Holdsworth Hall Proposed Rehabilitation and Impacts

Green Design and Historic Preservation:
Exploring the Historic Building Envelope
Holdsworth Hall

- Architectural and Campus Context
  - Carl Fiocchi, M.Arch.

- Proposed Rehabilitation
  - Benjamin Weil, Ph.D.

- Importance to the University
  - Ludmilla Pavlova, AIA
Architectural and Campus Context
Holdsworth Hall

Welcoming Orientation
Architects

Lynn City Hall

Government Service Center (Boston)
Vestiges of Art Deco 1
Vestiges of Art Deco 2
Modernist Details
Dignity of the Early Years

Contribution to UMass’ Architectural Legacy

Images courtesy of: Special Collections and Archives, W.E.B. Du Bois Library, University of Massachusetts Amherst.
UMass Construction Timeline

Total Gross Square Footage = 15,282,731
Goals

- The University is struggling with a $2 billion backlog of deferred modernization and maintenance. As that backlog begins to be addressed, it is of the utmost importance that those modernizations to building envelopes and systems be executed with a methodology that is respectful of the building’s heritage, original materials, and aesthetics.

- Iconic buildings have little trouble in defending themselves from less than historically sympathetic invasive treatments.

- The more vernacular members of the historical inventory, such as Holdsworth Hall, are more easily ignored and insulted with invasions that demonstrate little sympathy to their provenance and heritage.

- Understanding of building physics, awareness of a building historical significance, realistic economics, and responsiveness to environmental imperatives will lead to creative interventions that must become new construction standards.

- These standards will permit the existing buildings of UMass Amherst and buildings in other places similar to those to extend their aesthetic and practical lives well into this new century and the next.

- Work suggested for Holdsworth Hall is not planned as an individual project, but rather to serve as a template of necessity.
Proposed Rehabilitation
63% reduction in energy cost
82% reduction in CO$_2$e
9 yr. simple payback
Working Principle 1

Respect architectural intention

Do not undermine currently effective systems and designs

Holdsworth Hall

Design 1961

Dedicated 1963

Exemplifies Modernist design that defines the aesthetic of UMass campus

Stood the test of time.

Image courtesy of: Special Collections and Archives, W.E.B. Du Bois Library, University of Massachusetts Amherst. RG150-0003318
Working Principle 2

The building is a complex system.

Single measures may achieve savings, but cannot maximize savings or performance without complementary changes in related systems.

Final package defines a new qualitatively different and better building.
Confidence in Modeled Results

<table>
<thead>
<tr>
<th>Deviation from actual usage</th>
<th>Heating</th>
<th>+0.39%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>-2.75%</td>
<td></td>
</tr>
</tbody>
</table>

Data correction and normalization procedure:
- Delete Baseline (median of 4 lowest months)
- Baseline corrected usage correlated to HDD \( r = 0.96, p < 0.001 \)

\[
\text{NormalizedUsage} = \frac{\text{ActualUsage}}{\text{HDD}_{\text{UMass}}} \times \text{HDD}_{\text{TMY3Chicopee}}
\]
Poor Solar Orientation
December, 1:00 PM
December, 9:00 AM
Thermostats

Temperature °C  Sunlight Intensity (Lux)

Friday  Saturday  Sunday

occupied

Temp.

Light
Thermostats Control Setpoints

- **Current average temp:**
  - Occupied: 74.2°F
  - Unoccupied: 73.3°F

- **Change to**
  - Occupied: 70.0°F
  - Unoccupied: 60.0°F

- **Savings:**
  - $21,919.00
  - (28.03%)
But occupant comfort is a problem due to Mean Radiant Temperature.
Without envelope measures, thermostat savings are less than expected

With current insulation and windows...
70°F ambient ≈ 65°F MRT*
MRT 70°F ≈ 74°F Ambient
Savings would be more like $18,391.00 (23.5%)
(potential for greater savings and fault detection)

*calculated with design day outdoor temperature
Wall Insulation

- 2.5” cavity
- Steel Studs
- Dense Packed Cellulose
- Nominal R-9
- Clearwall R-4

Insulate Walls

Savings: $6,977.00 (8.9%)

Gas Consumption (Btu)

