THE LIVING BUILDING CHALLENGE

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AGENDA

- High Performance Building
- Leadership in Energy and Environmental Design
- Biophilic Design
- Zero Energy Building
- System Thinking
- Human Systems & Natural Resources
- Living Building Challenge
- LBC Group Exercise
- Case Studies
- Group Exercise - GoFish Game
HIGH PERFORMANCE BUILDING
A "high performance building" means a building that integrates and optimizes all major high-performance building attributes, including energy efficiency, durability, life-cycle performance, and occupant productivity.
LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN
LEADERSHIP IN ENERGY AND ENVIRONMENTAL DESIGN

- LEED (Leadership in Energy and Environmental Design) is an ecology-oriented building certification program run by the U.S. Green Building Council (USGBC).

- LEED concentrates its efforts on improving performance across five key areas of environmental and human health: energy efficiency, indoor environmental quality, materials selection, sustainable site development and water savings.
WHY LEED?

- Lower operating costs and increase asset value
- Reduce waste sent to landfills – 50 – 90% costs savings
- Save energy – up to 30%
- Conserve water – 30 – 50% less water consumption
- Reduce harmful greenhouse gases – 35%
SUSTAINABILITY PERSPECTIVE

- Buildings account for nearly half (48%) of all greenhouse gas emissions
  - More than Transportation (27%) and
  - More than Industry (25%)
- Buildings account for 76% of all electricity generated at power plants
- We spend over 90% of our time in a built environment.
WHY BUILDING GREEN?

We can create better built environments and other environments in which to work, play, live, and learn...for generations to come.

Sustainable development is formally defined by the World Commission on Environment and Development (WECD) as “development that meets the needs of the people today without compromising the ability of future generations to meet their own needs”.
GREEN ADVANTAGES

▪ Reduce human exposure to toxic materials
▪ Conserve natural resources
▪ Minimalize the ecological impact and materials
▪ Use renewal energy and materials
▪ Protect and restore ecosystems
▪ Positive influence on health and welfare of people
GREEN ADVANTAGES

- All this, and green buildings can cost little or no more to construct than conventional construction.
- Cost much less to maintain over their lifetime...often producing quick paybacks.
Bronx Library Center
New York, NY

90% of demolition debris recycled
20% energy cost savings
80% of wood is FSC certified
Boulder Associates, Inc. Office, Boulder, CO

39% of materials and furniture have recycled content
43% less water use
55% of demolition/construction waste diverted from landfill

Photography courtesy of Ed Larasse
Sidwell Friends Middle School
Washington, DC

90% reduced municipal water use
60% less energy demand than a conventional school
80% native plant species planted on site
Tepeyac Haven
Pasco, WA

15 units per acre

29% improvement of attic insulation heat resistance over state code energy

44 homes available for low-income families
Orchard Garden Hotel
San Francisco, CA

22% of building materials manufactured within 500 miles

77% of construction waste diverted from the landfill

100% of interior spaces designated tobacco-free
LEED CREDENTIALS

Tier 1

Tier 2

Tier 3
19

fresher air

One Bryant Park is a 66-story air filter.

Fresher air means improved health and working environment.

Supply air shaft brings more fresh air than required by code.

100% outside fresh air can be delivered to any four floors at any time.

Exhaust air from building is considerably cleaner than ambient air.

95%

of the particulates in fresh air are removed as it enters the building, and then is filtered again on a floor by floor basis.

rain harvest

Rain water is collected on all roof areas.

Water tanks on 4 different levels reduce pumping needs for lavatories.

Zero storm water discharged to the city system.

Storage tanks can store over 50,000 gallons of collected rainwater.

Treated water is used according to need.

Water used to irrigate plants and flush toilets.

Water is spread in a "greenway" treatment plant.
In 2011, a building that began as a grocery store in the 1950s is now a place where you'll find the latest in energy and environmental technologies.

- The Energy Innovation Center is 1 of 10 buildings in the world to achieve double LEED Platinum® certification. Platinum is the highest rating in the LEED®
- The center earned LEED Platinum for New Construction and Major Renovation in August 2012
- Existing Buildings: Operation and Maintenance (EBOM)® in December 2013.
Today over half of the world’s population lives in urban areas, and this number will increase to about two thirds of the world’s population by 2050.

That means that today, 3.9 billion people are living in cities, and that number will continue to rise exponentially.

