Radical | Green

Arch 125: Introduction to Environmental Design
“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 $\text{CO}_2$
#2 – RUNNING OUT OF OIL (oil causes $\text{CO}_2$)
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."
EVEN THIS BUILDING!
Radical PHILOSOPHY!??

WASTE = FOOD

(the human race is the only species to DESIGN things with the INTENTION that they become GARBAGE!)

MIMIC NATURAL CYCLES

Design for a closed loop where WASTE becomes FOOD and FEEDS back into a healthy cycle....

compostable end product
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

- Buildings 48.7% (47.8 Qبتا)
- Transportation 28.1% (27.5 Qبتا)
- Industry 23.2% (22.7 Qبتا)

Source: ©2011 2030, Inc. / Architecture 2030. All Rights Reserved.
Data Source: U.S. Energy Information Administration (2011)
You might not 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.
You might 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 CO\textsubscript{2})
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  

80% of the problem!  

Embodied Carbon in Building Materials  

Landscape + Site  

Disturbance vs. sequestration  

People, “Use” + Transportation  

Renewables + Site Generation  

+ purchased offsets
Radical REALIZATION

#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?
## CO₂ Production by Country in 1997

<table>
<thead>
<tr>
<th>Country</th>
<th>CO₂ Produced Total (millions)</th>
<th>(tonnes of carbon) Per Capita</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S.</td>
<td>1,489.6</td>
<td>5.48</td>
<td>Radical Problem here!</td>
</tr>
<tr>
<td>China</td>
<td>913.8</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td>390.6</td>
<td>2.65</td>
<td></td>
</tr>
<tr>
<td>Japan</td>
<td>316.2</td>
<td>2.51</td>
<td></td>
</tr>
<tr>
<td>India</td>
<td>279.9</td>
<td>0.29</td>
<td></td>
</tr>
<tr>
<td>Germany</td>
<td>227.4</td>
<td>2.77</td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>142.1</td>
<td>2.41</td>
<td></td>
</tr>
<tr>
<td><strong>Canada</strong></td>
<td><strong>133.9</strong></td>
<td><strong>4.42</strong></td>
<td>Radical Problem here!</td>
</tr>
<tr>
<td>Italy</td>
<td>111.3</td>
<td>1.94</td>
<td></td>
</tr>
<tr>
<td>Ukraine</td>
<td>100.4</td>
<td>1.97</td>
<td></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???
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.)
The tiered approach to reducing carbon for heating:

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

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
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
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 trellises 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**: Orientation and planning of building to allow light to reach maximum no. of spaces.
- **Tier 2**: Glare, color, reflectivity and material concerns.
- **Tier 3**: Efficient artificial Lighting w/ sensors.

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

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

GLARE, COLOUR, REFLECTIVITY, MATERIALS:

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

- COLD
- TEMPERATE
- HOT-ARID
- HOT-HUMID

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**

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
- Respect the DIURNAL CYCLE
- Use heavy mass for walls

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

House in Seaside, Florida
Bio-climatic Design: TEMPERATE

The summers are hot and humid, and the winters are cold.

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

IslandWood Residence, Seattle
Radical **GREEN**

IS POSSIBLE!

RIGHT NOW!
Radical | Green

Terri Meyer Boake
School of Architecture | University of Waterloo
tboake@uwaterloo.ca