<table>
<thead>
<tr>
<th>Month</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run 1</td>
<td>830.8</td>
<td>736.8</td>
<td>646.4</td>
<td>437.2</td>
<td>211.5</td>
<td>56.7</td>
<td>10.7</td>
<td>22.0</td>
<td>138.0</td>
<td>301.0</td>
<td>534.8</td>
<td>760.5</td>
<td>4,686.6</td>
</tr>
<tr>
<td>Run 2</td>
<td>735.5</td>
<td>643.8</td>
<td>567.3</td>
<td>379.5</td>
<td>183.3</td>
<td>47.9</td>
<td>9.7</td>
<td>18.8</td>
<td>120.0</td>
<td>261.8</td>
<td>456.2</td>
<td>666.4</td>
<td>4,100.0</td>
</tr>
</tbody>
</table>
Current Single Pane
- Poor thermal resistance, but in good condition
- Good rain screen
- Air leakage 0.17% of window area, but 14% building leakage

- Replacement windows
  - Savings: $10,394 (13.3%)
  - Expensive
  - Requires staging
  - Remediation for lead, asbestos, and PCBs
  - Repair to interior finishes
  - Possible change to Modernist aesthetic.

Custom Interior Panels
- 2 pane, Argon filled
- Conservative assumptions for model
  - Savings: $6,344.00 (8.11%)
Custom Interior Window Panels

2 pane, Argon filled (3 panes total)
Thermal break, insulated stops and mullion
Standard desiccant gasket on install
Similar performance to full replace
Lower operable windows remain operable
No change to exterior
No staging
No disturbance of PCB, SiO$_4$, or Pb
Conservative assumptions for model

Savings: $6,344.00 (8.11\%)
Improved Wall and Window results in:
Lower Setpoints and Greater Comfort

Current (radiant asym: 51°F)
- R 3.5
- 54°F
- R 1.68
- 34°F
- 73°F_{db}
- 68°F_{MRT}
- 65°F

Proposed (radiant asym: 29°F)
- R 6.9
- 61°F
- R 3
- 49°F
- 70°F_{db}
- 68°F_{MRT}
- 69°F
- 67°F
Obstacle:

Window Air Conditioning Units
### Air Leakage

<table>
<thead>
<tr>
<th></th>
<th>ELA (ft²)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doors</td>
<td>2.97</td>
<td>3%</td>
</tr>
<tr>
<td>Double Doors</td>
<td>3.56</td>
<td>4%</td>
</tr>
<tr>
<td>Overhead doors</td>
<td>11.42</td>
<td>12%</td>
</tr>
<tr>
<td>Windows</td>
<td>13.65</td>
<td>14%</td>
</tr>
<tr>
<td>Roof (Penthouses)</td>
<td>50.02</td>
<td>52%</td>
</tr>
<tr>
<td>AC units</td>
<td>6.99</td>
<td>7%</td>
</tr>
<tr>
<td>Inaccessible Joints</td>
<td>7.88</td>
<td>8%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>96.47</strong></td>
<td></td>
</tr>
<tr>
<td><strong>ACHn</strong></td>
<td><strong>1.20</strong></td>
<td></td>
</tr>
</tbody>
</table>
Air Seal: Penthouses inside Envelope

- Closed cell spray foam for complete coverage and access.
- Problem: Current steam coil for incoming air preheat keeps the penthouses around 90°F which is why all louvers are open.
- Solution: Preheat at a lower temp with less waste (hint: heat recovery)
14% total air leakage (after penthouses sealed)

Window Air Conditioning Units
Air Sealing Savings

- All accessible areas addressed (Doors, Windows, AC removal, Penthouses)
  - $ACH_{nat} = 0.1075$, Savings = $29,196 (37.34%)$

- Without window panels and AC removal
  - $ACH_{nat} = 0.46$, Savings = $10,392.00 (13.29%)$

- Challenges:
  1. Ventilation for IAQ
  2. Provide cooling
Ventilation

- Code Ventilation Rate: 0.5 cfm/ft²
- Current Rate: 0.17 cfm/ft²
- ½ system not functioning.
- Fix it, but incur ventilation heat loss penalty…

- Heat Recovery
  - Effectiveness:
    - Glycol pump-around 34%
    - Heat pipe w/pump assist 55%
  - Savings $4,848
Exterior Shading?
Shades would work to Reduce Summer Solar Gains

June 2, Current Condition

June 21, with Exterior Shades
Cooling demand reduced, Heating increased

Current Condition

With Exterior Shades

High occupancy  Low occupancy

High occupancy  Low occupancy
Some Glare Control
Glare Control:
Existing Blinds feathered to bounce Light Up
Use existing hydronic radiant ceiling for sensible loads (DOAS for latent + some sensible)

