

# ASHRAE Headquarters Renovation

Vhat Happens When the Leaders Try to Do it

Riahtí

# **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!

35	A	B	C	D	E	F	G	Н	1	J	К	L	M	N	0	P
35 36 37																
38																
39 40				A 14-4	rnative 2: R	en els Curre	ant Duilding	Minimum	Deneviation							
41	Year	1	2	3	4	5	6	7	B	9	10	11	12	13	14	15
42 43		05/06	06/07	07/08	08/09	09/10	10/11	11/12	12/13	13/14	14/15	15/16	16/17	17/18	18/19	19/20
44	Financial Statement Impact Exponses															
46	Depredation - Building	119,817	119,817	119,817	119,817	119,817	119,817	8,052	8,052	8,052	8,052 100,386	8,052 100,685	8,052	8,052	8,052 100,686	8,052
48	Depreciation - Repairs Cocupancy Costs (see note 1)	19,966 186,332	51,410 190,990	70,697	70,697 200,659	70,897 205,070	70,697 210,818	70,697 210,038	70,697 221,490	70,697 227,027	232,703	238,521	100,686 244,484	100,686 250,596	256,861	100,636 263,232
49 50	Total Cumulative Expenses	326,115 326,115	362.217 688,332	386.279	391.173 1,465.735	396,190 1,861,974	401.332 2,263,306	294,837 2,558,143	300,239 2,658,382	305,777 3,164,159	341,441 3,505,600	347.258 3,852,853	353.221 4,206,030	359,334	365.598 4,931,012	372.020 5,303.032
51 52	Cash Flow Impact															
53	Positive (Negative) Cost of Repairs	(299,500)	(471,700)	(289.300)								(449.850)				
55	Cccupancy Costs	(186,322)	(191,912)	(197,669)	(203,530)	(209,707)	(215,998)	(222,478)	(229,153)	(236,027)	(243,108)	(250,401)	(257,913)	(265,351)	(273,620)	(281,829)
56 57	Total Cumulative Cash Flow	(485,822) (485,822)	(563,612) (1,149,434)	(486,969) (1,636,4C3)	(203,599) (1,840,002)	(209,707) (2,049,709)	(215,998) (2,265,707)	(222,478) (2,468,185)	(229,153) (2,717,338)	(236,C27) (2,953,365)	(243,108) (3,198,173)	(700,251) (3,896,724)	(257,913) (4,154,637)	(265,551) (4,420,288)	(273,620) (4,693,908)	(281,829) (1,975,737)
58 59																
60				Alternative	3: Repair C	urrent Buil	ding, Renov	ate for Imp	proved Proc	ductivity						
61 62	Year	1 05/06	2 05/07	3 07/08	4	5 09/10	6 10/11	7 11/12	B 12/13	9 13/14	10 14/15	11 15/16	12 16/17	13 17/18	14 18/19	15 19/20
63 64	Financial Statement Impact															
65	Expenses															
67	Depredation - Building Depredation - Repaire	119.817 19,966	119.817 51,410	119.817 70,667	119 817 70 697	119.817 70,897	119.817 70,697	8.052 70,697	8,052 70,667	8.052 70,697	8.052 100,586	8.052 100,688	8.052 100,686	8.052	8.052 100,686	8.052 100,636
68 69	Depreciation - Renovation Depreciation - Furniture		31,447 13,333	65,667 26,667	65 637 26 637	65,667 23,867	65,667 26,667	65,667 26,667	65,667 26,667	65,667 26,667	65,667 23,667	65,667 26,667	65,637 26,637	65,667 26,667	65,667 26,667	65 667 26 667
	Cocupancy Costs (see note 1) Loss of RCI on Withdrawn Reserve Funds (see note 3)	186,332	190,990 44,525	195,705 92,919	200,659 98,959	205,676 105,391	210,818 112,242	210,038 119,537	221,450	227,027 135.582	232,703	238,521 183.021	244,484 194,917	200,596 207,587	256,861 221,080	263,232 235,450
72	Cost Savings - Productivity Improvements (see note 4)		250,000	250,000	(100,000)	(150,000)	(150,000)	(150,000)	(150,000)	(150,000)	(150,000)	(150,000)	(150,000)	(150,000)	(150,000)	(150,00C)
73 74	Total Cumulative Expenses	326,115 326,115	701,522 1,027,637	821,532 1,849,169	482,485 2,331,634	443,914 2,775,549	455,907 3,231,455	356,708 3,588,163	369,880 3,958,043	383,692 4,341,735	428,169 4,769,904	472,613 5,242,517	490,472 5,732,989	509,254 6,242,243	529,012 6,771,255	549,804 7,321,059
