“The world will not evolve past its current state of crisis by using the same thinking that created the situation.”

– Albert Einstein

...the world of DESIGN needs some Radical thinking!
Being less BAD is not GOOD enough
Radical CONFLICT!??

#1 – GLOBAL WARMING – too much CO\textsubscript{2}
#2 – RUNNING OUT OF OIL (oil causes CO\textsubscript{2})
If we ran out of oil right away…

We would solve part of the Global Warming problem.…

PROBLEM: there is still lots of coal, and coal is even dirtier.
POLLUTION IS AN ACT OF DESIGN
Remember, EVERYTHING that is called 'disposable' was DESIGNED from day one to be garbage--as its PRIMARY and overriding design consideration.”
this was ALL
designed
To be thrown
OUT!

EVEN THIS BUILDING!
Radical PHILOSOPHY!??

WASTE = FOOD

(the human race is the only species to DESIGN things with the INTENTION that they become GARBAGE!)
Design for a closed loop where WASTE becomes FOOD and FEEDS back into a healthy cycle....
Radical PROPOSITION!??

DESIGN FOR DISASSEMBLY
So that we can take things (even buildings!) apart and easily repair or reuse them
REUSE MEANS LESS ENERGY THAN RECYCLE
MIMIC OTHER INDUSTRIES

DESIGN BUILDINGS TO COME APART SO THAT THEY CAN BE REPAIRED, REUSED AND RECYCLED – EASILY!
Inconvenient TRUTH

BUILDINGS ARE RESPONSIBLE FOR BETWEEN 40% TO 70% OF WORLD CARBON EMISSIONS
**U.S. Energy Consumption by Sector**

Source: ©2011 2030, Inc. / Architecture 2030. All Rights Reserved.
Do you remember August 14, 2003?
Radical Wake Up Call

The Northeast Blackout of 2003 was a massive widespread power outage that occurred throughout parts of the Northeastern and Midwestern United States, and Ontario, Canada on Thursday, August 14, 2003, at approximately 4:15 pm EDT (20:15 UTC). At the time, it was the most widespread electrical blackout in history. The blackout affected an estimated 10 million people in the Canadian province of Ontario and 45 million people in eight U.S. states.
Do you remember December 21, 2013?
ICE STORM = NO POWER = NO HEAT
Radical PROBLEM!

• No power...
• Hot August weather... or
• Cold December temperatures...
• *Hooked* on electricity, heat and A/C
• What buildings/environment/systems “worked”? 
• What buildings/environment/systems “didn’t” work?
SEALED BUILDINGS CANNOT BREATHE
ELEVATORS AND LIGHTS NEED POWER
Radical AWAKENING!

• Grid and energy dependent buildings/environment/systems DID NOT WORK!
• OPERABLE WINDOWS WORKED!
• NATURAL VENTILATION WORKED!
• SHADE WORKED!
• SUNLIGHT WORKED!
• DAYLIT SPACES WORKED!
• WALKABLE NEIGHBOURHOODS WORKED!
• BICYCLES WORKED!
Radical THOUGHT!??

MAYBE WE SHOULD BEGIN TO DESIGN OUR BUILDINGS/ENVIRONMENTS IN REVERSE!

Start with a basic UNPLUGGED building
Radical Steps!

#1 - *start* by UNPLUGGING the building
Then...
#2 – heat only with the sun
#3 – cool only with the wind and shade
#4 – light only with daylight

USE the ARCHITECTURE first, and mechanical systems only to supplement what you cannot otherwise provide.

#5 – USE RENEWABLE CLEAN ENERGY BEFORE HOOKING UP TO NATURAL GAS, OIL OR THE REGULAR ELECTRICAL GRID (with all of its nastiness – including CO₂)
Radical IS Passive...

PASSIVE DESIGN is where the building uses the SUN, WIND and LIGHT to heat, cool and light

ARCHITECTURALLY
Carbon Reduction: The Passive Approach

...and the Mechanical Systems won’t be small enough to be powered by renewable energy.

...or the Passive Systems won’t work.

Basic Building Design MUST be Climate Responsive.

Image: Norbert Lechner, “Heating, Cooling, Lighting”
Radical Thought – Smaller is Better!

- **Simple!**...less building results in less embodied carbon; i.e. less carbon from materials used in the project, less requirements for heating, cooling and electricity....

- Re-examine the building program to see what is really required

- How is the space to be used?

- Can the program benefit from more inventive double uses of spaces?

- Can you take advantage of outdoor or more seasonally used spaces?