Benefits

- Comfort
- Less noise
- Less maintenance
- Energy efficiency
  - higher set points
  - dense fluid
  - smaller $\Delta T$

Concerns

- Condensation
- Capacity
- Cost
Energy Efficiency Measures

- Air Sealing
- Wall Insulation
- Interior Window Panels
- Thermostats & DDC
- Daylight harvesting and lighting design
- Radiant Cooling
- ventilation dehumidification and heat recovery
- Total First Costs: $624,498
  - (of which 26% is “soft costs”)
Net Present Value Analysis

Net Present Value of Investment and Non-energy Operating Costs

Year after investment

- Status quo

Net Present Value ($x10^5)$

-4 -3.5 -3 -2.5 -2 -1.5 -1 -0.5 0 0.5

3 4 5 6 7 8 9 10 11 12
Eliminating “soft costs” makes Payback Reasonable

Net Present Value of Investment and Non-energy Operating Costs

- Status quo
- EEM Implemented

Year after investment

Net Present Value ($x10^5)
63% reduction in energy cost
82% reduction in CO$_2$e
9 yr. simple payback
7 yr. simple payback if “soft costs” waived
Importance to the University
Master Plan and Campus Heritage Activities
Rapid Ice Melt in Ljakobshavn Glacier in Greenland
## Multifaceted Problem

- Knowledge and Attention
- Technology and Design
- Time and Money
- Skills and Capacities
- Politics and Power
- Organizational Limitations
- Failure to Understand
- Systemic Reality
# Sustainability is Complex: Requires Systemic Action

<table>
<thead>
<tr>
<th>Multifaceted Problem</th>
<th>Multifaceted, Systemic Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge and Attention</td>
<td>Advocacy</td>
</tr>
<tr>
<td>Technology and Design</td>
<td>Expertise in green building, energy, transportation, etc.</td>
</tr>
<tr>
<td>Time and Money</td>
<td>Business Development, Finance and Accounting, Risk Management</td>
</tr>
<tr>
<td>Skills and Capacities</td>
<td>Education and Training</td>
</tr>
<tr>
<td>Politics and Power</td>
<td>Leadership and Organizational Culture</td>
</tr>
<tr>
<td>Organizational Limitations</td>
<td>Social Marketing Techniques</td>
</tr>
<tr>
<td>Failure to Understand Systemic Reality</td>
<td>Systems Thinking</td>
</tr>
</tbody>
</table>

Adapted from Leith Sharp
The Solution Must Be System Based

<table>
<thead>
<tr>
<th>Institutional Drivers</th>
<th>Institutional Systems</th>
<th>Global Environmental Systems</th>
<th>Global Environmental Impacts</th>
</tr>
</thead>
</table>

Green arrow pointing right.
<table>
<thead>
<tr>
<th>Institutional Drivers</th>
<th>Institutional Systems</th>
<th>Create Relationship between Earth + Institution</th>
<th>Earth Systems</th>
<th>Earth Impacts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission</td>
<td>Material supply and disposal</td>
<td>Make hidden upstream &amp; downstream environmental impacts known</td>
<td>Ecosystems</td>
<td>Species extinction, increase in infectious vectors</td>
</tr>
<tr>
<td>Leadership</td>
<td>Food supply</td>
<td>Develop learning organization capacities</td>
<td>Climate systems</td>
<td>Climate disturbance</td>
</tr>
<tr>
<td>Organizational Culture</td>
<td>Energy supply and distribution</td>
<td>Mission alignment between teaching, research &amp; operations</td>
<td>Oceanic systems</td>
<td>Ozone depletion, air pollution</td>
</tr>
<tr>
<td>Finance/Accounting Structures</td>
<td>Building design and construction, mechanical systems, occupancy</td>
<td>Align Finance &amp; accounting systems to support long term health</td>
<td>Geological systems</td>
<td>Rising sea levels, deep ocean current changes, fisheries depletion</td>
</tr>
<tr>
<td>Decision Making Processes</td>
<td>Water supply</td>
<td></td>
<td>Water systems</td>
<td>Desertification, land pollution</td>
</tr>
<tr>
<td>Human Resources</td>
<td>Transportation</td>
<td></td>
<td>Nutrient systems</td>
<td>Mineral and resource pollution</td>
</tr>
<tr>
<td>Building O &amp; M</td>
<td>Non-vehicular circulation</td>
<td></td>
<td></td>
<td>Water pollution, scarcity of rain fall</td>
</tr>
<tr>
<td>Academic Planning</td>
<td>Landscaping</td>
<td></td>
<td></td>
<td>Soil quality depletion</td>
</tr>
<tr>
<td>Campus Planning</td>
<td></td>
<td>REDUCE CONSUMPTION</td>
<td></td>
<td>build up of toxins</td>
</tr>
</tbody>
</table>