75 76	Cash Flow Impact															
	Positive (Negative) Cost of Repairs	(299,500)	(471,700)	(289,300)								(449,850)				
79	Cost of Renevations - Building Cost of Renevations - Furniture	,250,0007	(485,000) (200,000)	(500,000) (200,000)								(110,000)				
81	Coupancy Costs	(186,322)	(191,912)	(197,669)	(203,599)	(209,707)	(215,998)	(222,478)	(229,153)	(236,027)	(243,108)	(250,401)	(257,913)	(265,851)	(273,620)	(281,829)
82 83 84	Cost Savings - Productivity Improvements Total	(485.822)	(250,000) (1.598.612)	(250,000) (1.436.969)	100,000 (103,599)	150,000 (59,707)	150,000 (65.998)	150,000 (72,478)	150,000 (79,163)	150,000 (36.027)	150,000 (93.108)	150,000 (550,251)	150,000 (107.913)	150,000 (115.851)	150,000 (123.620)	150,000 (131,829)
85	Cumulative Cash Flew	(485,822)	(2,084,434)	(3,621,403)	(3,825.002)	(3,681,709)	(3,750,707)	(3,823,185)	(3,902,338)	(3,938,365)	(4,081,473)	(4,631,724)	(4,739,637)	(4,855,288)	(4,678,908)	(5,110,737)
86 87	Withdrawn from Reserves Cumulative Withdrawn From Reserves	0	(685,000) (685,000)	(700,000) (1,429,525)	(1,522,444)	(1,621,403)	(1,726,794)	(1,859,036)	(1.958,573)	(2.035,680)	(2,221,403)	(449,850) (2,815,703)	(2,998,729)	(3,193,646)	(3,401,233)	(3,322,315)
88 89		Ĵ	(000,000)	(1, 20,020)	(characterity)	(1021)100/	(1).201.017	(1,000,000)	(1,000,010)	(2,000,000)	(2)221)100)	(2,010,100)	(2,000,00)	(0) (0) (0)	(0) 10 (1000)	(0,022,010)
90					Alternative	4: Sell Bu	ilding, Move	to Leased	Space							
91 92	Year	1	2 09/07	3 07/08	4 03/05	5 09/10	6 10/11	7	B 12/13	9 13/14	10 14/15	11 15/10	12 19/17	13 17/18	14 18/19	15 19/20
93		0.00	00/07	0//00	05/05	08/10	10.11	10/12	12/13	13/14	14/10	13/10	10/17	1// 10	10/19	15/20
94 95	Financial Statement Impact Revenues															
	Proceeds from Sale of Building Increase in Reserves @ 6.5% ROI	3,100,000	201,500	214,598	228,546	243,402	259,223	276,072	294,017	313,128	333,482	355,155	378,243	402,829	429.013	456,899
98 99	Increased (Decreased) Revenues	3,100,000	201,500	214,598	228,546	243,402	259,223	276,072	294,017	313,128	333,482	355,158	378,243	402,829	429,013	456,899
100	Expenses Depreciation - Building	119,817	0	0		0		0	0	0	0	0	0	0	0	
102	Lease Payment	0	8,645	17,508	727,048	753,869	781,361	809,540	839,424	868,029	898,375	929,479	961,361	994,080	1,027,536	1,061,870
104	Depreciation - Furniture Moving Expenses	0 50,000	13,333	26,667	26,667	26,667	26,667	26,667	26,667	26,667	26,667	26,667	26,667	26,667	26,667	26,667
105 106	Cost Savings - Productivity Improvements Increased (Decreased) Expenses	250,000 419,817	(100,000) (78,022)	(100,000) (55,825)	(150,000) 603,715	(150,000) 630,536	(150,000) 658,028	(150,000) 686,207	(150,000) 716,091	(150,000) 744,696	(150,000) 775,042	(150,000) 806,146	(150,000) 838,028	(150,000) 870,747	(150,000) 904,203	(150,000) 938,537
107 108	Net Change - Positive (Negative)	2,680,183	279,522	270,423	(375,168)	(387,134)	(398,805)	(410,134)	(422,073)	(431,567)	(441,560)	(450,988)	(459,784)	(467,918)	(475,190)	(481,638)
109	Cumulative Net Change - Positive (Negative)	2,680,183	2,959,705	3,230,128	2,854,959	2,467,825	2,069,021	1,658,886	1,236,813	805,246	363,686	(87,302)	(547,087)	(1,015,004)	(1,490,194)	(1,971,832)
110 111																

