Bio-Regenerative Building Design
(Indoor Ecosystem Services contribution to SDGs)

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Humber
Faculty of Applied Sciences & Technology
Global Challenges Facing Humanity

1. Climate Change
2. Natural Resource Depletion
3. Health Risk
4. Social Inequality
Global Challenges Facing Humanity

To mitigate these global challenges, the build environment shall:

1. reduce carbon footprint
2. minimize resources consumption
3. be conducive to occupants health
4. contribute to the SDGs
Millennium Ecosystem Assessment

The objective was to assess the consequences of ecosystem change to human well-being.

The findings provide a scientific basis for action needed to enhance the restoration, conservation, and sustainable use of those ecosystems and their contribution to human well-being.
Ecosystem Services

- Ecosystem services are the many and varied benefits to humans provided by the natural environment and healthy ecosystems.

<table>
<thead>
<tr>
<th>Provisioning</th>
<th>Regulating</th>
<th>Cultural</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Products</strong> humans obtain from ecosystems:</td>
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<td>Non-material benefits of nature for humans:</td>
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<td>• Fresh Water</td>
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<td>• Mental and Physical Health</td>
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<td>• Extreme Events Moderation</td>
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**Supporting**

The underpinning services that enable all other services to function – encompasses both human and ecosystem needs:

- Photosynthesis
- Nutrient Cycling
- Soil Formation

Source: https://www.greenelement.co.uk/blog/ecosystem-services-the-fundamentals-part-i/
# Ecosystem Services

1. **Climate Change**  
   - reduce carbon footprint
2. **Natural Resource Depletion**  
   - minimize resources consumption
3. **Health Risk**  
   - be conducive to occupants health
4. **Social Inequality**  
   - contribute to the SDGs

## Provisioning

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Source: [https://www.greenelement.co.uk/blog/ecosystem-services-the-fundamentals-part-i/](https://www.greenelement.co.uk/blog/ecosystem-services-the-fundamentals-part-i/)
The 2005 Millennium Ecosystem Assessment (MA), identified a problem, in addition to energy efficiency and climate change, which is seldom addressed by the built environment – the degradation of ecosystems and their constituent ecosystem functions.

The MA identified that out of the 24 ecosystem services examined for the report, 15 are being degraded over time as a direct result of unsustainable resource and land uses.
### UN Millennium Ecosystem Assessment

<table>
<thead>
<tr>
<th>Services</th>
<th>Ecosystems</th>
<th>Agro ecosystems</th>
<th>Forests</th>
<th>Grasslands</th>
<th>Heath and scrubs</th>
<th>Wetlands</th>
<th>Lakes and rivers</th>
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**Status for period 1990–present**
- Red: Degraded
- Yellow: Mixed
- Green: Enhanced
- Black: Unknown
- Blank: Not applicable

**Trend between periods**

- ▲ Positive change between the periods 1950–1990 and 1990 to present
- ▼ Negative change between the periods 1950–1990 and 1990 to present
- = No change between the two periods

UN Millennium Ecosystem Assessment

Four Main Findings

1. Over the 50 years (1950-2000), humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fiber, and fuel. This has resulted in a substantial and largely irreversible loss in the diversity of life on Earth.
UN Millennium Ecosystem Assessment

Four Main Findings

2. The changes that have been made to ecosystems have contributed to substantial net gains in human well-being and economic development, but these gains have been achieved at growing costs in the form of the degradation of many ecosystem services and the aggravation of poverty for some groups of people. These problems, unless addressed, will substantially diminish the benefits that future generations obtain from ecosystems.

Four Main Findings

3. The degradation of ecosystem services could grow significantly worse during the first half of this century (2000 – 2050) and is a barrier to achieving the Millennium Development Goals.
Four Main Findings

4. The challenge of reversing the degradation of ecosystems while meeting increasing demands for their services can be partially met under some scenarios that the MA has considered, but these involve significant changes in policies, institutions, and practices that are NOT currently under way.

Source: https://www.nichq.org/insight/what-comes-first-policy-or-change-0
• There are options existed to conserve or enhance specific ecosystem services in ways that reduce negative trade-offs or that provide positive synergies with other ecosystem services.

