Training for Feedback

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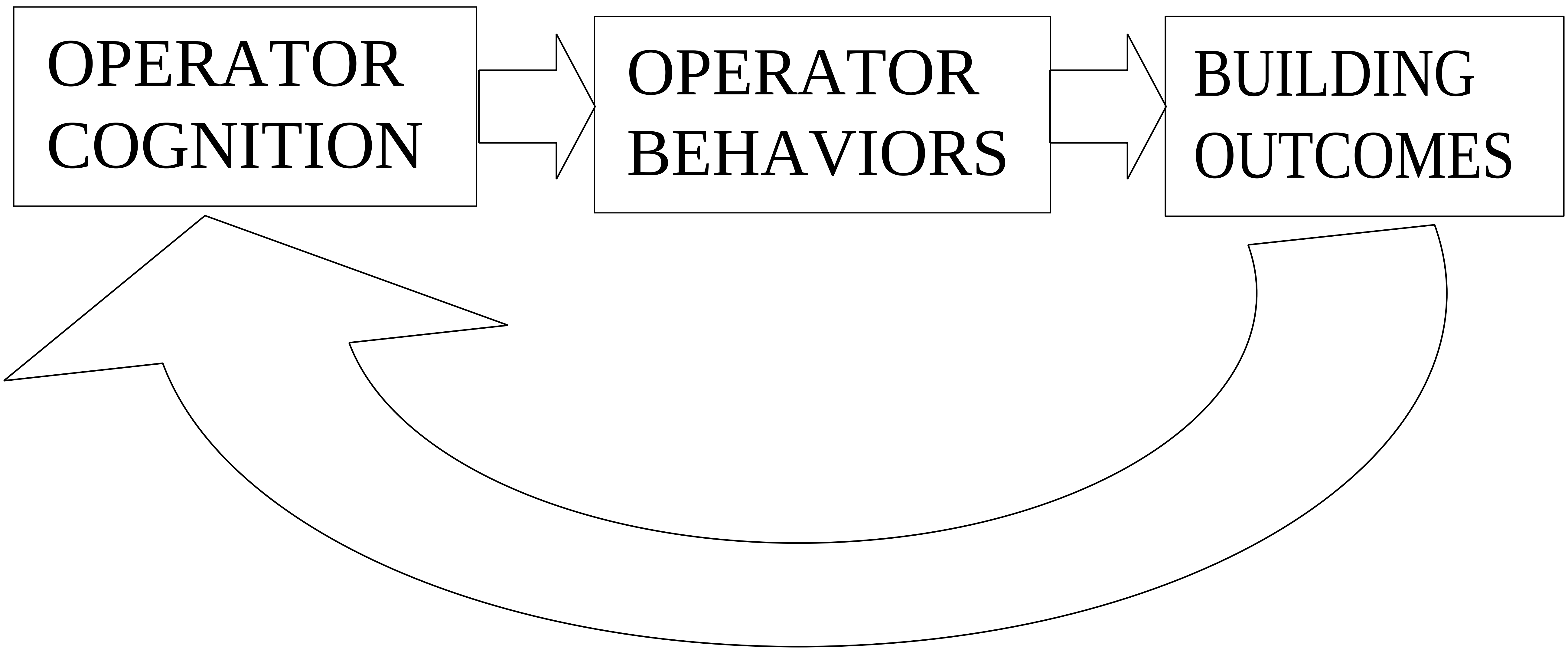
Feedback in the commissioning model

- An essential mechanism for action
- Preparing the Operator to be "in the loop"
  - Getting the data
  - Appreciating the data
- Operating Engineers are a unique breed
  - Intuitive, not highly quantitative
  - Hands-on approach, get things done

Logic Model


OPERATOR COGNITION
OPERATOR BEHAVIORS
BUILDING OUTCOMES

Program

- BOC Program in NYC
  - Private sector and public (NYC DCAS)
  - 90 hours of class time
  - Projects based in home facility
- NYC DEPT OF EDUCATION
  - 1,100 schools, each with Custodial Engineer
  - Train all over 2 years
  - 30 week cycle, 14 sections of 25 students each week

Training Objectives

- Energy dimension of system operations
- Energy data
- Work quantitatively
- Identify projects

Project- based learning

Initial

schematics of building systems

- **Mechanical**
- **Electrical**

Second level

introduce energy data.

