REVIEW

December 4, 2019 11:30 PM

MODULE 1

Drivers

- per capita material footprint = sum of extracted material req by the per person consumption habits in countries
- total material footprint = sum of material footprints of biomass, fossil fuels, metal ores, non-metal ores
- IPAT eqn: IMPACT = POPULATION * AFFLUANCE * TECHNOLOGY
- **Primary Drivers:**
    - Increasing global population growth
    - Increasing global per-person material consumption rate

Sustainable development

- development that meets the needs of the present without compromising the needs of future generations to meet their own needs

Carrying Capacity

- Number of people who can be supported by natural, social, human and built capital
- depends on resources available in ecosystem and consummed by population
- **Biocapacity**
    - productivity of land areas
    - ~1.7 hecares/person

Eco footprint

- EF = measurementof human demand on ecosystems, estimate of area land/sea needed to support human activities (area/year)
- ~2.6 global hectars

Natural Capital

- NC = land, air water, living organism and all formations of earth's biosphere that provide us with ecosystem services

Paris Agreement 2015

- NDC = Nationally Determined Contributions
- COP21 2015 Dec 12 Paris Agreement, 195 contries
- limit average surface global temp increase this century to 2 deg above pre-industrial levels and limit increase to no more than 1.5 deg
- commit to regularly report national emissions and progress made
- new mechanism enabling emissions reductions in one country to be counted towards another country's NDCs

Global Warming Potentials

- GHG = atmosphere gas absorbs re emits heat, keeps atmosphere warmer

Carbon Footprint Calculations

- Contribution to global warming of human activity
- Tonnes of atmospheric GHG, Tonnes CO2e

Biodiversity

- Variety of species and ecosystems
- Biodiversity loss occurs naturally
    - reduces healthy functions of ecosystems

Ecosystem Services

- Air/water purification
- Waste decomposition
- soil/nutrient cycling

MODULE 2

Code and Guidelines

- engineers and geoscientist code
    - Hold paramount the safety, health and welfare of public, protection of environment and promote ehalth and safety within workplace
- 5 EGBC guidelines
    - Maintain current knowledge of sustainability
    - integrate sustainability in professional practice
    - collaborate with peers and experts from conception to completion
    - develop and prepare clear justification to implement sustainable solutions
    - Assess sustainability performance and identify opportunity for improvment

Argumentation

- used in social environment, aids in consideration of issues, may lead to tentative and resolution of issue
- **4 Components**
    - Claim
    - Reasons
    - Evidence
    - Warrants

Self Regulated Learning

- skill to determine what you need to learn
- know how to gain knowledge needed
- **Skills**
    - set learning goals
    - strategies to attain goals
    - reflect on progress
    - revise goals and strategies
    - self-evalutate methods chosen
    - adapt future methods

Metacognition

- ability to think about way you learn
- continuous self-improvement

MODULE 3

Cartesian thinking (reductionist perspective)

- assumes problem will be addressed if all problems in sonstituent parts are solved
- System = group of components interconnected such that they work together for common purpose

Simple System

- whole is equal to sum of parts
- modelled using physics, calculus...

Complex System

- greater than sum of parts
- **Properties**
    - Complex collective behaviour
    - Signalling and information processing
    - Adaptation
- **Self organizing**
    - Organized behaviours arise without internal or external controller

Systems Thinking

- focuses on observing relationships between things, context or relationships, and recurring patterns between relationships

Complexity Science

- study of coplex systems using post-normal science techniques

Resilience

- protects its nested group of interacting sub-systems from devastating disturbances
- system must always be experimenting with the boundaries and disruptions system cannot handle

Adaptive cycle

- **Rapid Growth**
  - Fast phase
  - resources abundantly available
- **Conservation**
  - Slow phase
  - Resources no longer plentiful
- **Release/Disturbance**
  - Causes System to collapse
  - fast chaotic phase
- **Reorganization**
  - System reorganizes into different structure, new entities formed, innovation
  - fast phase
- ex. Forest Ecosystem
  - Rapid growth: quick growing seedlings, nutrients in the ground
  - Conservation: Growth reaching its peak, slower to grow, fewer nutrients
  - Release/Disturbance: Forest fire, forest collapse
  - Reorganization: Trees fall and rot, new nutrients in the ground for new seedlings to grow, different species
- ex. The Adaptive Cycle of Vancouver's Water Supply
  - Vancouverites pay for the provision of clean water (a resource) as part of their property taxes, with one fee per residential user paid, regardless of the volume of water consumed.
  - Water remains plentiful (conservation), however Vancouver's population continues to grow.
  - A very dry winter, spring and summer could spark a severe water shortage in Vancouver (disturbance)
  - resulting in the implementation of a new water management framework with conservation and user-pay-per-volume as the new norm (reorganization)

Emergent Behaviour

- self-organized without controller or leader, system components following simple set of rules, unpredictable

Concept Maps

- **Characteristics**
  - Concept
  - Linking words
  - concept hiarchies
  - Cross-links
- **Steps**
  - Find focus question
  - Create ranked list of key concepts
  - preliminary concept map
  - add cross links

Urban Ecology

- Study fo ecology within cities, study of ecology of cities
- By considering ecology of city as a whole, start to consider dynamic feedbacks between systems nested within urban ecology

MODULE 4

Infrastructure Systems

- Interconnected and nested systems that exist at different scales and across a wide range of location

