

MEBS6020 Sustainable Building Design

<http://www.hku.hk/bse/MEBS6020/>



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Introduction



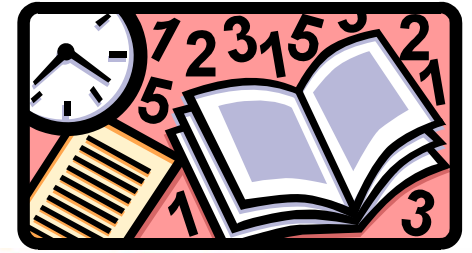
Dr. Sam C. M. Hui

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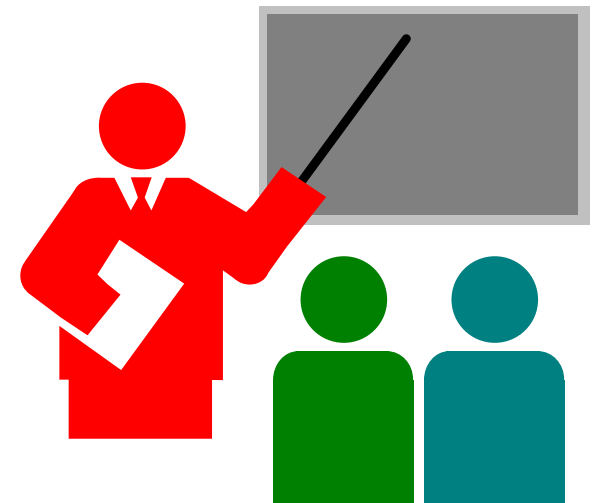
E-mail: cmhui@hku.hk

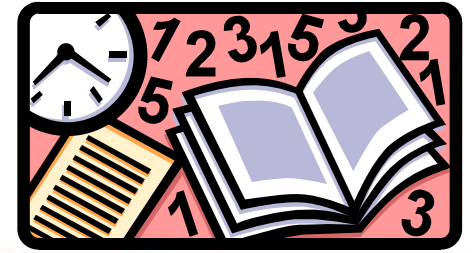
Aug 2014



Introduction

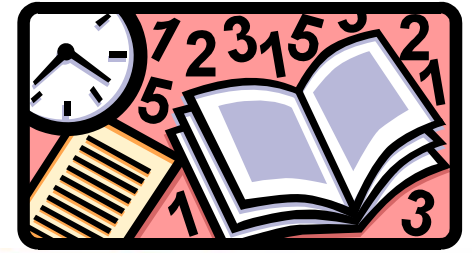
- MEBS6020 Sustainable Building Design
 - Educational Objectives
 - To introduce the key concepts and important issues of sustainable buildings.
 - To develop practical skills for planning and designing sustainable building projects.
 - Assessment:
 - Examination (80%)
 - Continuous Assessment (20%)





Introduction

- MEBS6020 Sustainable Building Design
 - Learning Outcomes:
 - Describe and apply the key concepts and design strategies to develop sustainable buildings.
 - Understand the important issues and major considerations for planning and assessing sustainable buildings.
 - Develop practical knowledge and information to study and implement sustainable building projects.



Introduction

- Study topics of MEBS6020:
 - 1. Sustainable Building Concepts
 - 2. Sustainable Masterplanning
 - 3. Energy and Environmental Design
 - 4. Green Building Assessment
 - 5. Analysis Methods for Sustainable Building Projects
 - 6. Practical Examples



About the Lecturer

- ***Dr. Sam C. M. Hui*** (*Building Services Engineer*)

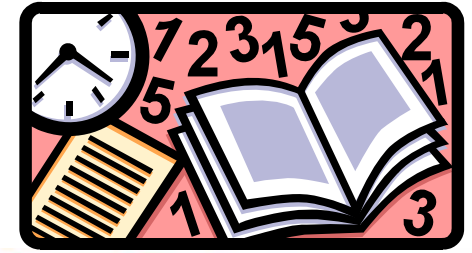
- PhD, BEng(Hons), CEng, CEM, BEMP, MASHRAE, MCIBSE, MHKIE, MIESNA, LifeMAEE, AssocAIA

ASHRAE Distinguished Lecturer (2009-2011)

- CEng = Chartered Engineer
- CEM = Certified Energy Manager
- BEMP = Building Energy Modeling Professional

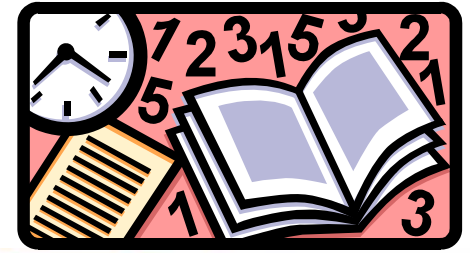
- LifeMAEE = Life Member, Association of Energy Engineers
- Worked in 1998 as a visiting researcher in the Asia Pacific Energy Research Centre, Japan
- Research interests: energy efficiency in buildings and sustainable building technologies





Introduction

- Recommended references:
 - ASHRAE, 2010. *ASHRAE Greenguide: the Design, Construction, and Operation of Sustainable Buildings*, 3rd ed., Elsevier/Butterworth-Heinemann, Amsterdam and Boston. [720.47 A82 A] (2nd ed.: ebook)
 - European Commission, Directorate General XVII for Energy, 1999. *A Green Vitruvius: Principles and Practice of Sustainable Architectural Design*, James & James, London. [720.47 G79 E]



Introduction

- Recommended references: (cont'd)
 - PTI, 1996. *Sustainable Building Technical Manual: Green Building Design, Construction and Operations*, Public Technology, Inc. (PTI), Washington, D.C. [721.0467 S964]
 - www.smartcommunities.ncat.org/pdf/sbt.pdf
 - Salat, S. (ed.), 2006. *The Sustainable Design Handbook: China: High Environmental Quality Cities and Buildings*, CSTB, Cedex, France. [720.470951 S96]

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Sustainable Building Concepts (I)



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Contents



- Sustainable development
- Sustainable built environment
- Green/sustainable building
- Why going green?
- Basic principles



What is



Sustainable
Development?



OUR COMMON FUTURE

THE WORLD COMMISSION
ON ENVIRONMENT
AND DEVELOPMENT

The Brundtland Report
defines
“Sustainable Development”



Full text of the report:

<http://www.un-documents.net/wced-ocf.htm>

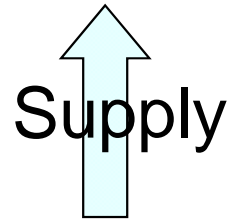
<http://www.worldinbalance.net/agreements/1987-brundtland.html>

Sustainable development

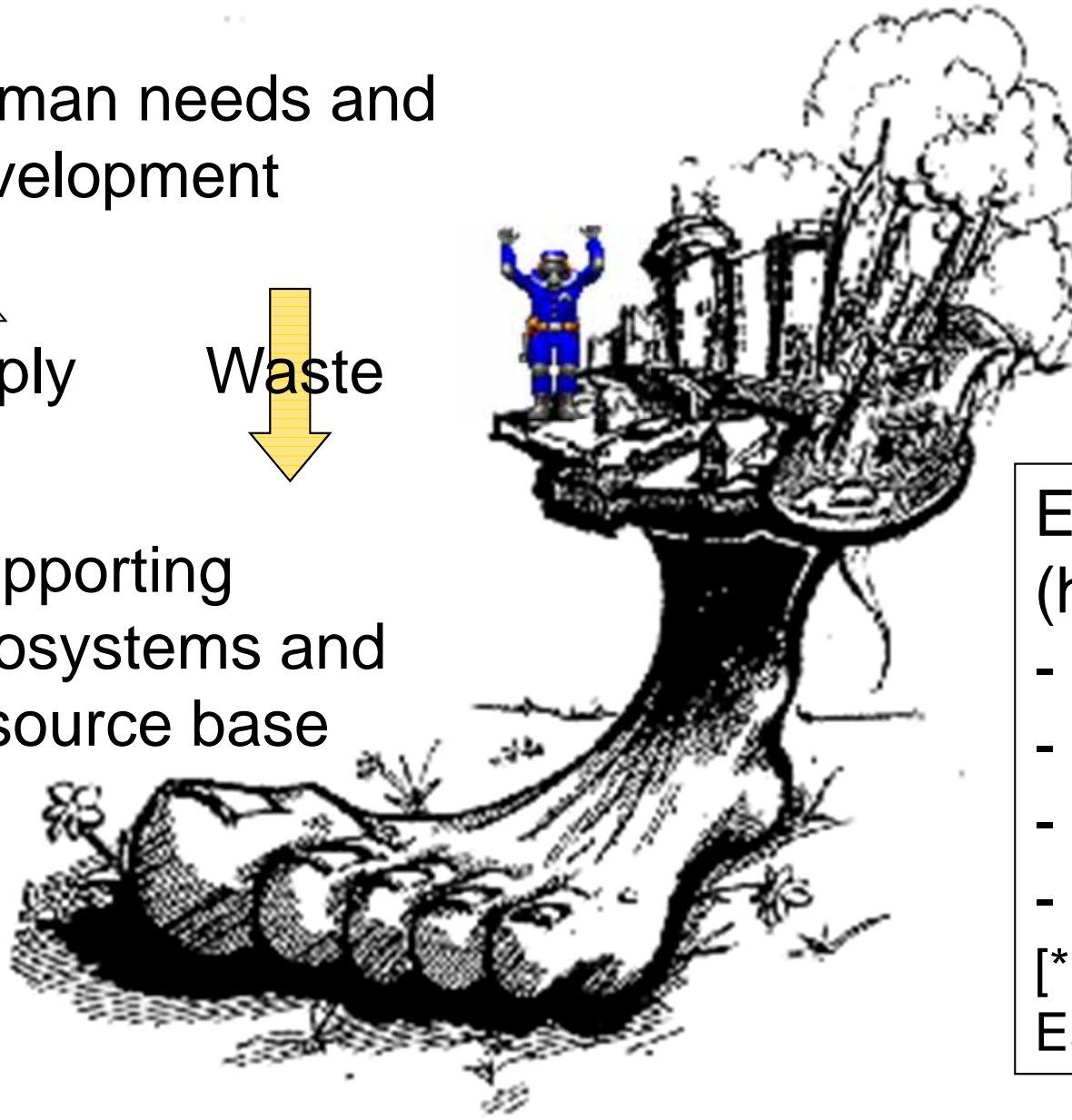


- The Brundtland Report (*Our Common Future*)
 - “...is development which meets the **needs of the present** without compromising the ability of **future generation** to meet their own needs.” – World Commission on Environment and Development.
- Two important concepts
 - Needs – maintain an acceptable life standard
 - Limits – within the carrying capacity of supporting ecosystems and resource base