Tokyo, Japan is today’s most populous city, with 38 million dwellers.

Jakarta, Indonesia with a population of 32 million.

Delhi, India with a population of 25 million people and expected to grow to 36 million by 2030.

In the U.S., 81% of our population of 320 million live in urban areas or suburbs as of this year.
CITY FACTS

Cities account for about two-thirds of global energy demand.

Buildings produce a fifth of the world’s CO2 emissions.

Cities produce up to 70% of global greenhouse gas emissions.

Buildings account for roughly 40% of the world’s energy use.

An estimated 80% of global GDP is generated in cities.
World’s Largest Built-Up Urban Areas

POPULATION: 2017 ESTIMATES

- Tokyo-Yokohama
- Jakarta
- Delhi, DL-UP-HR
- Manila
- Seoul-Incheon
- Karachi
- Shanghai, SHG-JS-ZJ
- Mumbai, MH
- New York, NY-NJ-CT
- Sao Paulo
- Beijing, BJ-HEB
- Mexico City
- Guangzhou-Foshan, GD
- Osaka-Kobe-Kyoto
- Dhaka
- Moscow
- Cairo
- Bangkok
- Los Angeles, CA
- Buenos Aires

Figure 2
BIOPHILIC DESIGN
Biophilic design dates back to the early 1980s, when the biologist Edward O. Wilson outlined his philosophy of biophilia, hypothesizing that humans have an innate, biological affinity for the natural world.
Biophilic design takes this idea one step further: Because humans today spend 90% of our time indoors.

It’s necessary to bring the outdoors in and create indoor environments that reference nature in both obvious and subtle ways.

A landmark 2019 study found that children in Denmark who had been exposed to more greenery had 55% less mental health problems later in life compared to those who weren’t exposed to nature.

Other research has shown that plants can reduce stress, help with focus, and even increase immunity.
BIOPHILIC DESIGN

- Scientists think that plants could act like sensors to help keep tabs on things like mold and volatile organic compounds in our buildings.

- A 2016 report from the engineering firm Arup argues that buildings should all be covered with greenery as a way of pulling carbon dioxide from the air, filtering air pollution, reducing noise, and keeping cities cooler.

- To be happy and healthy and lead meaningful lives we need contact with nature.
THE BIOPHILIC CITIES

- By 2050, 70% of humanity will live in cities. But that doesn’t mean that city dwellers have to be disconnected from nature.

- The Biophilic Cities Project, an initiative organized by a Professor at the University of Virginia’s School of Architecture.

- We have coevolved with the natural world and to be happy and healthy and lead meaningful lives we need contact with nature.
  - The percentage of population within a few hundred feet of a green space
  - The percentage of city land covered by vegetation
  - Number of green design features (i.e. rooftop gardens)
  - Average portion of the day spent outside by residents
  - Number of trips made on foot
  - Percent of residents who can identify local flora and fauna
  - Priority given to nature conservation by local government
"In every walk with nature one receives far more than one seeks." – John Muir, 19 July 1877
BIOPHILIC DESIGN

- Biophilic design can reduce stress, improve cognitive function and creativity, improve our well-being and expedite healing.

- As the world population continues to urbanize, these qualities are ever more important.

- Biophilia is the humankind’s innate biological connection with nature.

- It helps explain why crackling fires and crashing waves captivate us; why a garden view can enhance our creativity; and why animal companionship have restorative, healing effects.

- Biophilia may also help explain why some urban parks and buildings are preferred over others.
The human appreciation for the physical beauty of the natural world is often invoked as evidence of biophilia.

For example, the appearance of the natural world, with its rich diversity of shapes, colors, and life, is universally appreciated.
Reducing the average length of stay in hospitals by 0.41 days can amount to $93 million in reduced hospital costs every year. According to scientific studies, adequate access to daylighting and other biophilic elements can impact the health of patients in such a positive way that they can achieve and possibly go beyond these estimated savings.
“You never change things by fighting the existing reality.”

“To change something, build a new model that makes the existing model obsolete.”

R. Buckminster Fuller
SYSTEM THINKING
SYSTEM THINKING

- Ecological understanding requires shifting to a new way of thinking.

- One lesson that nature teaches is that everything in the world is connected to other things.