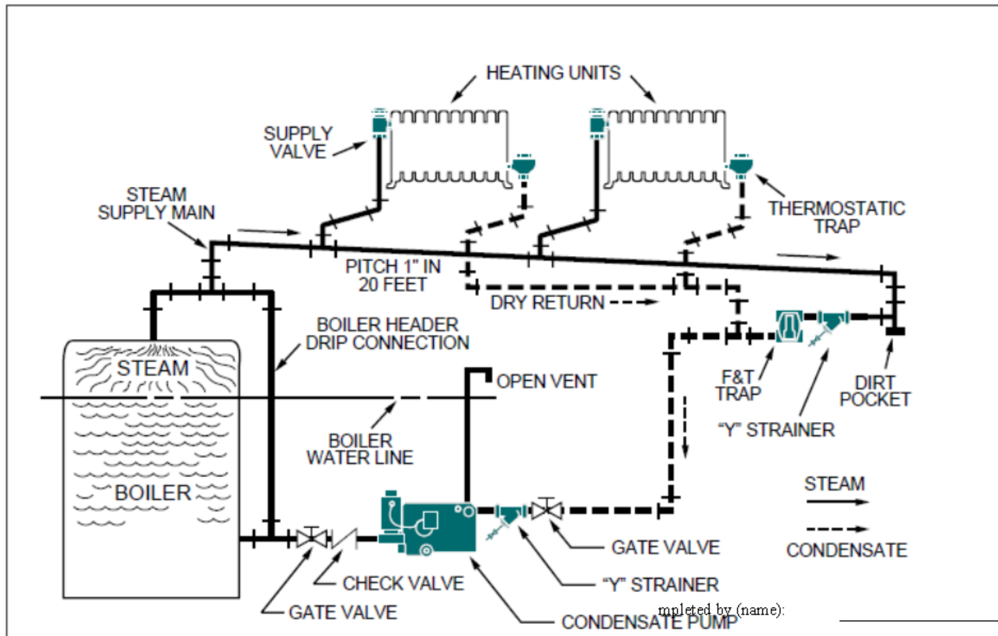
- **ESPM**
- **dashboard**
- **Lab learning.**

