Energy Engineering: Tools and Trends

AEE Northeast Ohio

Chapter Meeting

March 27, 2008

Introduction
Background and Experience

- Energy Engineer for Trane
- 20 years in HVAC Industry
  - Equipment design and Manufacturing
  - Sales Engineering
  - Energy Engineering

Energy Engineering & Trane

Americas Services & Contracting Group

- St. Paul, MN
- Performance Guarantee projects
- Design-Build projects
- North America and Latin America
- Europe, Asia, South America

High Performance Buildings for Life

- Create the right comfort and critical control environment that supports energy efficiency, maximizes indoor air quality, and takes a sustainable approach to the environment.
- Lowers the total cost of ownership by utilizing resources more effectively to minimize energy requirements and reduce environment impact throughout the life cycle of the building.

Energy Engineering

Engineering discipline of the practical application of scientific and technical knowledge for the consumption, use, and conservation of energy

Energy Engineering Tools of the Trade

Building design, energy, and economic analysis software tools:

- DOE2 / E Quest
- Trace 700™
- Market Manager
- HAP
- Spreadsheets
- …others?

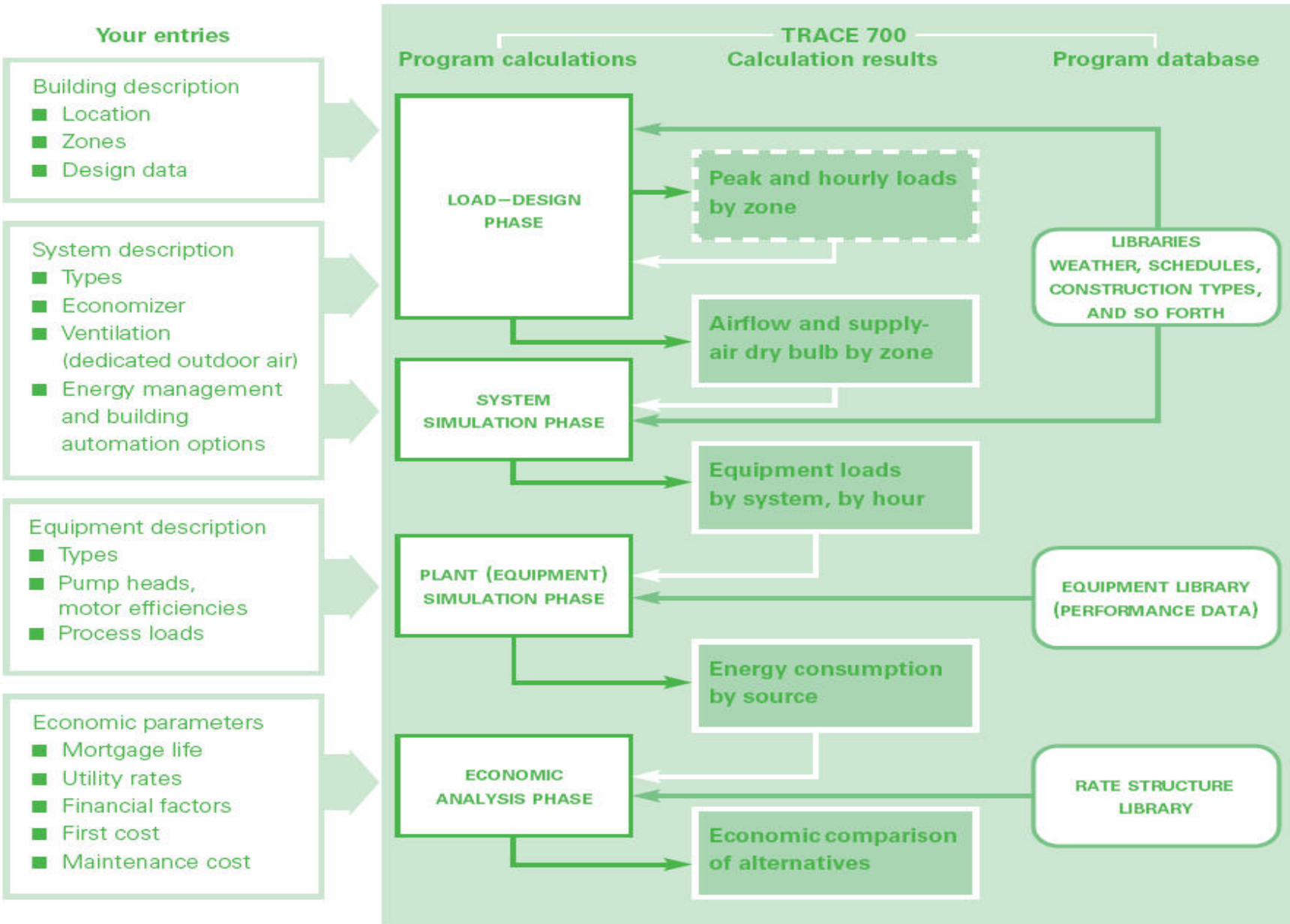
Trane Trace 700™ Software

- Introduced in 1972