## 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



- 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



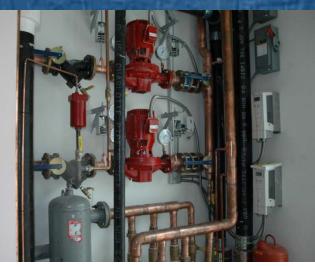
## Multiple system decision made

- 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



- Dew point temp
- Relative humidity
- Fine particulates (PM 2.5)
- Enthalpy
- CO<sub>2</sub>
- 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) OLEE

LEED NC V2.2 Checklist

- Additional points possible for Platinum
  - Community Connectivity
  - Public transportation
  - Construction waste managemen (91% = Second point)

12/3/2

- 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**

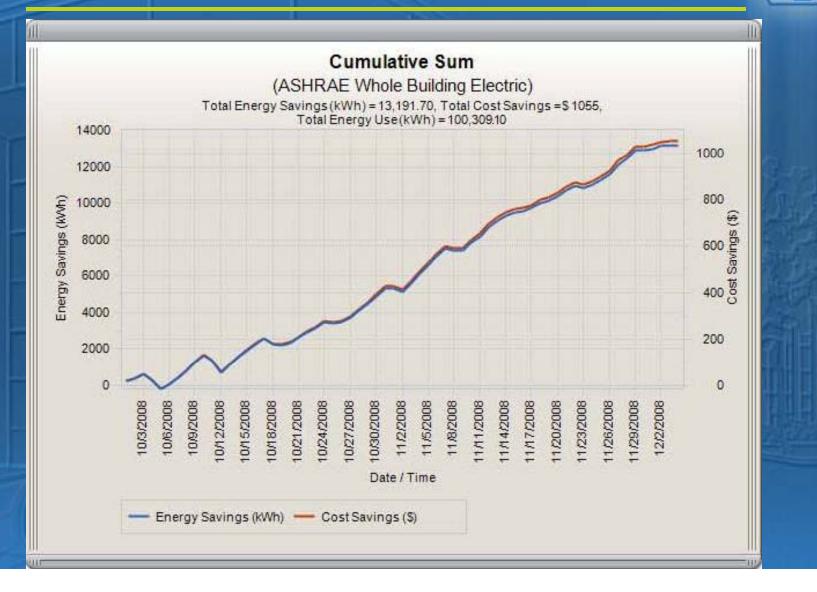
- Part of the renovation plan was the development of a "living laboratory" to help members learn about building performance
- Additional electrical circuits and sensors were installed to monitor equipment, systems and subsystems
- Ultimately the actual energy use and performance data will be made available online for members – now available!

