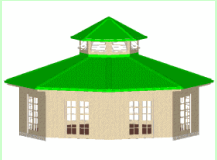
Technical Talk for Environmental Innovation Centre, Gammon-Skanska
15 November 2003



Sustainable Construction & Green Building: A Practical Overview

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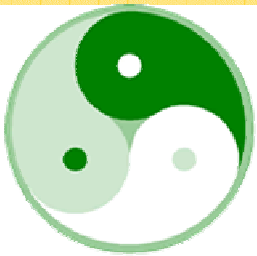
Contents

- Sustainable Construction
- What is Green Building?
- Basic Principles
- Green Building Assessment
- Practical Examples

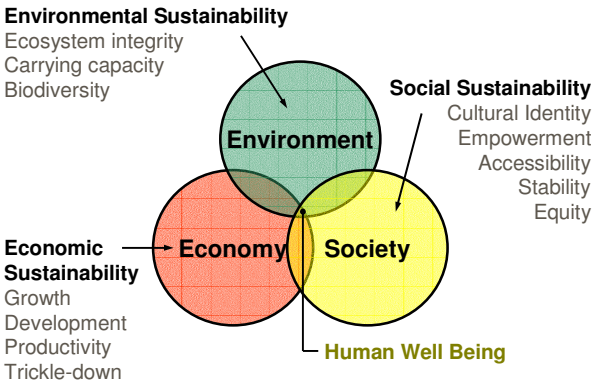
Sustainable Construction

What is Sustain-able Development?

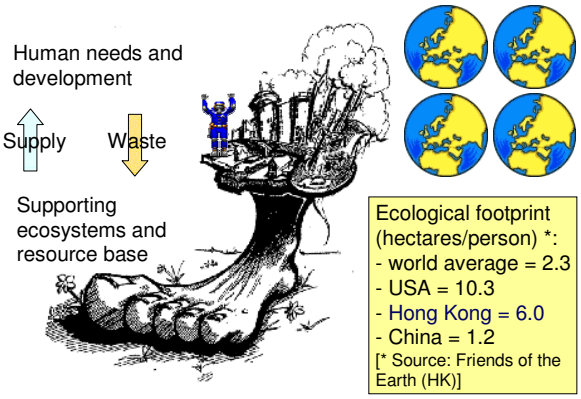


Sustainable Development

- The Brundtland Report (*Our Common Future*)
  - "S.D. 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



Three dimensions of sustainability



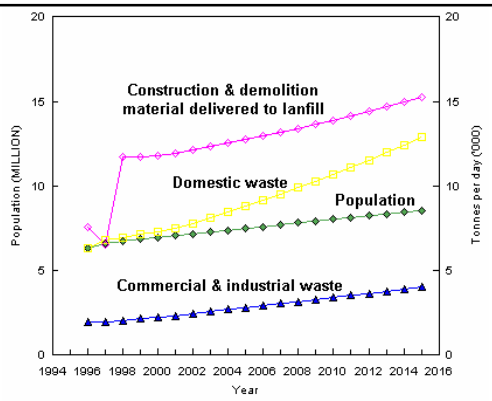
Carrying capacity and ecological footprint

Sustainable Development

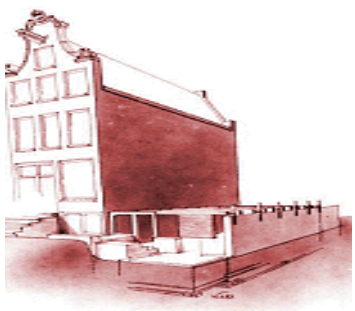
- Sustainability is about: [Mei Ng, FoE(HK)]
  - System thinking (harmonize human & living)
  - Value judgment (importance of natural capital)
  - Efficiency (resources & eco-efficiency)
  - Fair share (inter- & intra-generational equity)
  - Making informed choices
  - Quality people & quality life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

