ASHRAE Headquarters Renovation

What Happens When the Leaders Try to Do it Right?
Building Overview

- Built – 1965
- Original building – 30,100 sq ft
- ASHRAE acquisition – 1981
- First renovation – 1991
- January 2005 – Committee formed
Project Administration

• Building Committee formed January 2005
  – Bill Harrison, Trane Arkansas
  – Gordon Holness (Albert Kahn Associates)
  – Damon Gowan, Gowan Inc.
  – Darryl Boyce, Carleton University
  – Ron Jarnagin, Pacific Northwest Nat’l Labs
  – Jeff Littleton, Executive Vice President, ASHRAE
  – Cindy Simmons, Finance Director, ASHRAE
  – Lois Benedict, Executive Assistant, ASHRAE
In the beginning...

• Options
  – Do nothing
  – Repair (code)
  – Renovate?
  – Sell and buy?
  – Sell and build?
  – Sell, buy and renovate?
  – Sell & lease?

• Information
  – Condition of building?
  – Value?
  – Purchase market?
  – Lease options?
  – Usage parameters?
    • # of staff?
    • Member use?
Can’t decide? Do a spreadsheet!

<table>
<thead>
<tr>
<th>Year</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
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<tr>
<td><strong>Alternative 2: Repair Current Building, Minimum Renovation</strong></td>
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<td><strong>Cash Flow Impact</strong></td>
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<tr>
<td>Positive (Negative)</td>
<td>211,532</td>
<td>311,109</td>
<td>390,683</td>
<td>460,257</td>
<td>529,831</td>
<td>600,405</td>
<td>670,979</td>
<td>741,553</td>
<td>812,127</td>
<td>882,701</td>
<td>953,275</td>
<td>1023,849</td>
<td>1094,423</td>
<td>1164,997</td>
<td>1235,571</td>
<td>1306,145</td>
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<tr>
<td>Cumulative Cash Flow</td>
<td>211,532</td>
<td>522,640</td>
<td>913,322</td>
<td>1,373,579</td>
<td>1,833,830</td>
<td>2,394,091</td>
<td>2,954,352</td>
<td>3,514,613</td>
<td>4,074,874</td>
<td>4,635,135</td>
<td>5,212,409</td>
<td>5,809,684</td>
<td>6,407,959</td>
<td>7,005,234</td>
<td>7,602,509</td>
<td>8,199,784</td>
</tr>
</tbody>
</table>

| **Alternative 3: Repair Current Building, Renovate for Improved Productivity** |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| **Cash Flow Impact** |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Positive (Negative) | 211,532 | 311,109 | 390,683 | 460,257 | 529,831 | 600,405 | 670,979 | 741,553 | 812,127 | 882,701 | 953,275 | 1023,849 | 1094,423 | 1164,997 | 1235,571 | 1306,145 |
| Cumulative Cash Flow | 211,532 | 522,640 | 913,322 | 1,373,579 | 1,833,830 | 2,394,091 | 2,954,352 | 3,514,613 | 4,074,874 | 4,635,135 | 5,212,409 | 5,809,684 | 6,407,959 | 7,005,234 | 7,602,509 | 8,199,784 |

| **Alternative 4: Sell Building, Move to Leased Space** |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| **Cash Flow Impact** |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |
| Positive (Negative) | 211,532 | 311,109 | 390,683 | 460,257 | 529,831 | 600,405 | 670,979 | 741,553 | 812,127 | 882,701 | 953,275 | 1023,849 | 1094,423 | 1164,997 | 1235,571 | 1306,145 |
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Lease is cheaper...

• Best financial option
  – Invest proceeds of the sale of existing building
  – Investments appreciate faster than real estate value.
  – The Great Debate: HQ as a demonstration project.

– Infamous LEFT turn settles the issue
But renovation wins.....