- REDUCE CONSUMPTION
- SHIFT TO RENEWABLE energy and materials
- ENHANCE ECOSYSTEM HEALTH in campus design
- CLOSED LOOP SYSTEMS

Adapted from Leith Sharp
UMass Sustainability Chronology

- 2002: Governor’s Executive Order 438 (State Sustainability Program)
- 2004: Start of DCAM/UMass Energy Services Contract with Johnson Controls
- 2005: UMass Sustainability Plan
- 2007: Mass LEED Plus
- 2007: Governor’s Executive Order 484
- 2007: ACUPCC Signatory
- 2007: Central Heating Plant comes on-line
- 2008: Environmental Performance Advisory Committee (EPAC)
- 2009: First Sustainability Coordinator Hired
- 2009: Eco-Rep Program
- 2010: Green Building Guidelines
- 2010: Completed Climate Action Plan
- 2010: Initiated Master Plan Framework (completed 2012)
- 2011: AASHE STARS Gold

http://www.umass.edu/livesustainably/
GOING BEYOND
LEED is one tool in the quest for a more sustainable built environment. The GBC is using LEED to help steer sustainable design and building on campus. However, the GBC is aware that LEED is a limited approach to sustainable building. For this reason, we continue to look beyond LEED, towards more integrative and holistic environmental design.

UMass Sustainability Viewer

www.umass.edu/livesustainably
Master Plan Guiding Principles

- Understand the long-term growth potential
- Build a series of systems as the framework for growth
  - Build an open space framework
  - Create a clear vehicular and pedestrian circulation system
  - Develop an active mixed-use campus core
- Create growth opportunities and flexibility for the future
- Respect the planning and building heritage
- Sustainability – live it, learn it, lead it
- Embrace community connectivity
People like good outdoor spaces with nice plantings and views.

People like the views from the campus core.
Web Based Survey  
“Dislikes”

People comment on tired old buildings that need to be demolished and replaced.

People don’t like cars where only pedestrians should be and there are complaints about dangerous crosswalks and intersections.
spines & views
courts
Complete streets
UMass Master Plan

Wilson Architects, Ayers Saint Gross Architects and Planners, VHB, Tighe and Bond
Historic Inventory

- Properties built more than 50 years ago
- 103 Individual Building Inventoried (Form B)
- Provided the basis of eligibility of neighborhood
- 58 Buildings and Pond and Lawn Landscape recommended as eligible for district
Historic Criteria

- Constructed over fifty years ago
- Significant in
  - history,
  - architecture,
  - archeology,
  - engineering,
  - culture
Open Space

Existing

Proposed

Massachusetts North Pleasant East Pleasant
Historic Buildings Survey

ETL:
GIS Building Layer
Historic Buildings Survey (MS Access)
Images
Stewardship

- Completed
  - Grinnell Reuse
  - Skinner
  - Wilder Roof
  - Chapel Clock Tower
  - Residence Halls (continued renewal)
  - Munson Hall
  - Stockbridge House (Faculty Club)
  - Stockbridge Hall
Stewardship cont.

- In Process
  - Paige Reuse
  - Goessmann Reuse
  - Research Administration Mechanical/Fire Alarm
  - Chapel Study

- Evaluation and Assessments
  - South College
  - Draper
  - East Experiment
  - West Experiment
  - Horse Barn
  - Blaisdell House
  - French
  - Clark
  - Hasbrouck
UMass Emissions: Can We Reach EO484 Targets?

Executive Order 484: FY12 Target = 25% down from FY02 base

FY20 Target = 45% down from FY02 base

Master Plan Phase 1 Projected Growth: 1.9M GSF or +22,241MT

EO484 Mandate: 40% reduction relative to FY02

93,600 tons eCO₂ (by 2020)
Building EUI FY2011 (kBtu/sf) – CBECS
Average % Difference

http://www.eia.gov/emeu/cbecs/
Climate reduction targets will likely not be met

Energy efficiency reductions likely to be overcome by growth

Building renovation tends to be coupled with higher energy utilization intensity due to existing codes

Considering policies to reduce emissions impact
  - new construction/additions coupled with deep energy retrofits of existing buildings
  - net zero energy for new construction
  - net zero emissions growth
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Questions?