Human needs and development



Supporting ecosystems and resource base



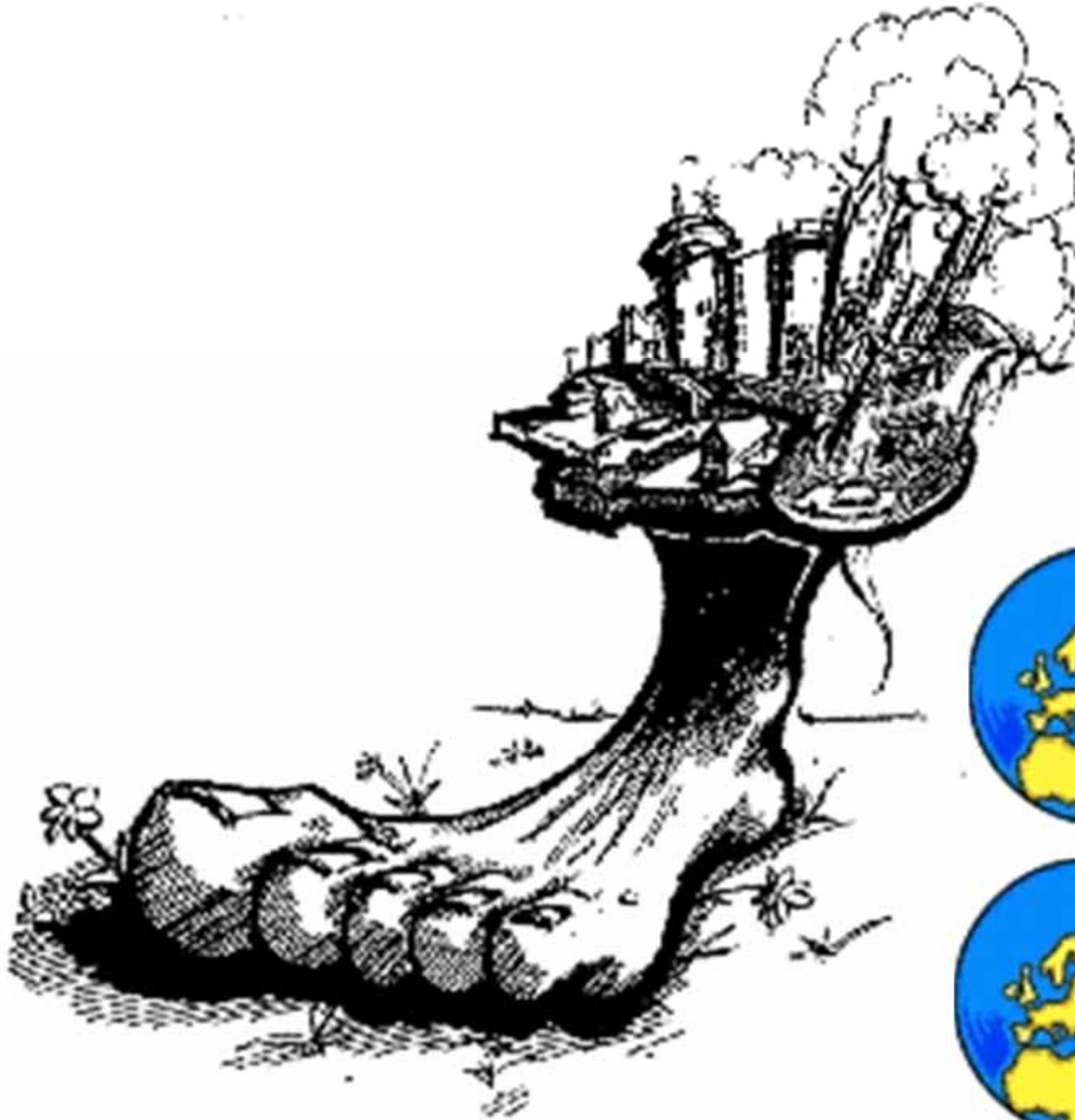
Ecological footprint (hectares/person) *:

- world average = 2.3
- USA = 10.3
- **Hong Kong = 6.0**
- China = 1.2

[* Source: Friends of the Earth (HK)]

Carrying capacity and ecological footprint

Sustain-able Future?

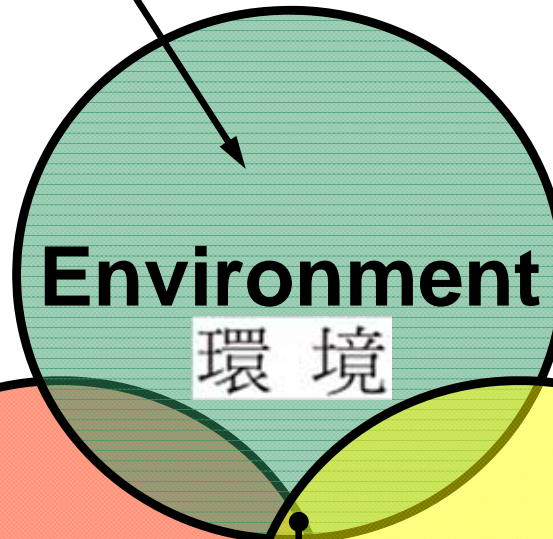


If all countries have ecological footprints same as current industrialized ones, we need four earth planets to support the living.



Environmental Sustainability

Ecosystem integrity
Carrying capacity
Biodiversity

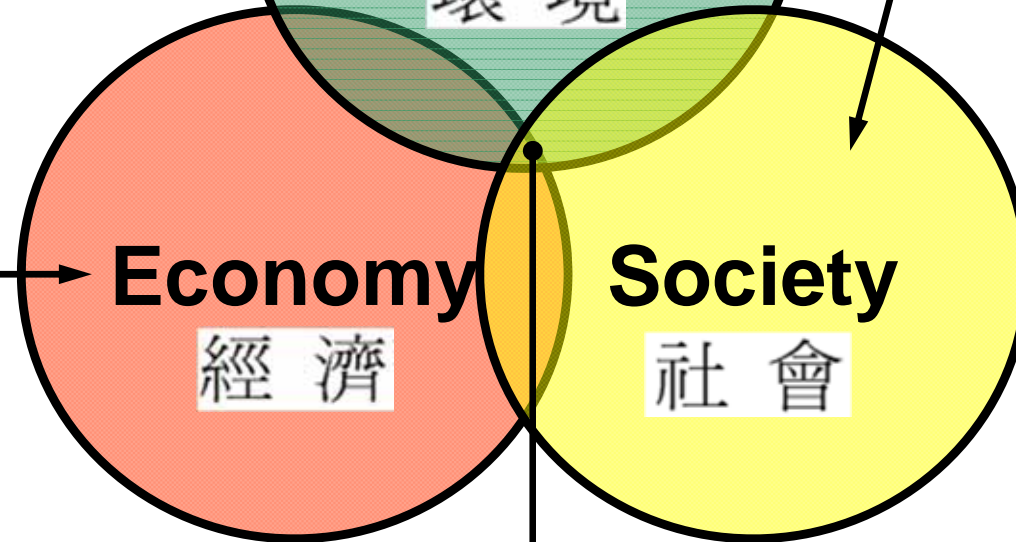


Social Sustainability

Cultural Identity
Empowerment
Accessibility
Stability
Equity

Economic Sustainability

Growth
Development
Productivity
Trickle-down



Human Well Being

Three dimensions of sustainability





Sustainable development

- Sustainability is about: [Mei Ng, FoE(HK)]
 - System thinking (harmonize human & living)
 - Value judgment (importance of natural capital)
 - Efficiency (resources & eco-efficiency)
 - Fair share (inter- & intra-generational equity)
 - Making informed choices
 - Quality people & quality life
 - Self-reliance (self-help & regeneration)