- **How much building do you really need?**

- **Inference of LIFESTYLE changes**

Calculating your “ecological footprint”

... can naturally extend to an understanding of your “carbon footprint”
Counting Carbon costs…

Operating Energy of Building

Embodied Carbon in Building Materials

Landscape + Site

Renewables + Site Generation

People, “Use” + Transportation

Disturbance vs. sequestration

80% of the problem!
#1 - OUR NORTH AMERICAN LIFESTYLE OF CONSUMPTION IS NOT SUSTAINABLE

#2 – DEVELOPING COUNTRIES (WITH ZILLIONS MORE PEOPLE THAN WE) ARE STRIVING TO BE JUST LIKE US....
Radical TOUGH QUESTION:

IS EVERYONE IN THE WORLD ENTITLED TO LIVE LIKE US?

IS EVERYONE IN THE WORLD ENTITLED TO WASTE RESOURCES LIKE WE DO?

MUST WE SHARE – IF IT MEANS LOSS OF LIFESTYLE?
<table>
<thead>
<tr>
<th>Country</th>
<th>CO₂ Produced Total (millions)</th>
<th>(tonnes of carbon) Per Capita</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>1,489.6</td>
<td>5.48</td>
</tr>
<tr>
<td>China</td>
<td>913.8</td>
<td>0.75</td>
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<tr>
<td>Russia</td>
<td>390.6</td>
<td>2.65</td>
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<tr>
<td>Japan</td>
<td>316.2</td>
<td>2.51</td>
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<tr>
<td>India</td>
<td>279.9</td>
<td>0.29</td>
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<tr>
<td>Germany</td>
<td>227.4</td>
<td>2.77</td>
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<tr>
<td>UK</td>
<td>142.1</td>
<td>2.41</td>
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<tr>
<td><strong>Canada</strong></td>
<td><strong>133.9</strong></td>
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<tr>
<td>Italy</td>
<td>111.3</td>
<td>1.94</td>
</tr>
<tr>
<td>Ukraine</td>
<td>100.4</td>
<td>1.97</td>
</tr>
</tbody>
</table>

Source: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, Tennessee

And can you even IMAGINE how bad this might be if everyone in India and China lived like we do???
CO$_2$ Production by Country in 2006

World Carbon Dioxide Emissions from the Consumption and Flaring of Fossil Fuels, 2006
(Million Metric Tons of Carbon Dioxide)

China: 6017
Usa: 5902
Russia: 1704
India: 1293
Japan: 1246
Germany: 837
Canada: 614
United Kingdom: 585
South Korea: 514
Iran: 471
Rest of the world: 9987

Source: Energy Emission Administration

China is catching up!!!???
Radical **PROBLEM:**

MUST WE SHARE – IF IT MEANS LOSS OF LIFESTYLE?

**AVERAGE** ONTARIAN NEEDS 4 PLANETS TO SUPPORT LIFESTYLE....
Radical POTENTIAL!!

COMFORT ZONE
WHAT IS IT?
WHAT DOES IT HAVE TO DO WITH GREEN BUILDING?
This famous illustration is taken from “Design with Climate”, by Victor Olgyay, published in 1963.

This is the finite point of expected comfort for 100% mechanical heating and cooling.

To lower our energy consumption, we must work within the broader area.

AND move this line DOWN to 18C (point of heating or cooling in degree day calculations.)
PASSIVE Strategies - HEATING

The tiered approach to reducing carbon for HEATING:

**Tier 1**
- Maximize Heat Retention

**Tier 2**
- Passive Solar Heating

**Tier 3**
- Mechanical Heating

First reduce the overall energy required, then maximize the amount of energy required for mechanical heating that comes from renewable sources.

*Source: Lechner. Heating, Cooling, Lighting.*
PASSIVE Strategies - HEATING

MAXIMIZE HEAT RETENTION:

1. Super insulated envelope (*as high as double* current standards)
2. Tight envelope / controlled air changes
3. Provide thermal mass *inside* of thermal insulation to store heat (COMPLETE OPPOSITE OF REGULAR WOOD FRAME CONSTRUCTION!)
4. Top quality windows with high R-values – up to *triple glazed* with argon fill and low-e coatings on two surfaces

Premise – what you don’t “lose” you don’t have to create or power…. So make sure that you keep it! (*...NEGAwatts*)
PASSIVE STRATEGIES: HEATING

PASSIVE SOLAR HEATING:

1. primarily south facing windows
2. proportion windows to suit thermal mass and size of room(s)

3 MAIN STRATEGIES:

Direct Gain
Thermal Storage Wall
Sunspace

Source: Square One Archives (http://squ1.com/archive/)

Direct Gain
Trombe Wall
Sun Space
Thermal Mass is Critical

• To ensure comfort to the occupants....
• People are 80% water so if they are the only thermal sink in the room, they will be the target.

