Principles and Practices of Sustainability

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Webinar for CXC Green Engineering Students

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CARIBBEAN EXAMINATIONS COUNCIL

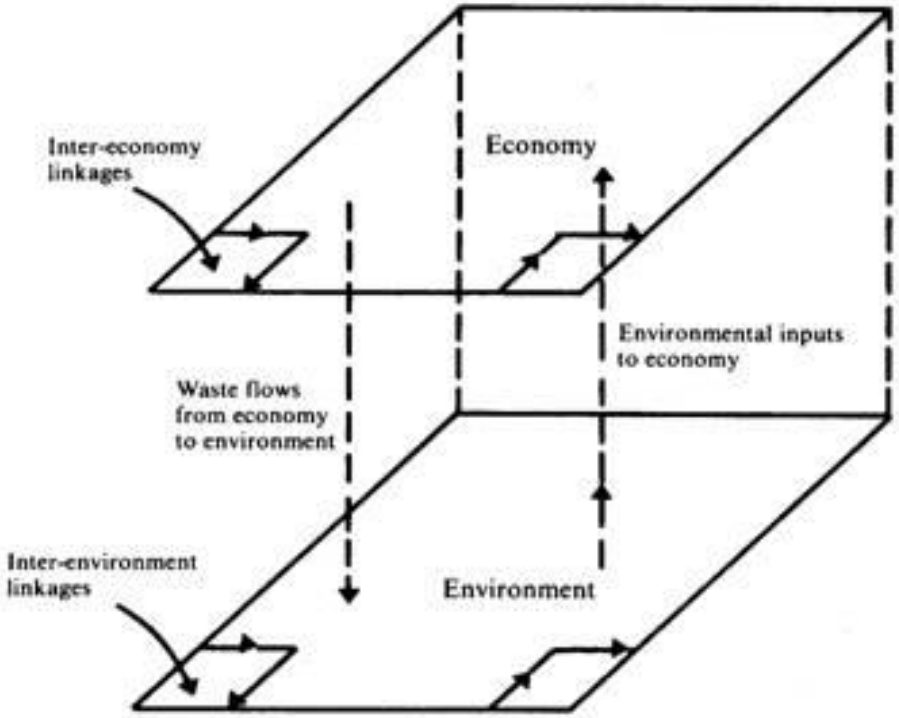
Outline of Lecture/Discussion

UNIVERSITY of GUYANA

- Sustainability – A Necessity
- Sustainability Performance Principles
- Cost-efficiency and Resource-efficiency
- Waste Minimisation
- Social Responsibility

Sustainability – A Necessity

- Evolution of SD is underlined by the realization that economic development without consideration for environmental impact is problematic.



- See Brundtland Commission Report (Our Common Future), 1987)

- http://sustainabledevelopment.un.org/futurewewant.html

Millennium Ecosystems Assessment

Main Findings

1. Humans have radically altered ecosystems in last 50 years.

2. Changes have brought gains but at growing costs that threaten achievement of development goals.

3. Degradation of ecosystems could worsen, but can be reversed.

4. Workable solutions will require significant changes in policy.

(MEA original slide)

Sustainability – A Necessity

- **Definition of the concept:**

  *"Sustainable development is development that meets the **needs** of the present without compromising the ability of future generations to meet their own needs."*

(The Brundtland Commission Report, 1987)

Sustainability – A Necessity

Strategic Imperatives for SD

- Reviving growth;
- Changing the quality of growth;
- Meeting essential needs for jobs, food, energy, water and sanitation;
- Ensuring a sustainable level of population;
- **Conserving and enhancing the resource base;**
- **Reorienting technology and managing risk; and**
- Merging environment and economics in decision making.

Sustainability – A Necessity

Green Engineering

Environmentally conscious attitudes, values, and principles, combined with science, technology and innovation directed towards improving local and global environmental quality. It is the design of materials, processes, systems and devices with the objective of minimising overall environmental impact over the entire life cycle whilst meeting required performance, economic and societal constraints.