- John Muir famously wrote, "When we try to pick out anything by itself, we find it hitched to everything else in the universe."
CITIES ARE COMPLEX SYSTEMS

...AND THEY'RE MADE OUT OF PEOPLE
LINEAR VS SYSTEM THINKING

**Event Oriented Thinking**
Thinks in straight lines

A → C → D
B

In event oriented thinking everything can be explained by causal chains of events. From this perspective the **root causes** are the events starting the chains of cause and effect, such as A and B.

**Systems Thinking**
Thinks in loop structure

A → B → C → D → E

In systems thinking a system's behavior emerges from the structure of its feedback loops. **Root causes** are not individual nodes. They are the forces emerging from particular feedback loops.
"The problems we have created in the world today will not be solved by the level of thinking that created them”

Albert Einstein
THE SYSTEMS ICEBERG

EVENTS
WHAT JUST HAPPENED? WHAT IS HAPPENING NOW?

PATTERNS OF SYSTEMS BEHAVIOR
HOW DO ELEMENTS IN THE SYSTEM CHANGE OVER TIME, GENERATING PATTERNS AND TRENDS?

SYSTEMS STRUCTURES
WHAT HAS INFLUENCED THE PATTERNS? WHAT ARE THE RELATIONSHIPS BETWEEN THE PARTS?

MENTAL MODELS
WHAT ASSUMPTIONS AND BELIEFS DO MEMBERS OF THE SYSTEM HOLD?

REACT

ANTICIPATE

DESIGN

TRANSFORM
Sure glad the hole isn’t at our end.
HUMAN SYSTEMS & NATURAL RESOURCES
BIG OIL
The oil market is bigger than all raw metal markets combined

The global market for oil was 94 million barrels per day in 2015.
This puts the oil market at $1.7 trillion per year with today's prices - far more than all raw metals combined!

The largest metal market by tonnage is Iron ore.
China alone consumes 1 billion tonnes per year mostly to produce steel.

The world's largest metal market by dollar value is gold.
The physical market is worth $170 billion per year at today's spot price.
KEY FACTS – ENERGY

- Renewable energy has an important role in providing modern energy access to the billions of people in developing countries that continue to depend on more traditional sources of energy (e.g. biomass).
  - More than 1.5 billion people worldwide still lack access to electricity.
  - And more than 2.6 billion rely on wood, straw, charcoal, or dung for cooking.
  - Renewable energy is a key factor in the modernization of billions of households and industries.

Source: UNDP
Worldwide demand for these natural resources (minerals, water etc...) were at a all time high in the 2007-08.

In the 1900s the ‘World” had abundant natural resources and very a small human population.

As of June 2019, the world population is 7.7 billion.

The Earth’s “overshoot day” for 2019 July 29, 2019 the point at which humanity goes into ecological debt, occurred on nine days earlier than last year.

The Global Footprint Network estimate that the world’s population currently consumes the equivalent of 1.6 planets.

This figure should rise to two planets by 2030 based on current trends.
Barcelona forced to import emergency water

The tanker Sichern Defender arrived at the port of Barcelona yesterday carrying something far more precious than its usual cargo of chemicals.

Nearly 23m litres of drinking water - enough for 180,000 people for a day - was the first delivery in an unprecedented emergency plan to help this parched corner of Spain ahead of the holiday season.

As the country suffers its worst drought since records began 60 years ago, Catalonia, of which Barcelona is the capital, has been the worst-hit region. After months without adequate rainfall its reservoirs are down to just over a quarter of normal capacity. A year ago they stood at almost double that.
### How many Earths do we need if the world's population lived like...

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<thead>
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<tr>
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<td>U.S.A.</td>
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<tr>
<td>Switzerland</td>
<td>3.3</td>
</tr>
<tr>
<td>South Korea</td>
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<td>Russia</td>
<td>3.3</td>
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<tr>
<td>Germany</td>
<td>3.1</td>
</tr>
<tr>
<td>France</td>
<td>3.0</td>
</tr>
<tr>
<td>U.K.</td>
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</tr>
<tr>
<td>Japan</td>
<td>2.9</td>
</tr>
<tr>
<td>Italy</td>
<td>2.7</td>
</tr>
<tr>
<td>Spain</td>
<td>2.1</td>
</tr>
<tr>
<td>China</td>
<td>2.0</td>
</tr>
<tr>
<td>Brazil</td>
<td>1.8</td>
</tr>
<tr>
<td>India</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>World</strong></td>
<td><strong>1.6</strong></td>
</tr>
</tbody>
</table>