Sustainable Development

- One day in HK (popul. = 6.97 million) [1999]
  - Fresh water consumption = 358 litre/person
  - Electricity consumption = 13.9 kWh/person
  - Food consumption:
    - Vegetables 1,100 tonnes; fruits 1,800 tonnes
    - Live pigs 6,200 heads; live cattle 170 heads
    - Live poultry 190 tonnes; fresh eggs 200 tonnes
    - Freshwater fish 120 tonnes; marine fish 170 tonnes
  - Solid waste production = 18,040 tonnes



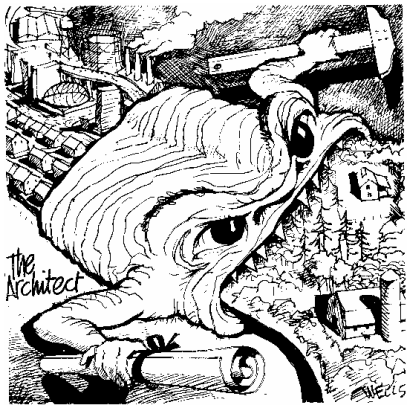
Projection of waste requiring disposal and population in HK
(source: Waste Reduction Framework Plan)



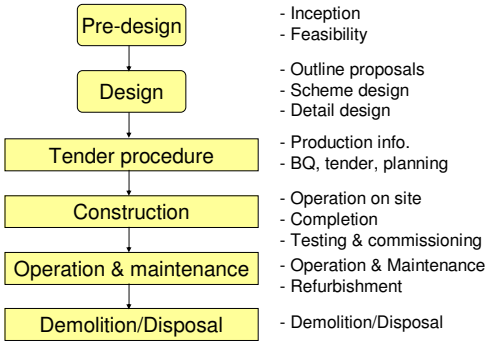
Sustainable Construction

Sustainable Construction

- Current building & construction practices
  - Most materials are not recyclable
  - Generates waste & pollution
  - Energy supply is based on fossil fuels
  - Buildings are not always designed for optimal energy & environmental performance
  - Lack of connection with nature
  - Health & well-being of occupants are overlooked



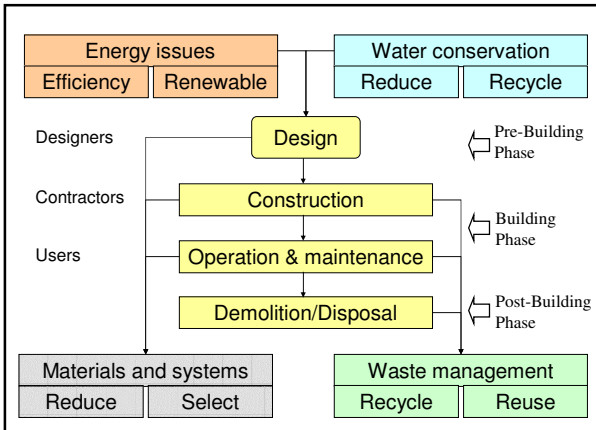
Drawing by the American architect Malcolm Wells



Building and construction process

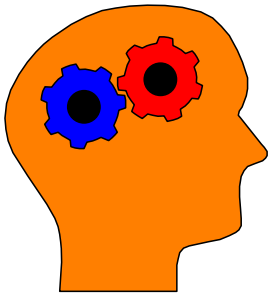
Sustainable Construction

- Goals of sustainable building
  - Design buildings that are minimal consumers
  - Use materials that have a benign impact on the environment throughout their life cycle
  - Arrange buildings and urban areas so they foster community and connection with nature
  - Construct buildings with healthy and inspiring internal environments
  - Promote efficient transport and communication



Building life cycle and sustainable construction

QUIZ

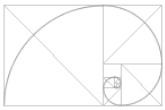


In 1987, the World Commission on Environment and Development, headed by Gro Harlem Brundtland, developed a definition of sustainable development and published the well-known "*Brundtland Report*". Which country does Gro Brundtland come from?

What is Green Building?

Kyoto Face House, 1998

"What is green building?"



Cologne

Building
+
Green

Toronto

Green building is NOT just adding a green outlook

What is green 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

What is green 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

What is green building?