(CXC GE Syllabus)

Sustainability Performance Principles

Interactive Session: Students will be asked to explain the 12 Principles of Green Engineering (These 12 Principles of Green Engineering provide a framework for designing new materials, products, processes, and systems that are benign to human health and the environment)

- **Principle 1:** Designers need to strive to ensure that all material and energy inputs and outputs are as inherently nonhazardous as possible.
- **Principle 2**: It is better to prevent waste than to treat or clean up waste after it is formed.
- **Principle 3**: Separation and purification operations should be designed to minimize energy consumption and materials use.
- **Principle 4**: Products, processes, and systems should be designed to maximize mass, energy, space, and time efficiency.

Sustainability Performance Principles

- **Principle 5**: Products, processes, and systems should be "output pulled" rather than "input pushed" through the use of energy and materials.

- **Principle 6**: Embedded entropy and complexity must be viewed as an investment when making design choices on recycle, reuse, or beneficial disposition.

- **Principle 7**: Targeted durability, not immortality, should be a design goal.

- **Principle 8**: Design for unnecessary capacity or capability (e.g., "one size fits all") solutions should be considered a design flaw.

Sustainability Performance Principles

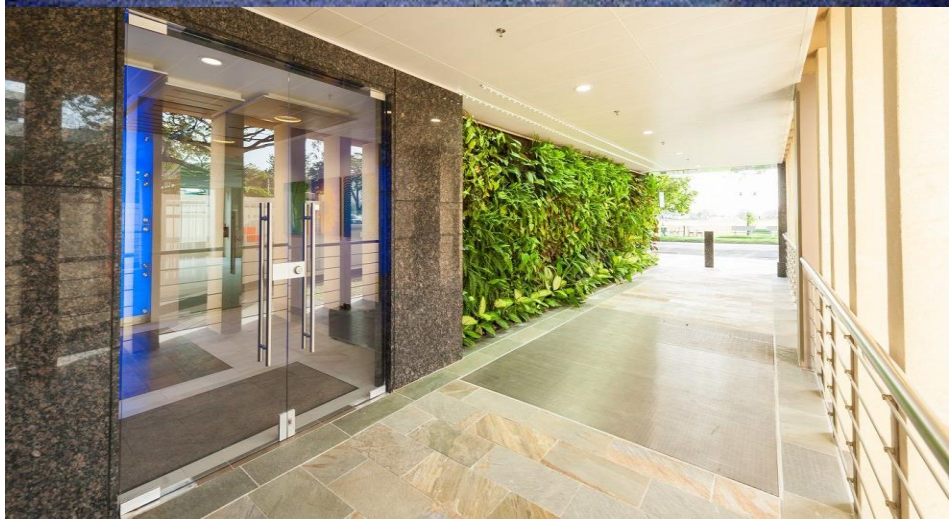
- **Principle 9**: Material diversity in multi-component products should be minimized to promote disassembly and value retention.
- **Principle 10**: Design of products, processes, and systems must include integration and interconnectivity with available energy and materials flows.
- **Principle 11**: Products, processes, and systems should be designed for performance in a commercial “afterlife”.
- **Principle 12:** Material and energy inputs should be renewable rather than depleting.

Source: https://www.nap.edu/read/11577/chapter/9#56

Cost-efficiency & Resource-efficiency

- Leadership in Energy and Environmental Design (LEED) projects are examples of cost efficiency and resource efficiency.

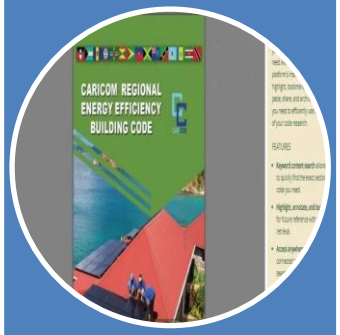
- Presents an integrated and comprehensive approach, the principles encompass each of the green building phases, including construction, operation, maintenance, and decommissioning.