• And to store the FREE energy for slow release distribution....

Aldo Leopold Legacy Center: Concrete floors complement the insulative wood walls
PASSIVE Strategies - COOLING

The tiered approach to reducing carbon for COOLING:

Maximize the amount of energy required for mechanical cooling that comes from renewable sources.

PASSIVE Strategies - COOLING

HEAT AVOIDANCE:

1. Shade windows from the sun during hot months
2. Design materials and plantings to cool the local microclimate
3. Locate trees and trellis’ to shade east and west façades during morning and afternoon low sun

If you don’t invite the heat in, you don’t have to get rid of it…..
PASSIVE Strategies - COOLING

NATURAL VENTILATION:

1. design for maximum ventilation
2. keep plans as open as possible for unrestricted air flow
3. use easily operable windows at low levels with high level clerestory windows to induce stack effect cooling
PASSIVE Strategies - COOLING

INNOVATION:

1. wind cowls
2. solar chimneys
3. water features
The tiered approach to reducing carbon with **DAYLIGHTING**:

**Tier 1**
- Use energy efficient fixtures!
- Maximize the amount of energy/electricity required for artificial lighting that comes from renewable sources.

**Tier 2**
- Orientation and planning of building to allow light to reach maximum no. of spaces

**Tier 3**
- Efficient artificial Lighting w/ sensors
- Glare, color, reflectivity and material concerns

**Source:** Lechner. Heating, Cooling, Lighting.
PASSIVE Strategies - DAYLIGHTING

GLARE, COLOUR, REFLECTIVITY, MATERIALS:

- incorporate light dynamics
- avoid glare
- understand the function of material selection; ie. reflectivity and surface qualities
- balance color and reflectivity with amount of daylight provided
PASSIVE Strategies - DAYLIGHTING

ENERGY EFFICIENCY AND RENEWABLES:

- use energy efficient light fixtures (and effectively!)
- use occupant sensors combined with light level sensors
- aim to only have lights switch on only when daylight is insufficient
- provide electricity via renewable means: wind, PV, CHP

Lights on due to occupant sensors when there is adequate daylight – WASTES ENERGY!
Radical RETHINKING:

DESIGN FOR YOUR LOCAL CLIMATE!

ERADICATE

“MacDonald’s Type Architecture”
Design must first acknowledge regional, local and microclimate impacts on the building and site.
Bio-climatic Design: COLD

Where **WINTER** is the dominant season and concerns for conserving heat predominate

**RULES:**
- **First INSULATE**
- *exceed* CODE requirements
- build tight to reduce air changes
- **Then INSOLATE**
- ORIENT AND SITE THE BUILDING PROPERLY FOR THE SUN
- maximize south facing windows for easier control
- fenestrate for DIRECT GAIN PASSIVE
- apply THERMAL MASS to store the FREE SOLAR HEAT
- create a sheltered MICROCLIMATE

YMCA Environmental Learning Centre, Paradise Lake, Ontario
Bio-climatic Design: HOT-ARID

Where very high summer temperatures with great fluctuation predominate with dry conditions throughout the year.

RULES:
- Solar avoidance: keep DIRECT SOLAR GAIN out of the building
- Avoid daytime ventilation
- Promote nighttime flushing with cool evening air
- Achieve daylighting by reflectance and use of LIGHT non-heat absorbing colours
- Create a cooler MICROCLIMATE by using light / lightweight materials
- Respect the DIURNAL CYCLE
- Use heavy mass for walls and DO NOT INSULATE

Traditional House in Egypt
Bio-climatic Design: **HOT-HUMID**

Where **warm to hot** stable conditions predominate with **high humidity** throughout the year.

**RULES:**
- SOLAR AVOIDANCE: large roofs with overhangs that shade walls and to allow windows open at all times
- PROMOTE VENTILATION
- USE LIGHTWEIGHT MATERIALS that do not hold heat
- use STACK EFFECT to ventilate through high spaces
- use of COURTYARDS and semi-enclosed outside spaces
- use WATER FEATURES for cooling

House in Seaside, Florida
Bio-climatic Design: TEMPERATE

The summers are hot and humid, and the winters are cold. In much of the region the topography is generally flat, allowing cold winter winds to come in from the northwest and cool summer breezes to flow in from the southwest. **The four seasons are almost equally long.**

**RULES:**
- BALANCE strategies between COLD and HOT-HUMID
- maximize flexibility in order to be able to modify the envelope
- understand the natural benefits of SOLAR ANGLES that shade during the warm months and allow for heating during the cool months
Radical GREEN

IS POSSIBLE!
RIGHT NOW!
Radical | Green

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