- "Green" is different for every building
  - No building is completely green in every aspects
  - It is a continually evolving concept, a goal
- What makes a particular building green?
  - A unique solution that responds to the specific functional requirements and the climatic condition
  - Truly green design is more than a technological add-on – consider the context

Hong Kong

Current issues in HK

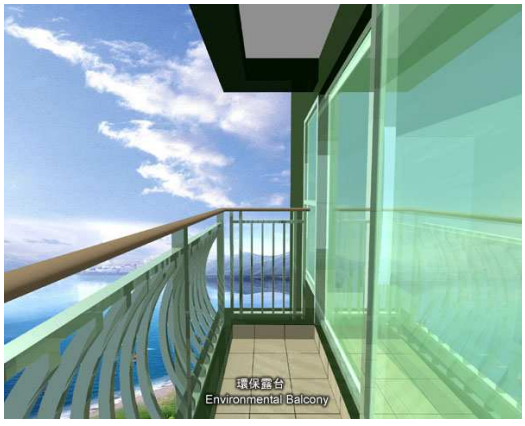
- Green and innovative buildings
  - Joint Practice Notes by BD, LandsD & PlanD
    - Provide incentives: exemption from gross floor area (G.F.A.) & site coverage calculations
  - Green features included (currently):
    - Balconies
    - Wider common corridors & lift lobbies
    - Communal sky gardens & communal podium gardens
    - Acoustic fins
    - Sunshades & reflectors
    - Wing walls, wind catchers & funnels

買環保樓送露台花園

推，將業府台花每層層
府，置政露中商樓災
」給。造空展宅化
港，厦園素建「發住綠
【訊大花實商的望層」
明保及屋展新希五個。
報「環台住發嶄，十一草
建」改鼓揽概十預花
興送，了更」造便栽
動者除，園建，」

19-10-2000

Turning
G.F.A. (Gross Floor Area)
Into
Green-Featured Architecture



Example: Balconies

Conditions:
- restricted to the living room, dining room and bedroom
- open at least 2 sides
- area 2 m^2 or 4% of usable floor space (max. 5 m^2)

Example: Balconies (cont'd)

Benefits:
- as barriers for street noise
- sunshading for the floor below
- provide space for vegetation/planting/drying clothes

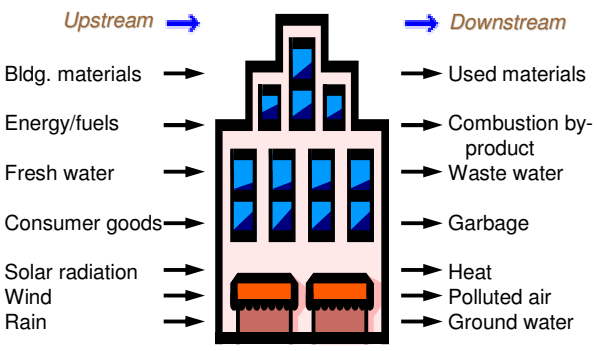
Larger communal area to provide light and ventilation

Basic Principles

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

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

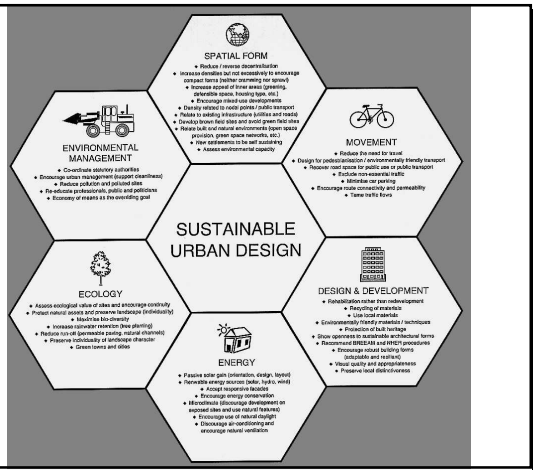
Major issues

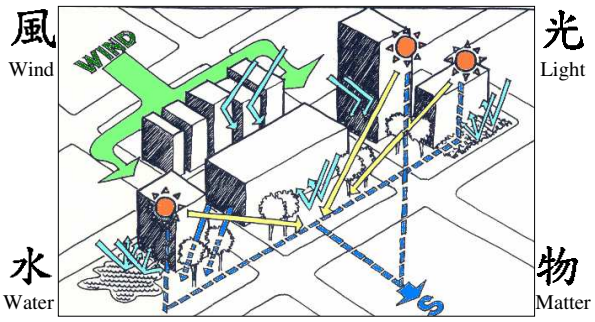
- Sustainable site
- Energy efficiency
- Renewable energy
- Building materials
- Water conservation
- Indoor environmental quality

(* Some are common senses!)