Source: Global Footprint Network National Footprint Accounts 2016
Global Mean Surface Temperature (January-June)

NASA GISTEMP Baseline: 1880-1899

1°C above late 19th Century

Year

Temperature Anomaly (°C)

2016

1880 1900 1920 1940 1960 1980 2000 2020
NATURAL RESOURCES

U.S. Drought Monitor
California

September 30, 2014
(Released Thursday, Oct. 2, 2014)
Valid 8 a.m. EDT

Drought Conditions (Percent Area)

<table>
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<tr>
<th>Region</th>
<th>DN</th>
<th>D1</th>
<th>D2</th>
<th>D3</th>
<th>D4</th>
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<tbody>
<tr>
<td>Current</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>81.92</td>
<td>89.41</td>
</tr>
<tr>
<td>Last Week</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>81.92</td>
<td>89.41</td>
</tr>
<tr>
<td>3 Months Ago</td>
<td>0.00</td>
<td>100.00</td>
<td>0.00</td>
<td>76.97</td>
<td>36.46</td>
</tr>
<tr>
<td>Start of Calendar Year</td>
<td>2.61</td>
<td>97.39</td>
<td>94.25</td>
<td>87.53</td>
<td>27.59</td>
</tr>
<tr>
<td>Start of Water Year</td>
<td>2.63</td>
<td>97.37</td>
<td>95.95</td>
<td>94.12</td>
<td>11.36</td>
</tr>
<tr>
<td>One Year Ago</td>
<td>2.63</td>
<td>97.37</td>
<td>95.95</td>
<td>94.12</td>
<td>11.36</td>
</tr>
</tbody>
</table>

Intensity:
- DN Abnormally Dry
- D1 Extreme Drought
- D2 Severe Drought
- D3 Moderate Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for these local statements.

Author:
Richard Heim
NCCO/NOAA

http://droughtmonitor.unl.edu/
WILDFIRES

Size of U.S. Wildfires, 1983 to 2008

Data on wildland fires in the United States show that the number of acres burned per fire has increased since the 1980s.

U.S. Wildfires

Acres Burned (millions)
In Kuwait temperature reaches 62 degrees
Hurricane Irma is expected to hit South Florida and the Gulf Coast: What we know

Dangerous storm surge, high winds, and rain are predicted for today and tomorrow.

Updated by Brian Resnick and Zack Beauchamp | Sep 8, 2017, 12:36pm EDT

Hurricane Irma is already one for the record books.

Earlier in the week, Irma sustained 185 mph winds for more than 24 hours, a record length of time for a hurricane in the Atlantic. And Irma was a Category 5 storm for around 3 days — which is also nearly a record.

Now, Irma has weakened a bit to a Category 3 storm, slowing over Cuba to 125 mph. But don’t let that fool you: The National Hurricane Center believes that it will speed back up when it leaves Cuba before it makes landfall on the Florida Keys (expected on Sunday morning).
GARBAGE IN THE OCEAN
Extremely small pieces of plastic, too tiny to be removed by water filtration systems, are turning up in the vast majority of tap-water systems globally.

The US-based non-profit journalism outfit Orb sampled tap water from more than a dozen countries globally, and found 83% of the samples were contaminated with plastic fibers. These fibers are known to shed off of synthetic fabric in clothes dryers, though there are likely many other sources.

Tap water from the US—where machine-drying clothing is ubiquitous—was the most contaminated, with plastic fibers showing up in 94% of Orb’s samples. Lebanon also had a 94% contamination rate, and India was next-most contaminated, with 82% of samples containing plastic. Europe had plastic fibers in 72% of its samples.
The term “day zero” refers to the exact predicted date that municipal authorities will cut off the taps to homes and businesses, meaning that a massive city — a city roughly the size of Los Angeles — will have no access to running water.
Instead, the government will be setting up about 200 water collection stations for residents to gather their strictly-rationed 25 liters (~6.6 gallons) per day. For context as to how much water this actually is, the average American individual uses 300 liters (80 gallons) of water per day. Currently, Cape Town resident’s have already been advised to not consume more than about 85 liters (~22 gallons) per day.
CLIMATE POLICY
The Intergovernmental Panel on Climate Change (IPCC) is a scientific intergovernmental body tasked with evaluating the risk of climate change caused by human activity.

A main activity of the IPCC is publishing reports on topics relevant to the implementation of the UN Framework Convention on Climate Change (UNFCCC).