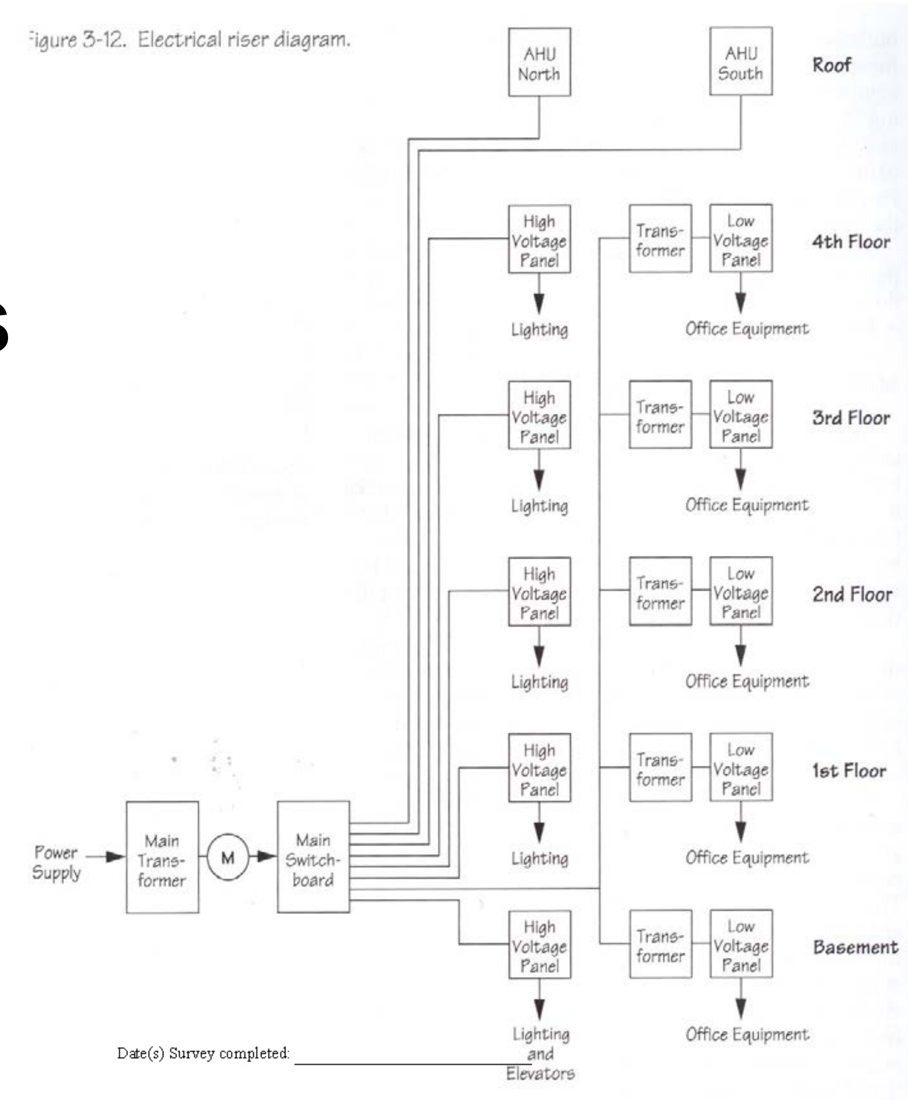
Conclusion

identify and characterize improvement project

Teaching Tools – 1
What students have to do:
Schematics, Sequences & Schedules

Two-pipe steam heating system





mpleted by (name):

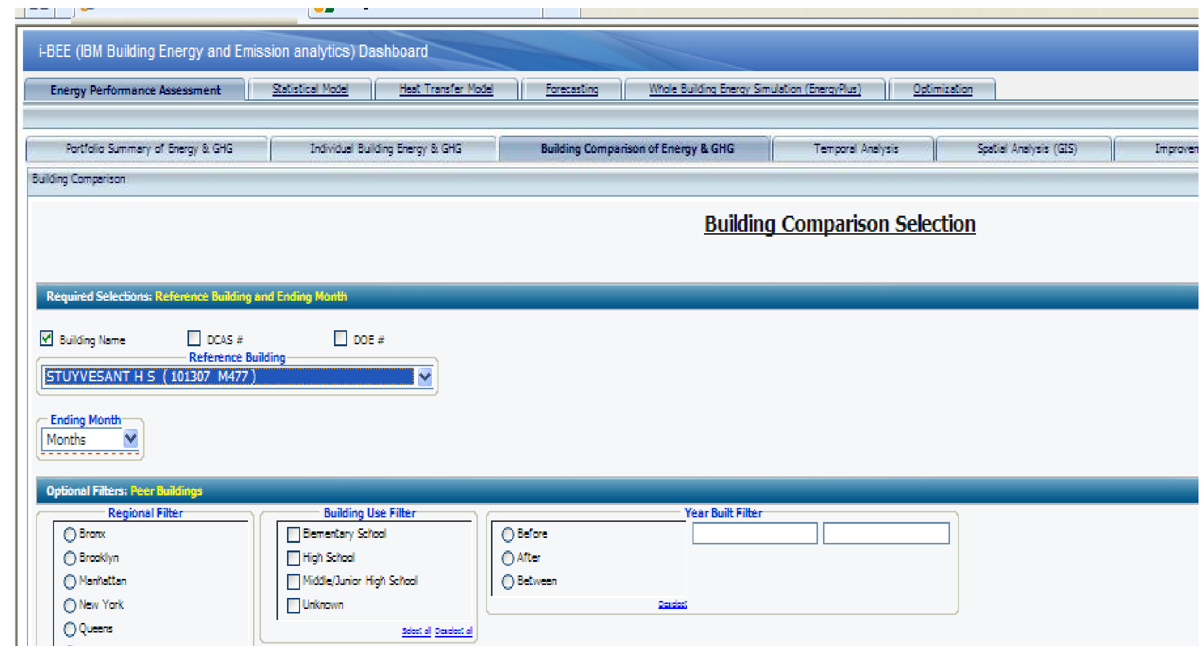
Date(s) Survey completed:

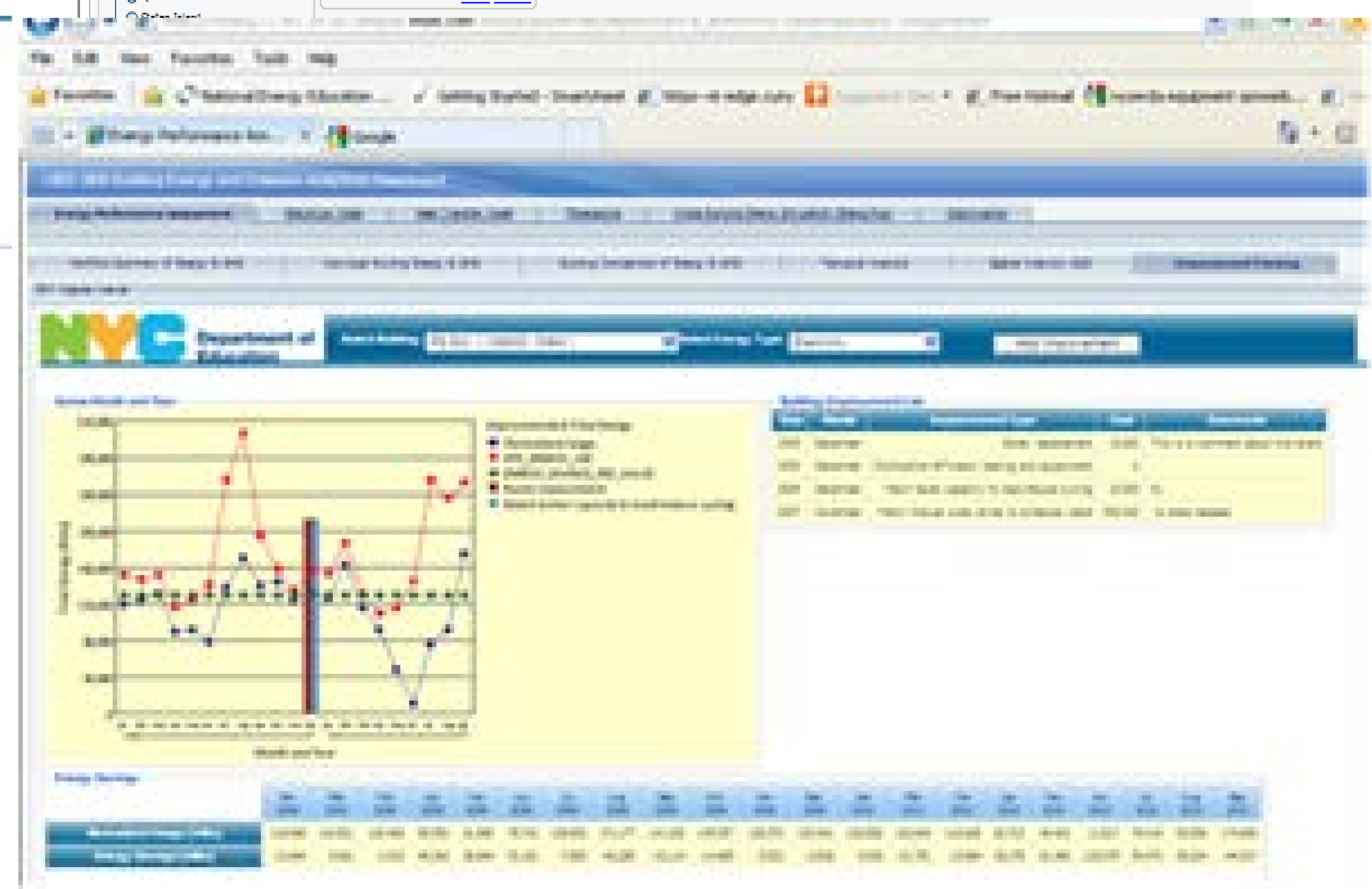
'RUCTIONS

fixture type in a room or area.