Sustainable site

- Basic principles:
  - Site selection (e.g. prefer brownfield site)
  - Promote efficient movement network & transport
  - Control & reduce noise impacts
  - Optimise natural lighting & ventilation
  - Design for green space & landscape
  - Minimise disturbance to natural ecosystems
  - Enhance community values

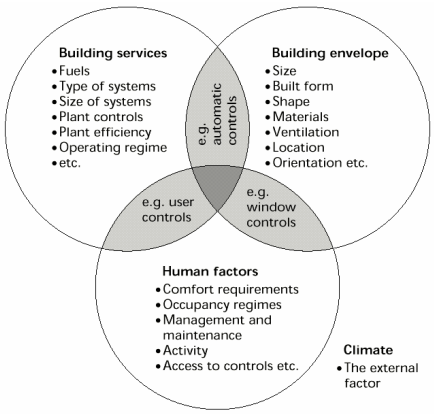




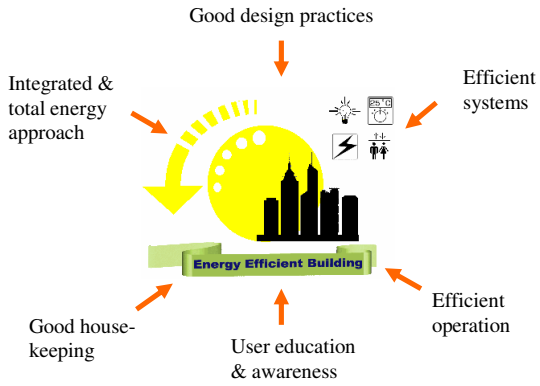
Major site factors

Energy efficiency

- Design strategies:
  - Minimise thermal loads & energy requirements
    - e.g. by reducing heat gains from equipment
  - Optimise window design & fabric thermal storage
  - Use of heat recovery & free cooling methods
  - Total energy approach (e.g. district cooling)
  - Energy efficient lighting design & control
  - High-efficiency mechanical & electrical systems

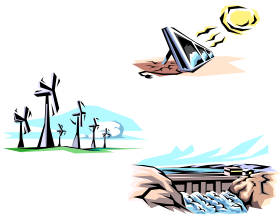


Key factors influencing energy consumption



Renewable energy

- Energy that occurs naturally and repeatedly on earth and can be harnessed for human benefit, e.g. solar, wind and biomass
- Common applications
  - Solar hot water
  - Solar photovoltaic
  - Wind energy
  - Geothermal
  - Small hydros



Solar heating for a swimming pool complex

PV system for a weather radar station

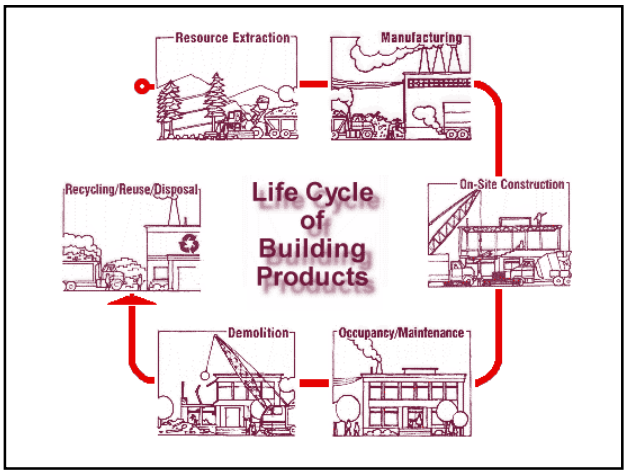
Solar energy systems in Hong Kong

Dutch pavilion, EXPO 2000 Hannover

Project Zed - London

Building materials

- Specify green materials & products
  - Made from environmentally attractive materials
  - That reduce environmental impacts during construction, renovation, or demolition
  - That reduce environmental impacts of building operation
  - That contribute to a safe, healthy indoor environment
  - That are green because what isn't there (e.g. CFC)