Sustainable development

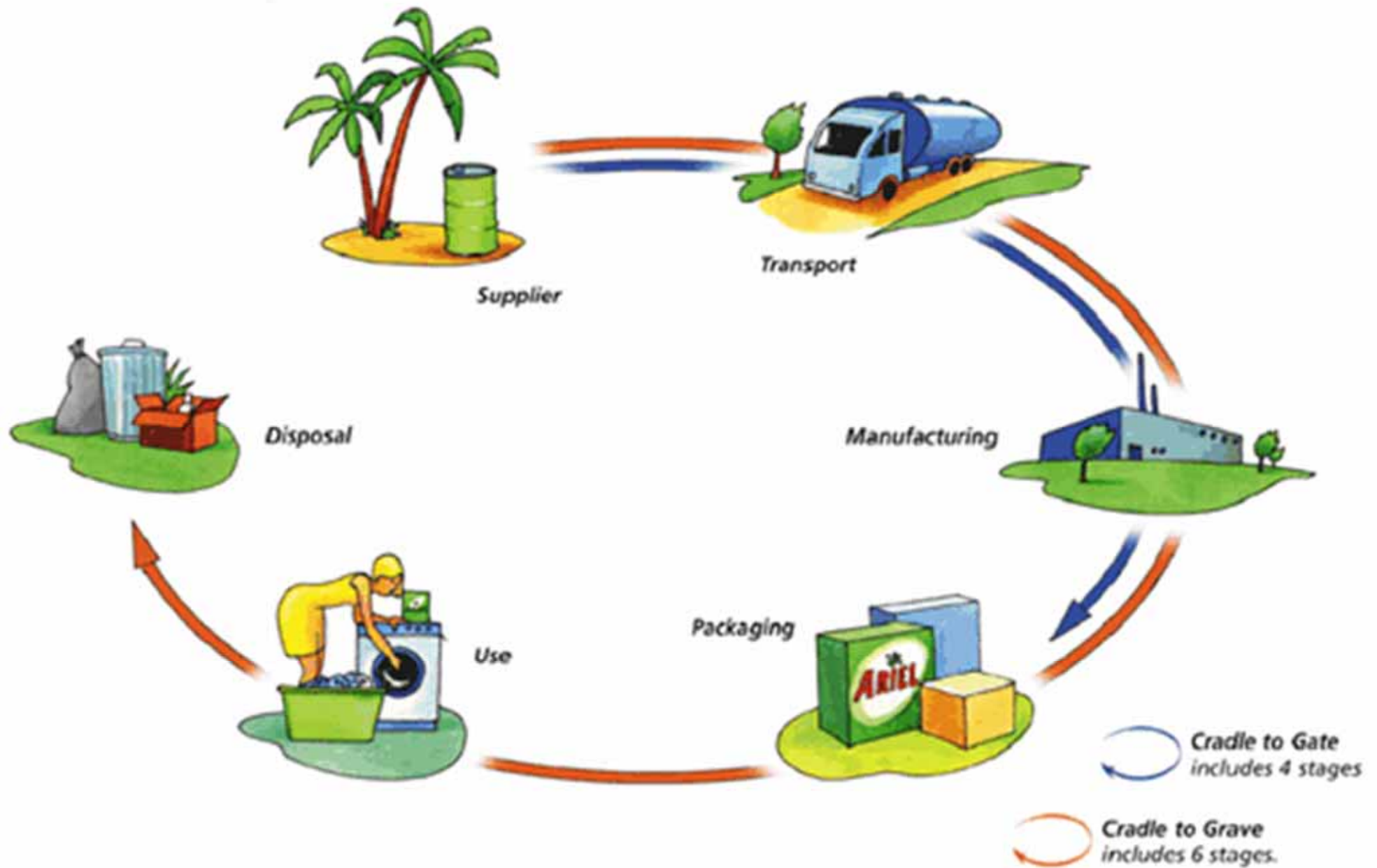
- A total plan for sustainability requires (from the Institution of Structural Engineers):
 - Reduction of emission of greenhouse gases
 - More efficient use (and reuse) of resources
 - Minimisation and constructive reuse of waste
 - Reduction of harmful effects from construction activities and building occupation
- Life cycle assessment to evaluate environmental impacts: [cradle to grave](#)

Cradle-to-Grave



Cradle-to-grave is the full Life Cycle Assessment from resource extraction ('cradle') to use phase and disposal phase ('grave').

Cradle-to-Gate and Cradle-to-Grave



Video Presentation

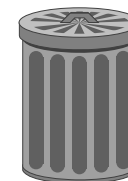
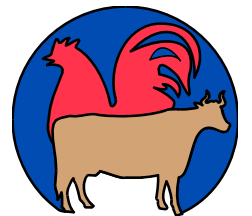


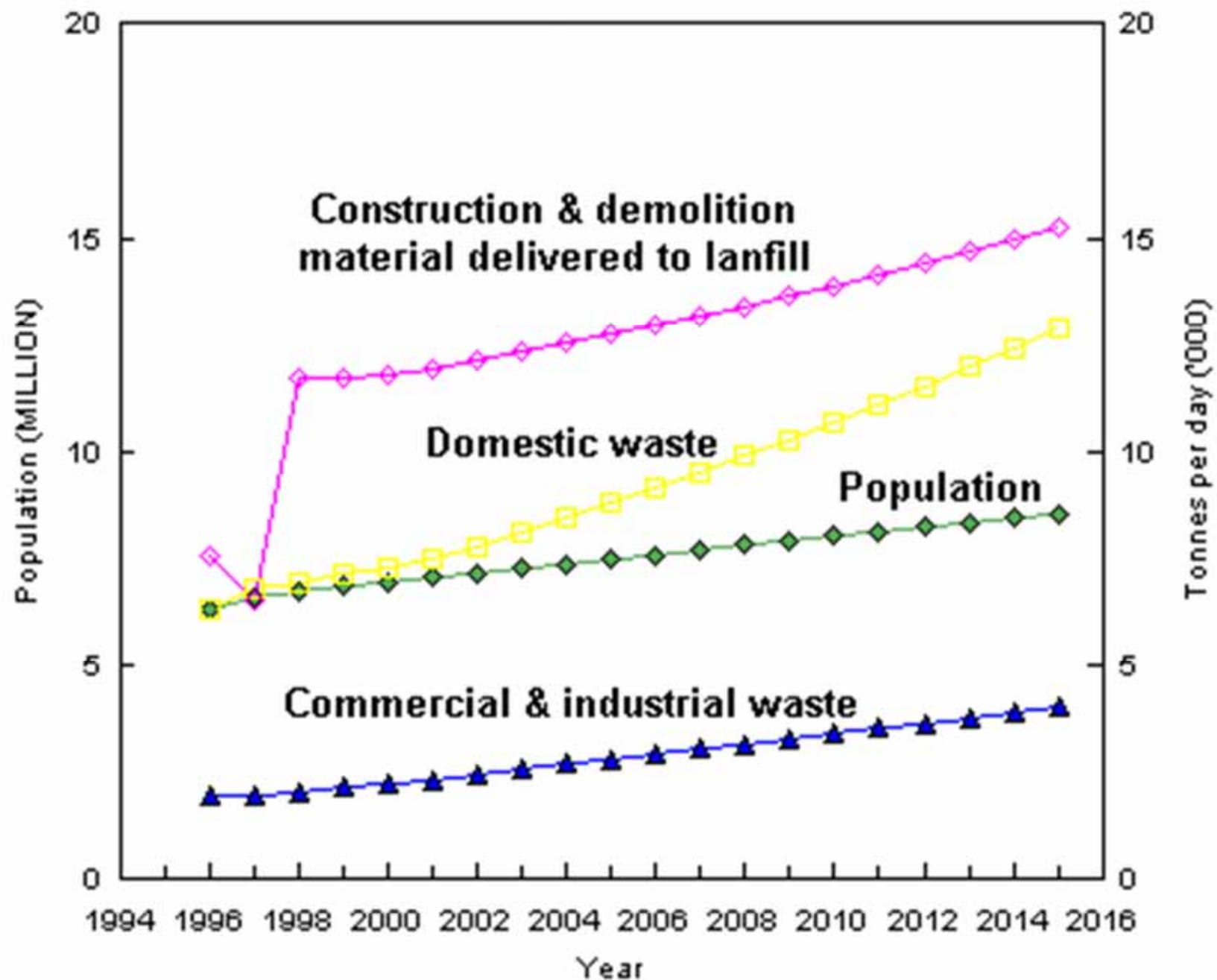
- Sustainability explained through animation
(2:00) <http://youtu.be/B5NiTN0chj0>
- Sustainability is also about green building
(6:18) <http://youtu.be/vQk9lo2eUDg>
 - How can we help preserving the environment and the well-being of their occupants by constructing eco-friendly buildings?
 - What is an eco-building?

Sustainable development



- One day in HK (population = 7 million) [2007]
 - Fresh water consumption = 374 litre/person
 - Electricity consumption = 17.4 kWh/person
 - Food consumption:
 - Vegetables 1,780 tonnes; fruits 1,460 tonnes
 - Live pigs 4,860 heads; live cattle 120 heads
 - Live poultry 80 tonnes; fresh eggs 230 tonnes
 - Freshwater fish 100 tonnes; marine fish 210 tonnes
 - Solid waste production = 13,901 tonnes





Projection of waste requiring disposal and population in HK
 (source: Waste Reduction Framework Plan)

Sustainable built environment



- Built environment is everything that has been made by humans to modify the spaces in which we live and work
 - Ranges from the large-scale civic surroundings to the personal places
- Sustainable built environment
 - It is a built environment that is well balanced for the needs of the present and the future from the economic, social and environmental perspectives

Hong Kong



Major characteristics of the built environment in Hong Kong



Hong Kong has been praised as a model of "Vertical City" which surpasses New York



Hong Kong is a city famous for its dynamic lifestyle and vibrancy



Affordable, efficient and comfortable public transport system



Most people enjoy having their homes, workplaces, schools, and facilities for social and other activities conveniently located and nearby each other

Typical problems of the built environment in Hong Kong



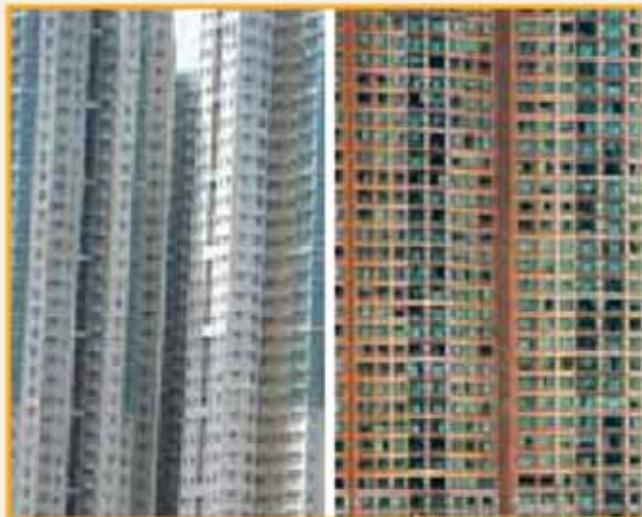
Narrow streets - Limited opportunity for urban greening or social amenity at ground level



Traffic and pedestrian in conflict



Canyons - narrow streets and pavements, high walls and a poor pedestrian environment



Wall-like barriers causing negative visual impact and reducing air flow



Impact on neighbouring buildings, through overshadowing and glare

Sustainable built environment



- Related policies and practices in Hong Kong
 - Hong Kong Planning Standards & Guidelines
 - www.pland.gov.hk/pland_en/tech_doc/hkpsg/
 - Town planning (by outline zoning plans OZP)
 - Buildings Ordinance (Cap. 123) and the Building (Planning) Regulations
 - Practice Notes for Authorized Persons and Registered Structural Engineers (PNAPs) and Joint Practice Notes (JPNs)
 - Building energy codes