- Over 35 years in use as a de facto industry design standard
- Tested in accordance with ASHRAE Standard 140-2004 “Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs”
- Designed to be in compliance with ASHRAE Standard 90.1-2004
- Meets requirements for simulation software set by ASHRAE Standard 90.1-2004 and LEED® Green Building Rating System
- Federal government approved simulation software

Trace 700™ Overview & Process

- Load-Design Phase
- System Simulation Phase
- Plant-Equipment Simulation Phase
- Economic Analysis Phase

Figure 2–1 Functional organization of TRACE 700



Minimum Energy Performance
LEED®-NC 2.2: EAc1

Reduction of proposed energy cost	
New construction*	LEED points
10.5 %	1
14	2
17.5	3
21	4
24.5	5
28	6
31.5	7
35	8
38.5	9
42	10

*** For a major renovation, compares proposed design to pre-renovated building to determine energy cost savings**

Example
Single-Story Office

Synopsis:

- Whole building simulation
- 15,000 ft², natural gas heat,
  St. Louis (Climate zone 4A)
- Modeled per ASHRAE Std 90.1-2004, Appendix G
- No glass or insulation changes
- Options from ASHRAE's *Advanced Energy Design Guide for Small Office Buildings* (based on ASHRAE Std 90.1-2004)

Office example

Baseline HVAC System

Per Tables in

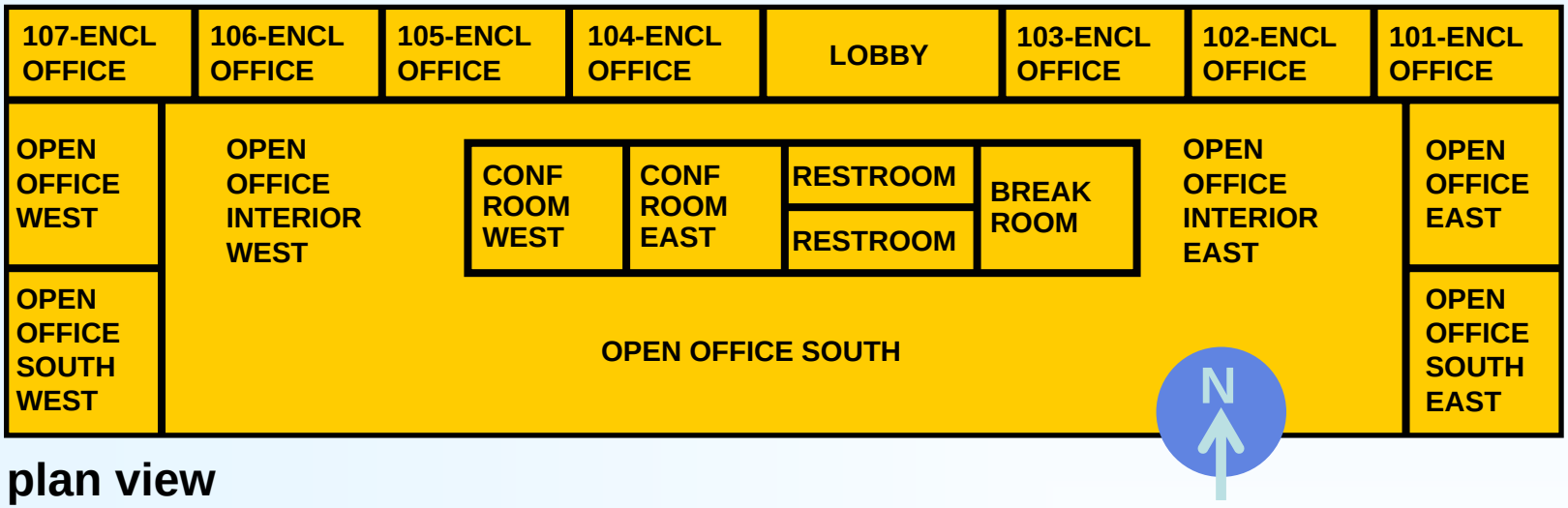
ASHRAE Std 90.1-2004, Appendix G:

System 3:
Packaged single-zone air conditioner

- Packaged rooftop air conditioner
- Constant-volume fan control
- Direct-expansion cooling
- Fossil fuel heating

Office Example

Building Layout



plan view

elevation view

TRANE

Office Example

Modeling Energy Options

ECM	Baseline	Proposed
Lighting	1.0 W/ft²	0.9 W/ft²
Daylighting	None	Cont. Dimmer
Economizer	None required	Comparative enthalpy
Fan Modulation	Constant volume	Variable volume
Fan Pressure Optimization	Not applicable	Yes
Equipment efficiency	9.5 EER 9.7 IPLV	10.0 EER 10.4 IPLV
Ventilation based on	ASHRAE Std 62	ASHRAE Std 62 & ventilation reset

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Modeling energy options

Lighting Power

Reduce the lighting load

- Directly reduces electrical energy consumption
- Indirectly reduces HVAC cooling load

For office example:

- 0.9 W/ft² (proposed) from 1.0 W/ft² (baseline)

Modeling energy options

Daylighting

Use natural lighting

- Reduces electrical energy consumption
- May enhance productivity

For office example:

- Add daylighting to proposed design

Modeling energy options

HVAC System Options

Economizer

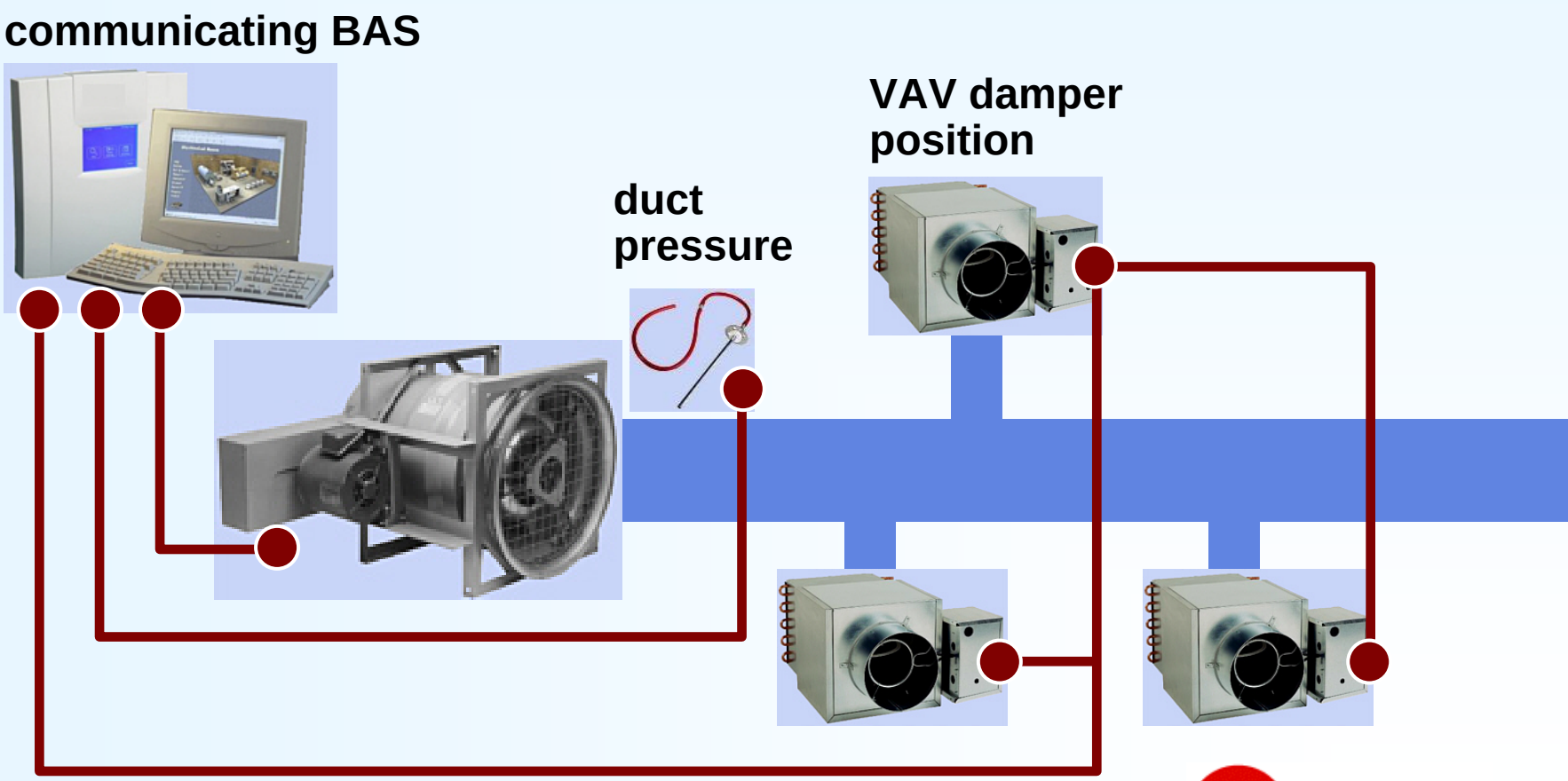
- Reduces mechanical cooling load when outdoor air is suitable
- Increases ventilation air for occupants

Variable air volume

- Helps control humidity at part load
- Variable air flow control dependent on occupied space requirements