- Culture – ‘We should own our building…’.
- Walk the Sustainability Talk – Lead by example.
  - Re-use is the purest form of sustainability.
  - Opportunity to do LEED-NC and LEED-EB
- Control our headquarters destiny.
- Renovation seen as lower risk.
- Donor funding possibilities
- Living lab potential
- Demonstration project
Our Goals

• Deliver a healthy and productive workplace for staff
• Demonstrate commitment to sustainability
• Provide a learning center to advance education
• Create a living lab for access by members

The greatest opportunity to change energy consumption in the built environment is through modification of existing buildings. Only 2 percent of building stock is new construction each year.
Project Team

- Architects – Richard Wittschiebe Hand
- General Contractor - Gay Construction
- Mechanical Engineer – Johnson, Spellman and Associates
- Mechanical Contractor – Batchelor and Kimball
- Electrical Engineer – Jeffers Engineering Associates
- Electrical Contractor – Gene Lynn Electric
- Commissioning Agent – CxGBS
- TAC – Technical Advisory Committee (Volunteers)
Timeline

• March 2006 – Architect’s team selected
  – Included LEED consultant and MEP team
• May 2006 – General Contractor selected
  – GMP Contract
• June 2006 – Independent commissioning agent selected
• Design development- late 2006 to mid 2007
• Board approval of project and budget – June, 2007
• Sept. 2007 – Moved out
• July 28, 2008 – First day in building
What Guidance was Followed?

- Standard 90.1-2004 (energy efficiency)
- Standard 55-2004 (thermal comfort)
- Standard 62.1-2004 (ventilation)
- Standard 100-2006 (energy in existing buildings)
- Standard 15-2007 (refrigerant safety)
- Guideline 0-2005 (commissioning)
- Guideline 1-2006 (HVAC&R system commissioning)
- USGBC LEED® Rating System EB Version 2.0
- USGBC LEED®-NC Rating System 2.2
- Applicable local, state and national building codes
Multiple system decision made

• Decided to showcase alternate technologies
• Wanted to be able to compare multiple systems against one another
• Wanted to demonstrate the operation of technologies that had lower penetration in the marketplace
• Desire to not do the “standard thing”
• Technical Advisory Committee developed a rating matrix to evaluate and recommend technologies
Primary Mechanical Systems

- **First floor:** Multi-split air-cooled variable refrigerant flow fan coil units with inverter-driven outdoor DX heat pumps (refrigerant HFC 410A) - 28 ton capacity

- **Second floor:** 13 ground-source direct expansion heat pumps serviced by 12 wells – 32 ton capacity
Dedicated Outdoor Air System (DOAS)

- 6,000 cfm roof mounted air-to-air heat exchanger with dual-state, total enthalpy wheel and packaged DX air-cooled condensing unit
  - 55F air at 46F dewpoint
  - 35 tons of cooling and 250 MBH heating
- 24 supply VAV units (100-600 cfm)
- 2 exhaust VAV units (500-1000 cfm)
- Supply Fan 6.22” TSP, 15 hp
- Exhaust Fan 3.69” TSP, 7.5 hp
- Feeds both mechanical systems
This is one big DOAS!
IAQ Monitoring

- Dry bulb temp
- Dew point temp
- Relative humidity
- Fine particulates (PM 2.5)
- Enthalpy
- CO₂
- Total VOCs

- 24 separate locations throughout the building
- Outdoor sampling for comparison
PV System

- 20 kW capacity
- Power flows to grid
- Donation and purchase agreement
- Designed to provide about 8% of building load
Weather station

- Outside air temp
- 10 minute minimum/maximum air temp (1 min. samples)
- Humidity – Dew point
- Barometric pressure
- Wind direction, speed (10 min. average), gust
- Solar radiation
Construction
Construction
Surprises

- Parking lot system
- Soffit de-lamination
- Standard 15 issues
Surprises

• Learning center roof moisture
Sustainable Features

• Reduced estimated annual energy usage by more than **31 percent**
  – Dedicated outside air supply with energy recovery
  – Ground-source heat pumps
  – Mini-split systems with heat recovery
• Providing **30 percent** additional outdoor air ventilation to improve indoor air quality for improved occupant comfort, well-being and productivity
• Reduced estimated overall annual water consumption by **46 percent** (135,921 gallons to 253,021 gallons) through low-flow fixtures
Sustainable Features