'Green features' under the Joint Practice Notes in Hong Kong



Balconies



Wider common corridors



Sky gardens



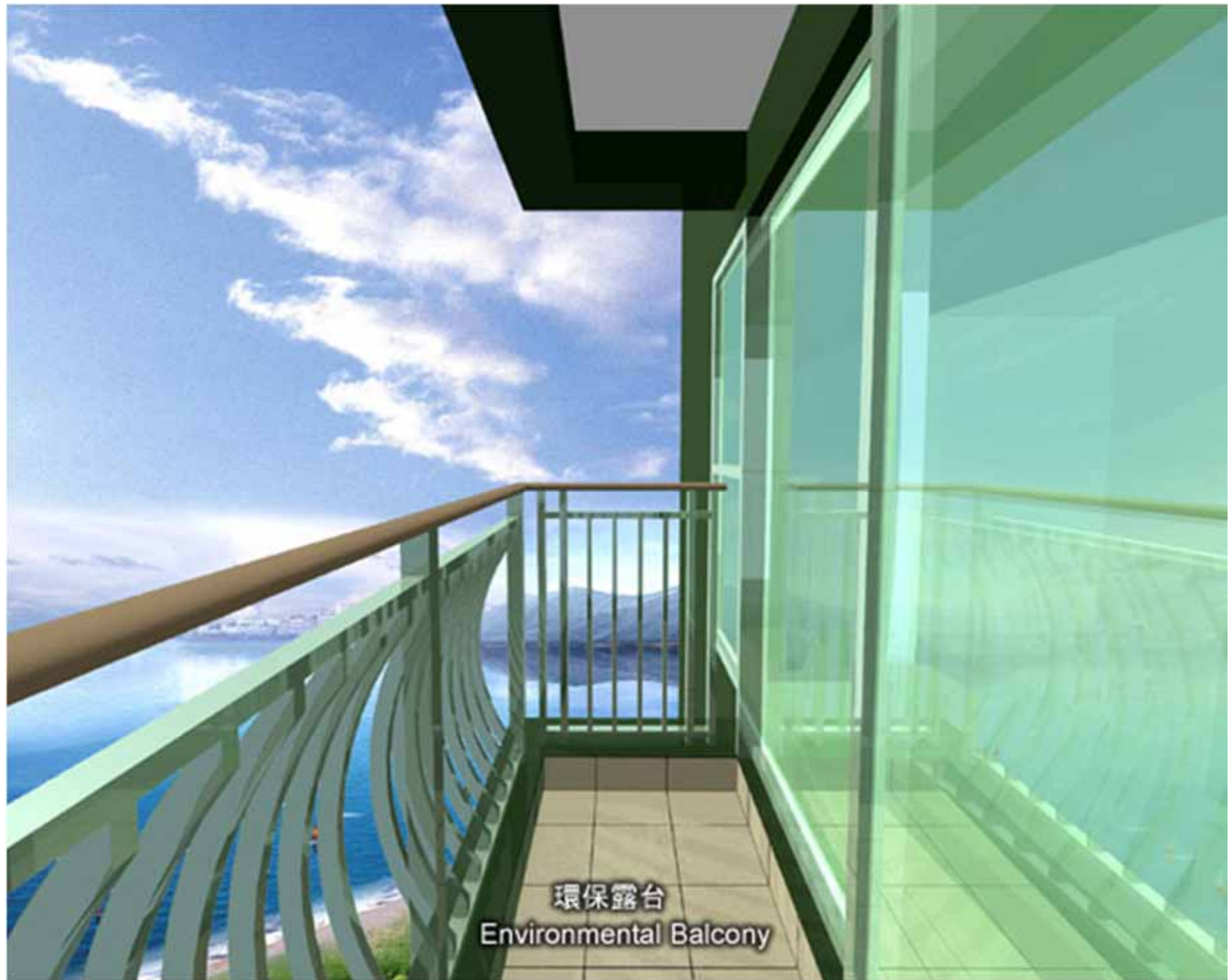
Mail delivery rooms



Podium gardens



Utility platforms

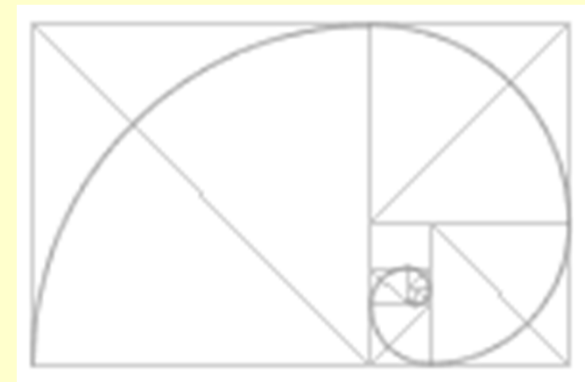


環保露台
Environmental Balcony



Kyoto Face House, 1998

**“What is
green
building?”**



An example of green building in Hong Kong ?!



(A building in Pokfulam; photo taken by Dr Sam C M Hui)



Cologne

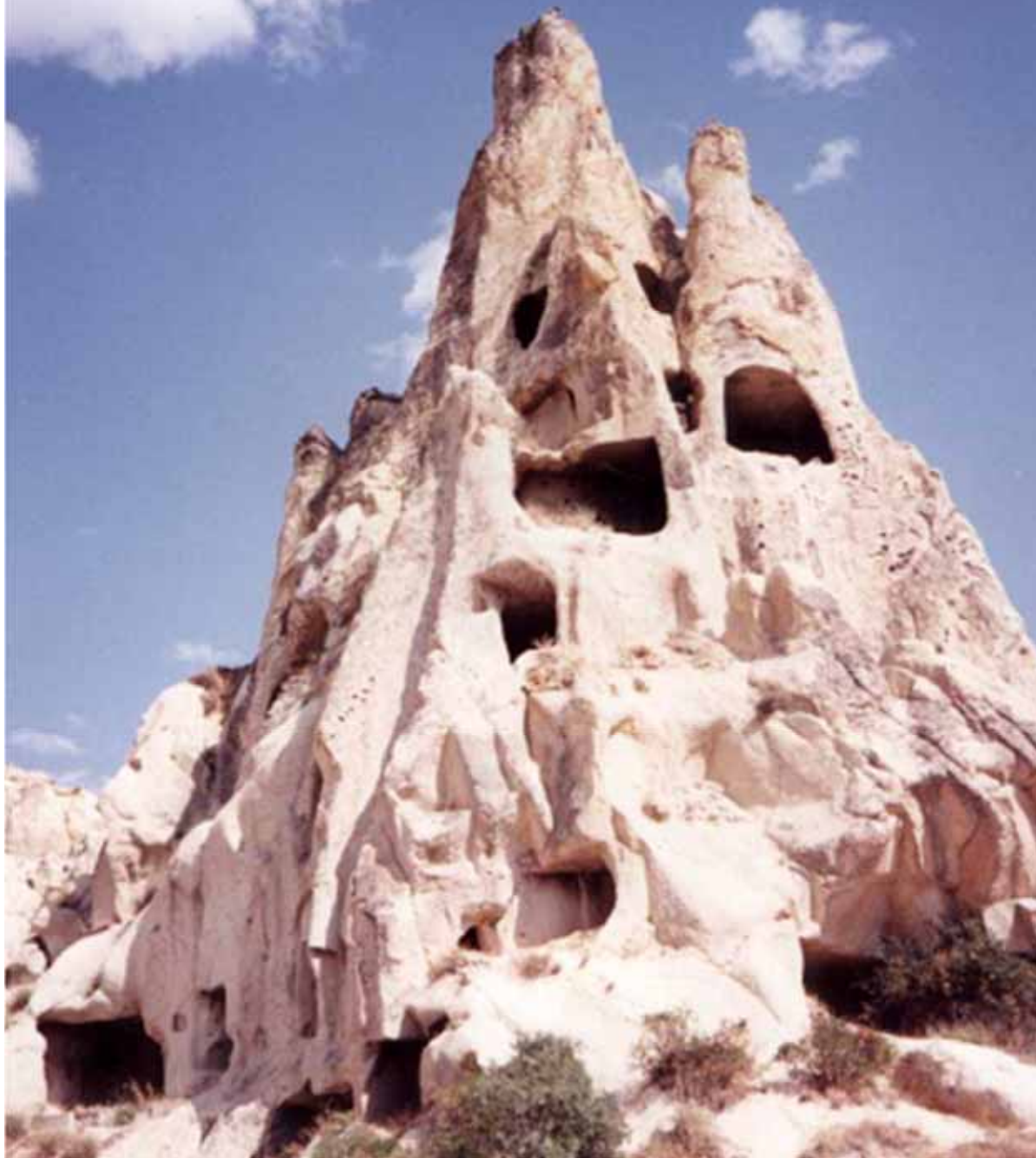
Building
+
Green

Toronto



Green building is NOT just adding a green outlook

Cave dwellings in Cappadocia, Turkey



(Photo taken during my travel to Turkey in 1992)

Sustainable
architecture
in ancient time
(cave dwellings)

- cooperate with nature (climate, topography)
- durable and longlife are the trend