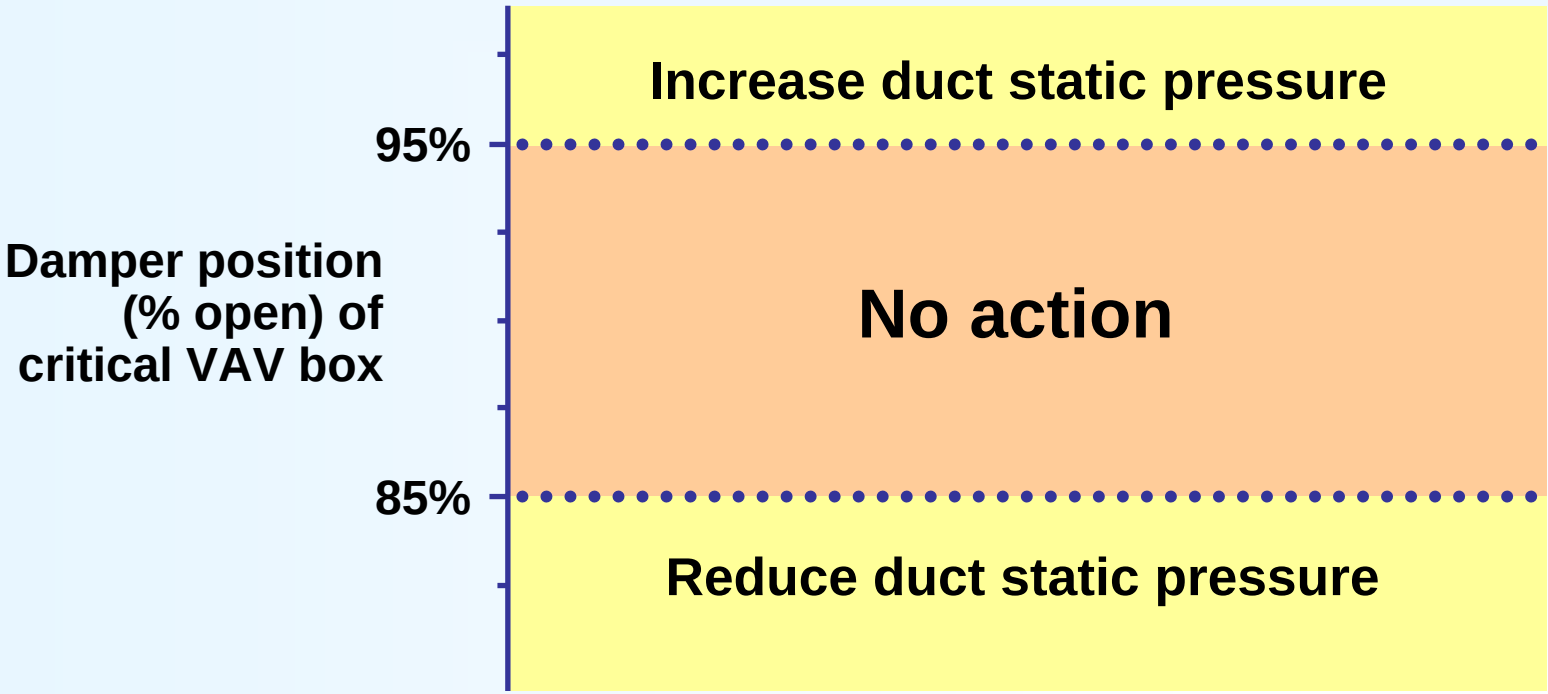
Modeling energy options

Fan-Pressure Optimization



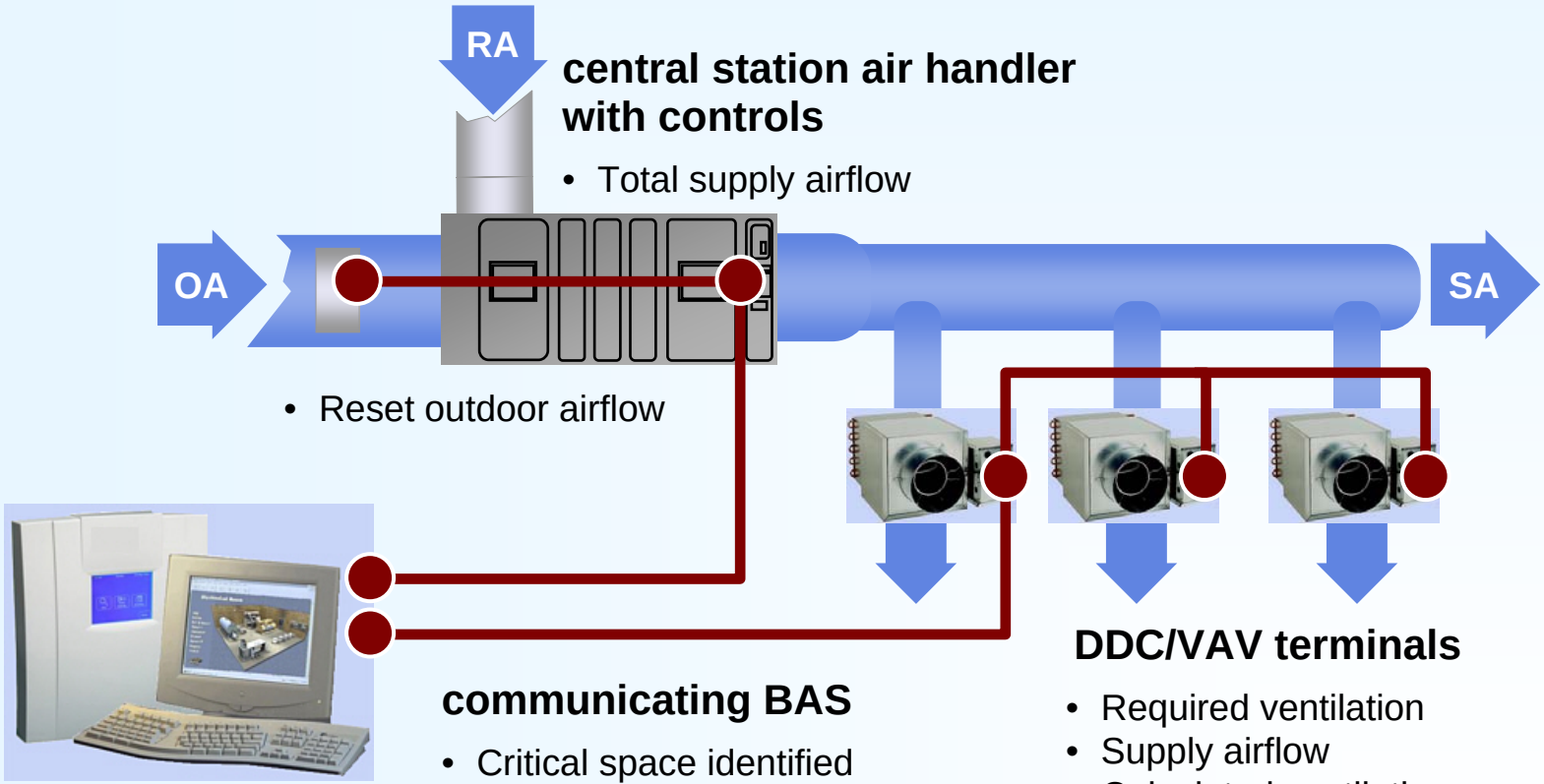
Fan-pressure optimization

Control Logic



Dynamic System OA control

Ventilation Reset



Office example

Baseline Model

Building orientation	Annual energy cost
 As proposed	$24,057
 90° from proposed	$25,032
 180° from proposed	$24,072
 270° from proposed	$25,198
Average	$24,590

Office example

Energy Cost Comparison

Proposed design = $17,706
Baseline design = $24,590

So, proposed design:

$$100 \times \frac{\text{baseline bldg performance} - \text{proposed bldg performance}}{\text{baseline bldg performance}}$$

$$100 \times \frac{24{,}590 - 17{,}706}{24{,}590} = 27.995\% \text{ improvement}$$

Office example

EAc1 Points Earned

Reduction of proposed energy cost	
New construction*	LEED-NC 2.2 points
10.5 %	1
14	2
17.5	3
21	4
24.5	5
28	6
31.5	7
35	8
38.5	9
42	10