• One way to reduce or to possibly reverse the negative environmental impact of the built environment could be to create new developments or redesign existing buildings and urban areas so that they provide or support ecosystem services.

• If the built environment can provide some of its own ecosystem services, pressure is potentially decreased on local and distant ecosystems. And the degraded ecosystem functions may be able to begin to regenerate and therefore be able to support more species.
UN Millennium Ecosystem Assessment

1. Reclamation
2. Rehabilitation
3. Reforestation with native trees
4. Assisted natural regeneration
5. Natural regeneration

Source: http://science.sciencemag.org/content/320/5882/1458
A Visionary Statement

I think the biggest innovations of the 21st century will be at the intersection of biology and technology. A new era is beginning.

— Steve Jobs —
A Missional Statement

“I think the biggest innovation and design of the 21st century is at the intersection of natural science (nature) and engineering.”

*(Phil Fung, 2021)*
Nature’s design solutions have been tested for 3.8 billion of years and are sustainable and harmonized with the ecosystem.
Ecosystems are resilient and utilize existing relationships for symbiotic advantage. They adapt to disturbance and create conditions conducive to ongoing life.
How does Nature operate and survive?

- Nature utilizes local natural resources to build.
- Nature recycled, reused and renewed all materials constantly.
- Nature uses only resources it needs and relies on.
- Nature produces neither permanent garbage nor toxic to harm their living environment.
- Nature is resilient to unforeseeable changes to the environment.
- Nature optimizes rather than maximizes - biodiversity.
- Nature runs on information-feedback loops.
- Nature operates on close-loop systems.
- Nature is adaptive and responsive.
Nature-Inspired Design (Bio-Design)

Natural Science
- Biology
- Chemistry
- Physics
- Geography
- Environmental Science
- etc...

Multidisciplinary Nature-Inspired Design

Engineering
- Mechanical
- Electrical
- Structural
- Civil
- Environmental Energy
- etc...

Humber College, Canada

Bio-Regenerative Building Design

Phil Fung, PEng., LEED AP, LFA, CEM
Nature-Inspired Design (Bio-Design)

RECONNECT WITH NATURE
BIOPHILIC DESIGN
Biophilia evolved from within the fields of biology and psychology, and relate to the desire for a (re)connection with nature and natural systems.
Nature-Inspired Design (Bio-Design)

- Biophilic design provides people opportunities to live and work in healthy places and spaces with less stress and greater overall health and well-being.
Nature-Inspired Design (Bio-Design)

Learn from Nature
Biomimetic Design

Humber College, Canada
Bio-Regenerative Building Design
Phil Fung, PEng, LEED AP, LFA, CEM
Biomimicry comes from the Greek words bios, meaning life, and mimesis, meaning to imitate.
Biomimetic design is the adaptation of biological principles into modern technology to address a variety of human needs.

Every ecosystem provides ecosystem services. If we emulate nature’s genius, cities can too.
Nature-Inspired Design (Bio-Design)

Utilize Nature

Bio-Synergistic Design

- Sunlight and air
- Water
- Soil
- Plants
- Animals
Bio-Synergy is broadly defined as the combined effects of two or more organisms to produce a greater result than each would achieve individually.
Nature-Inspired Design (Bio-Design)

- Bio-Synthetic Design - Facultative Mutualism
Organisms benefit from the interaction but are not dependent upon their survival.
Regenerative Design & Sustainable Design

• Sustainable design implies something that endures over time without degrading, but it does not regenerate itself or create anything new.

• Regenerative design looks to sustainability practices as the starting point and builds on them in order to increase ecosystem health.

• Sustainable design aims to provide for fundamental human needs; regenerative design plans for the future co-existence of humans and other species (nature).