- Reduced site runoff by **34 percent** and reduced runoff rate by **30 percent** through stormwater detention and bioretention
- Installation of a cool white reflective roof membrane with a solar reflectance index of 78 to minimize heat island effects
- Installation of parking lot reflective coating to reduce heat island effect
- Working to demonstrate how **PV arrays** can be used to generate clean power by taking advantage of under-utilized space on building roof
LEED Status (NC)

- 56 LEED Credits Attempted (52 needed for Platinum)
- Additional points possible for Platinum
  - Community Connectivity
  - Public transportation
  - Construction waste management (91% = Second point)
  - Onsite renewable energy
  - Innovation & Design (IAQ)
  - Indoor pollutant control
ASHRAE Foundation Learning Center

• One large room
  – Subdivided into three rooms
  – 200 person capacity
• Two smaller rooms
  – Subdivided into two rooms
  – 75 person capacity
• 7 rooms, + two upstairs
• Fully AV equipped
• Wireless mini-networks
ASHRAE Foundation Learning Center

• Committee meetings
• Topical conferences
  – NZEB Conference
  – DOE Energy Alliance Workshops
• Member gatherings
• Tours and demonstrations
  – Grand opening: “Building Bootcamp”
  – YEA Leadership Weekend
• Other organizations
  – USGBC, AIA, IESNA, etc.
• Video conferencing
Building performance online

- Part of the renovation plan was the development of a “living laboratory” to help members learn about building performance
- Additional electrical circuits and sensors were installed to monitor equipment, systems and sub-systems
- Ultimately the actual energy use and performance data will be made available online for members – now available!
<table>
<thead>
<tr>
<th>DOAS</th>
<th>VRV System</th>
<th>1st Fl Lighting</th>
<th>TPI=Third Party Interface</th>
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<tr>
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<td>61.6 Amps A</td>
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<td>119.3 Volts B Phase</td>
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<tr>
<th>1st Fl Plugloads</th>
<th>2nd Fl Plugloads</th>
<th>CL1 Computer Room</th>
<th>L1D Outside Lighting</th>
<th>Total Bldg Load</th>
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</thead>
<tbody>
<tr>
<td>23.6 Amps A</td>
<td>17.0 Amps A</td>
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<tr>
<td>21.7 Amps B</td>
<td>35.3 Amps B</td>
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Miscellaneous Power Consumption | Computer Room Power Monitoring
So, we started right out saving energy
A building model is used for comparisons.
Work environment performance

• Open office is quiet! (white noise)
  – 120 work locations, less footprint, expansion capability
• Day lighting has positive impact
• Meeting space is highly-functional
• Staff activity is highly visible
  – Productivity has improved
Improved Environment – In and Out
Project summary

• Total project cost: $7.65 million
  – $1.65 million donated; $6 million out-of-pocket to ASHRAE
  – Costs include moving, temporary space and all new furniture

• Goals accomplished
  – Learning and meeting center
  – Improved staff work environment
  – Existing building sustainable showcase
  – LEED-NC Platinum Achieved!
  – Living lab

• Need performance data?
• www.ashrae.org/building
So Where Are We Today?

- Final commissioning being completed as we speak
- Targeting initial online data availability in March-April timeframe
- Whole building energy use tracking indicates that we have been accumulating savings since occupancy
- Comparisons are being made to the original modeling results for energy savings
- We will are applying for Energy Star rating now
- LEED-EB to follow once we have sufficient data
Lessons Learned

- Multiple vendors with multiple systems create multiple points of fault
- Donations are not necessarily “free”
- Everybody assumes everything that they haven’t checked is working correctly
- You can never have enough sensors (and they can never be calibrated enough either)
- Whatever you thought would work actually works the other way (that is the way you didn’t think)
- Everyone needs to report to the General Contractor
- **Big Learning:** There probably isn’t a building anywhere that is operating correctly!
Sustainability Showcase!
Name this picture!
Cheapest LEED Point!
How to find me/Questions

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- Phone: (509) 375-3813