DOAS	VRV System	power monitoring-T GSHP's	TPI=Third Party Interface 2nd Ft Lighting		
42.0 Amps A	61.6 Ampsi A	10.3 Amps A	25.2 Ample 4	32.9	
37.9 Amps 8	537 Amps E	5.4 Amps St	32.6 Amps 5	22.6 Amps B	
29.4 Ampti C	25.6 Amps C	10:1 Amps C	20.1 Amps C	24.5 Amos C	
207.4 Volta A-B	207.6 Vote A B	207.6 Vote A-B	207.7 Volts A-B	207.4 Volts A-B	
205.3 Volta B-C	205.4 Vults B-C	205.4 Vote B-C	2053 Volte B-C	205.3 Volts B-C	
2017.7 Votes C-A	207.5 Vote C-A	208.0 Wine C-A	207.5 Vote C-4	207.5 Web C-4	
12011 Vote A Phase	120.3 Vots A Phase	120.5 Vote APhase	120 3 Volts A Phase	120.2 Volts A Pillase	
119.3 Volta & Phase	119.3 Volta B Phase	119.4 Volte B Phase	119.3 Volts B Phase	119.3 Volts B Phase	
119.0 Vulta C Phase	118.8 Vots C-Phase	11951 Volts C Phape	118.9 Volts C Phase	1188 Volts C-Phase	
60.0 Ht	60.0 Ht	60.0	60.0 +1	50.0	
12.9 10/4	16.6 838	-28	9.2 KMA	0.5	
730.0 KWH	2196.3 KWH	845 T KWH	1498.1 6994	1204.3 STH	
112 68	13.0 KW	28	9.1 NW	9.3	
0.0 Power Fattor	1.0 Power Factor	1.0 Power Factor	10 Power Factor	10 PowerFactor	
				11012265010000	
fist FI Phigloads	2nd Fl Plugloads	CL1 Computer Room	L16 Outside Lighting	Total Bidg Load	
23.6 Amps A	17.0 Ampti A.	22.3 Amps A	0.0 Amps A	242.7 Amon A	
21.7 Ampie 🗄	35.3 Mmps B	24.2 Arrigh B	0:0 Amps B	223.7 Amos H	
13.2 Amps C	B.7 Arright G	19.2 Amera C	0.0 Amps C	171.9 Ampt C	
207.7 Vill: 4-B	207.8 Volta 4-8	207.9 Vote	207.5 Volta 4-8	207.4 Vitto A.B	
205.3 Volts B-C	205.4 Vens 6-0	205.4 Vol: BC	205.6 Vints 8-C	205.4 Wetts B+C	
207.7 Vota C-4	207.6 Volts C-4	207.8 Vote G-A	207.6 Vete C-	207.9 Volta C-A	
120.2 Volts A Prinse	120.3 Volts A Phase	120,3 Vota A Phase	120.3 Volts A Phase	120.1 Volta A Phase	
119.2 Vote B Phase	119.3 Vote B Phase	119.8 Vote 6 Phase	1192 Vots 8 Phase	119.4 Volte B Phase	
	1188 Volto C Presse	118.8 Vilm C Phase	1189 Volta C Phase	1190 Volta C Phase	
118.9 Vote C Phase		50.0 Hz	60,0 H.	60 0 Hz	
118.9 Vote C Phase 60.0 Hz	60.0 Hz				
A REAL PROPERTY AND A REAL	72 KWA	7.6 HOW	<b>0.0</b> KWA	67,0 KNA	
60 0 H.		7.6 HD/A 1961.9 K0/H	0.0 KVA 382.1 KVVH	57.0 11858 4 10011	
60.0 HE 4.5 KWA	72 804		STATES AND A STATES		

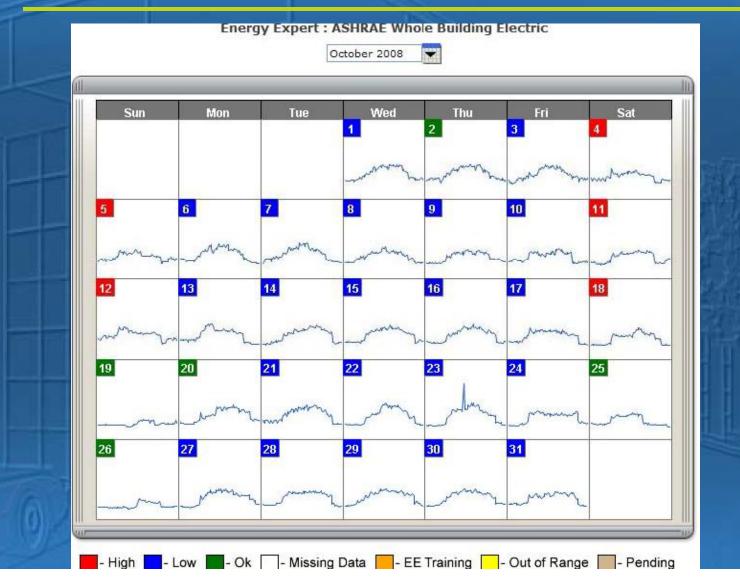
Miscellaneous Power Consumption

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?





## 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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