Implementation of the UNFCCC led eventually to the Kyoto Protocol.

The aims of the IPCC are to assess scientific information relevant to:

- human-induced climate change,
- the impacts of human-induced climate change, options for adaptation and mitigation.

The IPCC first assessment report was completed in 1990, and served as the basis of the United Nations Framework Convention on Climate Change (UNFCCC).
THE KYOTO PROTOCOL

- The Kyoto Protocol is an international agreement linked to the United Nations Framework Convention on Climate Change.

- The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European community for reducing greenhouse gas (GHG) emissions.
  - Annex I & Annex II countries

- These amount to an average of 5% against 1990 (base year) levels over the five-year period 2008-2012.

- The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and entered into force on 16 February 2005.
  - As of 2009 187 signed and ratified the treaty
  - The treaty expired in 2012

- Climate Change Conference Copenhagen
  - Developing countries commitment to reduce GHGs emission

- Clean Power Plan sets to reduce carbon dioxide emissions by 32 percent from 2005 levels by 2030

- Climate Change Conference, will be held in Paris, France from November 30 to December 11, 2015

Source: IPCC
PARIS CLIMATE CHANGE AGREEMENT

- Holding the increase in the global average temperature to well below 2°C above pre-industrial levels
  - To pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels

- Ahead of the agreement, 186 countries submitted plans detailing how they reduce their greenhouse gas pollution through 2025 or 2030.
  - The agreement requires all countries to submit updated plans that would ratchet up the stringency of emissions by 2020 and every five years thereafter.
PARIS CLIMATE CHANGE AGREEMENT

- The agreement acknowledges “the importance of averting, minimizing and addressing loss and damage associated with the adverse effects of climate change.”
  - This was deemed crucial by poor and small-island countries that suffer the most from extreme weather and from long-term impacts like droughts.

- The deal requires a global an overall assessment of how countries are doing in cutting their emissions compared to their national plans – starting in 2023, every five years.
PARIS CLIMATE CHANGE AGREEMENT

▪ The deal requires countries to monitor, verify and report their greenhouse gas emissions using the same global system.

▪ The agreement a “Capacity-Building Initiative for Transparency” to help developing countries meet a new requirement.

▪ The agreement, which takes effect in 2020:
  ▪ Calls on nations to establish “a new collective quantified goal” of at least $100 billion a year in climate-related financing by 2020.
Co-Building sustainable cities

70% of carbon emissions comes from cities. Citizens can lead the change in their cities to fight climate change.

| 1 | Extreme weather events (e.g. floods, storms, etc.) |
| 2 | Failure of climate-change mitigation and adaptation |
| 3 | Major natural disasters (e.g. earthquake, tsunami, volcanic eruption, geomagnetic storms) |
| 4 | Massive incident of data fraud/theft |
| 5 | Large-scale cyberattacks |
| 6 | Man-made environmental damage and disasters (e.g. oil spills, radioactive contamination, etc.) |
| 7 | Large-scale involuntary migration |
| 8 | Major biodiversity loss and ecosystem collapse (terrestrial or marine) |
| 9 | Water crises |
| 10 | Asset bubbles in a major economy |
ZERO ENERGY BUILDING
Zero-energy building (ZE) (zero net energy - ZNE) building, is a building with zero net energy consumption:

- Meaning the total amount of energy used by the building on an annual basis is equal to the amount of renewable energy created on the site.

To Create a Zero Energy Building...

**STEP 1** Increase energy efficiency
- Efficient building construction
- Efficient systems and appliances
- Operations and maintenance
- Change in user behavior

**STEP 2** Address remaining needs with on-site renewable energy generation
- Wind
- Solar
- Hydro Energy
ZNE Buildings have very low energy loads such that the annual energy consumption is balanced by on-site renewable energy.
1-3% added initial cost of construction could save up to 60 percent of energy use in new buildings.

California’s Net Zero Energy Building Mandate To Reshape US Construction Industry

Buildings are responsible for at least 40% of energy use in most countries. (The World Business Council for Sustainable Development)

The first commercial-scale net-zero building was a center for environmental studies, completed at Oberlin College in Ohio in 2000. (Scientific America)
WHO IS GOING TO ZERO?

