Building for Sustainability FORUM
Sydney Coastal Councils Group
July 2011

Responding to Climate Change - buildings

Presenter:

Professor Deo Prasad
Director: Master of Sustainable Built Environment Program, Faculty of the Built Environment
The University of New South Wales, Sydney

UNSW fbe

Contents

- Historic Responses
- Emerging approaches
- Climatic influences
- Challenges in high performance and adaptive buildings

AGSO, Canberra (Design Inc)

Overview

- Emerging concerns and Responses
  - Oil prices (1970's)
  - Environmental and sustainability (1980=>)
  - Climate change (1990's =>)
    - Mitigation
    - adaptation
  - Oil price (2005 =>)

Snapshot of emissions（碳排放简介）

Large-Scale Solar Thermal System（大规模的太阳能光热系统）

- The threshold for dangerous climate change = +2oC（气候变化门槛：温度上升2度）
- Adding 1 trillion tonnes of carbon to the atmosphere = a warming of 2oC（1万亿吨的碳排放就意味着温度上升2度）
- Amount emitted in the last 250 years = 500 billion tonnes（过去的250年排放了5000亿吨二氧化碳）
- Amount remaining to be emitted before +2oC reached = 500 billion tonnes（只余5000亿吨）
- Projecting current patterns of emissions, time to emit this amount = 40 years.（按照目前的排放速度，只要40年就可以达到这个限额）

[NCCARF Data]

Sustainable buildings

- According to the Worldwatch Institute about 40% of the world's total energy usage is dedicated to the construction and operation of buildings.
- The building industry consumes 3 billion tons of raw materials annually -- 40 % of the total material flow in the global economy.
- Only about 0.003 % of earth's water is readily available as fresh water for human use (Miller, 1992). Building materials manufacturing, construction and operations consumes 16% of available fresh water annually
- Buildings account for about one-third of the emissions of heat-trapping carbon dioxide from fossil fuel burning and two-fifths of acid rain-causing sulfur-dioxide and nitrogen oxides.
- Low hanging fruit – the no cost and low cost options

Driving change: EU NEWS.May 2009（欧洲新闻）

- 'European Parliament voted for 'zero energy buildings…. Zero Energy Buildings is a key element in the renewed EU legislation on buildings. During the last plenary session the Parliament adopted new legal requirements for Europe's buildings and their energy performance（零耗能建筑成为欧洲建筑法规的核心）
- From 2019 all new buildings in the EU will have to produce more renewable energy onsite for example by solar panels than they consume, the Parliament decided by recasting the Energy Performance Buildings Directive of 2002.（2019年起，所有欧洲的新建筑必须在场址内生产出超过本身所需的可再生能源，通过譬如太阳能板）
- These zero energy buildings will include energy efficient buildings whose overall annual primary energy consumption is equal to or less than the energy production from renewable sources on site. By 2015 national targets will be set to fix minimum percentages of existing buildings to be zero energy' --*EU Media*（*2015*年欧洲各国必须设立目标确保最低份额的现存建筑实现零耗能）
- *Zero Carbon regulations in the UK*

Singapore ZEB

- S$10 million spent to retrofit of an existing facility to incorporate some of the latest energy-efficient inventions
- The building is able to generate as much electricity as it consumes through renewable energy. This works out to a net energy consumption of zero over a typical year
- The solar panels which constitute about 15% of the building cost
- 60 percent of utility bills usually goes into air-conditioning. Sensors will detect the presence of users and will direct fresh air to their breathing zones. Recycled air will be used for ambient cooling

Global examples - Japan

Ota, Gunma, Japan - over 500 houses totalling 2,16 MWp

PV as part of Building function

221kWp of blessed Vatican PV

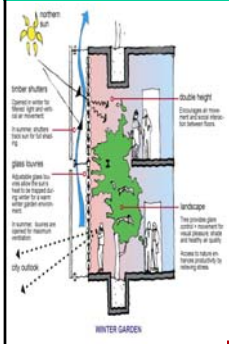
Homebush Bay – Sydney Olympics Site

•Showcasing

•A holistic vision which embraces a 'whole of life' perspective rather than a 'short term' approach.

