Each building is a unique ecosystem within the larger ecosystems of landscape and region... Ecologically designed buildings and institutions afford a chance to make such relationships explicit, thereby becoming part of the educational process and research agenda organized around the study of local resource flows, energy use, and environmental opportunities.

David Orr (2006)

Design on the Edge: the Making of a High-Performance Building.
The MIT Press. Page 181

**ZERO+ TRANSDISCIPLINARY PEDAGOGY**

Optimizing the building/landscape interface

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The mission of the Salovich Zero Plus Campus Project is to develop an innovative interdisciplinary curriculum focused on research based modeling of integrated buildings and landscapes in order to optimize their environmental benefits.

Zero+ (Z+) refers to the project’s goal of creating zero-energy, carbon-neutral places that provide positive environmental benefits.

$255K funding from the UMN Provost
4 Faculty
4 Graduate research assistants
Many stakeholders
+$15k for demonstration project
Z+ Project Learning Outcomes

- Applying energy and environmental performance metrics,
- Mastering water and energy modeling tools
- Understanding sustainability decision-making processes at the institutional/municipal level
- Provide students with opportunities to implement ideas as demonstration projects
- Using the campus as a living laboratory
Z+ Project Timeline
Zero+ Pedagogical Theories

Theory
• ‘Designerly Ways Of Knowing’ (Cross, 2001, 2007)
• Ecopedagogy (Kahn, 2010)
• Transdisciplinary Action Research Pedagogy (Stokols, 2006; Thering, 2011)
• Performative Design Pedagogy (Oxman, 2008)

Application
• Multidisciplinary teams – architecture & landscape architecture students and instructors
• Leave the problem open-ended
• Use performance modeling tools to validate ideas and evaluate design options

Teaching
• Transdisciplinary collaboration uses strengths of other disciplines
Four Critical Evaluative Skills

• *Deep reflection*: the capacity for critical and constructive reflection on the actions, underlying mental models, and worldviews of themselves and others

• *Rich observation*: the ability to observe and construct useful models of complex situations

• *Future scenario construction*: the ability to apply design thinking to complex relationships embedded in solutions to future challenges

• *Responsible participation*: skills in fostering meaningful civic engagement (e.g. language and media adaptation, listening and reformulation)
Energy Water Nexus Modeling

**INTEGRATING ENERGY & WATER MODELING**

- **WATER**
  - E: evaporation
  - ET: evapotranspiration
  - S: shading

- **ENERGY**
  - C: cooling (tons)
  - H: heating (kBTU)
  - RE: power (KW)
  - EC: energy conservation
  - CC: climate cooling potential (UHI mitigation)

- **BIOLOGICAL (plants)**
  - living walls/roofs
  - trees/shrubs
  - rainwater gardens
  - landscape ground care

- **SOLAR**
  - daylighting
  - passive
  - PV power
  - increased evaporation
  - increased heat gain

**BUILDING -> HOLISTIC MODELING**

**FORMULAS**

**EVAPOTRANPIRATION (ET)**

\[ \text{ET} = \frac{g \times \text{H2O/evap} 	imes \text{SF x surface area x btu}}{\text{to evaporate 1g H2O}} \]

**COOLING POTENTIAL**

\[ \text{Cooling Potential} = \frac{(E \text{ or ET} \text{ btus})}{12,000 \text{ btu/ton}} = \text{tons cooling} \]

- calculate potential reduction in H+C loads form combined effects of strategies and balance water needed to sources
- calculate effect of Urban Heat Island mitigation on aggregate building loads (both H+C)
Optimization and Modeling

Performance modeling steps

• Baseline performance analysis of site systems and ecosystem services
• “Shoebox” modeling that approximate the design under consideration (buildings, hardscapes, vegetation, water systems, and other infrastructure) for design optimization (Balcomb & Hayter, 2001)
• “Patchwork Calculator” aggregation and integration of several assessment tools
• Compare multiple iterations at all steps of the process to optimize
Objectives: To conceive of integrated building and landscape design solutions that can move the University toward a zero emissions, zero-energy, zero water, zero runoff, and zero-waste campus through creative integrated and interdisciplinary approaches to design.