Ownership Types of ZNE Buildings

- McDonalds
- Solterra
- Architects
- Domus
- Frito-Lay
- Adobe
- JC Johnson Co.
- TNT Express
- Bayer

- Walgreens
- PNC Bank
- Melink Corp.
- Kaiser Permanente
- TD Bank
- Honda
- 3C Company
- Bubbly Dynamics
- IBEW 595
- Morphosis
- Hines
- Green Leaf Inn
- DPR Construction
- KB Homes
- Hewlett Packard
- Walt Disney

States: CA, CO, DC, DE, MA, MN, NY, NM, OR, RI, VT, WA
Cities: Seattle, Austin, Cambridge, Lancaster, Fort Collins, Tucson/Pima County
All U.S. Federal Buildings, The European Union
British Columbia, Canada

Courtesy of New Buildings Institute | newbuildings.org
Features of a net-zero home

- **Photovoltaic Panels**
  - Sized to meet building's energy demand

- **Low-Flow Water Fixtures**
  - To reduce use of hot water

- **Double Insulation**
  - Reduces heating and cooling demand

- **Energy Management**
  - Optimizes energy use throughout the home

- **Heat Pump**
  - Efficient electric heating and cooling

- **Heat Pump Water Heater**
  - Efficient electric water heating

- **Heat Recovery Ventilation**
  - Distributes tempered fresh air throughout the home

- **High Performance Windows and Doors**
  - Reduces heat loss, increases daylighting and passive solar heating

- **Exceptional Air Sealing**
  - Dramatically reduces largest source of heat loss

- **Tier 3 Appliances**
  - Most efficient models for all major appliances

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*Efficiency Vermont*
THE LIVING BUILDING CHALLENGE
The Living Building Challenge is an international sustainable building certification program created in 2006 by the non-profit International Living Future Institute. It is a certification program that promotes the most advanced measurement of sustainability in the built environment.

- It can be applied to development at all scales, from buildings both new construction and renovation
- To infrastructure, landscapes, neighborhoods and communities.
THE LIVING BUILDING CHALLENGE

- International Living Future Institute
- The Living Building Challenge is the world’s most rigorous proven performance standard for buildings.
- The Living Building Challenge is a green building certification program and sustainable design framework that visualizes the ideal for the built environment. It uses the metaphor of a flower because the ideal built environment should function as cleanly and efficiently as a flower.
DESIGN FOR THE FUTURE

- With the Living Building Challenge, you can create buildings that are:
  - Regenerative spaces that connect occupants to light, air, food, nature, and community.
  - Self-sufficient and remain within the resource limits of their site. Living Buildings produce more energy than they use and collect and treat all water on site.
  - Healthy and beautiful.
  - Living buildings give more than they take, creating a positive impact on the human and natural systems that interact with them.
THE LIVING BUILDING CHALLENGE HAS TWO CORE RULES

▪ All Imperatives assigned to a Typology are mandatory.

▪ Living Building Challenge certification requires **actual**, rather than anticipated, performance demonstrated over twelve consecutive months.
The Bullitt Center was designed to show what’s possible today, changing the way people think about high performance green building.

- Unlike other green buildings, Living Buildings must prove themselves for a full year.
  - They can’t contribute any waste to the environment. They can only use as much water as they can collect. And they must only be powered by as much energy as they can generate.
  - In addition, all the heavy building materials like concrete and steel must come from within 300 miles of the site.
  - And none of the building products can contain any of the red-listed 362 toxic chemicals that are commonly used in construction materials.
PETALS & IMPERATIVES

- The Living Building Challenge is organized into seven performance areas called Petals.

- Each Petal is further subdivided into Imperatives, which address specific issues through detailed requirements.
THE LIVING BUILDING CHALLENGE

▪ Seven performance areas, or ‘Petals’: Site, Water, Energy, Health, Materials, Equity and Beauty.

▪ Petals are subdivided into a total of twenty Imperatives, each of which focuses on a specific sphere of influence.

▪ There are two rules:
  ▪ All Imperatives assigned to a Typology are mandatory.
  ▪ Some Typologies require fewer than twenty Imperatives because the conditions are either not applicable or may compromise other critical needs.
  ▪ However, teams are encouraged to integrate the optional Imperatives into their projects wherever possible.
  ▪ Living Building Challenge certification is based on actual, rather than modeled or anticipated, performance.
  ▪ Therefore, projects must be operational for at least twelve consecutive months prior to evaluation.
### SUMMARY MATRIX

The 20 Imperatives of the Living Building Challenge: Follow down the column associated with each Typology to see which Imperatives apply.