•Establish an equitable balance between environmental, social and economic strategies – with cultural sensitivity, both now and into the future.

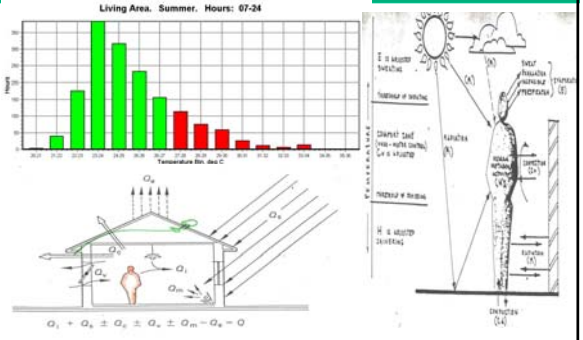
Building Design



- Daylighting and attractive views
- Passive solar gain
- Solar thermal panels
- Solar electric 'photovoltaic' panels
- Sustainable ventilation strategies
- High-rise buildings
- Plants in buildings

•CH2 Melbourne

Changing climate
Ventilation – comfort and structure



Thermal comfort issues

PMV rating: 0.81

Dissatisfied:18%

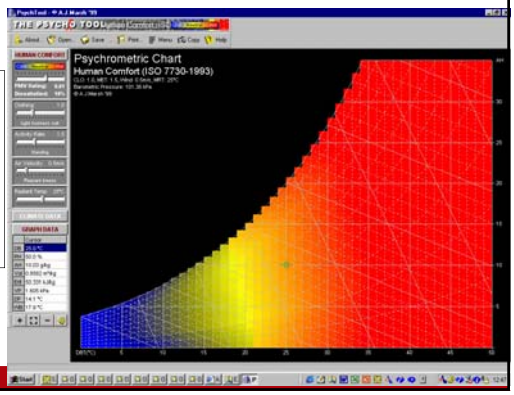
DB-25

Clothing-Light Business Suit

Activity-Standing

Air velocity-Pleasant Breezes

Radiant Temp-25



Thermal comfort issues

PMV rating:1.18

Dissatisfied:38%

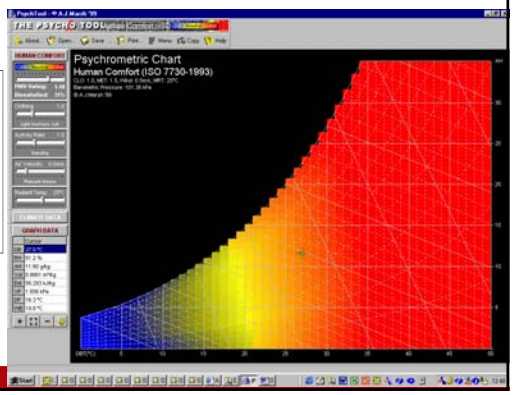
DB 27

Clothing-Light Business Suit

Activity-Standing

Air velocity-pleasant Breezes

Radiant Temp-25



Thermal comfort issues

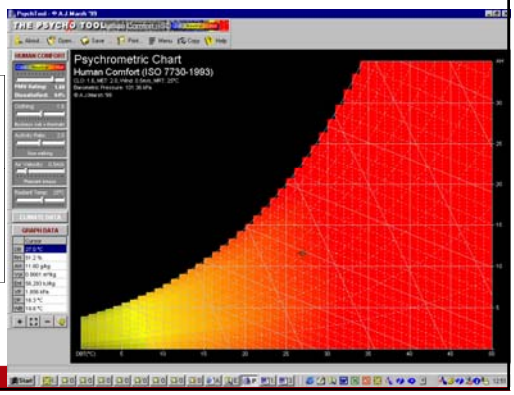
PMV rating: 1.8

Dissatisfied: 64%

DB 27

Change in Clothing from Light business suit to business suit

Change in activity-Slow walking



Thermal comfort issues

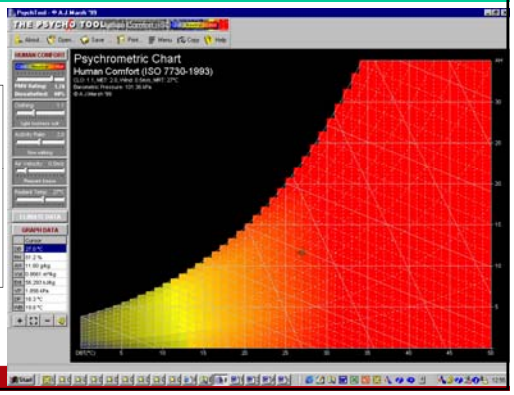
PMV rating: 1.7

Dissatisfied: 60%

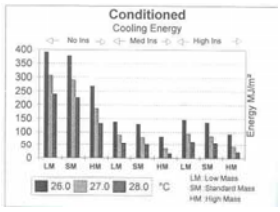
