UW Sustainability & the Next Generation

Angela Pakes, PE, LEED AP
BS 1996
UW GLE Professor of Practice
WHY BUILD GREEN?
Global CO$_2$ Emissions by Sector

Can you guess the top 3?

3. Industry
2. Transportation
1. Buildings

U.S. Energy Consumption

- Buildings: 39%
- Industry: 29%
- Transportation: 32%
U.S. Building Impacts:

- 12% water use
- 39% CO₂ emissions
- 65% waste output
- 71% electricity consumption
Green Buildings Can Reduce...

Green Building Occupants Are Healthier & More Productive

- In the U.S., people spend, on average, 90% or more of their time indoors*
- Green buildings typically have better indoor air quality and lighting
- LEED certified project case studies illustrate 2-16% increased worker and student productivity**

** Source: LEED project data, USGBC
### Nutrition Facts

**Serving Size** 8 crackers (28g)

**Servings Per Container** About 12

<table>
<thead>
<tr>
<th>Amount Per Serving</th>
<th><strong>% Daily Value</strong>*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Calories</strong></td>
<td>120</td>
</tr>
<tr>
<td><strong>Calories From Fat</strong></td>
<td>30</td>
</tr>
<tr>
<td><strong>Total Fat</strong></td>
<td>3.5g</td>
</tr>
<tr>
<td>Saturated Fat</td>
<td>1g</td>
</tr>
<tr>
<td>Trans Fat</td>
<td>0g</td>
</tr>
<tr>
<td>Polyunsaturated Fat</td>
<td>1.5g</td>
</tr>
<tr>
<td>Monounsaturated Fat</td>
<td>0.5g</td>
</tr>
<tr>
<td><strong>Cholesterol</strong></td>
<td>0mg</td>
</tr>
<tr>
<td><strong>Sodium</strong></td>
<td>140mg</td>
</tr>
<tr>
<td><strong>Total Carbohydrate</strong></td>
<td>22g</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>Less than 1g</td>
</tr>
<tr>
<td>Sugars</td>
<td>7g</td>
</tr>
<tr>
<td><strong>Protein</strong></td>
<td>2g</td>
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</table>

*Percent Daily Values are based on a 2,000 calorie diet.*

LEADERSHIP in ENERGY and ENVIRONMENTAL DESIGN

A leading-edge system for certifying DESIGN, CONSTRUCTION, & OPERATIONS of the greenest buildings in the world

Scores are tallied for different aspects of efficiency and design in appropriate categories.

For instance, LEED assesses in detail:

1. Site Planning
2. Water Management
3. Energy Management
4. Material Use
5. Indoor Environmental Air Quality
6. Innovation & Design Process
What did I do?

- Led planning, design & construction of new buildings & major remodels
- Campus Master Plan: orchestration of form, open space structure, material, texture and color
- Focus: Sustainable Building Design and Construction
UW-Madison Today

- 930 acres
- 220+ buildings
- 20+ million gross sq. feet
- \( x = \$ \) value of projects in planning, design and construction
A PLAN BASED ON PRINCIPLES

A Spectacular Setting
Experience of Place
Connections
Edges and Boundaries
The Environmental Campus
Regional Community
• How much should we build?
• Where should it be sited?
• What should look like?
What did we look at?

- Buildings
- Open Space
- Transportation
- Utilities
Favorite Campus Places
Not-so Favorite Campus Places
Not-so Favorite Campus Places

Engineering Research Building – 1968

Semen Nikolaevich Korsakov - 1805
Parking at the University of Wisconsin
Parking Improvements

Parking:
- Total Area: 98 acres
- 3 Story Garages
- Area Gained: 65 acres
Transportation Improvements
Existing Campus Utility Map
Master Phased Utility Project Map
2005 Existing Conditions
Future Architectural Neighborhoods
Student Athlete Performance Center - McClain Center
LEED Silver Certified

Student Athlete Performance Center - Camp Randall North Addition
LEED Silver Certified
Lakeshore Residence Hall Phase II
LEED Gold Certified

Wisconsin Energy Institute
LEED Gold Certified

Signe Skott Cooper Hall
LEED Silver Certified
Office of Sustainability

- UW Task Force - 2010
  - Represented all areas of campus
  - Led the Natural and Built Environments

- Started Office of Sustainability 2012
  - Advisory Board Member
  - Leadership Team
Thick vs. Thin Sustainability?

- Locally grown food vs. corporate food supply?
- Composting vs. landfilling?
- Oil pipeline from Alberta to Texas?
- Biofuels vs. natural gas?

Thick sustainability requires thoughtful quantitative assessment and evaluation of alternatives.

