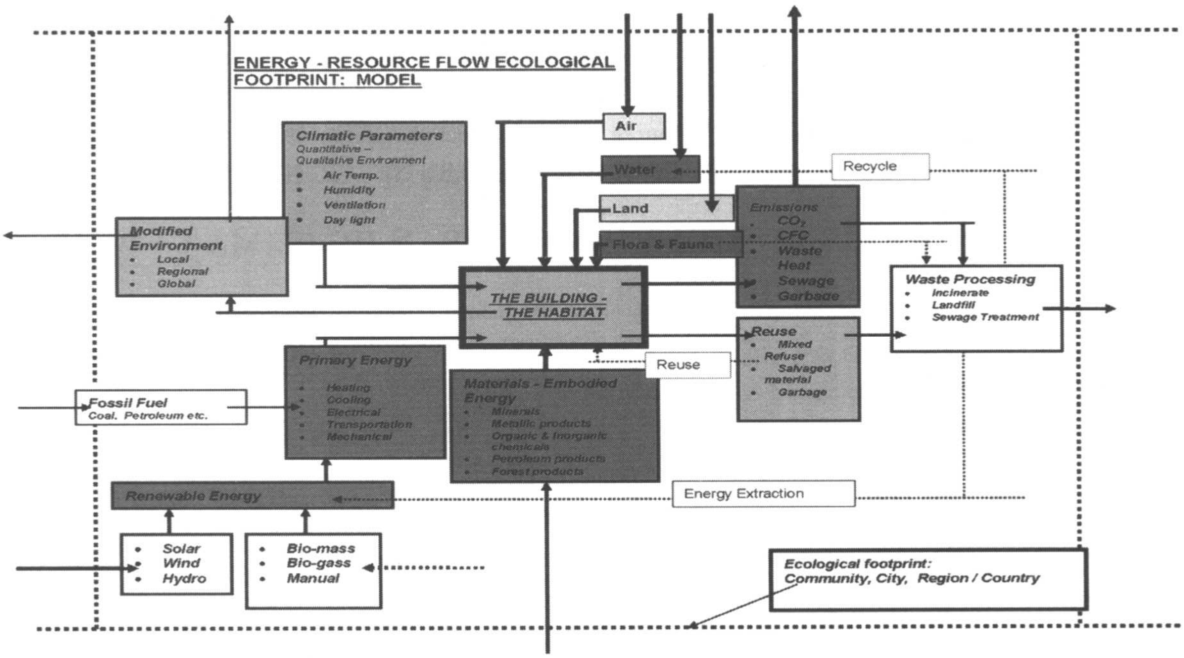

Figure 1

Outlining the criticality of planning and design of the habitat/building. Wherein, Climate-Responsive Architectural design and Ecological Planning become the determinants of energy-resource flow and offer a powerful tool for optimisation.

5 PARAMETERS FOR ENERGY 'E' OPTIMISATION

In order to achieve an optimum ecological footprint, various parameters may be optimized as follows:

5.1 Reduction in Energy Input

(1) Through Climate Responsive Design

(2) Appropriate technology

(3) Optimization of Embodied energy through Value Engineering and Life Cycle costing.

This may thus be formulated as:

Climate 'C' ↑ (Systemic strategy of Climate responsive design is critical and is the first level of priority)

App. Tech. & Embodied E. 'D' ↑ (Optimize embodied energy through Valueengineering and Life Cycle costing)

User 'E' ↓ (Intelligent and participatory use through daylight optimization, activeenvironmental control)

∴ Low E(1) α Climate'C' ↑ + App. Tech. & Embodied E. 'D' ↑ + User'E' ↓

5.2 Lower Environmental Impact

Env. Imp. ↔ 'F' (Optimize land use, Maximize landscape integration, Recycle rain water)

Tox. 'M' ↓ (Avoid Toxic materials)

Emi. 'EM' ↓ (Minimize CFC, CO_2 and other environmentally degrading emissions)

∴ Low E(2) α Env. Imp. ↔ + Tox. 'M' ↓ + Emi. 'EM' ↓

5.3 Lower Waste Production

Low 'W' ↓ (Use of re-cycled materials, increase ability of elements and materials in building to be re-cycled.)

High 'R' ↑ (Re-cycle waste as alternative material/source for Energy, Water etc.)

∴ Low E(3) α Low 'W' ↓ + High 'R' ↑

5.4 Maximise Use of Renewable Energy

Sol. 'SE' ↑ (Maximize use of Solar Energy through Passive (building design) and active PV integration, and Solar Thermal means etc.)

Ren. Energy ' RE' ↑ (Maximize Alternative Energy sources of energy, i.e. Cogeneration, Wind, Mini-Hydro, Bio-mass etc.)

High E (4) α Sol. 'SE' ↑ + Ren. Energy ' RE' ↑

6 SUSTAINABILITY INDICATOR: Sus 'I'

Above parameters of planning and design can thus be optimized leading to a sustainability indicator.