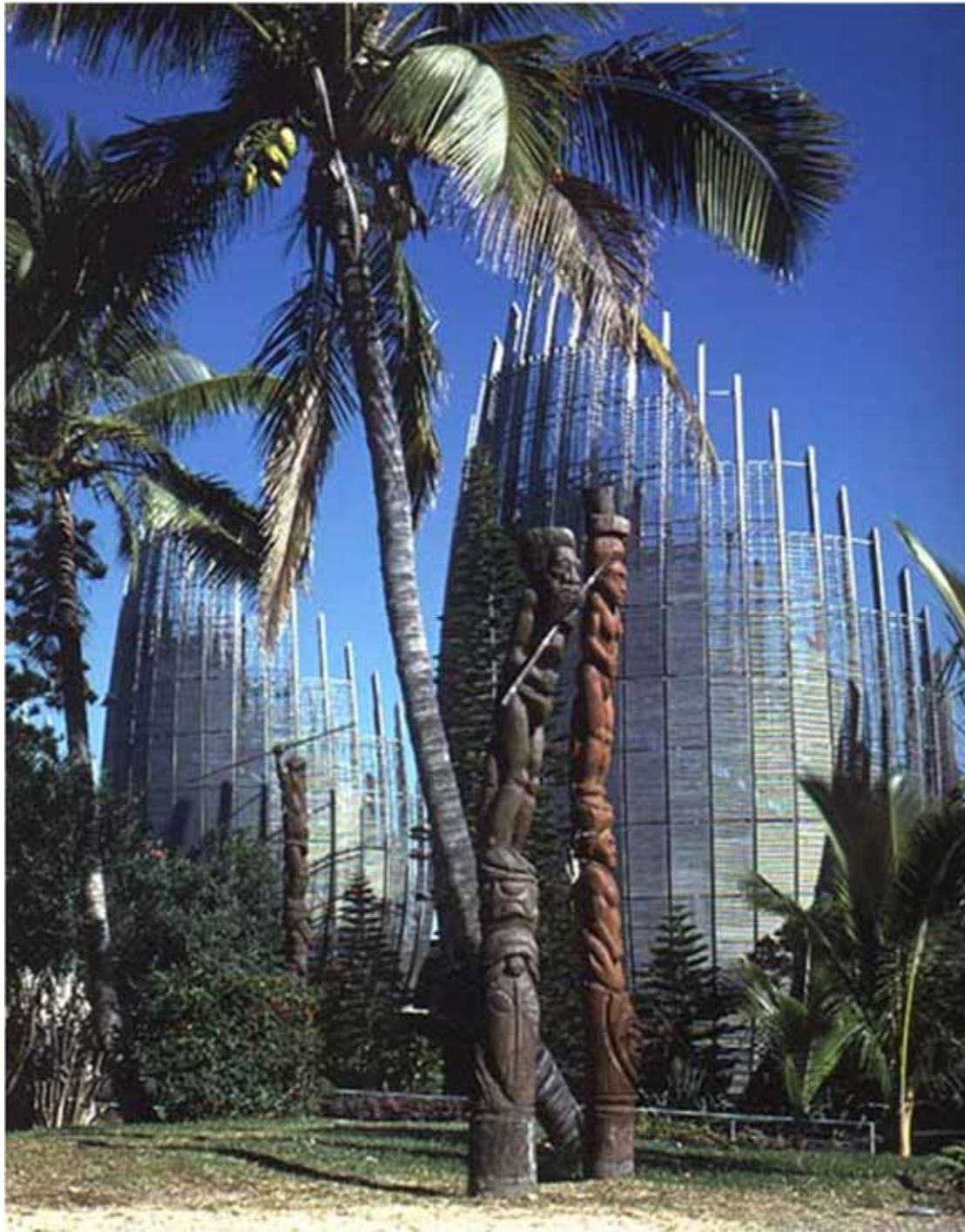


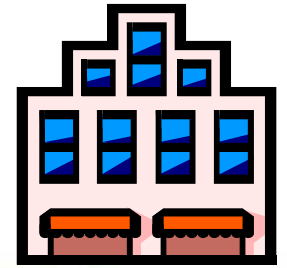
Photo credit: Renzo Piano Workshop Foundation

Example of sustainable
Architecture:

Jean Marie Tjibaou
Cultural Center
(by Renzo Piano)

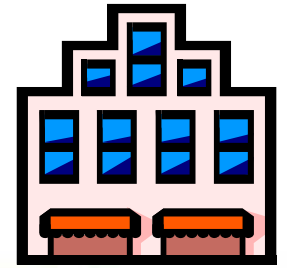
- Integration of
regional materials,
traditional construction
methods, contemporary
technology and
ecological design

Green/sustainable building



- A loosely defined collection of land-use, building design, and construction strategies that reduces the environmental impacts
- The term “green” is extremely wide ranging, encompassing many viewpoints and open to broad interpretation
 - Debate around green building/architecture
 - Complexity of environmental issues

Green/sustainable building



- It involves a *holistic* approach to the design and operation of buildings. It considers:
 - *1) Economy and efficiency of resources*
 - *2) Life cycle design*
 - *3) Human well-being*
- Main objectives
 - Be environmentally friendly and responsible
 - Improve the quality of built environment

- site selection
- urban design
- landscape planning

- CO₂ emissions
- acid rain
- ozone depletion
- rainforest depletion

- energy performance
- renewable energy
- water conservation

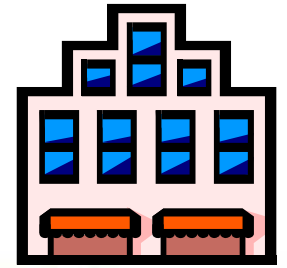
**Environmental
Criteria &
Factors**

- environmental policy
- transport strategy
- building maintenance

- material selection
- recycling of materials
- waste management
- disposal & reuse

- air quality
- thermal comfort
- lighting & noise
- hazardous materials

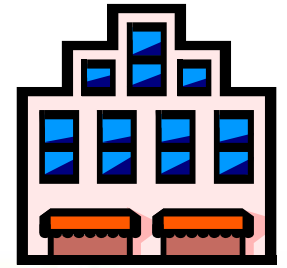
Green/sustainable building



- Green buildings are
 - Energy and resource efficient
 - Non-wasteful and non-polluting
 - Sustainable design that helps minimise broad environmental impacts (e.g. ozone depletion)
 - Highly flexible and adaptable for long-term functionality
 - Easy to operate and maintain (lower running costs)
 - Supportive of the productivity and well-being of the occupants

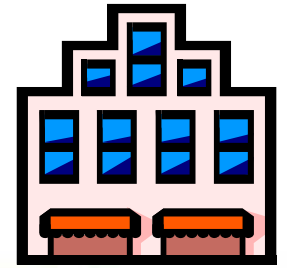


Green/sustainable building



- **Sustainable Building** [by an OECD project]
 - Have minimum adverse impacts on the built and natural environment, in terms of the buildings themselves, their immediate surroundings and the broader regional and global setting
 - Apply practices which strive for integral quality (economic, social and environmental performance) in a very broad way

Green/sustainable building

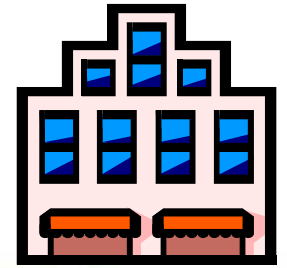


- **Sustainable Building** [HKGBC]



- Provides a quality living amenity for its users and neighbours in terms of social, environmental and economic aspects while minimising negative environmental impact at the local, regional and global levels throughout its full life cycle

Green/sustainable building



- **Principles of Sustainable Design**
 - Understanding place
 - Connecting with nature
 - Understanding natural processes
 - Understanding environmental impact
 - Embracing co-creative design processes
 - Understanding people

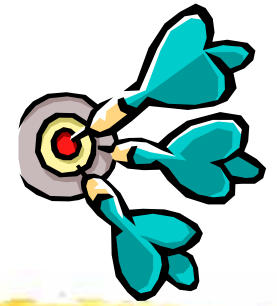


"It's not easy being green." -- Kermit the Frog, 1972.



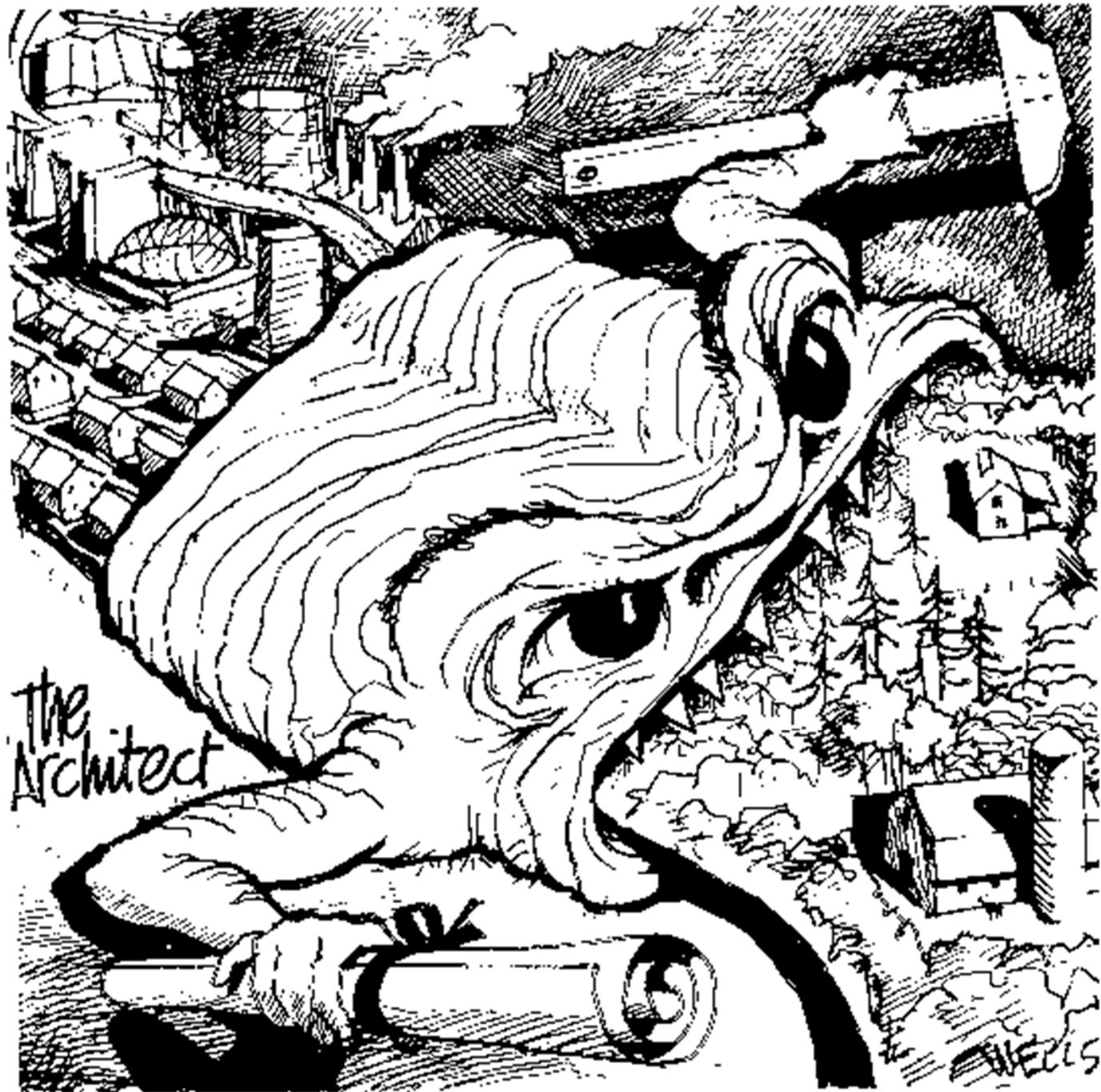
Why going green?