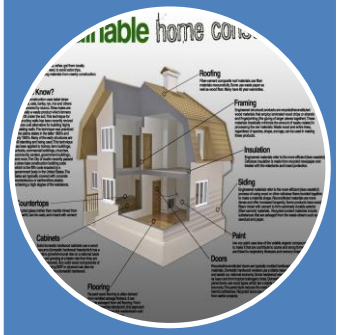
Cost-efficiency & Resource-efficiency

Sustainable Siting

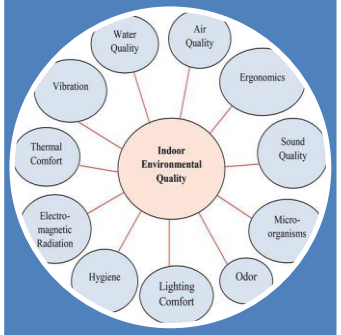
Energy Efficiency



Water efficiency



Building Materials



Healthy Indoor Environmental Quality

Waste Minimisation

- **Kinds of Wastes:**
  - **Solid**
  - **Liquid**
  - **Bio-degradable**
  - **Hazardous**
  - **Non-hazardous**

- The need for waste minimisation in the context of Green Engineering **(Class Discussion)**

Waste Minimisation

- **Recall Principle # 2.** Stress need for designing out waste at the earliest stages of the construction process offers the greatest fundamental opportunities for waste minimisation.

- Link waste minimization to other terms:
  - Waste reduction
  - Clean technology
  - Pollution prevention/reduction
  - Environmental technologies

Waste Minimisation

Prevention through eco-design

(Zero waste)

Source reduction

Replacement of materials

Reuse, Recycling and Recovery

Efficient use of resources (water, energy, etc.)

Equipment modifications

Waste Minimisation

Benefits

- Saves money through avoided disposal and raw materials purchase costs;
- Reduces regulatory burdens and compliance costs;
- Builds better community relations;
- Minimizes short and long term liability;
- Creates safer working conditions for employees;
- Protects human health and the environment;
- Demonstrates environmental leadership; and
- Improves competitiveness through greater efficiencies and decreased overhead costs.

Source: https://www.eiu.edu/environ/doc123/Waste%20Minimization.pdf

Social Responsibility

- Corporate Social Responsibility often embraces ideas of sustainability, including human rights and environmental issues, as well as a chain of responsibility and duty of care.

- Green Engineering should be socially responsible. Recall the 3 pillars of sustainability.

- **ISO 26000**

  Social Responsibility (SR) is the responsibility of an organization for the impacts of its decisions and activities on society and the environment through transparent and ethical behaviour that:

  – Contributes to sustainable development, including the health and welfare of society

Social Responsibility

- Social responsibility must be integrated early into the product development process, especially the product design stage (a precautionary principle)
- Design ‘for needs’ (cultural and social significance)
- Other requirements:
  - Protection of human health, safety and welfare;
  - Environmental protection and preservation;
  - Community and stakeholder engagement in developing engineering solutions; and
  - Sustainability.
- Can you share examples?

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Useful Websites

UNIVERSITY of GUYANA

- https://www.nap.edu/read/11577/chapter/9#56
- https://repositorio.cepal.org/bitstream/handle/11362/45046/1/S1900929_en.pdf
- https://www.ccreee.org/
- http://newenergyevents.com/cref/wp-content/uploads/sites/6/2018/11/Renewable-Energy-Caribbean-10-Year-Report.pdf
- https://www.slideshare.net/josephalex7/waste-minimization-113047050
- http://www.caribbeanhotelandtourism.com/downloads/CHTAEF_WasteManagement.pdf
- https://innovate.suny.edu/sustainabilityeducation/wp-content/uploads/2014/09/Sustainability-in-manufacturing-Carribean-perspective.pdf
- https://opensiuc.lib.siu.edu/cgi/viewcontent.cgi?article=1212&context=jcwre
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- https://www.intechopen.com/books/social-responsibility/professional-social-responsibility-in-engineering