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<th>PLACE</th>
<th>BUILDINGS</th>
<th>RENOVATIONS</th>
<th>LANDSCAPE + INFRASTRUCTURE</th>
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<th>RENOVATIONS</th>
<th>LANDSCAPE + INFRASTRUCTURE</th>
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<td>SCALE JUMPING</td>
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<tr>
<th>MATERIALS</th>
<th>BUILDINGS</th>
<th>RENOVATIONS</th>
<th>LANDSCAPE + INFRASTRUCTURE</th>
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<th>EQUITY</th>
<th>BUILDINGS</th>
<th>RENOVATIONS</th>
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<th>BEAUTY</th>
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<table>
<thead>
<tr>
<th>IMPERATIVE</th>
<th>DESCRIPTION</th>
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<tbody>
<tr>
<td>01. LIMITS TO GROWTH</td>
<td></td>
</tr>
<tr>
<td>02. URBAN AGRICULTURE</td>
<td></td>
</tr>
<tr>
<td>03. HABITAT EXCHANGE</td>
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</tr>
<tr>
<td>04. HUMAN-POWERED LIVING</td>
<td></td>
</tr>
<tr>
<td>05. NET POSITIVE WATER</td>
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<tr>
<td>06. NET POSITIVE ENERGY</td>
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<tr>
<td>07. CIVILIZED ENVIRONMENT</td>
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<tr>
<td>08. HEALTHY INTERIOR ENVIRONMENT</td>
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<td>09. BIOPHILIC ENVIRONMENT</td>
<td></td>
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<tr>
<td>10. RED LIST</td>
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</tr>
<tr>
<td>11. EMBODIED CARBON FOOTPRINT</td>
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</tr>
<tr>
<td>12. RESPONSIBLE INDUSTRY</td>
<td></td>
</tr>
<tr>
<td>13. LIVING ECONOMY SOURCING</td>
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<tr>
<td>14. NET POSITIVE WASTE</td>
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</tr>
<tr>
<td>15. HUMAN SCALE + HUMANE PLACES</td>
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</tr>
<tr>
<td>16. UNIVERSAL ACCESS TO NATURE + PLACE</td>
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</tr>
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<td>17. EQUITABLE INVESTMENT</td>
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<td>18. JUST ORGANIZATIONS</td>
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<td>19. BEAUTY + SPIRIT</td>
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<td>20. INSPIRATION + EDUCATION</td>
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GROUP ACTIVITY
BIOMIMICRY
WHAT IS BIOMIMICRY?

▪ Biomimicry is the practice of applying lessons from nature to the invention of healthier, more sustainable technologies for people.

▪ Biomimetic designers (“biomimics”) focus on understanding, learning from, and emulating the strategies used by living things, with the intention of creating designs and technologies that are sustainable.
  ▪ “Conscious”: being intentional
  ▪ “Emulation”: learning from living things, then applying those insights to the challenges humans want to solve.
  ▪ “Life’s genius”: recognizing that life has arrived at well-adapted solutions that have stood the test of time, within the constraints of a planet with finite resources.
<table>
<thead>
<tr>
<th>Man-made designs</th>
<th>Nature’s designs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear system</td>
<td>Cyclical system</td>
</tr>
<tr>
<td>Homogeny &amp; Uniformity</td>
<td>Diversity</td>
</tr>
<tr>
<td>Maximization of resources</td>
<td>Optimization of resources</td>
</tr>
<tr>
<td>Heat, beat &amp; treat</td>
<td>Self assembly</td>
</tr>
<tr>
<td>Cheapest sources</td>
<td>Locally sourced</td>
</tr>
<tr>
<td>Disposable</td>
<td>Biodegradable</td>
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</tbody>
</table>
FUNCTION AND STRATEGY
INTEGRATE BIOLOGY INTO DESIGN

- The biological mechanism of what is happening must be understood.
- Think of mechanism as how the strategy works.
- Strategy is how the function is achieved.
- The function is what nature is doing.
How do Polar Bears keep themselves warm?
Function:
- Attachment on wet surface

Strategy:
- Regular microstructure on toe pads increases attachment forces

Design Principle:
- A microstructure of fractal hexagons with capillary size channel provides attachment to wet surface
GROUP ACTIVITY
“Each species is a masterpiece...”

E.O. Wilson

Jacques Chirazi
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Certified Biomimicry Professional + Founder
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