1. Establish a clear vision for Zero+ Campus Design – what is it, and how will it be different from the campus of today?

2. Approach the problem using an interdisciplinary process which integrates ecological scales and issues (e.g., energy, water, wastewater treatment, materials, pollution, habitat, biodiversity, etc.).

3. Use hands-on fieldwork, case study analyses, and design investigations to explore and apply sustainable design concepts, principles, and strategies in creating design proposals that respond to the goals of net-zero energy, water and resource use in buildings.
Linkages

Image credit: Thea Holmberg-Johnson
System Integration

Image credit: Vince de Britto
System Integration

Image credit: Vince de Britto
SALOVICH Zero+ Campus Design Project integrating carbon, energy, and water management strategies toward zero- and net-positive design

Image credit: Emily Stover

Lance Neckar, Principal Investigator
Loren Abraham, Coordinator

Mary Guzowski, Co Investigator
Barry Lehrman, Research Fellow

CELA 2012
Demonstration Projects

Image credit: Emily Lowery
# Landscape Performance Tools

<table>
<thead>
<tr>
<th>TOOL NAME</th>
<th>INTERFACE FEATURES</th>
<th>INPUTS</th>
<th>OUTPUTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athena Impact Estimator for Buildings</td>
<td>Normalized text output</td>
<td>Predictive</td>
<td>Location/Climate</td>
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<td>Community Viz</td>
<td>s</td>
<td>p</td>
<td>s</td>
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<tr>
<td>EnergyPlus / ECOTECT Analysis</td>
<td>p</td>
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<tr>
<td>EnergyPlus / OpenStudio</td>
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<tr>
<td>Facility Energy Decision System (FEDS)</td>
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<td>HolisticCity</td>
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<tr>
<td>IES VE-Toolkit, VE-PRO</td>
<td>s</td>
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<td>INDEX and Cool Spots</td>
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<tr>
<td>i-Tree suite (Eco, Streets, &amp; Hydro)</td>
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<tr>
<td>i-Tree Green Roof Tool (GBO Mini-model)</td>
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<td>UPlan</td>
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<tr>
<td>Andrew Edwins Water Balance Model</td>
<td>s</td>
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</table>

**Note:** The information in this table was gleaned from the website of the tool developer or as noted from (London, 2009) or the Building Energy Software Tools Directory (BESTD) http://apps1.eere.energy.gov/buildings/tools_directory/subjects.cfm (accessed November 2010).
Zero+ Campus Design Calculator

Version 5.1.1
Instructions and Notes

INSTRUCTIONS:

1) There are three INPUT worksheets where critical data is entered regarding the project floor area and program.
   - dimensions, IES VE Simulation data exported from IES Vista and other project information.
2) Enter requested information in (green) fields in the “Input Program” worksheet - revise the proposed building program
   as required if different from the given program info.
3) Paste the simulation results from your IES VE simulation in (green) the designated fields in the “Input IES Data”
   worksheet. You can enter results from up to three projects. You can also input data from split-year (seasonal)
   simulations if you have dynamic shading or natural ventilation that requires separate winter and summer simualtion,
   or for any other reason.
4) Calculations of all loads, energy use, energy production, costs, system sizes, life-cycle cost results and other factors
   can be seen in the Z4 Summary worksheet.

Color Key

- Data to be entered by user
- Parameters that affect the results of the model & may be customized by the User
- Calculations performed by the model
- Data imported from other parts of the model
- Features to be added or revised at a later date
So what’s next for the Zero+ Campus Project?

SPRING 2012: LA 8575 BIKE PASTURE DETAILING
The Art and Ecology of Landscape Detailing (Prof. Koepke and Prof. Krinke)

SUMMER 2012 BIKE PASTURE INSTALLATION!

Developing tools beyond the Campus Design Calculator
• REVIT plug-in
• GIS plug-in
• Decision tools

Making campuses beautiful and integrating carbon, energy and water management strategies towards zero and net-positive design

www.zeropluscampus.umn.edu/
Questions?

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References