Change in Radiant temperature-increased from 25 to 27

Activity-slow walking

Clothing-Light business Suit

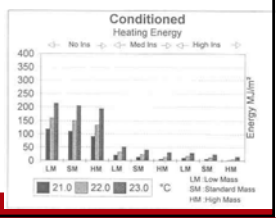


Changing thermostat settings

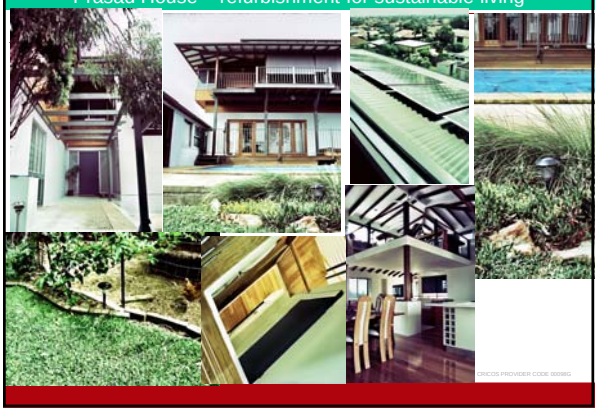


Cooling Energy requirements for a range of mass and insulation combinations. Three cooling thermostat temperatures are shown

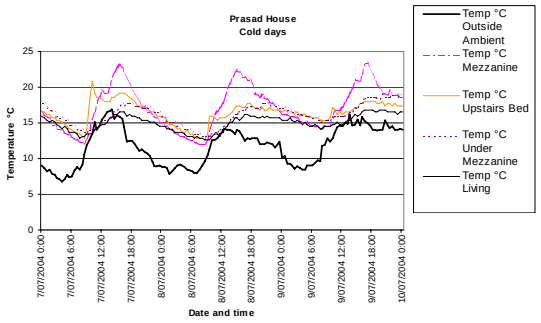
Heating Energy requirements for a range of mass and insulation combinations. Three heating thermostat temperatures are shown



Prasad House – refurbishment for sustainable living



Performance



System Design

Mixed Mode System

✓In contrast to naturally ventilated buildings, HVAC system gives less opportunity to adjust the systems for their personal comfort preferences which vary significantly.

✓Mixed mode refers to a hybrid approach to space conditioning that combines attributes of natural ventilation and cooling for peak cooling loads and high load areas

✓Mixed mode approach is appropriate to both - the design of new buildings and retrofitting.

✓For successful operation this system requires a high degree of integration and coordination. A mixed mode system, if not operated properly, might sometimes be energy intensive.