Megacities

- vulnerable to disruptions since located near river, deltas or coastlines

Rotterdam

- **Benthemplein Square**
  - provides vibrant social space, AND can act as water catchemnt
- **Museum Park Garage**
  - provides space for automobiles AND used as underground stormwater reservoir
- **Dakakkers Green Rooftops**
  - contributes to stormwater drainage system AND provides vegetables and honey for urban residents

Resilience in Cities

- Capacity of systems within urban environment to survive, adapt and grow no matter the stress imposed
- **Resilience Theory**
  - Resilient systems have specific qualities, and for overall resiliency to be achieved, sub-systems within city need to possess CRF
- **City Resiliency Framework CRF**
  - Health and Wellbeing
  - Economy and Society
  - Leadership and strategy
  - Infrastrucutre and Environment
- For system to be resilient, substystems of large system must also be resilient at different scales
- **Qualities**
  - Reflective
  - Robust
  - Flexible
  - Integrated
  - Resourceful
  - Redundant
  - Inclusive

Integrative Design Process IDP

- interactive design process focuses on resource effiiency by employing systems thinking to derive multiple benefits from single expenditures
- Occupency, Operations, Performance
- 7 Stages
  - Design Preparation
  - Evaluation
  - Conceptual Design
  - Schematic Design
  - Design Development
  - Construction Documents
  - Bidding and Construction

MODULE 5

Decoupling Material Consumption

- **Dematerialization:**
  - government policies need to support dematerialization
  - New business models need to include improved efficiency of production
  - Greater consumer awareness of role we can play

Biomimicry

- develop products that contribute to sustainably supply chain
- **4 Stages**
    - Scoping
    - Discovering
    - Creating
    - Evaluation
- **Substages**
    - Defining context of problem
    - Identifying function that design will perform
    - Integrating life's principles into the scope of design
- **Design inspired by nature**
    - ex. Coloured fabrics without chemical dyes
        - chemical dyes require pigments from nature, can be toxic, Teijin fibers created blue coloured fabric without use of chemical dyes, creating fabric of varying fibre thickness inspired from Morpho butterfly wings

IE Industrial Ecology

- thinking about a factory as an industrial organism and thinkign of set of factories as industrial ecosystem
- **Kalundborg industrial ecosystem**
    - World's first industrial symbiosis
    - Cooperation between companies in symbiosis provide mutual benegits both economically and environementally
    - Residue from one company becomes resource in another
    - Allows for resource saving and recycling

Circular Economy

- Eliminating waste
- Minimizing inputs
- Adopting Renewable energy

Recycling of Construction Materials

- Pine Beetle Wood
- Masonry
- Unfired bricks

Life Cycle Assessment

- determine environmental impact of product over lifetime
- functional unit: ex. paper and ceramic cup:
    - unit volume held by single container over lie-time of container
    - unit area of paper over life-time of paper

Formal LCAs

- Global and Scope
- Definition Inventory
- Impact Assessment
- Interpretation

MODULE 6

Least Developed Countries LDCs

- Countries with low levels of human assets and income

Humanitarian Engineers
- altruistic, creative, possess engineering know-how

Wicked Problems
- Sustainability issues ill-structured, highly complex, hard to define, multiple possible solutions
- approaches to humanitarian and complex sustainability problems
    - interdisciplinary
    - systems thinking
    - iterative thinking

Ethucal Frameworks
- **Ethical Considerations**
    - Who should receive benefits?
    - Who should provide benefits?
    - Are there winners and losers in providing benefits?
    - Who determines who needs what and when
- **Ethics of Care**
    - Theory centered around interdependence of all individuals
- **Non-Maleficience and Beneficience**
    - intention to avoid needless harm or injury taht can arise through acts of commission or omission
- **Ethical Pluralism**
    - many theories about what is right and wrong
- **Feminism**
    - inclusion leads to equality

Facing Failure
- learn from mistakes, innovate and change

7 Questions to Sustainability
- Engagement
- People
- Environment
- Economy
- Traditional and Non-Market activities
- Institutional arrangements and governance
- Synthesis and continuous Learning

MODULE 7

Future Scenario Planning
- Long-term planning technique
- imagine multiple possible futures and prepare to respond to each
- challenging, likelihood ot changes and unforseen events

Traditional vs Future Planning
- **Traditional**
    - performend short term
    - traditional forcasting techniques, time-series analysis, regression
- **Future Scenario Planning**
    - Long-term planning technique
    - imagine multiple possible futures and prepare to respond to each
    - challenging, likelihood ot changes and unforseen events

Carbon Neutrality

- Bhutal carbon neutral, achieve zero carbon footprint
- balancing economic growth with social development, environmental sustainability, cultural preservation
- Gross National Happiness GNH

Adaptive Leadership

- Approach to makign progress on most important challenges you face in your world
- **Iterative Process**
    - Observe events and patterns around (Personal Reflection)
    - Interpret what you are observing (Personal Reflection)
    - Designing iterations based on observations and interpretation to address adaptive challenge
- **Leadership**
    - Integrity
    - Authenticity
    - Committing to something bigger than oneself
- **Characteristics**
    - Successful adaptive changes build on the past rather than jettison it.
    - Organizational adaptation occurs through experimentation.
    - Adaptation relies on diversity.
    - Adaptation generates loss and is therefore difficult.
    - Adaptation takes time.