∴ Sus 'I' α Low E (1) + Low E (2) + Low e (3) + High E (4) (Renewable energy systems)

7 CLIMATE RESPONSIVE ARCHITECTURE-THE TOOL AND THE PROCESS

This leads to defining a process of architectural design that is scientific and developed on an ecological basis.

Process of architectural design is a complex exercise, involving interactive relationships between parameters of diverse nature and varying magnitude. Yet, it is the prime generator of architecture as we see and experience.

Various ideas have dominated architectural thought from time to time. Yet, the fundamental issue of energy as an embodiment of Sun, Wind and Light-the ecological context-have not been a basic paradigm of design. Therefore relationship between built-form and ecology should become the driving force behind the process, based on a scientific methodology-leading to climate Responsive Architecture.

The idea of climatically responsive design is to modulate the conditions such that they are always within or as close as possible to the band of appropriate design as illustrated in the ecological process of design.

Figure 2 Graphical Representation of Process of Design

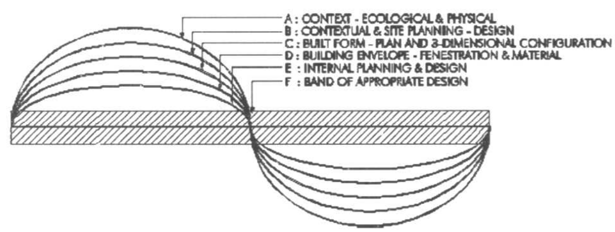

Figure 3 Ecological Procees of Design

Ecological Process of Design:

Based on this premise, a design decision making knowledge based expert system has been developed by the author and published in *Climate Responsive Architecture -A design handbook*[1] (*Tata McGraw Hill, New Delhi 2001*)

8 SOME CONTEMPORARY SOLUTIONS

One single parameter that embodies the state and use of natural resources in their various forms is energy. Author presents some contemporary solutions that optimize energy use/consumption through architectural design.

Design principles elicited from analysis of indigenous architecture and the scientific process of design have been translated into design of following modern buildings at various locations in the country with diverse ecological context-outline critical architectural responses to key issues.

8.1 How Do We Build In A High Altitude Extreme Cold-Dry Ecological Context?

Sustainable solutions for these projects incorporate the following elements and features achieved through architectural design:

(1) Architectural design optimizes solar exposure through-out the daily and annual solar cycle.

(2) Day-light distribution is optimized by three dimensional configuration of the building and reflecting it off design elements: light shelves and ceiling, providing a uniform and glare-free distribution.

(3) Embodied energy consumption in building construction is optimized by the use of local materials and relevant technology of construction.

Hill Council complex, Leh, India

A major Civic Structure designed and built as architectural design solutions for this context.

Located at 3514 M above M.S.L. in cold-dry climate with a sever long winter: October to March end (Min. DBT - 30℃).

Main objectives and features of the design besides elements as sustainable solutions are:

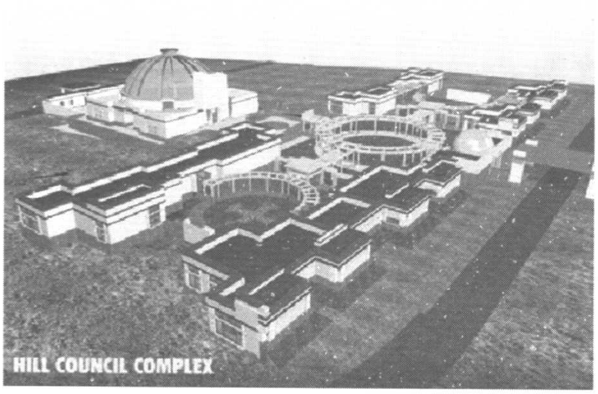

Figure 4 Birds Eye View of the Complex

Figure 5 Section Through Council Hall

(1) The complex has been designed for the severe winter period. Earth sheltering and earthberning on the north side and a sunken lobby reduces northern exposure and stabilize internal temperatures even in critical period.

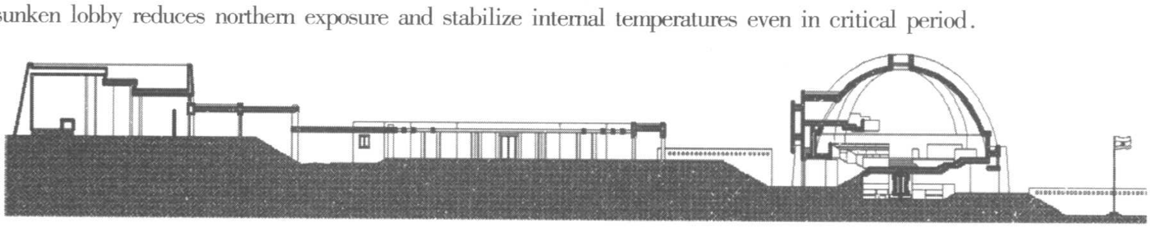

Figure 6 Scetion

Optimize solar heat gain to office and assembly hall during critical periods of the year, with adequate penetration of Sun. While heat gain is optimized, its absorption in the judiciously designed thermal; mass, provides heat in the spaces over the diurnal cycle.