Be skeptical!
Denim or Water?
The Grainger Institute for Engineering is Dedicated to Enhance Innovation

- The Grainger Institute for Engineering was created in June 2014
  - Funded with $25 million from The Grainger Foundation of Lake Forest, Illinois.
- Drawing on a collaborative, trans-disciplinary approach to:
  - Incubate large-scale centers
  - Develop new strategies for external collaborations and program development
A Succinct Statement of Goals and Methods

Goals
- Large Scale Proposals (>\$1-2M annually)
- Self-Sustaining Centers (GIE incubation)
- Industrial Interactions (New resources)

Methods
- New Proposal Teams (help the faculty)
- Talent searches (hires in topical thrusts)
- Showcase facilities (science to technology, scale-up)
- New Public-Private Partnerships (streamline IP)
Sustainable Infrastructure
Material Constraints &
the Triple Bottom Line

- Environmental and economic benefits are influenced by a combination of amount and type of recycled materials used.
- Large-scale proposal development.
- Industrial connections to cutting edge research.

Angela Pakes, P.E.
Assistant Director, New Technologies Directions
Grainger Institute for Engineering
The Organizational Chart - hires will be developed through the home departments of the faculty.

- Director
  - Dan J. Thoma

- Administrative Assistant
  - Page Metcalf

- Asst. Director
  - for New Technology Directions
  - Angela Pakes
  - for Industrial Outreach
  - Felix Lu

- Asst. Director for
  - Advanced Manufacturing Thrust
  - Senior Faculty (TBD)

- Materials Discovery
  - Thrust
  - Senior Faculty (TBD)

- Energy & Sustainability
  - Thrust
  - Todd Allen

- BioManufacturing
  - William Murphy

- Smart and Connected
  - Health Care
  - Pascale Carayon

- Internal Guidance Coalition

- External Advisory Board

- Proposal Development

- Computational Science and Engineering

2/5/2018
Research will be Agile to Adapt to Current and Critical Societal Challenges

The thrust areas in the institute center around challenges in manufacturing and smart technologies. Together, they provide opportunities to accelerate the process of discovery to application, and to engage in this process in a sustainable manner.

- **Advanced Manufacturing**
  - Energy efficiency, waste reduction, accelerated qualification
  - 3D printing, digital manufacturing, supply-chain optimization

- **Accelerated Materials Discovery**
  - Computational and combinatorial methods
  - Rapid through-put analysis

- **Energy and Sustainability**
  - Energy-water nexus, environmental stewardship
  - Cradle to cradle engineering design lifecycle

- **Biomanufacturing**
  - Innovative manufacturing and delivery of next generation cell/tissue therapies
  - Tissue engineering, cell engineering, medical devices, and biosensors.
  - Organs-on-a-chip for precision medicine.

- **Smart and Connected Health Care**
  - Revolutionizing the patient experience, improving population health, controlling healthcare costs and enhancing clinician satisfaction

*New areas will incorporate the input and vision of many stakeholders*
- *Continue and extend the college’s leadership in discovery-based science*
- *Focus on existing or emerging challenges in our modern world*
GIE Technical Thrust Areas with Super Crosscuts

Computational and Data Driven Science and Engineering

Advanced Manuf.

Materials Discovery

BioManuf.

Smart and Connected Health Care

Energy and Sustainability

Innovation for Infrastructure Resiliency

Sensors and Sensing
Big Ideas at UW-Madison

UW-Madison is an Innovation Powerhouse

- Computational Optimization
- STC for Mathematical & Algorithmic Foundations of Computational Science and Engineering
- Infrastructure & Resiliency
- Material Innovation Platforms – NSF
- Clean Energy Deployment
- 2020 Computing Center
- Soft Materials
- Smart Healthcare
Borrowing from nature: UW-Madison scientists use plants to grow stem cells

DAVID WAHLBERG dwahlberg@madison.com  Mar 21, 2017
Big Idea: *Using plant leaves as scaffolding to grow human cells*

Murphy’s team found that leaf structures not only have an “incredible ability” for mass transport, moving and expelling fluids rapidly and efficiently from one end to the other, but that human cells pattern themselves in the same aligned and structured direction as the plant tissue.

Bill Murphy, PhD
BioManufacturing Thrust Lead
Biofunctionalization of plant scaffolds enables adhesion of human cells

hDF on mineralized parsley

Mineralized parsley stem

Calathea Zebrina stem (RGDOPA-coated)

Dopamine-RGD coating

Decellularization

Biofunctionalization

hDF on RGDOPA-coated parsley
Move over, solar: The next big renewable energy source could be at our feet

Xudong Wang, PhD
PI for Triboelectric Nanometers
Triboelectric Nanogenerator from Nanocellulose and Recyclable Wood Fibers

Chemical functionalized cellulose films with enhanced dielectric property for triboelectric nanogenerator development

Excellent transparency and flexibility

Seamlessly integrated with recycled fiber boards

Energy stored on capacitor (mJ)

Frequency (Hz)

Excellent transparency and flexibility

Triboelectric Nanogenerator from Nanocellulose and Recyclable Wood Fibers
Energy Harvesting Floor Structure