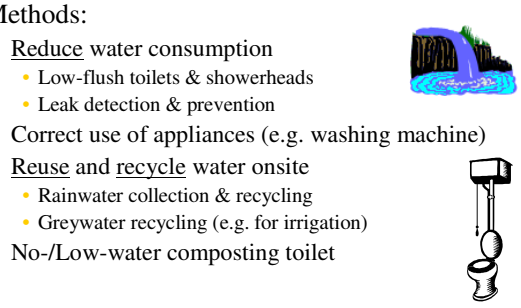


Green Features

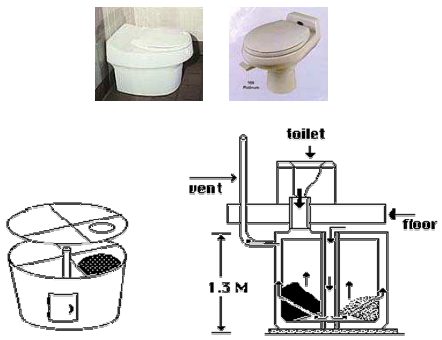
Manufacturing Process (MP)	Building Operations (BO)	Waste Mgmt. (WM)
Waste Reduction (**WR**)	Energy Efficiency (**EE**)	Biodegradable (**B**)
Pollution Prevention (**P2**)	Water Treatment & Conservation (**WTC**)	Recyclable (**R**)
Recycled (**RC**)	Nontoxic (**NT**)	Reusable (**RU**)
Embodied Energy Reduction (**EER**)	Renewable Energy Source (**RES**)	Others (**O**)
Natural Materials (**NM**)	Longer Life (**LL**)	

Water conservation

- Methods:
  - Reduce water consumption
    - Low-flush toilets & showerheads
    - Leak detection & prevention
  - Correct use of appliances (e.g. washing machine)
  - Reuse and recycle water onsite
    - Rainwater collection & recycling
    - Greywater recycling (e.g. for irrigation)
  - No-/Low-water composting toilet



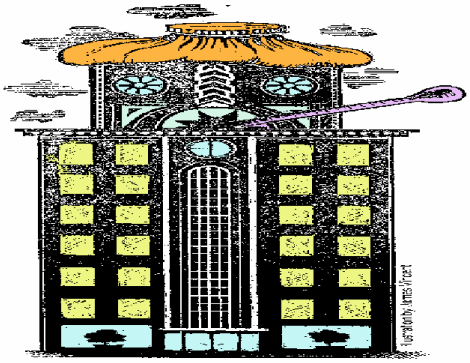
Rainwater recycling system



Composting toilets

Indoor environment

- Indoor air quality (IAQ)
  - People spend most of their time indoors
  - Pollutants may build up in an enclosed space
  - Effects on health and productivity
- Control methods
  - Assess materials to avoid health hazards
  - Ensure good ventilation & building management



Avoid "sick building syndromes" by maintaining good indoor air quality

Indoor environment

- Visual quality
  - Provide daylight & comfortable conditions
- Acoustic quality
  - Noise control
- Controllability
  - Allow occupant control over thermal & visual

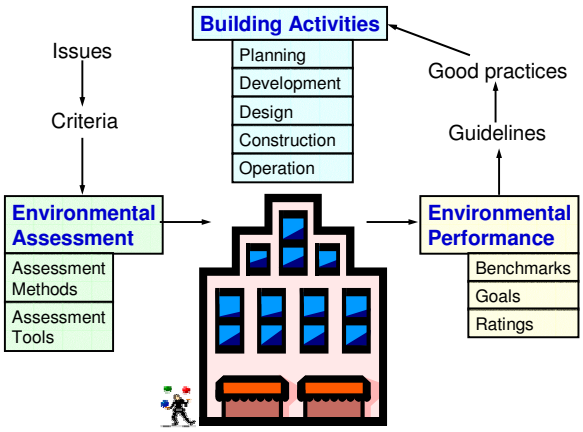
Green Building Assessment

Basic Principles

- Building environmental assessment
  - Identify & evaluate the environmental effects of building development or operation
  - Inform decision making and promote sustainable design & management
- An objective assessment is a useful starting point from which to make design and building improvements