(2) Glare-free day-light to minimize lighting load there by consumption of energy in the building.

(3) A new expression of 'Ladakhi' architecture by harmonizing indigenous with modern incorporating local materials has been created. This helps sustain the artisan and the local art of construction as well.

Figure 7 Main Approach and Front Facade of the Complex

8.2 What Possible Architectural Responses Can Be Evolved For A Composite Climate And The Context of Urbanity of Chandigarh?

PEDA Office complex, Chandigarh, India

Located at Chandigarh, on a flat practically square site with no major topo-graphical variations. Chandigarh as a city lies on the planes at the foot of 'Lower Himalayas', in a 'Composite climate context'.

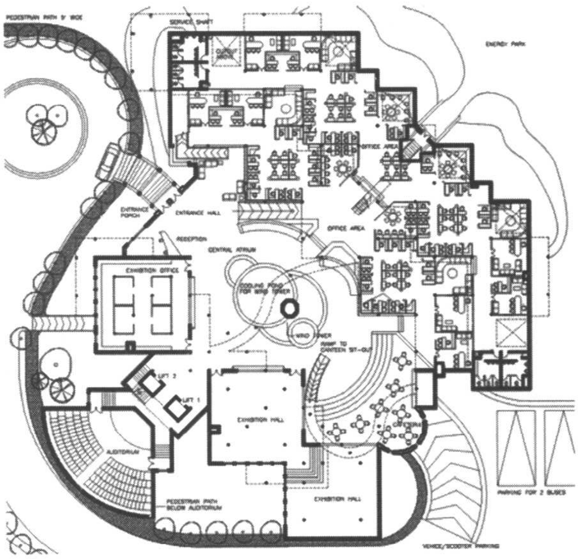

Figure 8 Plan

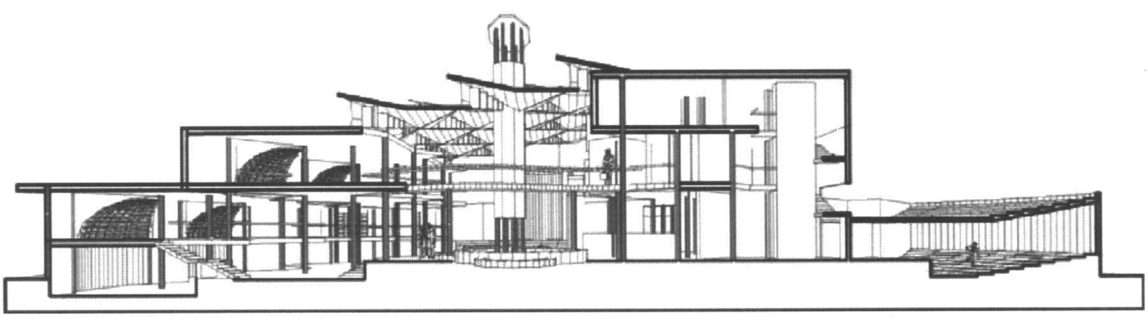

Figure 9 Sectional View

(1) With climate swings over the year i.e. very hot and dry period of almost two and a half months (Max. DBT 44℃) and a quite cold period of shorter duration (Min. DBT 3℃). The hot dry period is followed by a hot humid monsoon period (Max DBT 38℃ and Max R.H.90 %) of about two months with intervening periods of milder climate.

(2) Equally important, for Chandigarh is the context in space and time. Chandigarh, a bold experiment in city planning and architecture, was based on the professed ethos of design: build with climate. Le Corbusier put into practice his theory on "Brise Soleil". While the major buildings of the Capitol Complex extensively employed 'Brise Soleil' in its various form and applications, many residences designed by Pierre Jeanneret, Maxwell Fry and Jane Drew made solar shading devices as a major element of design and expression. Yet, in its application both the method and 'device' lack a scientific basis. Many times its repetitive use on buildings irrespective of orientation and the use of similar devices on different facade belie the claim.

(3) Can the design of a building be designed based on a scientific process of design, which responds to the ecologi-

cal context and yet does not violate the urbanity of Chandigarh and its urban palette, i.e., the material, texture and colour? That is the professional challenge unparalleled, to which we have addressed ourselves.

Figure 10 Overall Internal View

Figure 11 Southern Facade Showing the Domical Light Vaults and P.V. Integrated Roof System

(4) While the three dimensional form of the building has been developed in response to solar geometry i.e. minimizing solar heat gain in hot-dry period and maximizing it in winters.

(5) To achieve a climate responsive building an innovative concept in architectural design has been developed. In place of the 'central loaded corridor' plan stacked on top of each other to make various floors-which has virtually become the generic form for an office, the PEDA building is a series of over-lapping floors at different levels in space floating in a large volume of air, with inter penetrating large vertical cut-outs. These cut-outs are integrated with light wells and solar activated naturally ventilating domical structures.