No rounding, so 27.995% improvement is eligible for 5 points

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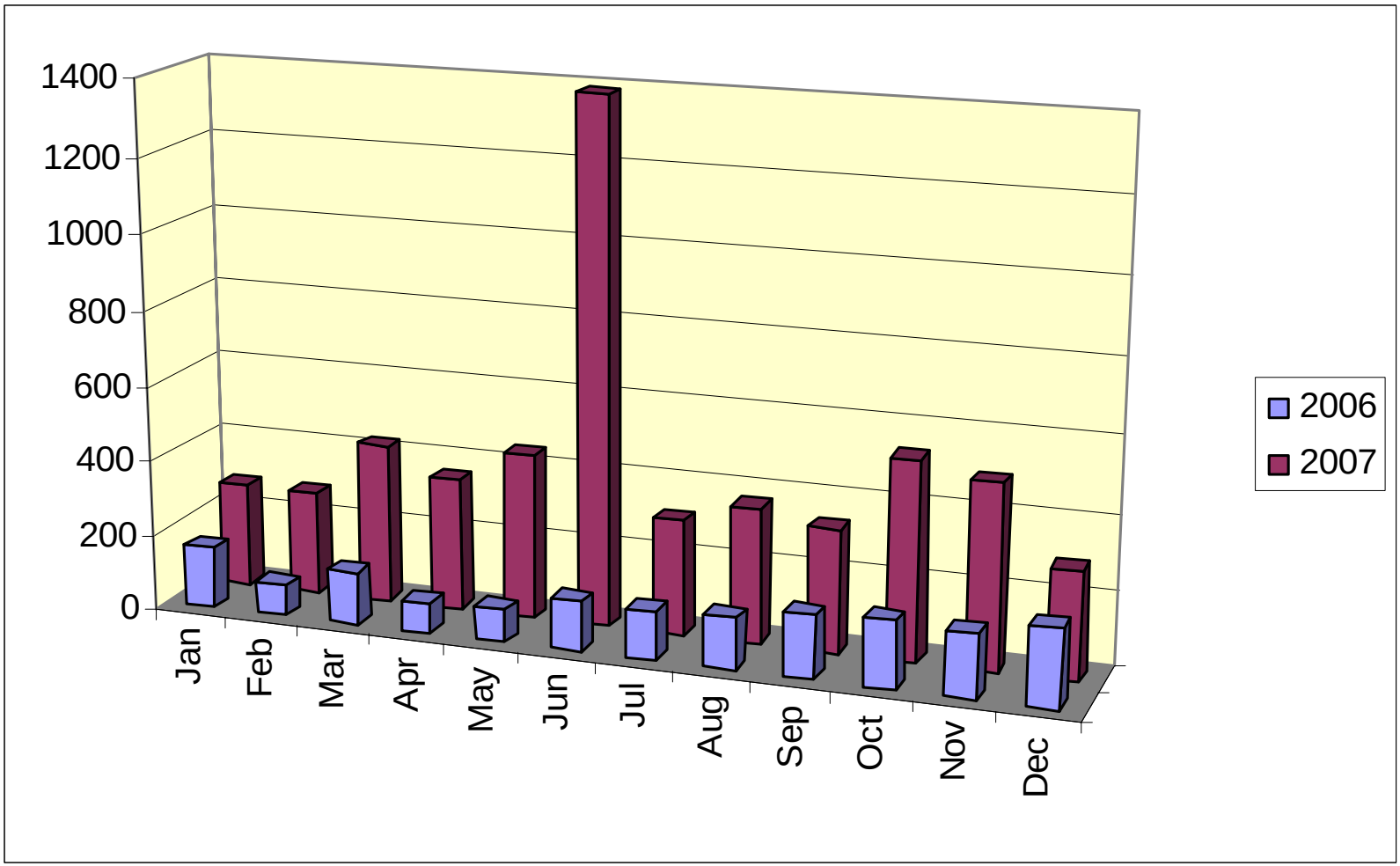
LEED® Certified Buildings by month

Month	2007	2006	2005	2004	2003	2002	2001	2000
January	26	27	15	8	3			11
February	26	13	18	1	5	2		
March	30	27	16	7	4			
April	50	30	13	6	1	2		
May	48	24	22	4	3			
June	36	38	13	12	5	1		
July	52	18	16	7	2	1		
August	65	34	22	16	2	3		
September	36	21	17	13	5	2	1	
October	40	28	17	18	7	1		1
November	32	38	16	10	4	6	2	
December	--	28	17	16	5	3	2	
Totals	**441**	**326**	**202**	**118**	**46**	**21**	**5**	**12**

Source: USGBC

LEED® Registered Projects



Source: USGBC

Trane System Analyzer™ software

- 2007 Gold Award winner for Product of the Year
  - Consulting-Specifying Engineer magazine
- Simplified version of Trace 700™ modeling software
- Focused on evaluating various HVAC systems against building loads

Equipment Innovations & Development

Chillers

- Heat recovery
- Refrigerants / Global warming
- Oil free compressors
- Lower kW/ton
- Variable primary flow
- High temperature differentials

Boilers

- High efficiency condensing boilers
- Exhaust stack heat recovery
- Modulating burners and controls

Equipment Innovations & Development

Filtration

- Meet IAQ standards
- Microbial contaminants
- Ultraviolet light

Control Systems & Strategies

- Demand limiting
- Air and water temperature resets
- ASHRAE 62 guidelines
- Optimization and scheduling

Energy Engineering - Trends

Renewables
- GHP
  - Ground source
  - Lakes, rivers, reservoirs
- Solar
  - Solar walls
  - Water heating
  - Photovoltaic
- Wind
  - Turbines

Biomass
Retro Commissioning
Behavior Modification
LED Lighting
Measurement & Verification
Six Sigma

Questions & Answers

Thank you!

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