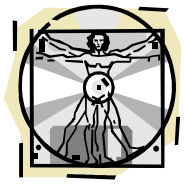
Basic Principles

- Why environmental assessment?
  - Provide a common set of criteria & targets
    - Guide design decisions & choices
  - Raise awareness of environmental issues/standards
    - Recognise & encourage good practices
    - Stimulate the market for sustainable construction
  - Allow a verifiable method & framework
    - Enable policies & regulation (e.g. certificate/label)
    - Improve management & prioritization (incentives)



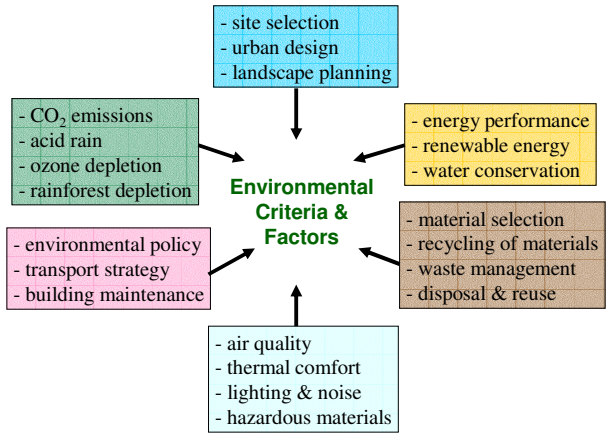
Basic Principles

- Scope/Scale of the evaluation
  - Building products
  - Building processes
  - Structural members/elements
  - Building systems
  - Single buildings
  - Groups of buildings
  - District, urban, regional & city
- New, existing & refurbished buildings



Assessment Criteria

- A broad range of criteria
  - Qualitative issues
  - Quantitative issues
- Types of criteria
  - Ecological *vs* health-related
  - Direct impacts *vs* indirect impacts
  - Immediate *vs* long-term implications
  - Global *vs* local

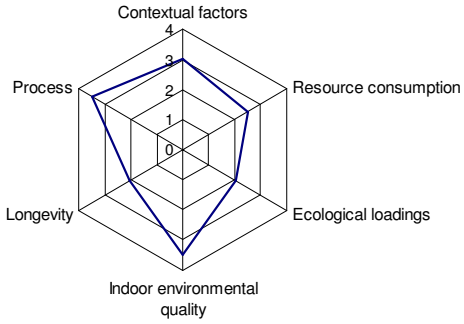


Assessment Criteria

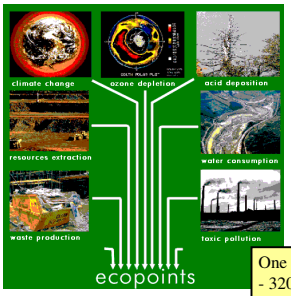
- Assessment process
  - Examine the performance of a building or its sub-system against a declared set of criteria
  - Usually voluntary (aim to stimulate the market)
- Scale of performance
  - Measure & assess relative performance
  - Assign 'points' or 'score' to various aspects
    - Quantitative criteria: relative to a baseline
    - Qualitative criteria: presence/absence of such features

Assessment Criteria

- Assessing multiple criteria
  - Indicate the 'best' overall performance
  - Methodology
    - Cost (or monetary value $)
    - Equivalence method (e.g. air/water pollution index)
    - EcoCost (in common Gaia scale 0-1)
    - EcoPoint or EcoProfile
  - Weighting system
    - To indicate relative importance, scale and urgency