Why going green?



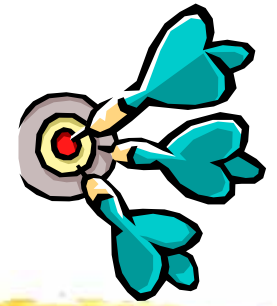
- Survival of our planet: environmental crisis
 - Air (destruction of Earth's atmosphere)
 - Global warming, climate change
 - Water (an undervalued resource)
 - Shortage and pollution
 - Fire (the problem of fuels)
 - Fossil fuel burning (coal, oil)
 - Earth (resources and materials)
 - Resources depletion





Drawing by the American architect Malcolm Wells

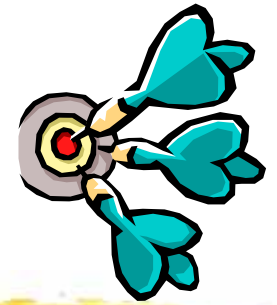
Why going green?



- Buildings consume significant resources
 - Consumption of energy & water
 - Use of building materials
 - Transport of materials & products
- Construction as the worst polluters
 - Operation on site and off site
 - Waste from construction/occupants
 - Pollutants from buildings



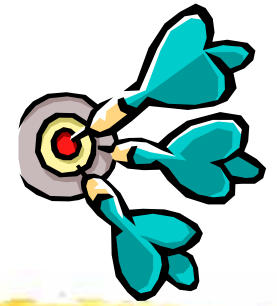
Why going green?



- Green buildings pay
 - Direct benefits (e.g. energy/cost savings)
 - Indirect benefits (e.g. healthier conditions)
 - Wider global benefits (e.g. reduced CO₂ emission)
- Life-cycle benefits
 - Total economic and environmental performance
 - Long-term “*sustainability*”

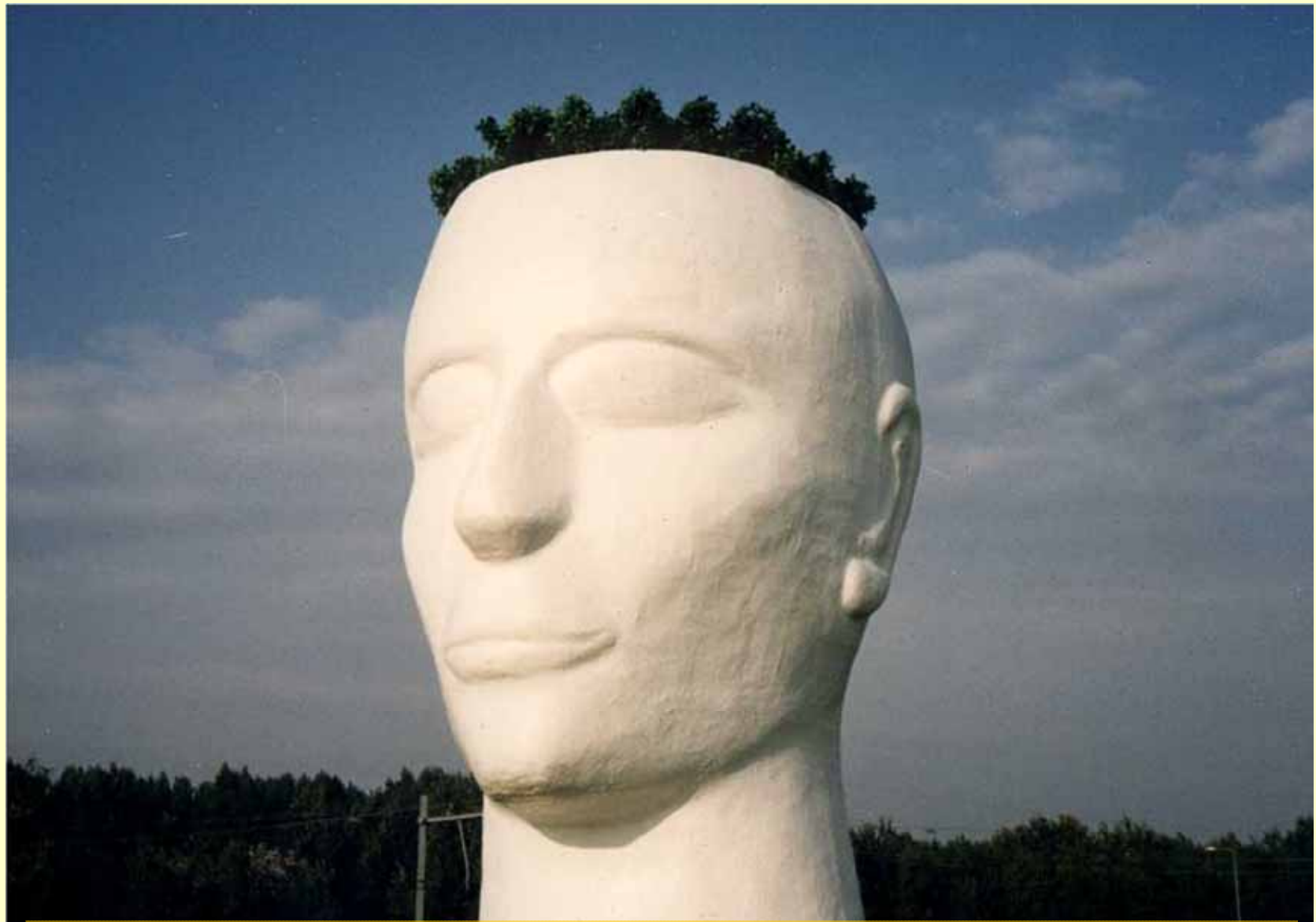


Why going green?



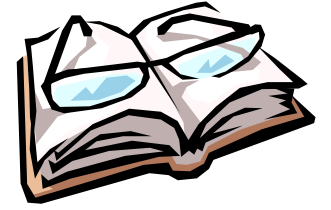
- Benefits of sustainable buildings:
 - They are designed to be cost effective
 - They boost employee productivity
 - They enhance health and well-being
 - They reduce liability
 - They create value for tenants
 - They increase property value
 - They benefit the community
 - They achieve more predictable results



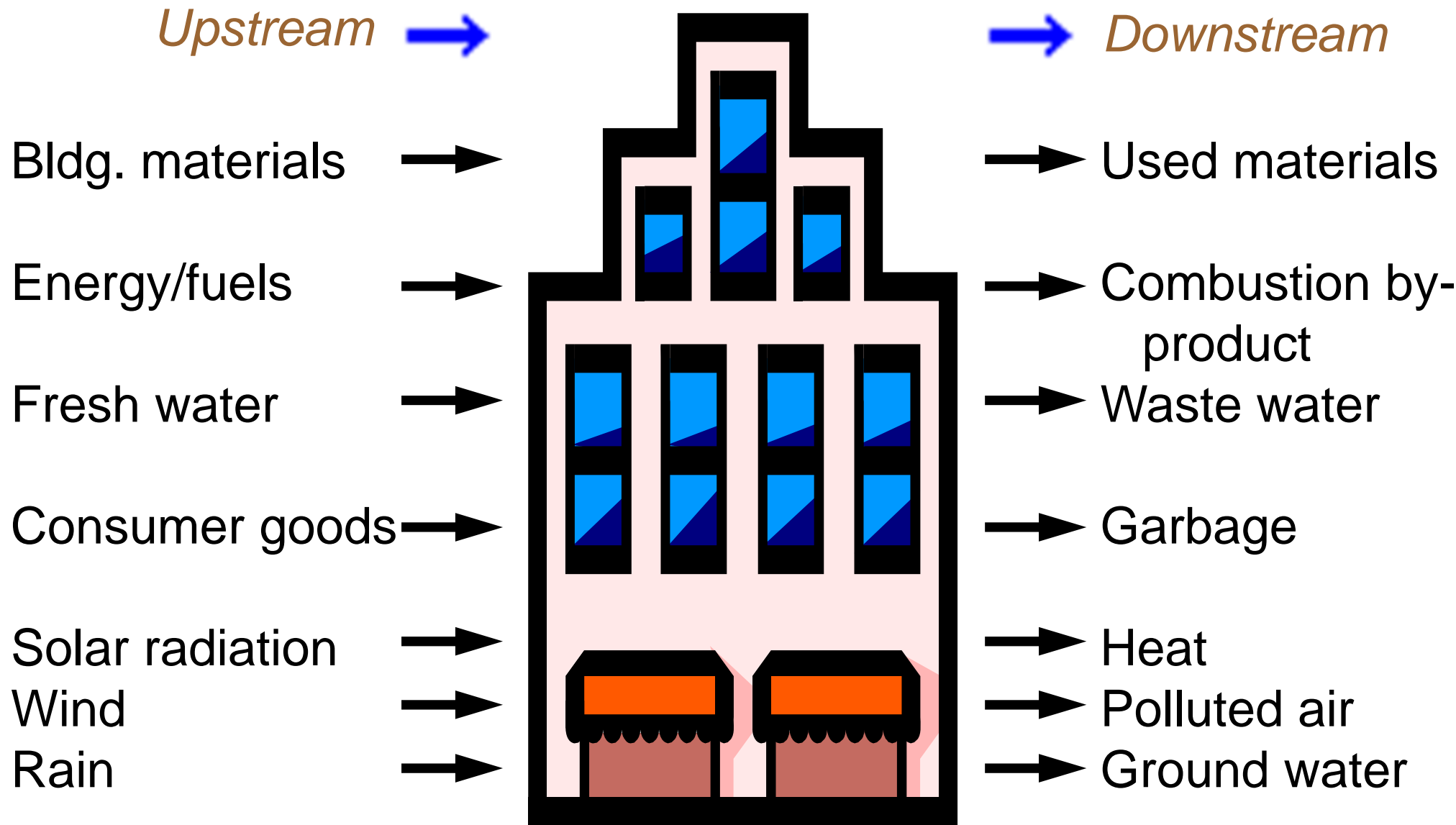


Basic Principles

Basic principles

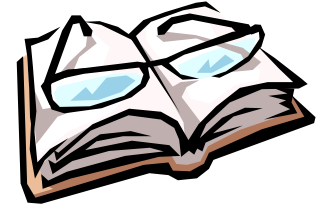


- Aims of green building design
 - Reduce energy in use
 - Minimise external pollution & environmental damage
 - Reduce embodied energy & resource depletion
 - Minimise internal pollution & damage to health
- Green design requires resolving many conflicting issues and requirements