• Success in sustainable design is measured by performance of building and development. Whereas regenerative design is measured by the improvements in health and wellbeing for humans, other living beings and ecosystems as a whole.
Clean Air

Source: https://biomimicry.org/learning-nature-designing-nature-regenerative-cultures-create-conditions-conducive-life/

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Bio-Regenerative Building Design

Phil Fung, PEng., LEED AP, LFA, CEM
Bio-Regenerative Building Design

- Biophilic Design
- Biomimetic Design
- Bio-synergistic Design

Bio-Regenerative Engineered Ecosystems

Building Ecosystem Services

- Reduce Carbon Footprint
- Minimize Resources Consumption
- Conducive to Occupants Health

Sustainable Development Goals

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Bio-Regenerative Building Design

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Bio-Regenerative Building Design

Sustainable Building design:
• ICF/SIP Shell
• Passive House Standard Envelope
• LEED Gold/BREEAM Excellent attributes

Bio-Regenerative Building design:
• Food Ecosystem Services
• Wellbeing Ecosystem Services
• Energy Ecosystem Services
• Air Ecosystem Services
• Carbon Ecosystem Services
Design Principle
Nature is our mentor and model.
Community is like a forest; buildings are the trees.
Research Projects
Bio-Regenerative Building Design
Food Ecosystem Services

How does nature grow organic food with natural inputs?

SDGs

1. Good Health and Well-Being
2. Decent Work and Economic Growth
3. Industry, Innovation and Infrastructure
4. Life on Land
High Quality Crops
(Certified Canadian Organic)

Food Safety

Food Security

Food Diversity

Aquaponics + Hydroponics + Soil
(organic) (natural) (organic)

Community Distributed Food System

Food Sovereignty

Diversified Crops
(3 growing platforms)

High Quality Crops
(Certified Canadian Organic)

Optimized Crops Yield
(3 pH platforms)
Bio-Regenerative Building Design
Wellbeing Ecosystem Services

How does nature nurture human well-being?

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Bio-Regenerative Building Design

SDGs

Phil Fung, PEng., LEED AP, LFA, CEM
'Nature therapy' program offered as new medical prescription to Canadians

March 2021

“More than 500 health-care workers across Canada have signed up to participate in the Park Prescriptions program.”
Bio-Regenerative Building Design
Energy Ecosystem Services

What are the functions of trees in nature?
Bio-Regenerative Building Design
Energy Ecosystem Services

- Regulator (AC & DC – renewable energy supply)
- Distributor (AC & DC)
- AC/DC Hybrid House
- Battery Storage (stand-by)
- AI Director (energy and peak management)
- Communicator (micro grid)
How does nature purify air?
Bio-Regenerative Building Design
Air Ecosystem Services

Air Regeneration – Triple-Filtration

- Absorption - Plants
- Adsorption - Biochar
- Bio-degradation - Microbes

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Bio-Regenerative Building Design

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How does nature perform carbon sequestration?
Commercial Projects
Off-Grid Food Shed
City of Brampton

We “build” a 🌳 to feed your community year round
Solar PV Off-Grid Food Shed
Country Heritage Park
Milton

Humber College, Canada
Bio-Regenerative Building Design
Phil Fung, PEng, LEED AP, LFA, CEM
Rainbow Trout Aquaponics + Hydroponics + Soil

Tilapia Aquaponics + Hydroponics + Soil

Rainbow Trout Breeding & Fingerlings Tank

Tilapia Breeding & Fingerlings Tank

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Bio-Regenerative Building Design

Phil Fung, P.Eng., LEED AP, LFA, CEM
St. James Town Co-op Housing
Toronto
Food Shelf

- Gold Fish Aquaponics
- Hydroponics with Worm Tea
- Soil
Nature Therapy delivers CALMNESS & PEACE
105 Gibson Center Indoor Farm
Markham
Indoor Farm

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Phil Fung, P.Eng., LEED AP, LFA, CEM
Community Engagement

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Bio-Regenerative Building Design

Phil Fung, P.Eng., LEED AP, LFA, CEM
Office Nature Room
Markham
Bio-Regenerative Building Design

Humber College, Canada

Phil Fung, PEng., LEED AP, LFA, CEM
“We’re the **first generation** to see the effects of climate change, and the **last generation** who can do anything about it. To refuse to use every tool at our disposal in **this fight** — to embrace inaction — is to endorse a trajectory that will **lead to suffering, privation, and calamity**.”

Michael McGinn
(former Mayor of Seattle)
Bio-Regenerative Building Design
(Indoor Ecosystem Services contribution to SDGs)

THANK YOU
Q&A

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