Radar chart for assessing multiple criteria



"Ecopoint" concept in the ENVEST (environmental impact estimating) tool (UK BRE)

envest

One "**ecopoint**" is equivalent to:
- 320 kWh electricity
- 83 m^2 Water: enough to fill 1,000 baths
- 65 miles by articulated truck
- landfilling 1.3 tonnes of waste
- manufacturing 3/4 tonnes brick (250 bricks)
- 540 tonne kms by sea freight
- 1.38 tonnes mineral extraction
- 300 miles of urban driving in new petrol car

Assessment Methods

- Common approaches
  - Checklists or forms
  - Computer-based methods
    - Spreadsheet or computer programs
- Models used
  - Environment model
  - Product model
  - Life cycle model
- Data required: from simple to very detailed

Assessment Methods

- Examples
  - Europe:
    - BREEAM-UK
    - ECO-PRO (Germany)
    - EcoProP & PIMWAQ (Finland)
    - EQUER (France)
    - ECO QUANTUM (Netherlands)
  - Canada & USA:
    - BREEAM-Canada & BEPAC-Canada
    - LEED (USA)
    - BEES (USA) (for building products)

Assessment Methods

- Examples (cont'd)
  - Asian countries:
    - HK-BEAM
    - Japan Green Building Guide
    - Korea Green Building Rating System
    - Taiwan Green Building Label
- International model (being developed)
  - GBTool (Green Building Challenge)

綠建築標章 GREEN BUILDING

Korea's Green Building Rating System Criteria
(multi-residential building)

Section	Resource Consump-tion	Environ-mental Loadings	Quality of Indoor Environ.	Longevity	Process	Contextual Factors
Criteria (Number)	- energy (8) - land (3) - water (2) - materials (7)	- airborne emissions (17) - solid waste (4) - liquid waste (4) - other loadings (2)	- air quality (10) - thermal quality (4) -visual quality (7) - noise & acoustics (3) - controll-ability of system (2)	- adapt-ability (5) - mainten-ance of perform-ance (6)	- design & construction process (6) - building operations planning (7)	- location & trans-portation (1) - loadings on immediate surroundings (4)
Total(102)	20	27	26	11	13	5

* Source: Green Building Council of Korea (www.gbc-korea.co.kr)

Example Tools

- BREEAM and EcoHome - UK
  - **B**uilding **R**esearch **E**stablishment **E**nvironmental **A**ssessment **M**ethod
  - Credits awarded for a set of performance criteria
    - Management (of the building and the occupant organisation), health and comfort, energy, transport, water consumption, materials, land use, site ecology and pollution
    - A weighting system is applied to determine final rating
  - Used as a reference in many countries

Example Tools

- LEED Green Building Rating System
  - Leadership in Energy & Environmental Design
  - By US Green Building Council
  - Scores
    - Sustainable sites
    - Water efficiency
    - Energy and atmosphere
    - Materials and resources
    - Indoor environmental quality
  - + Innovation credits

Example Tools

- HK-BEAM
  - Hong Kong Building Environmental Assessment Method
  - Credits awarded for a set of performance criteria or issues
    - Global issues & use of resources
    - Local issues
    - Indoor issues
  - Different versions:
    - Version 1/96R - for new office designs, 2/96R - for existing office buildings, 3/99 - for new residential buildings
    - Hotel Building Environmental Assessment Scheme (HBEAS)
    - Trial version 4/03 New Building Developments
    - Trial version 5/03 Existing Building Developments

Example Tools

- Latest development in Hong Kong
  - Comprehensive Environmental Performance Assessment Scheme for Buildings (CEPAS)
    - Under internal review by Buildings Department
    - A consultancy study is commissioned to develop this scheme (completed by end of 2003)

Practical Examples

Practical Examples

- Pennsylvania's First Green Building
  - Southcentral Regional Office Building, Department of Environmental Protection, Commonwealth of Pennsylvania, USA
  - Video: "Pennsylvania's First Green Building" [27 min.]
  - http://www.gggc.state.pa.us/building/scrob.html