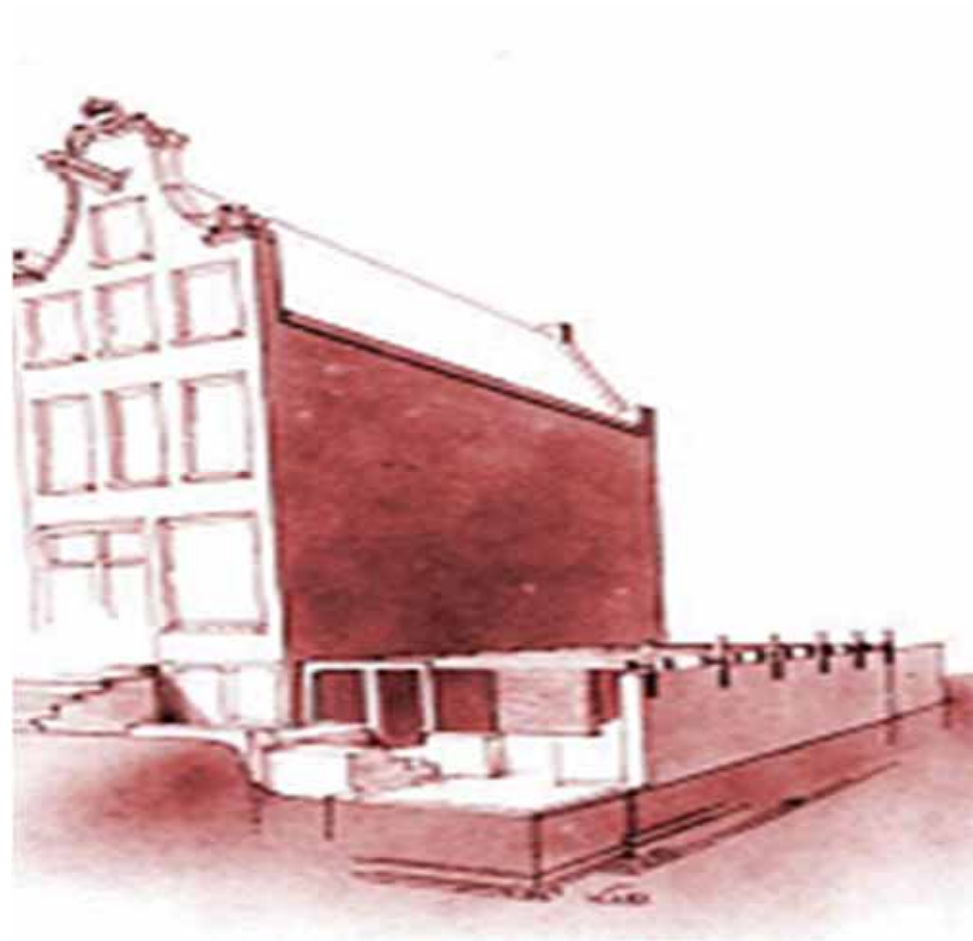


Resource and material flow in the building ecosystem

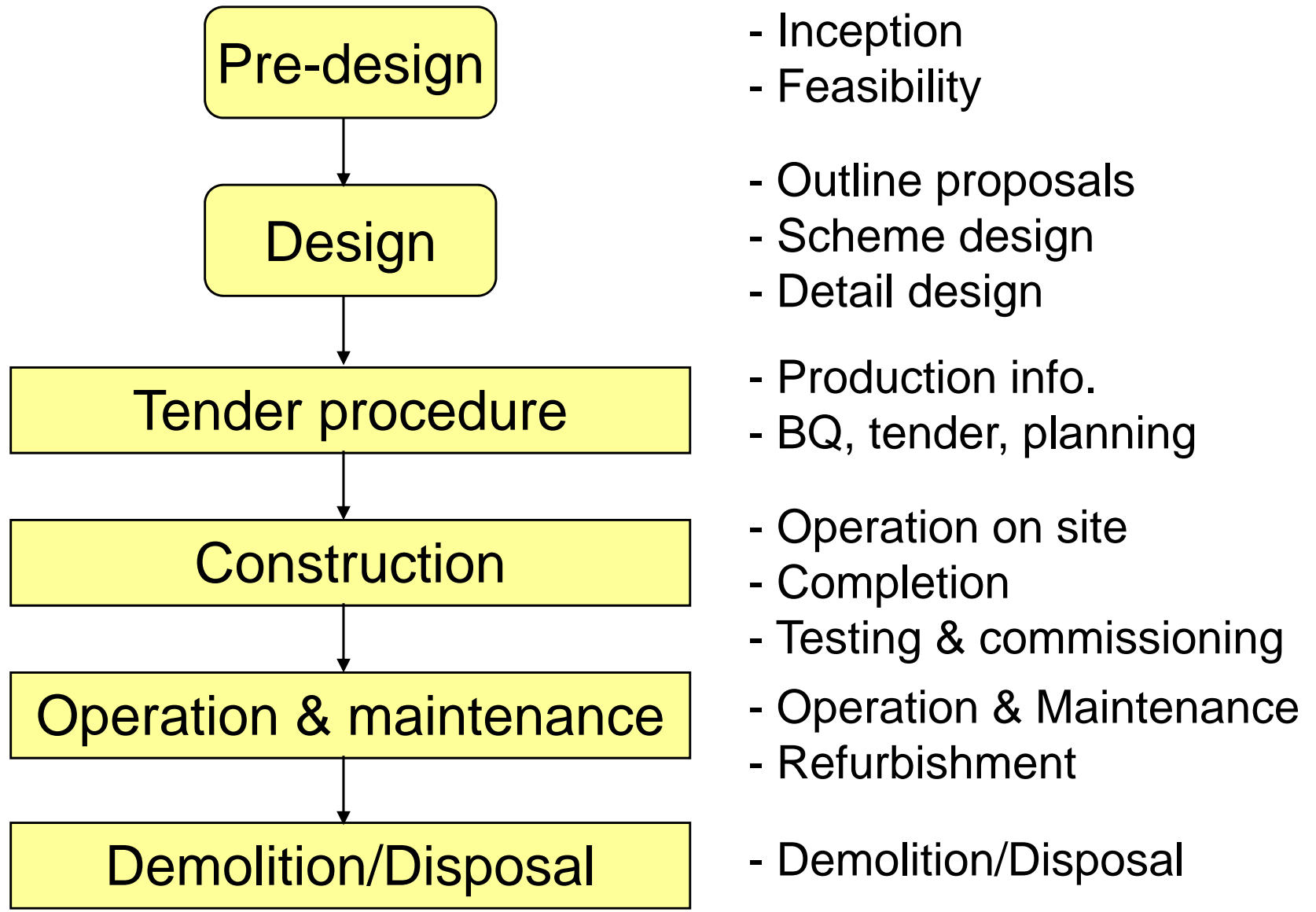
Basic principles



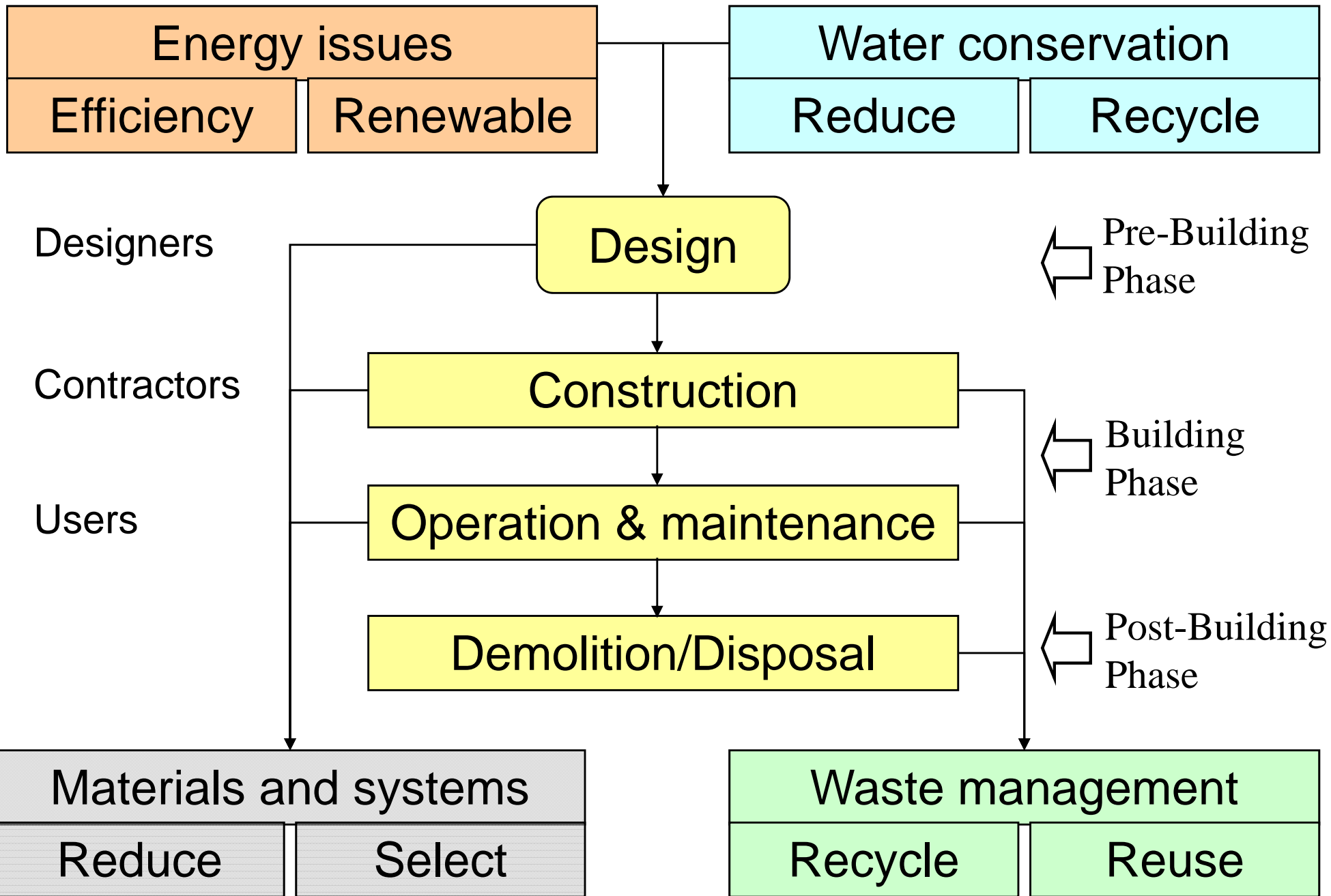
- Green building design involves
 - Holistic approach (whole systems thinking)
 - Each aspect is considered in relation to all others
 - Interdisciplinary efforts
 - Understanding & contribution from all involved
 - Understanding of building performance
 - Assessment & evaluation of performance
 - Caring for people
 - Well being of the occupants and users