					PRE-INSTALLATION								
Line Item	**Building**	**Floor**	**Area Description**	**Usage Group ID**	**Pre Fixt. No.**	**Pre Fixt. Code**	**Pre Watts/Fixt**	**NOP**	**Pre kW/Space**	**Existing Control**	**Baseline Annual Hours**	**Proposed Annual Hours**	**Annual kWh Saved**
Integer identifying the line, beginnin	Building Name	Building floor of the item	Unique description of the location that matches the site map	Descriptive name for the usage group	Number of fixtures before the retrofit	Code from Table of Standard Fixture Wattages	Value from Table of Standard Fixture Wattages	No. of non-operating (broken, intended for repair) fixtures	(Pre Watts/Fixt) * (Pre Fixt No.)	Pre-installation control device	Existing annual hours for the usage group	Propsed annual hours for the usage group	(Pre kW/Space * Baseline Annual Hours) - (Post kW/Space * Proposed Annual
1													
2													
3													
4													
5													
6													
7													
8													
9													
10													
11													
12													
				TOTAL	-			-	-				-

Teaching Tools for 2nd Level : Creating a user- friendly data interface with IBM Research "Smarter Planet" program





- Graphic plots
- Peer groups
- Event recording

Teaching Tools - 2
What students have to do: energy use histories

2 tables:

- Use by type
- End-use allocation

TABLE 1 SUMMARY OF ANNUAL ENERGY USE BY ENERGY TYPE — GROSS FLOOR AREA = ______ SF

FOR THE YEAR SEPT 1, 2009 - AUGUST 31, 2010 UNLESS OTHERWISE NOTED

	unit	QTY	MMBTU	$	unit cost	$ / MMBTU	MMBTU / SF	$ / SF	% of BTU	% of Cost
Electricity	kwh		0		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Nat Gas	therm		0		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Fuel Oil, #__	gallon		0		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Steam	mlb				#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
other					#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Total			0	0		#DIV/0!	#DIV/0!	#DIV/0!	100%	100%

NOTES:

1. MMBTU of all energy types are calculated at the Site Value
2. Building area (SF) is gross square footage, including basement

		per million	
kwh	3414	0.003414	kwh
nat gas	100000	0.100	therm
oil, #2	140000	0.140	gal
oil, #4	145000	0.145	gal
oil, #6	152500	0.153	gal

TABLE 2   ANNUAL ENERGY USE BY END-USE FUNCTION

FOR THE YEAR SEPT 1, 2009 - AUGUST 31, 2010 UNLESS OTHERWISE NOTED

	FUELS USED	default %	adjusted %	MMBTU	MMBTU/SF	% of TOTAL MMBTU	$	$ / SF	% OF TOTAL $
OIL, GAS, STEAM									
HEATING		70%							
HOT WATER		20%							
COOKING		10%							
OTHER		0%							
SUB-TOTAL		100%	100%						
ELECTRICITY									
LIGHTING		45%							
MOTORS		25%							
COMPUTERS & OFF EQUIP		10%							
AC		10%							
KITCHEN-REFRIG		10%							
HEATING & HOT WATER		see Note 1							
OTHER		0%							
SUB-TOTAL		100%	100%						
TOTAL						100%			100%

NOTES

1. If electricity is used for heating and/or hot water (other than for pump and fan motors), see Instructor

Spreadsheets

Teaching Tools - 3

What students have to do: Project Characterization

Brief Description of measure	
Problem Addressed:	
Expected Impacts Energy:	
Expected Impacts IEQ	
Pre-project Measurements	
Project Steps	
Observable Outcomes	
Project Requirements:	
Materials	
Manpower (internal)	
External resources	
Space access	
Timeframe	
Cost Estimate	
Internal manpower, __ man-hours @ $50 per hour =	
External manpower, __ man-hours @ $75 per hour =	
Materials (itemized)	
Supervision & overhead, 10%	
Contingency, 10%	
Total Estimated	