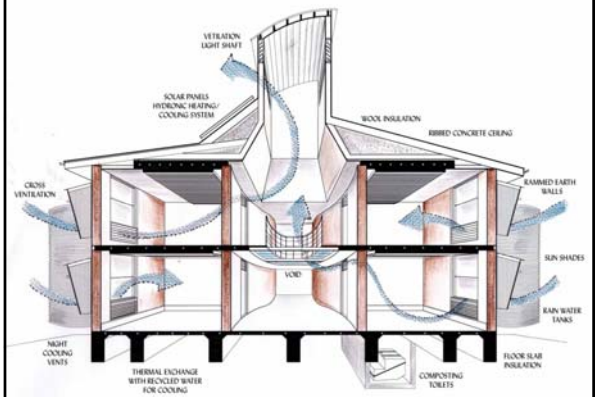
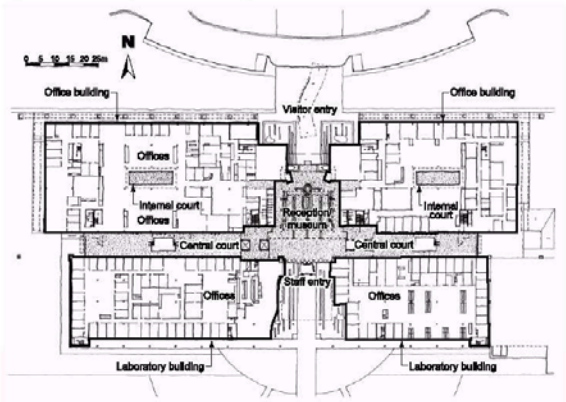
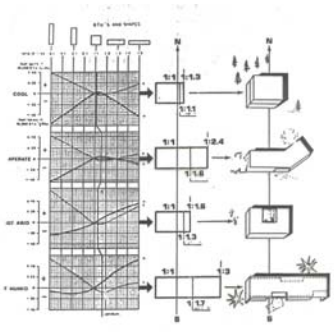


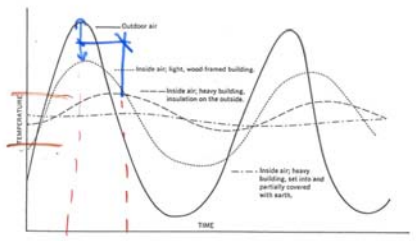
Figure 3. Ground floor plan of AGSO building



Climate responsive forms – climate change



Thermal Mass



Design for adaptability

❑ **Issues:**

✓Structural integrity

✓Climate responsive

✓Use an open building system allowing easy alterations through relocation of components

✓Use assembly technologies compatible with standard practices avoiding specialist disassembly labors

✓Separate the structure from the cladding allowing parallel disassembly

✓Standardize the parts allowing a rapid and speedy recovery and making reuse possible because of the standard size compatibility

✓Use lightweight materials and components making handling easier

Challenges for Net-zero and Low-energy homes/buildings

- Integration of solar technologies with the architecture and with the envelope.
- Integration and optimization of solar with energy efficiency technologies – must not be separate.
- Thermal storage and passive solar design – what are the obstacles; need to integrate in standards – design tool being developed by SBRN.
- Integrated control of energy and solar systems: reduction of peak loads will reduce need for new power plants.

Conclusions

- Minimising the ecological footprint of buildings and cities is essential
- System design needs to consider whole of life issues.
- Peak wind and other effects may be much more important than temperatures.
- Sustainable/green design and planning is now a basic requirement not just a fad.
- Professional leadership with social, economic, environmental and cultural impacts of buildings to be considered.
- ….and of course architectural character and quality is essential.
- Need for policy to drive change towards sustainability
- Need to mainstream this change

Creating sustainable futures

"Sophistication is not necessarily the product of highly developed machinery, nor intensive capital investment. It is more a way of using available equipment and resources with cunning and intelligence"

Reyner Banham The Architecture of the Well-tempered Environment 1984