Construction Process

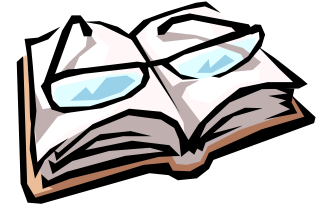


Building and construction process



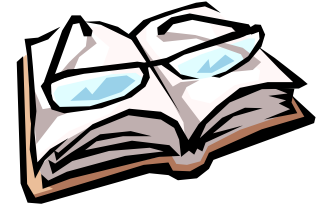
Building life cycle and sustainable construction

Basic principles



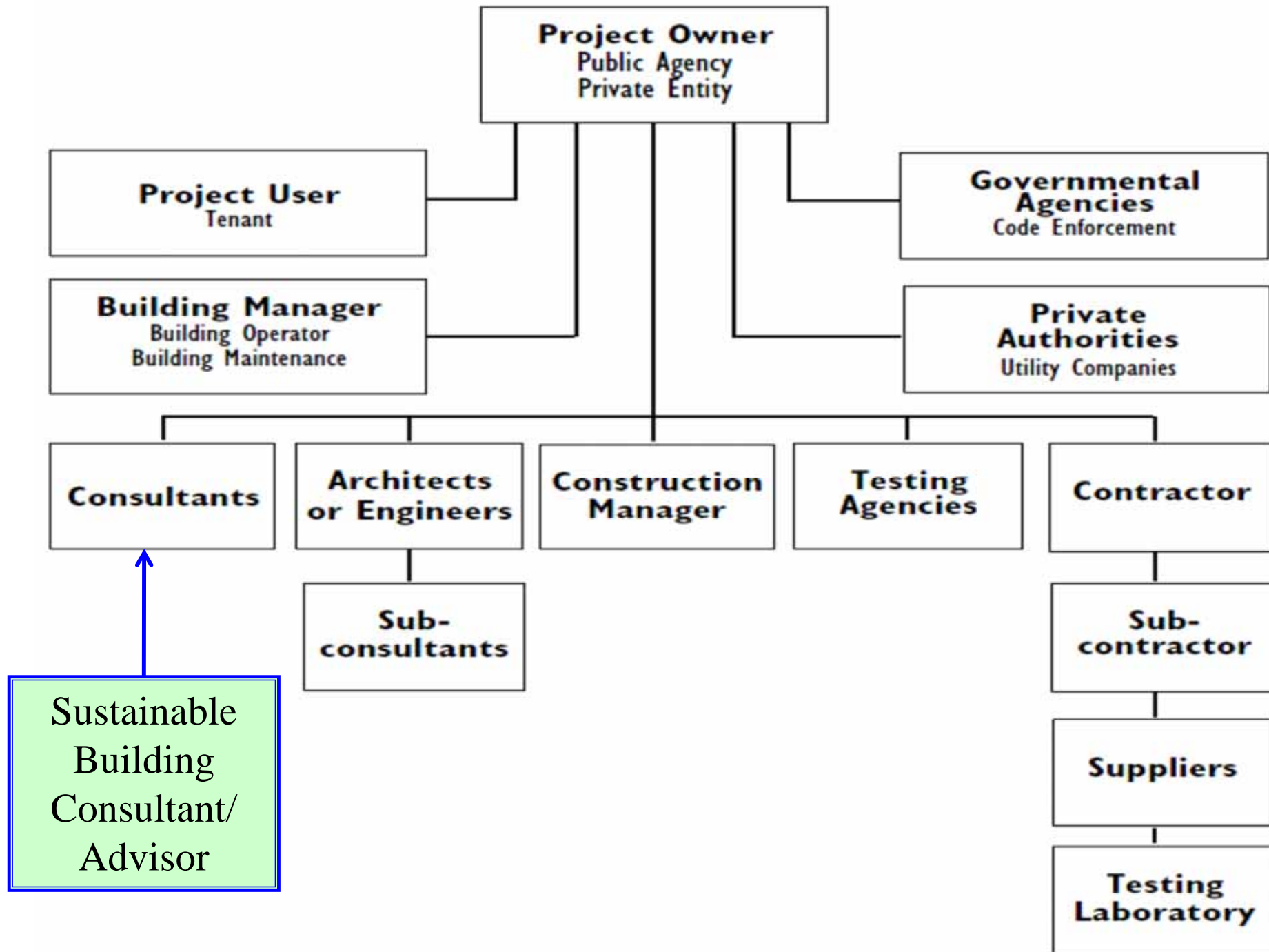
- Major concerns
 - Conserve non-renewable energy & scarce materials
 - Minimise life-cycle ecological impact
 - Use renewable energy and materials that are sustainably harvested
 - Protect & restore local air, water, soils, flora and fauna
 - Support pedestrians, bicycles and mass transit
 - Reduce human exposure to noxious materials

Basic principles

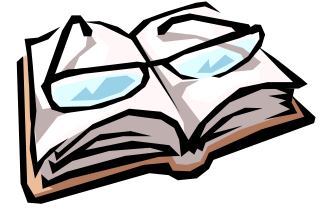


- Truly green design is more than a technological add-on. Green buildings are the one that
 - Work well
 - Suit the people in them
 - Show off the cultural context
- The need to cultivate “sustainable thinking”
 - Define & achieve sustainability in a given context
 - Connection to the mass of current design

Typical project team in building and construction process

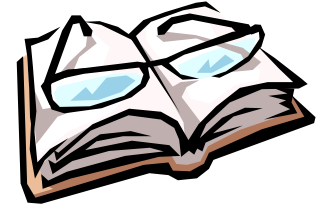


Basic principles



- Key areas for green specialist advice
 - Building structure & materials
 - Building envelope design
 - Heating, ventilation & air-conditioning (HVAC)
 - Lighting systems
 - Electrical power
 - Water services
 - Landscaping
 - Cost estimating (e.g. life cycle cost studies)

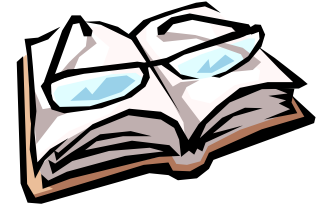
Basic principles



- Green building design strategies (see handout*)
 - Sustainable site
 - Energy and atmosphere
 - Water efficiency
 - Materials and resources
 - Indoor environmental quality

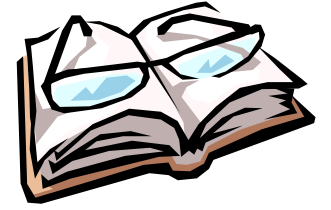
* http://www.mech.hku.hk/bse/MEBS6020/GB_design_strategies.pdf

Basic principles



- Green strategies at different stages:
 - Inception (briefing, targets, site)
 - Design
 - Preliminary studies
 - Sketch studies
 - Pre-project
 - Basic project
 - Execution of project
 - Construction (tendering, supervision, acceptance)
 - Maintenance and Refurbishment

Basic principles



- Teaching Kit: Sustainable Design for Buildings (ArchSD)
 - <http://www.archsd.gov.hk/archsd/html/teachingkits/tk1/>
 - Sustainable planning
 - Sustainable building design
 - Green procurement
 - Green construction management
 - Sustainable maintenance





Further Reading

- Green building – Wikipedia
 - http://en.wikipedia.org/wiki/Green_building
- Sustainable architecture – Wikipedia
 - http://en.wikipedia.org/wiki/Green_architecture
- Sustainable design – Wikipedia
 - http://en.wikipedia.org/wiki/Sustainable_design
- Sustainable development – Wikipedia
 - http://en.wikipedia.org/wiki/Sustainable_development



Further Reading

- "Hong Kong Architecture Goes Green", CCGC Vision, Sep 2010 [PDF]
- Green building design strategies
- Green strategies at different stages
- HK Green Building Technology Net
 - <http://gbtech.emsd.gov.hk>



Useful Websites

- Useful resources:
 - Case Studies on Sustainable Buildings
 - http://me.hku.hk/sbe/case_study/index/top.htm
 - Web Links on Sustainable Buildings
 - http://me.hku.hk/sbe/web_links/index.html
 - References on Sustainable Buildings
 - <http://me.hku.hk/sbe/refs/index.html>
- Whole Building Design Guide (WBDG)
 - <http://www.wbdg.org>