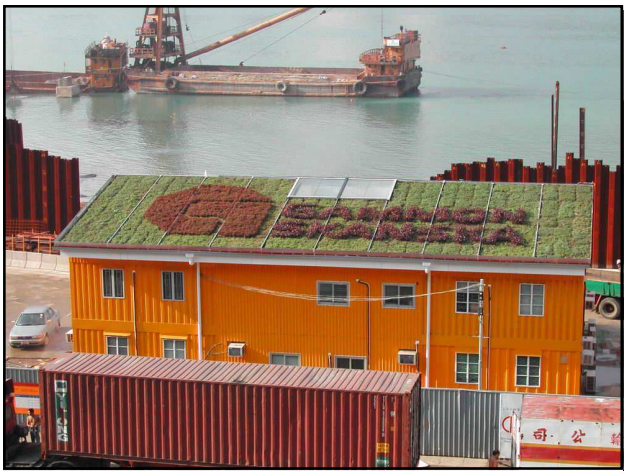
How many Green Team Members in the video?

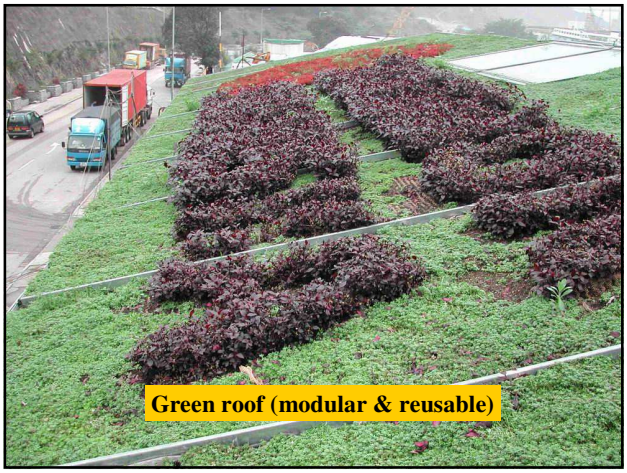
Practical Examples

- Pennsylvania's First Green Building – green features:
  - Reuse of a brownfield site
  - DOE-2 energy modelling for building system optimization
  - Building form, light shelves and sitting that reduces heat gain and augments daylighting
  - Gas-fried, CFC free adsorption air conditioning chiller
  - Desiccant wheel dehumidifying
  - High performance operable windows
  - High efficiency lighting and controls in concert with specially selected reflective surface
  - Raised floor air plenum and building system distribution cavity
  - Ecologically sound building materials
  - Interior air quality design control

Practical Examples

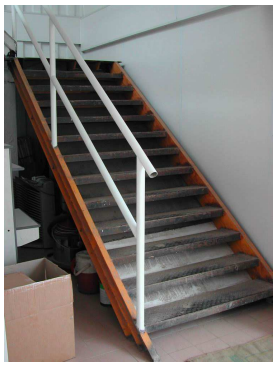
- Green Site Office – North Tsing Yi
  - Green roof
  - Use of atrium & skylight
  - Reused components & recycled materials
  - Energy efficient lighting & envelope
  - Water conservation
  - Protect local trees





Green roof (modular & reusable)

Use of atrium and skylight

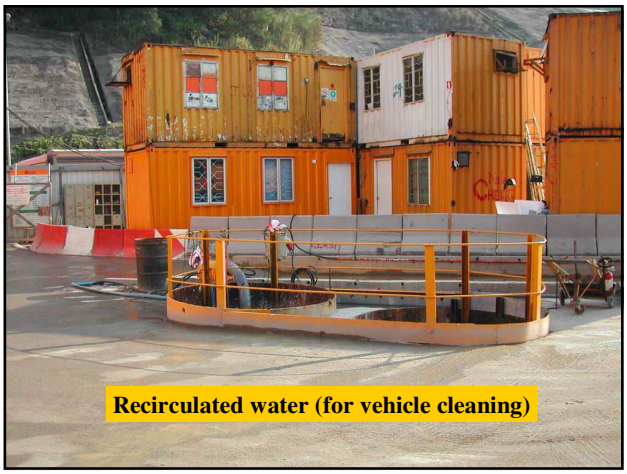


Reused components

Recycled materials

Occupant sensor

Energy efficient lighting



Recirculated water (for vehicle cleaning)

Protect local trees

Education for University students

Thank You !!