CATEGORY / MEASURES	CALCULATION GUIDANCE
BOILER PLANT	
Test and improve combustion efficiency Firing rate modulation Š reduce cycling Improve boiler sequencing Š reduce cycling Optimize start-up Optimize shut-down	1. Test CE. (84 Š test) / test = % improvement. 2. For cycling reduction, 1 Š 10% improvement based on how bad current operation is assessed to be 3. estimate how many operating hours/day can be saved; divide by total operating hours/day = % improvement. 4. Note Š if you are reducing boiler operating hours, you also have motor savings (see below).
HEATING SYSTEM	
Balance steam distribution, reduce overheating Reduce pneumatic air leakage Zone system for after-school programming Maintain steam traps (replace disc elements)	1. 1% reduction for every degree of overheating removed; pro-rated by portion of school affected. 2. For zoning, calculate portion (%) of school to be removed from heating and % of hours to be zoned off 3. For traps, use 5% for all trap elements, higher if you know you have very hot condensate 4. For pneumatic air leakage, estimate motor hours reduced and see ÒMotorsÓ below; note also relation to temperature control.
LIGHTING	
Get better turn-off of unoccupied areas Manually turn-off major areas when unoccupied (eg Š cafeteria) Use occupancy sensors in appropriate areas Reduce lighting during cleaning hours Introduce manual day-lighting in appropriate areas	1. Calculate the wattage affected in the area(s) to be controlled. Estimate the hours for which this lighting will be off. Watts x Hours = Watts saved. 2. Add 10% for the ballast energy saved.
MOTORS	
Change start-up and shut-down of motors Change kind of belts, adjust tension Check loading, reduce speed with sheaves and pulleys Adjust variable frequency drives (if present)	1. For change in motor operating hours, HP x .55 x hours off = kwh saved 2. For belt adjustment, use 5% of motor energy, motor energy as calculated above. 3. For speed changes, follow Herzog Appendix A.
AIR-C0NDITIONING & REFRIGERATION	
Clean coils and check/clear air flows Have refrigerant charge checked and adjusted Better control of air-conditioners after hours Raise refrigerator and freezer temperatures Increase air-conditioning set-points	1. For cleaning and charge, use 15% of AC usage 2. For AC hours reduction, apply % defined as [(hours eliminated) / (total on-hours)] 3. For kitchen refrigeration measures, use 10% of estimated refrigeration load
VENTILATION	
Change start-up and shut-down times Test and adjust exhaust fans Test and adjust Uni-vents Adjust kitchen hood Change kitchen hood operating schedule Use economizer cycle (rooftop units, air-handlers)	1. For reduction in fan electricity, see motors above (Herzog Appendix A) 2. For reduction in fuel, estimate the ventilation reduction in CFM and calculate to BTU as CFM x 1.08 x degree-days x 24. Use 2,500 degree-days.
IAQ/IEQ	
Improve kitchen hood performance Improve Uni-vent performance	1. Calculate per guidance above if you are

Initial Impact Findings

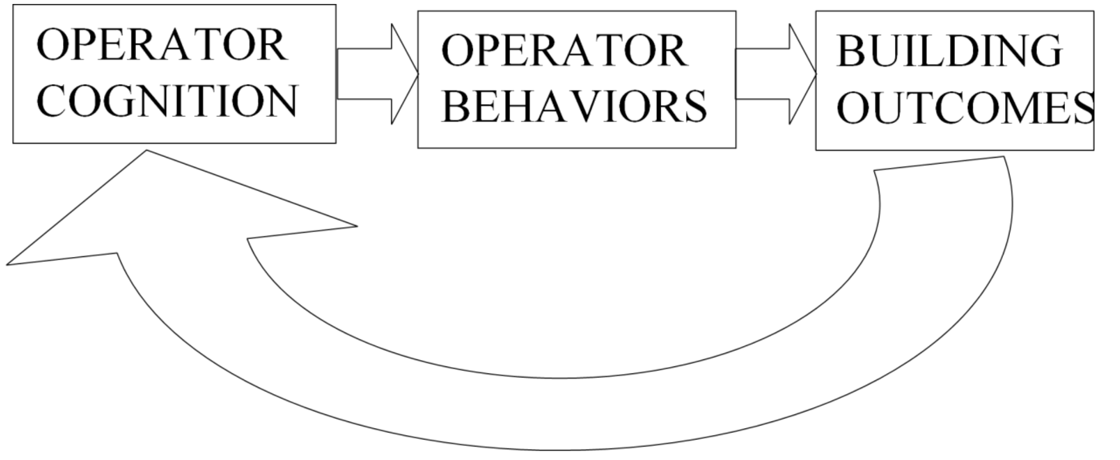
- Background on BOC Evaluation
  - High cost-effectiveness found by 3rd parties
  - Measures quantified by factors & stipulations
- Types of projects developed
  - Heavily lighting control
- Expectations and goals for improvement
  - Shift towards more boiler plant and heating control

On-going Evaluation

- Project Tracking
- On-line community
- Involvement of management - District Managers
- Competition between peers. Connection to Schools Green Challenge.

Conclusion

- Operator Training needs to be part of a performance improvement process



- Operators have particular training needs, especially when it comes to data

- Proven curricula and teaching tools exist